THE SOCIAL CONTEXT OF FOOT-AND-MOUTH DISEASE CONTROL IN TEXAS:

FOUNDATIONS FOR EFFECTIVE RISK COMMUNICATION

A Dissertation

by

AMY HALEY DELGADO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2011

Major Subject: Biomedical Sciences

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ABSTRACT

The Social Context of Foot-and-Mouth Disease Control in Texas: Foundations for Effective Risk Communication. (December 2011)

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Chair of Advisory Committee: Dr. Bo Norby

The introduction of FMD into the US would have serious economic and societal effects on the livelihoods and sustainability of affected livestock producers. Livestock producers serve as an important line of defense in both detecting an introduction of FMD as well, helping to prevent disease spread. However, due to the complexity of moral, social, and economic issues surrounding the control of highly contagious diseases, producer cooperation during an outbreak may not be assured. This study was conducted using a mixed-methods approach, including qualitative analysis of interviews and quantitative analysis of a postal survey, in order to explore the factors likely to influence producer cooperation in FMD detection and control in Texas.

Reporting of cattle with clinical signs of FMD in the absence of an outbreak was related to producers´ beliefs about the consequences of reporting, beliefs about what other producers would do, trust in agricultural agencies, and their perception of the risk posed by FMD. During a hypothetical outbreak, intentions to report were determined by beliefs about the consequences of reporting, and perception of the risk posed by FMD.

Intentions to gather and hold cattle when requested during an outbreak were determined by beliefs about the consequences of gathering and holding, beliefs about barriers to gathering and holding, trust in other producers, and perception of the risk posed by FMD. Compliance with animal movement restrictions was determined by experiential attitudes, beliefs about the availability of feed, space, and disinfection procedures, beliefs about what other producers would do, and perception of the risk posed by FMD.

Recommendations for improving producer cooperation include targeting specific beliefs in both planning and communication, increasing transparency in the post-reporting process, planning for and communicating plans for maintaining business continuity in order to better inform risk perception, and partnering with organizations to ensure sustained and meaningful communication that supports trust between producers within the affected agricultural community.

DEDICATION

I would like to dedicate this work in loving memory of my dad, Kevin Jay Haley. His strength and kindness was a constant source of encouragement to me, and I am very grateful that he taught me that "knowing how is not a requirement." He was an amazing example of a life-long learner who never shied away from a challenge.

I would also like to dedicate this work to my husband, Aminadab, and our two daughters, Miriam and Naomi, who patiently supported and encouraged me throughout my research. They deserve this degree even more than I do. I couldn´t have been blessed with a more amazing family.

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I also want to extend my gratitude to the cattle producers, organizations, regulatory authorities, and researchers who were willing to share their time and thoughts with me, and who helped to develop the survey instrument. I would also like to recognize Dr. Eric Bush from the Centers for Epidemiology and Animal Health and Bob Garino and the staff of the Texas field office of the National Agricultural Statistics Service for all of their help with the sampling and mailing logistics.

Thanks also go to my friends and fellow graduate students, Lindsey Holmstrom and Heather Engleking, who made a difficult task bearable through their own energy and genius.

Finally, thanks to my mom for her encouragement and love, and for giving me the gift of loving to read and learn. She is truly a brilliant woman, who inspires a love of science in hundreds of children every week. Thanks for inspiring me.

NOMENCLATURE

DEFRA	United Kingdom Department of Environment, Food, and Rural Affairs
DHS	US Department of Homeland Security
EPA	US Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FMD	Foot-and-Mouth Disease
FAD	Foreign Animal Disease
NASS	National Agricultural Statistics Service
NAHMS	National Animal Health Monitoring Service
TAHC	Texas Animal Health Commission
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TPB	Theory of Planned Behavior
USDA	United States Department of Agriculture

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CHAPTER I

INTRODUCTION

Overview

United States (US) animal health agencies responsible for preparing for and responding to outbreaks of highly contagious animal diseases such as foot-and-mouth disease (FMD) must often work with limited resources and personnel. In order to maximize their effectiveness, these agencies actively partner with the animal production industry in order to develop programs and recommendations for disease prevention and outbreak response. However, the risk communication process involved in developing and encouraging these programs and recommendations has often proved challenging.

Current US response plans for highly contagious diseases rely heavily on the willingness of livestock producers to serve important roles in the prevention, detection, response and eventual eradication of disease.[1] Livestock owners may be the first to notice signs of a foreign animal disease in their animals, and their participation in disease surveillance is critical to the effective coverage of the US cattle population. Basing disease control measures on the rapid removal of infected and at-risk animals means that animals must be gathered and held by their owners for testing and depopulation, while strict movement bans designed to slow disease spread are essentially unenforceable without the cooperation of livestock producers.

This dissertation follows the style of the *Journal of the American Veterinary Medical Association*.

In some situations, vaccination, with or without the subsequent destruction of vaccinates, may also be applied. In both of these situations, producers are expected to gather and hold their animals, often at significant personal expense. Producers are also expected to maintain strict bio-security and movement restrictions in order to prevent the spread of the disease.[2]

Many of these control strategies, which were based on strategies employed in Europe, have been in use for over 100 years.[3] However, public reactions to the measures used to control recent outbreaks of FMD in other countries would suggest that livestock owners today may be less supportive of the traditional measures used to eradicate outbreaks of FMD. During the 2001 outbreak of FMD in the UK, the slaughter policy and movement restrictions used to control the outbreak resulted in the death of approximately 6 million animals, many of which were not infected and were killed to prevent further disease spread or to alleviate animal suffering.[4,5] A large number of livestock owners (over 200 in Devon alone) turned to the legal system in order to prevent the death of their animals under the contiguous culling policy.[6] Some producers barricaded their farm entrances and refused access to their land, which ultimately required police intervention to resolve.[7] Although no studies were done to examine the reasons why livestock owners resisted the slaughter of their livestock, media interviews would suggest that producers assign much more value to their livestock than an economic valuation can provide, and they viewed the death of their animals as the death of a livelihood or their children’s future.[8,9] Studies conducted after the 2001 outbreak in the UK found that livestock owners experienced substantial emotional and psychological distress during the disease control process, and these effects lingered despite the passage of time.[10-12] Also, poor communication combined with constant changes in disease control policy led to decreased trust in the overall disease response process and decreased public acceptance of disease control measures.[13]

As Tim Tinker noted in his recommendations to improve risk communication within public health agencies, agencies interested in informing and helping the public make better decisions regarding their own health "…need to adopt a sophisticated approach to integrating behavioral and communications considerations into planning and development of prevention programs."[14] Certainly, the same could be said for animal health agencies seeking to partner with livestock producers for the detection and control of animal diseases. Risk communication efforts for animal disease detection and control should focus on encouraging cattle producers to implement measures and comply with recommendations which can reduce the scope and severity of a disease outbreak. Measures such as the identification of animals, record-keeping to enable the tracing of animal movements, movement prevention regulations which delay the movement of animals following the introduction of new livestock, and the rapid recognition of clinical signs in livestock by livestock producers have all been highlighted as useful preventive measures to reduce the size and scope of an outbreak of a highly contagious disease.[15-21] However, some animal health agencies may not be successful in increasing producers' willingness to adopt preventive measures, because of their inability to address livestock producers' current attitudes and practices.[22] Fisher and Chen reported the results of a survey evaluating customer satisfaction with the United States Department of

Agriculture – Animal and Plant Health Inspection Service (USDA-APHIS) risk communication activities. They found that 68% of customers felt that motivating changes in attitudes and practices was important, while only 23% indicated that APHIS was effective in doing so.[23] Customers' perceived ineffectiveness of APHIS may be related to the fact that "traditional" approaches, focused on communicating the technical details of disease epidemiology and control measures, are unlikely to succeed in influencing producers' attitudes and behaviors unless they take into account the broader context and two-way nature of risk communication.[24-26]

Effective planning, implementation, and evaluation of risk communication related to outbreaks of highly contagious diseases such as foot-and-mouth disease (FMD), requires an understanding of not only the behaviors to be encouraged, but the underlying social and psychological processes influencing those behaviors.[27] The incorporation of social-psychological theory and methodology with traditional epidemiologic approaches can provide a useful tool for assessing disease-prevention behaviors and the attitudes and beliefs that influence them.

Using this multidisciplinary approach, the aim of this study was to answer the following questions:

1. What are the key behaviors related to FMD detection and control for which Texas cow-calf producers´ compliance may be reduced?
2. What are producers´ currently held beliefs about the consequences of, barriers to, and social pressures for each of the identified key behaviors?

3. In addition to these beliefs, are there other factors which influence producers´ intentions to perform these key behaviors?
4. Which of the identified beliefs and factors are most significantly associated with producers´ intentions to perform these key behaviors?
5. Based on these findings, how can risk communication and emergency response planning both before and during an outbreak of FMD in Texas be strengthened?

CHAPTER II

THE CONTROL OF FMD AND LESSONS TO BE LEARNED FROM RECENT OUTBREAKS

Foot-and-Mouth Disease in the US

Foot-and-mouth disease is an excellent example of a highly contagious disease that can spread quickly through naïve wild and domestic cloven-hoofed animal populations if control and eradication measures are not immediately put into place. FMD was last eradicated from the United States (US) in 1929.[3] Since that time, livestock in the US have had no exposure to FMD virus or FMD vaccines, rendering them highly susceptible to infection. Introduction of the virus would result in severe illness followed by poor productivity, including long-term weight loss, poor growth, permanent hoof damage, and chronic mastitis.[28,29]

Despite low mortality rates, the economic costs associated with an outbreak of FMD can be enormous in countries which were previously free of the disease. In addition to losses in animal health and productivity, an outbreak of FMD in the US would result in immediate international trade embargoes for all susceptible species and related products. Recent estimates from the North American Animal Disease-Spread Model indicate that even a relatively small outbreak confined to small pig farms would cost the US from 2 to over 4 billion dollars in total trade losses and control costs.[30]

The effective control of an outbreak of FMD in the US will require a strong partnership between the animal agricultural industry and the government. United States response plans for highly contagious diseases rely heavily on the willingness of livestock producers to serve important roles in the prevention, detection, response and eventual eradication of disease. Surveillance for FMD in the US includes pre- and post-mortem inspection of animals by government veterinarians; however, by the time the disease is identified in a slaughter facility or processing plant, it may have spread extensively beyond the farm of origin. Accordingly, livestock producers are also expected to recognize when something is wrong with their livestock and request that a veterinarian examine their animals.[31] Once an outbreak of FMD is detected, the property where the disease is identified will be declared infected, and all animals on the property will be euthanized and disposed of. Nearby operations, whose animals were exposed either directly or indirectly to animals, animal products, materials, people, or aerosol from the infected premises, will be quarantined, tested for FMD, and possibly depopulated. Vaccination with or without the subsequent destruction of vaccinates may also be used to help slow the spread of disease.[1] In all cases, producers will be asked by authorities to gather and hold their animals, often at significant personal effort and expense. Producers will also be asked to maintain strict biosecurity and movement restrictions in order to prevent the spread of the disease, which may limit access to feed, veterinary care, and slaughter at the appropriate stage of production.[5]

Historical Perspective on FMD in the US

Outbreaks of FMD in the US have always been high-profile public issues, and the control strategies for FMD, which were developed based on strategies employed in Europe, have remained relatively constant since the late 1800’s. Foot and mouth disease was first introduced into the US in 1870. The disease was identified at least ten additional times in the years between 1870 and 1929. The worst of these outbreaks was in 1914, when the disease was introduced into Michigan and then spread to 22 other states via the Chicago stockyards. That outbreak took over two years to control using strict slaughter and quarantine methods.[3] Donald Spear gives a detailed account of the challenges, enormous costs, and far-reaching implications these outbreaks had in the US in his account of the 1924 outbreak of FMD in California.[32] The disease was first identified by a private veterinary practitioner in the San Francisco Bay area in a small herd of dairy cows in mid-February. Within four days, four counties were issued temporary quarantine orders. State and federal officials cooperated closely to quickly enact the USDA's contingency plan for outbreaks of FMD, which had been developed and approved by all US states in 1917.

One of the first problems encountered during the eradication campaign related to funding for the compensation of livestock owners. According to the contingency plan, the costs of compensation for livestock owners would be shared evenly by the state and federal government. Although the US Congress acted quickly to appropriate a total of six million dollars over three months to the eradication effort, state funds were not available. Spear goes on to note: "This was a matter of critical importance to the campaign, for success rested on the willing cooperation of the state's livestock interests. Such cooperation was unlikely unless individual stockmen were assured prompt payment for condemned herds." The issue was eventually resolved when the governor secured promises from the members of the legislation that funds would be approved in the legislature's next regular session to meet the two million dollar shortfall.

The next challenge identified by Spear related to the slaughter of uninfected livestock. He noted: "Given the nature of the contagion and the federal government's past experience, USDA officials regarded as impossible an eradication campaign without slaughter of all exposed susceptible animals." However, California had not approved legislation which would allow state agents to slaughter animals not actually diseased. The eradication campaign was carried out as though the state actually had that authority until the legislature met and approved the necessary legislation in 1925. G. H. Hecke, in his opening address to the Meeting of the Western Directors and Commissioners of Agriculture in 1925, noted that despite the fact that thousands of un-infected cattle were destroyed in the course of the eradication campaign, no injunctions were brought against state officials.[33] The compliance of the livestock sector in the face of questionable legal authority, albeit with the assurance of adequate compensation, supports the idea that US livestock producers believed that strict quarantine combined with the slaughter of all infected and exposed livestock was the best method for controlling and eradicating FMD. In addition, the widespread compliance of producers with disease control measures may have been due to the enormous amount of fear and dread associated with the disease.

The widespread fear of FMD in the US at that time was best reflected in the almost hysterical reaction that followed the discovery of FMD in California. Thirty-six states imposed quarantines on a wide variety of California products, ranging from the reasonable to the absurd. Various states embargoed or denied entry to raw farm products, nursery and greenhouse products, canned goods, baby chicks and eggs, bees, biological products, manure, house pets, clay pigeons, and railroad ties.[32,34] Arizona's restrictions were by far the most severe, extending even to motorists and tourists from California. In Yuma, a crowd of stranded travelers was held back by jets from a fire-fighting hose. The governor requested a squad of National Guardsmen, armed with a machine gun to enforce the barricade.[32,34] Although state reactions during the outbreak were overly drastic, the danger of the disease spreading was real, and the economic costs associated with FMD were high.[34] Control of the 1924 outbreak of FMD in California resulted in the deaths of over 100,000 domestic animals, 22,000 wild deer, and countless small animals. Direct costs of the eradication effort to the state and federal governments exceeded six million dollars. Indirect effects on California's business and tourism sector are difficult to estimate, but one study suggested that as much as a 9% reduction in total business activity could be directly attributed to the outbreak.[32]

The experience of the US in combating FMD from 1870 to 1929 has had enormous and long-lasting impacts on many aspects of American agriculture. Fear of additional outbreaks of FMD shaped US foreign agricultural trade policy, effectively eliminating trade in cattle, sheep, swine, and fresh, frozen or chilled meat from these animals from any country known to have FMD. The resulting ban created strained relationships with many countries.[34] In addition, the California outbreak led to the establishment of a commission on foot-and-mouth disease, charged with carrying out experimental research in Europe. This research focus eventually led to the establishment of an animal disease research laboratory on Plum Island, where FMD research is still conducted today.[32,34]

Social and Psychological Costs Associated with FMD

Clearly there have been economic and political consequences from FMD outbreaks in the US, and those consequences have had long-lasting effects on US agricultural policy. However, recent outbreaks in the United Kingdom (UK) and other European countries have highlighted additional social and psychological costs associated with modern, large-scale outbreaks of FMD.[10-13,35,36] Noordman and Endenburg[36] found that even six years after an outbreak of FMD in the Netherlands, 40% of veterinarians surveyed still showed signs of a traumatic stress reaction. The number of farm animals remains decreased from pre-outbreak averages, affecting the availability and viability of large-animal veterinary practice. In addition, cattle farmers have become more confrontational, and regulations affecting veterinarians have continued to change.[36]

A qualitative, diary-based study conducted in the UK following the 2001 outbreak found that despite the passage of time, affected people's lives were still characterized by "distress, feelings of bereavement, fear of a new disaster, loss of trust in authority and systems of control, and the undermining of local knowledge." [11] These effects were not limited to animal owners or farmers, but instead were found to affect local business people, health care personnel, and rural communities as a whole. The Lessons to be Learned Inquiry Report from the 2001 outbreak in the UK noted:

> Because disease control policy had not been debated widely before the outbreak, arguments took place as the disease was raging. Changes, in particular to culling policy, were introduced at short notice. Often they were poorly communicated. Large parts of the farming and wider rural community became distrustful of government. The public and the media – which had initially been broadly supportive of the Government's approach – turned against it.[4]

Poortinga et al.[13] examined public risk perceptions, trust, and beliefs about the government during the peak of the 2001 FMD outbreak in the UK. Study participants were all highly concerned about FMD; however, the FMD outbreak was seen predominantly as a social and economic issue, rather than a human or animal health issue. In their examination of trust, the authors found that in general, people had low levels of trust in governmental sources to tell the truth about FMD and were skeptical about the government's ability to handle the crisis. The authors suggested that in order to regain trust, people wanted more openness, either through greater access to governmental information or through an independent organization providing reliable information.

Unfortunately, during an outbreak of a highly contagious disease, opportunities for developing transparent, stakeholder-driven communication strategies are often limited. During the 2001 outbreak of FMD in the United Kingdom, numerous parties affected by the outbreak response described the risk communication as hastily crafted, poorly focused and only occurring in response to the outbreak.[37,38] The Lessons to be Learned Inquiry, chaired by Dr. Ian Anderson, noted two distinct communication failures during the 2001 outbreak of FMD in the UK.[4] The first failure related to the flow of communication within the agency responsible for controlling the outbreak. During the phase when the disease was still spreading rapidly, the report notes: “Clear messages about the severity of the worsening crisis were not getting through to senior management or Ministers. At the same time, communications from senior management downwards also appeared to have difficulty reaching their target recipients.”[4] The second failure related to the flow of information to the public and the affected industries. The inquiry found that important issues such as the opening of public footpaths, an integral part of rural tourism and the rural economy, were delayed and complicated by “frequent changes in guidance, the lack of clarity in communication, the loss of confidence in the Government’s scientific understanding and control of the outbreak.”[4] The farming community´s loss of trust in the government´s ability to manage a crisis has had long-lasting implications, despite concerted efforts to strengthen communication and emergency preparedness.

When FMD was again discovered in England in 2007, DEFRA and the Animal Health Agency worked to strengthen their communications and improve transparency. The Review into the Government’s Response to FMD 2007, also chaired by Ian Anderson, found that the agencies had significantly strengthened their communications framework, seeking out new and innovative ways of reaching their target audiences through their website, SMS services, voicemail, and direct mail. However, the review recommended that engagement with the local media and key stakeholders be improved. The Review found that although “DEFRA’s contingency plan envisaged the close involvement of local stakeholders…. these relationships were often stronger on paper than they were in practice.” [39] Ten years after the 2001 outbreak, DEFRA is still working to regain the trust that was lost during the control and eradication of FMD. Recently, DEFRA announced the development of the Animal Health and Welfare Board for England, comprised of farmers, veterinarians, other stakeholders, and the Chief Veterinary Officer. As described by the independent advisory group for responsibility and cost sharing, the purpose of this board is to not only reduce the risk and cost of animal disease, but also to rebuild and maintain trust between livestock owners and DEFRA.[40,41]

Factors Influencing Outbreak Size and Severity

Given the potential for serious economic and societal consequences, efforts should be made to reduce the potential size and severity of an outbreak of FMD in the US. Studies examining past outbreaks of FMD, as well as work involving disease spread models, have revealed that the size and severity of an outbreak of FMD is associated with many factors. One of the primary factors found to influence the size of an epidemic is the time-to-diagnosis of the index case. Initial descriptive epidemiology of the first five months of the 2001 outbreak of FMD in the UK suggested that the unusual size of the epidemic was largely due to a combination of factors including a delay in the diagnosis of the index case, the movement of infected sheep through livestock markets, the time of the year when the disease was introduced (i.e., high market activity, favorable weather for FMD persistence in the environment), and the density of the livestock population in affected areas.[42] Carpenter et al.[9] modeled the potential economic and epidemic impacts of a delayed diagnosis of FMD following introduction into a large dairy herd in California using a spatial, stochastic, individual-animal-based model. They found that as the delay in detection increased from 7 to 22 days, the median number of herds under quarantine increased from 680 to 6,200 and the number of animals slaughtered went from 8,700 to over 260,000. The median economic impact increased from $2.3 billion to $69.0 billion in national agricultural welfare losses. Assuming a 21 day detection delay, the authors found that each additional 1 hour delay in detection led to the slaughter of an additional 2,000 animals and an additional economic loss of $565 million. In addition to enormous economic impacts, delays in the detection of disease can have serious implications for the subsequent success of disease control strategies. A study, which developed decision trees in order to help inform early disease control decisions, found that the time between introduction of the disease and subsequent detection (the high risk period) had a significant effect on the infectiousness of the herd and the subsequent spread of the disease. The authors concluded that knowledge regarding the high risk period should be sought early in the epidemic, as the length of the high risk period had important effects on the selection of the optimal control strategy, including whether ring culling or ring vaccination would be effective.[43]

In addition to the time to detection, the density of livestock herds in the affected area and the extent of early disease spread have also been found to influence outbreak size. Persistence of FMD in the Cumbria region of England during the 2001 outbreak was attributed to the early, widespread dissemination of the virus and the movement of people and vehicles between farms during routine farming activity.[44] As noted earlier, the movement of animals through livestock markets early in the 2001 outbreak in the UK led to the widespread dissemination of the virus, including into areas with high livestock density.[42] Some authors have gone so far as to suggest that the movement of animals through livestock markets is the single most important factor contributing to extremely large-scale outbreaks of FMD.[15] Others have reported that cattle and sheep densities are one of the most important risk factors for farm-level transmission of FMD, and approximately 50% of transmissions of the virus during the 2001 outbreak were due to the nearest infectious premises. In addition, the effectiveness of the disease control measures related to the management of the epidemic also affected the farm-level transmission of FMD in the UK in 2001.[45] The local spread of FMD prior to the establishment of movement restrictions or in the absence of adequate biosecurity is most likely due to the complex movements of people and animals associated with the lifestyle of animal agricultural production. An examination of contact patterns in a small area of the Netherlands (approx 33km^2) for 144 farmers found that over a two-week period each farmer had an average of 92 contacts with other farms, and social visits comprised a large proportion of these contacts.[46]

Within the US, animal movements are also frequent and have been shown to have a significant effect on the spread of FMD in disease spread models.[47] Results from a survey examining beef cattle movements in California found that respondents kept cattle at up to five different locations throughout the year. Beef cattle were moved between states more than two times annually, and more than 40% of the reported movements were to sale yards or auction barns.[48] A separate study, focused on exhibitors of livestock at the California State Fair, found that the state livestock fair brought together animals from almost every county within the state, with 97% of the animals participating in the fair expected to return home afterwards. The survey also found that the show animals had participated in a median of three events during the past year, and in general, the reported biosecurity practices of the respondents were minimal.[49] While many of these epidemiologic factors are beyond the control or influence of livestock producers or regulatory authorities, some of them are directly impacted by the behaviors of livestock producers, such as the time to detection of disease and the movement of animals and people. These behaviors represent important targets for risk communication because of their potential influence on the size and severity of an outbreak.

Risk Communication and Disease Control

Successful risk communication may take a great deal of planning and effort; however, it can greatly enhance disease control efforts. For example, in 1989 a brucellosis task force was created in Ontario, California in order to eliminate brucellosis from a dairy community where the disease had become entrenched. The task force was comprised of a broad range of stakeholders including state and federal regulatory personnel, dairy owners, dairy association representatives, veterinary practitioners, and extension specialists. The task force was able to create a set of minimum standards that would be implemented in any herd where transmission was on-going. The task force was unique in that they took a community-level approach to the problem of brucellosis transmission. In addition, the task force worked to create a climate of open and continuous communication by maintaining an office in the community and providing space for meetings, consultations, and discussions. Overall, the approach was successful and brucellosis was eradicated from the community by 1992. Veterinarians who were involved in the program identified several critical elements for communicating with producers including: 1) the need to impress upon the owner the gravity of his herd being affected; 2) the importance of providing knowledge regarding the fundamentals and peculiarities of the disease; 3) the value of constructively discussing the apparent failures and inconsistencies that occur; 4) the goal of protecting other herds as well as eliminating disease from the owner's herd; and 5) the absolute importance of the owner's commitment to using his own time and resources to help control the disease.[50]

Strong communication within government agencies and between agencies and the public requires the mechanisms of communication to be in place prior to an outbreak. The National Academy of Science defines risk communication as "an interactive process of exchange of information and opinion among individuals, groups, and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management."[51] However, recent recommendations for preparation of outbreak response plans give minimum attention to risk communication, often limiting communication priorities to ensuring "that awareness of the disease is maintained within the veterinary profession, in the agricultural community, and by the general public. Information materials should be prepared and made available to different target groups."[52] During an examination of the risk communication challenges of the West Nile epidemic, Covello et al. noted that,

> Despite this interactive perspective, evaluation studies indicate that personnel from many agencies and organizations involved in risk controversies lack the knowledge, sensitivity and skills needed for effective risk communication. They adhere to the ‘decide, announce, defend’ (DAD) model and proceed with limited understanding of the stakeholders’ values and concerns…. They initiate risk communication efforts with inadequate resources, unclear objectives, and little or no empirically based information on: who is perceived to be the most trustworthy; who is best suited to communicate risk messages; which messages are most effective; which messages are most respectful of different values and worldviews; which messages raise moral or ethical issues; which messages are most respectful of process; where, when, and how the risk information should be communicated. [53]

Although West Nile is not a highly contagious disease, preparing for and responding to outbreaks of highly contagious diseases is likely to raise many issues which are morally, socially, and economically relevant to affected stakeholders. Issues such as the use of large-scale depopulation measures, compensation of certain segments of the agricultural industry for losses but not others, inability to move animals to slaughter and resulting animal welfare concerns, mandatory animal identification, the role of vaccination, and plans for business continuity during a disease outbreak are all decisions for which science has limited answers. Decisions such as these require an understanding and sensitivity to the social, cultural, and economic forces that impact how diseases are spread and controlled.

Dr. Lonnie King eloquently captured this sentiment during his reflections on the brucellosis eradication campaign in the southern US. He noted: “… I believe that we could have eradicated brucellosis in the United States much more quickly if we would have brought in social and behavioral scientists. They would have given us important insights into the connection of the social behaviors of small cattle producers who were concerned not about disease or economics – but about a lifestyle and the social status of owning and trading in cattle.” [54] Similarly, Bouma et al. in their description of the 2001 outbreak of FMD in The Netherlands, commented that poor communication between affected farmers and animal health authorities allowed for the disease to spread further, and suggested that the incorporation of disciplines such as sociology could prove very useful in improving communication and disease control.[55]

In order to minimize the negative consequences of disease eradication and ensure a rapid response to an outbreak of FMD, we need to develop a foundation for effective risk communication and education between those responsible for the eradication programs and the stakeholders involved. This requires developing an understanding of the moral, social, and economic exigencies that would affect producers’ decisions to fully participate in the detection and control of highly contagious animal diseases. Methodologies and theoretical models developed by social and behavioral scientists offer important and often under-utilized tools for exploring and determining important influences of behavior. The application of these methods within veterinary epidemiology and emergency response planning can create a useful foundation for effective risk communication, as well as for the development and implementation of response plans for highly contagious diseases.

CHAPTER III

SURVEY DESIGN: EXAMINING TEXAS CATTLE PRODUCERS´ INTENT TO PARTICIPATE IN FMD DETECTION AND CONTROL*

Introduction

Foot-and-mouth disease was last eradicated from the United States (US) in 1929.[1] Since then, cattle in the US have had no exposure to FMD or FMD vaccines, rendering them highly susceptible to infection. Introduction of the virus into the US (or any naïve cattle population) would result in severe illness followed by poor productivity, including long-term weight loss, poor growth, permanent hoof damage, and chronic mastitis.[2-3]

Despite low mortality rates, the economic costs associated with an outbreak of FMD can be enormous in countries which have been previously free of the disease. In addition to losses in animal health and productivity, an outbreak of FMD in the US would result in immediate international trade embargoes for all susceptible species and related products.[3] Recent estimates from the North American Animal Disease-Spread Model indicate that even a relatively small outbreak confined to small pig farms would cost the US from 2 to over 4 billion dollars in total trade losses and control costs.[4] To help mitigate these consequences, any introduction of FMD into the US must be quickly

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identified and control and eradication measures immediately put into place.

Preparing for and responding to outbreaks of FMD is likely to raise many issues which are morally, socially, and economically relevant to livestock producers, and because of these diverse influences, producers´ participation in disease detection and control may not be assured. For instance, during the campaign for the eradication of cattle brucellosis in the southern US, animal health authorities found that many small cattle producers "were concerned not about disease or economics – but about a lifestyle and the social status of owning and trading in cattle."[54] Insights into not only the behaviors of these small cattle producers, but the underlying social and psychological processes which drove them, could have allowed for improved communication and disease control strategies, and the more rapid control of brucellosis in this area of the US.[54] The blending of social-psychological theory and methodology with traditional epidemiologic approaches can provide a useful tool for exploring producers´ intentions to participate in disease detection or control and the attitudes and beliefs that influence those intentions. This or similar approaches have been used recently to examine a wide-range of animal health-related behaviors such as the control of mastitis in dairy cattle,[56] the implementation of on-farm biosecurity,[57,58] the use of antimicrobials in feedlot cattle,[59] and the reporting of pigs with clinical signs of classical swine fever.[60]

The purpose of this overall study was to identify key behaviors related to FMD detection and control for which producer compliance could be reduced, and to identify the factors (salient beliefs and other social or psychological factors) which may influence producers´ intentions to comply with disease detection and control. This chapter outlines, describes, and discusses the process of developing a quantitative questionnaire based on qualitative analysis of interviews with livestock producers. Specifically, the objectives of this chapter were to describe: 1) the identification of key behaviors for which cattle producer compliance may be reduced, 2) the determination of salient beliefs about the consequences of, barriers to, and social pressures for performing each of the identified behaviors, as well as, additional factors which may influence producers´ behavior in order to develop theoretical frameworks for explaining and predicting cattle producers´ intentions to perform each of the identified behaviors, and 3) the development of a stakeholder-driven questionnaire which would allow for the quantitative assessment of the theoretical framework.

Materials and Methods

Theoretical Foundations

Although numerous social-psychological theories have been proposed to better predict and understand health-related behavior (e.g. Health Belief Model[61], Protection Motivation Theory[62], or the Theory of Reasoned Action[63]), for the purposes of this study, the Theory of Planned Behavior[64] was chosen to serve as the foundation for the development of an appropriate social-psychological framework for understanding cattle producers' behavior during an outbreak of FMD. Within the Theory of Planned Behavior, shown in **Figure 1**, behavioral intentions are regarded as the proximal determinant of behavior. Behavioral intentions capture a person's motivation to perform a behavior, including how hard they are willing to try and perform the behavior.[64] The greater one's motivation to perform a particular behavior, such as reporting an animal

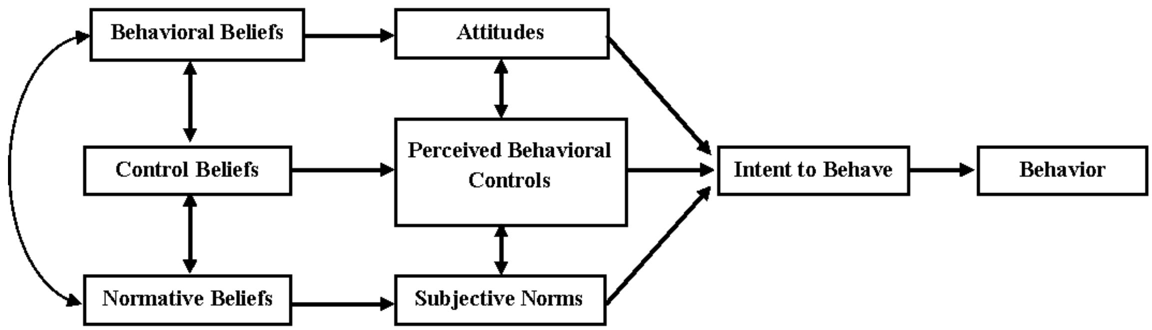

Figure 1 - Theory of Planned Behavior, adapted from Armitage and Christian.[65] Behavior is determined by intent to behave, which is determined by a person´s attitudes, perceived behavioral control, and subjective norms. Each determinant is made up of underlying beliefs. Intent to behave leads to the actual behavior, assuming adequate behavioral control.

suspected of having FMD, the more likely one is to actually perform the behavior, assuming that the person has actual control over the behavior.

A person's intention to perform a behavior is in turn determined by their attitudes toward the behavior (an overall disposition to respond favorably or unfavorably), subjective norms (perceived social pressure to perform or not perform the behavior), and perceived behavioral control (the extent to which people believe they are capable of performing the behavior, including both the perceived ease or difficulty of performing a behavior, as well as the perceived sense of control over being able to perform the behavior).[64]

Following on Fishbein's summative model of attitudes,[66] attitudes, subjective norms, and perceived behavioral control are determined by their salient underlying beliefs. Behavioral beliefs are beliefs about the advantages and disadvantages or consequences of performing a behavior which influence a person´s attitude about a behavior. These can include emotional consequences, such as pride, guilt, or shame, which people may anticipate will follow from performing the behavior.[67,68] Although a person may have many beliefs about a behavior, it has been argued that only salient or accessible beliefs (those that come readily to mind) are the primary determinants of attitudes, and that in general, a relatively small set of beliefs serve as the determinants of a person´s attitude.[69] Subjective norms, or perceived social pressure, are made up of underlying normative beliefs. Normative beliefs can be divided into injunctive norms, beliefs about what other people expect you to do, and descriptive norms, beliefs about what other people are actually doing. In general, the more strongly someone perceives social pressure to perform a behavior, the greater their intention to perform the behavior.[70,71] Perceived behavioral control is determined by underlying control beliefs about the ability of specific factors to facilitate or inhibit the likelihood of performing a behavior.[64]

Despite acceptance and wide-spread use of the TPB, it has been argued that the predictive power of the model could be improved through the incorporation of additional variables as predictors of intention to behave.[70,72] Qualitative interviews are a useful tool for identifying salient or accessible beliefs, as well as other factors which could be added to expand the theoretical framework of the TPB, relative to our behaviors of interest. Additional factors which have been suggested for inclusion in the model include: habit, moral obligation, self-identity, affective beliefs, descriptive norms, trust, and risk perception.[59,70,71,73-75] While not all of these factors may be necessary, the measurement and assessment of the predictive and explanatory value of some of these additional factors is likely to be important in certain situations.

Study Population

A total of 40 individuals were selected for interviews. Participants were selected using purposive sampling in order to capture the greatest diversity in beliefs, as well as other psychological or sociological factors. Purposive sampling is a non-probabilistic technique in which pre-defined groups of participants are purposely recruited due to their potential to provide data pertinent to the study. In order to achieve the objectives of this study, selected participants included private, state, and federal veterinarians, emergency response personnel from the state animal health agency, industry organization representatives, as well as, dairy, feedlot, and cow-calf producers. In addition, cattle producers were selected to represent: the geographic diversity in Texas; large and small cattle operations; traditional, organic and holistic production methods; and recent start-ups and family legacy operations. Interview participants were identified through a variety of industry and regulatory contacts and asked to participate in the study. Participants were offered no financial incentives to participate. The study protocol was reviewed and exempted from full review by the institutional review board committee for research involving human subjects at Texas A&M University (IRB no. 2006-0440).

Qualitative Survey

Selected participants were contacted by phone and asked to participate in the study. Arrangements were then made for the interviewer to meet with the participant at a location of their choosing, usually their home or office. Qualitative data were collected using semi-structured, face-to-face interviews. The content of the interview outline (available upon request) was developed through group discussions with veterinary epidemiologists, rural sociologists, and regulatory animal health officials. The outline was designed to stimulate conversation and allow the participants to bring up and expand on topics of their choosing. The interview outline consisted of a series of main questions, with secondary questions nested within each main question, which could serve as prompts if needed. Interviews began with basic background information regarding the participant and his or her work. Participants were then asked if they were familiar with FMD, what risk they felt FMD posed, and where they would look for information regarding FMD. In order to ensure that the participants had an equal and adequate understanding of basic emergency response plans for FMD in Texas, scenarios were written for each type of cattle producer (dairy, cow-calf, and feedlot), which described a typical foreign animal disease outbreak response involving their operation. They were then asked what their thoughts were regarding the scenario, its feasibility for operations like theirs, and any specific challenges or barriers they foresaw in the successful detection and control of FMD. Interviews with cattle industry organizations were very similar to cattle producer interviews except that questions focused on their constituency, rather than an individual operation. Interviews with regulatory officials did not include a scenario, but instead focused on current emergency response plans and challenges or barriers identified during previous outbreak and emergency response efforts in Texas (including avian influenza, exotic Newcastle's disease, malignant catarrhal fever, the

Boophilus vectors of bovine babesiosis, and numerous hurricanes.) Interviews with private veterinary practitioners began with a very brief description of the current surveillance plan for FMD in the United States. Practitioners were then asked what challenges or barriers might exist that could limit cattle producers' or private veterinarians participation in FMD detection and control. Additional discussion points included how they saw their practice functioning during an outbreak situation and any experiences or involvement they might have had in foreign animal disease investigations or outbreaks.

All interviews were conducted by the same team member, who was occasionally joined by other team members as observers. Interviews were recorded using a digital recording device, and the recordings were transcribed by a professional transcription service. Transcripts were re-evaluated by a team member to ensure accuracy of transcription and in order to remove any identifiers or personal information. Transcripts were assigned numbers and grouped according to interviewee type.

Qualitative Analysis

Interview transcripts were analyzed independently and collectively by a four-person research team comprised of two rural sociologists and two veterinary epidemiologists. Team members read through the transcripts initially in order to familiarize themselves with the raw data and to identify key themes and issues. Each team member then identified specific behaviors where it was mentioned that cattle producers´ compliance may be reduced. Drawing upon the framework approach [76] developed in Great Britain for applied qualitative research, the thematic framework contained within the Theory of Planned Behavior [64] was adapted and expanded to include additional themes, which the initial reading had suggested could influence behavior, including risk perception, trust, and moral norms. The overall thematic framework was then systematically applied to all data in order to identify salient behavioral, control, and normative beliefs. Similar to the charting process described in the framework approach, the verbatim text indexed into each category was then distilled into sets of beliefs statements related to the behaviors of interest, which could be incorporated into a quantitative questionnaire as close-ended questions. The research team met once a week in order to combine notes on the analysis and any discrepancies in the indexing were resolved by discussion amongst the research team.

Quantitative Survey Design

Based on the results of the qualitative analysis, survey drafts were prepared for each of the behaviors of interest and corresponding producer type. Using the TPB requires careful wording of the behavior to be studied. Traditionally, in the application of the TPB a survey would address only a single behavior.[64] Each behavior is accompanied by a specific set of questions, and every time a behavior is added to a survey, another iteration of the same set of questions must be added. The guide developed by Francis et al.[77] for the development of TPB-based questionnaires for the examination of health-related behaviors was particularly helpful. The goal of this study was to capture multiple aspects of producers´ behavior during the disease detection and response process. Accordingly, we had to prioritize the behaviors which would be examined and be as rigorous as possible in order to keep the final surveys to a reasonable length.

A two-day survey design workshop was held to evaluate the drafts and clarify or correct them as needed. Workshop participants included a diverse set of people, whom we considered to be our stakeholders, and which included epidemiologists, sociologists, cattle producers, veterinarians, industry organization representatives, regulatory animal health officials, and agricultural extension personnel. Drafts of the surveys were provided to the participants prior to the meeting, along with background reading on outbreak emergency response in Texas and the Theory of Planned Behavior. The workshop was designed so that participants had a chance to evaluate the overall theoretical framework as a whole, as well as specific questions or components of the survey drafts. Workshop participants were asked to help develop the scenarios used to introduce each intention question, in order to ensure that the scenarios were realistic and accurate.

Results

Study Population

All individuals identified for interviews agreed to participate in the study and were interviewed between September of 2007 and April of 2008. Interview participants included 9 state and federal regulatory animal health officials, 5 veterinarians (2 in academia and 3 in private practice), 22 cattle producers (10 cow-calf producers, 5 feedlot operators, 5 dairy producers, 1 sale barn owner, and 1 order buyer who regularly purchased and put together large groups of calves for his clients), and 4 cattle industry organizations. One interview was partially recorded due to a recording device malfunction, so the remainder of the interview was summarized by the interviewer. In addition, one participant refused to have the interview recorded, and so the interview was summarized by the interviewer for the research team.

The characteristics of the cattle producers interviewed are summarized in **Table 1**. Among producers interviewed the mean number of years working in the cattle industry was 31.5, with a range from 4 to 60 years of experience. The majority of producers were men; however we interviewed 3 women, all of whom were heavily involved in the management of their livestock. Over 50% of the producers (12/22) were located in either the northern or western parts of the state, while the remainder were scattered over the other regions. Small, medium, and large operations were represented among all cow-calf, feedlot, and dairy producers interviewed. In addition, one of the dairy producers and one of the cow-calf producers utilized organic management methods, and two of the cow-calf producers utilized holistic management methods.

Identification of Behaviors

Following the analysis of the qualitative interviews, the research team identified the following as behaviors for which producer compliance may be reduced and which could serve as potential candidates for further quantitative assessment: biosecurity practices; reporting of animals which may have FMD; observation of a movement ban; allowing testing and inspection of animals; allowing depopulation; and participation in the National Animal Identification System (NAIS). The final behaviors to be included in the quantitative questionnaire had to be intentional with some variability expected in study

Table 1 – Characteristics of 22 Texas cattle producers interviewed regarding FMD and outbreak response in Texas, 2007-08.

Attribute	**Levels**	**# of producers**
Producer type	Cow-calf	10
	Feedlot	5
	Dairy	5
	Other [a]	2
Years in Industry	Mean	31.5 years
	Range	4 - 60 years
Gender	Male	19
	Female	3
Geographic Location	North	5
	East	2
	Central	4
	South	4
	West	7
Operation Size		
Cow-calf	Small (<50 head)	4
	Medium (50-200 head)	1
	Large (>200 head)	5
Feedlot	Small (< 10,000 head)	2
	Medium (10,000 to 35,000 head)	2
	Large (>35,000 head)	1
Dairy	Small (< 50 head)	1
	Medium (50-1000 head)	2
	Large (>1000 head)	2
Other[a]	Large (>1000 head)	2

[a]These cattle producers were a sale barn owner and an order buyer.

participants' attitudes, subjective norms, and perceived behavioral controls. Based on our desire to keep the survey instrument as similar as possible for all types of producers, we elected not to pursue biosecurity practices as a behavior to model at this point in time. Similarly, producer participation in the National Animal Identification System was also excluded as a potential behavior for examination, because we felt that this behavior lacked the specificity of the other behaviors in relation to FMD detection and response. In the end, the following behaviors were identified as potential behaviors for which Texas cattle producers would show variable cooperation and which met our criteria for quantitative examination:

- Reporting cattle with clinical signs of FMD in the absence of and during an outbreak of FMD
- Gathering and holding cattle for testing or depopulation during an outbreak
- Maintaining cattle in their current location during an outbreak (compliance with animal movement restrictions)

Reporting cattle with clinical signs of FMD requires that a producer notice that something is wrong with his cattle and then request that a veterinarian examine those cattle. In Texas, the veterinarian is then required by law to report a diagnosis of FMD, initiating the emergency response process. Several producers interviewed felt that livestock producers may be reluctant to request veterinary examination of animals with FMD-like lesions. For example, one cow-calf producer felt people would be unlikely to report sick cattle. She went on to note: "They would probably dispose of the cow themselves. That´s just the old way of doing things." Another cow-calf producer felt that the fear of inadequate compensation would keep some producers from reporting sick cattle; however, in addition, the same producer also felt that some people would not report for emotional reasons:

> There are people in that category that are not gonna report it ´cause they do not wanna give up old Betsy or her sisters and brothers. We have a lot of really small cattle operations, and they name all the cows and pat them on the head and feed them cubes. And some of them are worthless cattle from a financial standpoint, but that doesn´t matter. They´re emotionally attached to them. Those folks, if they had a foot-and-mouth cow and they didn´t know for sure it was foot-and-mouth, they´ll throw it in the creek in the back. Hope the rest of them don´t get sick.

In addition, through our discussions with livestock producers, we found that many producers viewed the advantages and disadvantages of reporting livestock with FMD-like symptoms differently depending on whether or not there was a known outbreak of FMD in the area. One cow-calf producer commented that no one would want to be the first person to say they have the disease; however once an outbreak was established, it would be to everyone´s benefit to report sick cattle quickly. The owner of a small feedlot felt that in the absence of an outbreak, he would be much more likely to consider other potential causes of the clinical signs. The ordeal of quarantining a feedlot, collecting and shipping samples, and waiting for laboratory results was not something that he would undertake lightly. However, another producer pointed out during his interview that if you are a large operator, it would be advantageous to report as quickly as you can so that there is a chance you won´t lose all of your animals. Based on the different ways in which producers view reporting of cattle with FMD-like symptoms, we chose to include both reporting prior to an outbreak and reporting during an outbreak in our study.

The next behavior identified related to the requirement for producers´ to gather and hold their cattle for testing and/or depopulation. In many areas of Texas, cattle may be widely scattered or hidden within thick brush. Many of the larger ranches require a combination of cowboys on horseback and helicopters in order to gather their cattle. One rancher mentioned the enormous cost associated with this effort (he estimated $10,000-$12,000 dollars for 3,000 head of cattle) and suggested that for some producers, it would not be economically feasible on short notice. Other ranchers felt that finding cowboys could be difficult if many ranches are trying to gather their cattle at the same time. Although producers often discussed the physical or material constraints affecting their ability to gather cattle, regulatory officials noted that during the eradication of brucellosis and the on-going work in the control of the *Boophilus* tick in South Texas, producers´ resistance and delays in gathering and holding cattle was, and remains, one of the most serious impediments to disease control, despite the availability of government cowboys and equipment. One federal veterinarian shared his experience during the eradication efforts for bovine brucellosis:

> …I´ve probably stopped to talk to that guy five or six times, and every time he had a different excuse for why he couldn´t present his cattle. And so one time, he said, 'Well, I don´t have good facilities and I don´t have any help.' So we were down testing another herd not far away, where we were done fairly early. And I had a crew of guys… chutes, panels, and I had probably five or six animal health technicians. I pulled up and all those guys pulled up, and I said, 'Alright.' I said, 'We got the help. We got the facilities. What´s your excuse?' He goes, 'Okay, come on.'

Many officials felt that delays by producers in gathering cattle are often tied to economic reasons or to a general dislike or distrust of regulatory officials. For example, officials suggested that a producer may delay gathering cattle from a tick-infested pasture until the producer is ready to sell them. Although regulatory veterinarians can request a penning order or dipping order to force the producer to comply, if the producer appeals the order, it can take up to nine months for the cattle to be gathered and treated. During this time, the tick continues to spread. A regulatory veterinarian observed: “In other words, it is to our benefit to get them to comply willingly. We can force them. We can end up with the cattle in the pen whether they want to or not. But it defeats our purpose too, because it takes so long.” Based on our interviews, the behavior was then defined as not only gathering and holding cattle, but doing it at the date and time requested by animal health authorities.

The last behavior identified from the interviews was maintaining cattle in their current location during an outbreak of FMD (movement ban compliance). Although the large feedlots and dairies found in Texas would not be able to move all of their animals out of a quarantine zone given the enormous logistical challenges involved, many producers were concerned about the ability to provide feed, ship fattened cattle, house calves that would normally be raised off-site, and sell milk. The illegal movement of animals was primarily mentioned as a concern with cow-calf producers. Many people in Texas own small numbers of cows and calves which could be easily loaded into a trailer and moved. A regulatory veterinarian recalled his experience with quarantines for the control of *Boophilus* ticks:

> I was working there with an old, experienced inspector, right about dark one evening we caught an old boy loaded with cattle heading out of the zone. And they were heavily infested, and he had already sprayed them with something. I don´t know what it was, but it was very smelly. He knew he had ticks, and he was trying to sneak those cattle out. He probably would have taken them to the sale and messed up a bunch of other peoples. There is always a few like that.

Regulatory officials from east Texas identified the control of animal movements as the major challenge they would face in dealing with an outbreak of FMD. The large number of private roads which may or may not show up on a map would provide numerous opportunities for people to move cattle, and animal health agencies would face significant challenges in identifying and communicating with the numerous, small cow-calf operations.

The cattle producers interviewed stressed the importance of feed availability and market access for their animals. Cattle production in Texas relies heavily on the ability to move cattle, and a single calf may visit four separate properties prior to its entry into a feedlot for finishing. The timing of each movement is often determined by factors outside of the producer´s control such as changing weather conditions or the changing nature of grass as it ages. When the conditions dictate that cattle need to be moved, a movement ban would result in serious losses in cattle growth and value, particularly as feed costs rise. One producer succinctly noted, “You either have to move them or feed them.” Although we wanted to keep each behavior as specific as possible, interviews suggested that “movement ban compliance” encompassed a great number of behaviors and obligations, all of which influence each other. For example, some producers would not consider moving their cattle until feed became so scarce that the animals began to deteriorate or suffer. At that point, they may feel they have no choice but to move them to a different pasture, regardless of the distance.

Theoretical Frameworks and Salient Beliefs

Social-psychological frameworks were developed for each of the identified behaviors (see **Figure 2** for the overall framework for requesting veterinary examination of animals with clinical signs of FMD). The initial framework for each model was based on the components of the Theory of Planned Behavior.[64] Specific behavioral and control beliefs were identified for each of the behaviors of interest, as well as additional factors not normally included in the TPB, which our interview participants suggested could have an impact on producers´ behavior. Because we wished to compare producers´ responses on the quantitative questionnaires, beliefs and norms identified for the behavior of reporting cattle with clinical signs of FMD were considered to apply for both reporting in the absence of and during an outbreak of FMD. So, although these two reporting behaviors have a slightly different context, the list of salient beliefs and moral norms were considered relevant for both and are presented for the single behavior, reporting cattle with clinical signs of FMD.

Behavioral beliefs reflect the advantages or disadvantages of performing a behavior or the perceived consequences of performing the behavior. **Table 2** shows the lists of specific beliefs identified for each of the behaviors. In general, the behavioral beliefs identified for each of the behaviors fell into 5 categories: economics, disease control, animal well being, animal production, and owner satisfaction. In general, the producers interviewed felt that participating in FMD detection and control would reduce the overall economic impact of an outbreak on the US cattle industry; however, many

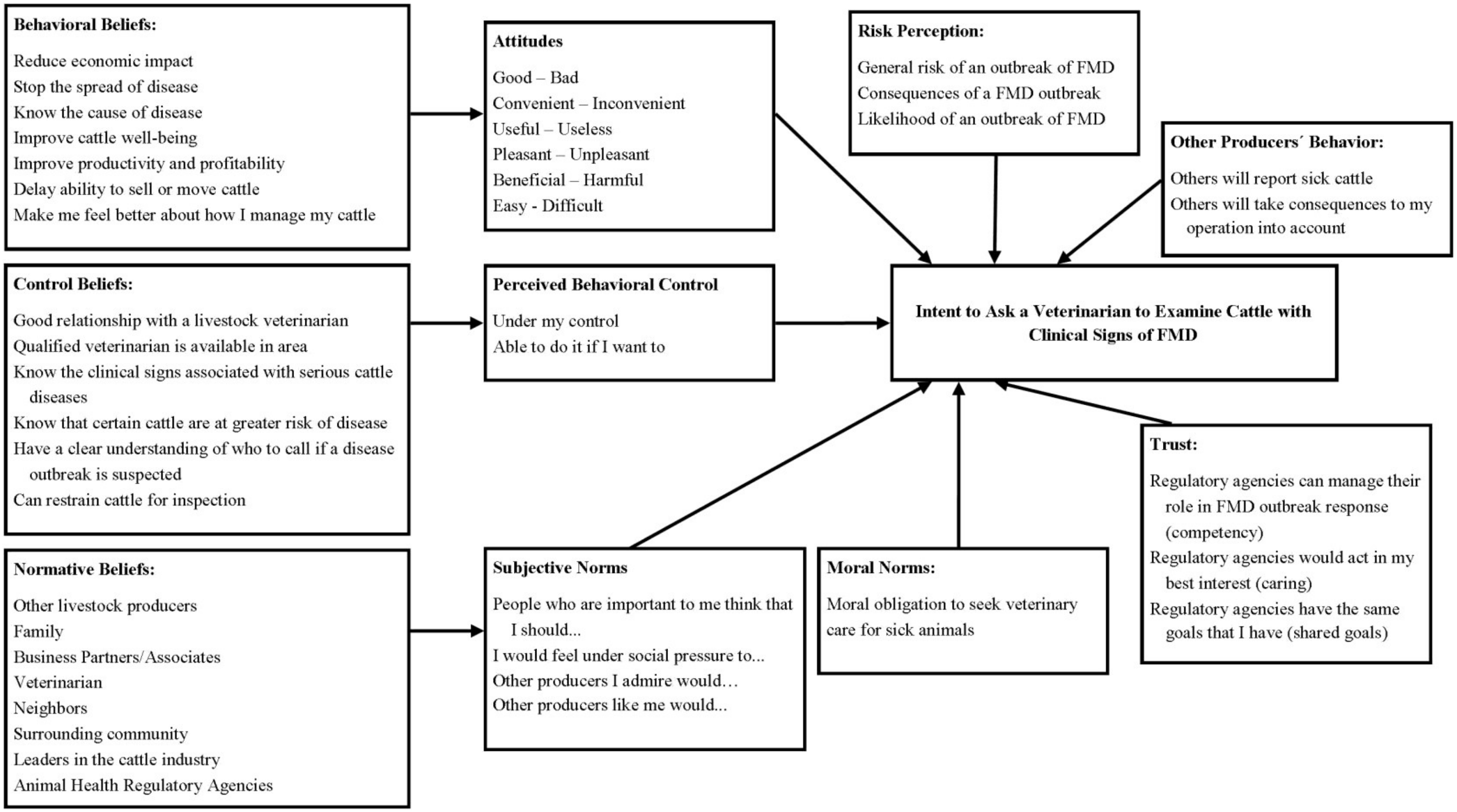

Figure 2 – Theoretical Framework. The full framework developed for explaining a producers´ intention to request veterinary examination of cattle with clinical signs of FMD. Specific underlying behavioral, control, and normative beliefs are identified, as well as, specific wording designed to assess attitudes, perceived behavioral control, and subjective norms. In addition to the traditional components of the Theory of Planned Behavior, risk perception, trust in other producers and regulatory agencies, and moral norms are also included and shown to influence producers´ intentions.

Table 2 – Specific behavioral and control beliefs and moral norms identified for each selected behavior (asking a veterinarian to examine cattle with clinical signs of FMD, gathering and holding cattle, and maintaining cattle at their current location).

	Behavioral Intention		
	1) Ask a veterinarian to examine cattle with clinical signs of FMD	2) Gather and hold cattle for testing or inspection at a requested date or time	3) Maintain cattle at their current location during an outbreak of FMD
Behavioral Beliefs[a]			
	Reduce economic impact Stop the spread of disease Know the cause of disease Improve cattle well-being Improve productivity and profitability Delay ability to sell or move cattle Make me feel better about how I manage my cattle	Reduce economic impact Stop the spread of disease Know if herd is infected Cause cattle to suffer Make me feel better about how I manage my cattle Reduce the value of my cattle Result in my cattle being killed Result in my neighbors cattle being killed	Reduce economic impact Stop the spread of disease Result in feed shortages for my cattle Will cause my cattle to suffer Will be adequate to protect cattle from FMD I will not be blamed for the spread of FMD Make me feel better about how I manage my cattle Will delay my ability to sell cattle
Control Beliefs[b]			
	Good relationship with a livestock veterinarian Qualified veterinarian is available in area Know the clinical signs associated with serious cattle diseases Know that certain cattle are at greater risk of disease Have a clear understanding of who to call if a disease outbreak is suspected Can restrain cattle for inspection	Have needed facilities Have needed manpower Have necessary financial resources Live close enough to cattle Cattle are tame enough to gather and hold	Expect that feed can be delivered Own/have access to adequate feed Will be responsible for paying for additional feed Will cause my cattle to become crowded Will cause environmental damage Will cause my cattle to be killed during disease control process Have facilities to keep all calves born Can set up appropriate disinfection procedures for myself and my staff
Moral Norms[c]			
	Moral obligation to seek veterinary care for sick animals	Moral obligation to gather and hold cattle at date and time requested	Moral obligation to ensure access to adequate feed and water Moral obligation to protect cattle from exposure to diseased animals Moral obligation to prevent spread of disease from my cattle to others

[a] Behavioral belief questions were written by combining the behavior with the outcome shown in the table. For example, asking a veterinarian to examine cattle with clinical signs of FMD will reduce the economic impact of FMD on my operation.
[b] Control belief questions were written by creating a statement with the identified factor and then asking how strongly the producer agreed or disagreed with the presence of the identified factors. For example, I have a good relationship with a livestock veterinarian.
[c] Moral norm questions were written by creating a statement from the identified moral norm and then asking how strongly the producer agreed or disagreed with the statement. For example, I have a moral duty to seek veterinary care for sick animals.

felt that the economic impacts on their operation were likely to be substantial even if they complied 100% with the expectations of regulatory agencies. Delays in the ability to sell cattle and losses in cattle value due to movement restrictions or damages incurred during gathering and holding were highlighted as negative consequences of compliance.

Producers also expressed fears that compliance could result in the slaughter of their own and their neighbors´ herds, as well as the suffering of their animals due to crowding and lack of feed. Our study participants pointed out that there were many positive consequences to complying with FMD detection and control measures, including stopping the spread of disease. Participants pointed out that complying with a movement ban would protect their animals from disease and prevent them from being blamed for spreading disease. Reporting cattle with clinical signs of FMD would allow the producer to know the cause of the clinical signs seen in his or her animals, which overall results in improved cattle productivity, profitability, and animal well-being regardless of whether the disease is actually FMD or not. Our analysis found that the participants felt that complying with FMD detection and control measures was an important part of being a good cattle producer, which made them feel better about how they manage their cattle. This emotional consequence of compliance was identified as a salient belief for all of the behaviors.

Control beliefs represent things that make performing the behavior either easier or more difficult. Control beliefs identified were very specific to the corresponding behavior. The control beliefs identified for each of the behaviors are shown in **Table 2**. In general, the identified control beliefs addressed physical limitations such as lack of facilities to hold cattle or feed to maintain them, financial limitations such as a lack of funds to hire cowboys, and informational limitations such as lack of knowledge regarding the clinical signs of FMD or who to call if disease is suspected.

Normative beliefs are beliefs about what other people, who may or may not be important to you, think you should do. In order to assess the normative beliefs of producers, we had to identify a list of salient people whose opinions producers may take into account. Based on the interviews, the following persons were identified as having potential influence over producers´ behavior: animal health regulatory agencies, their county extension agents, their surrounding community, their professional organizations, other producers like themselves, leaders in the cattle industry, their family, their business partners/associates, their veterinarian, and their neighbors. The list of salient people did not vary by behavior.

In addition to the traditional components of the Theory of Planned Behavior, several additional factors emerged as potentially important influencers of producer behavior during FMD detection and control. Several producers felt that some neighboring producers or "other producers" in general, would be unlikely to report sick cattle or comply with a movement ban for instance, and their behavior could have an impact on the behavior of their surrounding neighbors. As a result, for each of the behaviors, we included trust in other producers (neighbors, other producers in the area, and other producers in Texas), measured as their belief in what others would do and whether or not they believed that these other producers´ would take into account the effects of their behavior on the respondents´ operation.

Another related factor which emerged from the qualitative analysis was trust in regulatory agencies. Producers interviewed expressed varying levels of trust in the state and federal governments´ abilities to respond to an outbreak of FMD. One dairy producer who had been affected by the bovine tuberculosis eradication program expressed high levels of trust in regulatory agencies to not only control disease but provide prompt and adequate compensation for the loss of animals. However, other producers were more skeptical. Some suggested that although agencies might have the best of intentions, they lacked the resources or skill to control an outbreak of FMD. One small cow-calf producer complained that the agencies responsible for responding to an outbreak would most likely cater to the needs and expectations of "big agribusiness" without consideration of the consequences to or concerns of small producers. Some large feedlot and dairy owners also suggested that responding agencies would not understand the reality of their business or scale of operation. Some producers commented that agencies´ goals for slaughter of infected or at-risk livestock were unrealistic and/or inappropriate, and that the emergency response process should be focused on minimizing animal suffering or death and economic losses to business, rather than simply eradicating the disease as quickly as possible at whatever cost. Three overall components of trust emerged from the analysis: caring (how much an agency cares about your operation), competency (the perceived ability of an agency to handle their role in outbreak response), and shared goals (whether or not an agency has the same goals as you in the control of an outbreak).

Similarly, the degree to which interviewed producers perceived FMD to be a risk also varied greatly, and there was no clear consensus on how risk perception might affect producers´ behavior. Some producers felt that any producer who understood the risk that FMD poses would quickly and immediately comply with disease detection and control measures. However, others suggested that fear of the consequences of FMD could hinder or delay producers´ cooperation. Similar to what has been suggested in other studies, [58,78,79] interviewed producers identified FMD as an enormous risk to the US livestock industry, while at the same time suggesting that the risk to their individual operation was quite low. Others felt that since FMD has not been seen in the US for so many years, any future appearance was unlikely and thus the risk posed by FMD was very low. Through the qualitative analysis, producers´ responses were distilled down to three aspects of risk perception measured at two different levels: overall risk, likelihood of an outbreak of FMD, and the magnitude of the consequences at the level of both the US cattle industry and the individual producer.

The last factor which emerged from the qualitative analysis was moral norms. Moral norms reflect beliefs about what you should do, regardless of what other people think.[80] Many of the producers interviewed expressed a deep responsibility for the health and care of their animals and would comment that it was their duty to provide for their animals´ health and well being. One large feedlot manager noted during his discussion of the challenges in restricting movements into and out of the feedyard, “Those cattle, we have a moral responsibility to even care for the cattle that will be depopulated until such time as their demise comes. So we have to be able to get in trucks with grain." The specific moral norms identified for each behavior are shown in **Table 2**.

Quantitative Survey Design

Once the theoretical frameworks were completed, the research team developed survey drafts which included close-ended questions, designed to allow for quantitative assessment of the relationships expressed in the framework. Initial survey drafts had seven pages of questions for each behavior of interest, plus five additional pages of questions related to trust and risk perception, and two pages of demographics. The survey drafts were presented to the workshop participants for review, and the participants concluded that only two behaviors could be assessed in a single survey due to length. Given the large number of cow-calf producers found in Texas, the decision was made to administer two separate surveys, each assessing two behaviors, to two separate samples of cow-calf producers.

The first survey included questions related to requesting veterinary examination of cattle with clinical signs of FMD when an outbreak of FMD was not present, and for the behavior of gathering and holding cattle at the date and time requested by authorities. The second survey included the same questions related to requesting veterinary examination of cattle with clinical signs of FMD during an outbreak of FMD in Texas, and for compliance with animal movement restrictions during an outbreak of FMD. Through discussion at the workshop, scenarios were developed to help introduce each behavior, while defining the target, action, context, and time of the behavior of interest. The scenarios for each behavior of interest are listed in **Table 3**.

Table 3 – Scenarios developed to clarify the target, action, context, and time for each behavioral intention question for cow-calf producer surveys. First and second scenarios and corresponding questions were included on one questionnaire (Survey 1), while the remaining two scenarios and corresponding questions were administered with a second questionnaire (Survey 2).

Behavioral intention	Scenario
Ask a veterinarian to examine cattle with signs of FMD prior to FMD outbreak	It has come to your attention that **many**[a] of the cattle in your herd appear depressed and seem reluctant to move. Several of the animals are noticeably lame. Some of the depressed animals appear to be drooling.
Gather and hold cattle at date and time requested	*Foot-and-mouth disease is a very easily spread, viral disease that affects cattle, sheep, goats, pigs, llamas, alpacas, and deer. It does not affect humans.* An outbreak of foot-and-mouth disease has been reported in your area. Cattle which reside within a certain distance from the infected herd must be inspected and tested for the disease. Herds that have an animal test positive for foot-and-mouth disease, as well as their neighboring herds will be killed in order to control the spread of the disease. All susceptible animals including cattle, sheep, goats, pigs, llamas, alpacas, and deer may be killed. You are contacted by state and federal authorities and asked to gather and hold your cattle for inspection and testing at a date and time designated by the authorities.
Ask a veterinarian to examine cattle with signs of FMD during FMD outbreak	An outbreak of foot-and-mouth disease has been detected in Texas. Herds that have an animal test positive for foot-and-mouth disease, as well as their neighboring herds, will be killed in order to control the spread of the disease. All susceptible animals including cattle, sheep, goats, pigs, llamas, alpacas, and deer may be killed. The clinical signs of foot-and-mouth disease are drooling, lameness, fever, loss of appetite, and the formation of blisters in the mouth or at the top of the hooves. It is brought to your attention that **many** of the cattle in your herd appear depressed and seem reluctant to move. Several of the animals are noticeably lame. Some of the depressed animals appear to be drooling.
Maintain cattle in their current location during an outbreak of FMD	Once foot-and-mouth disease is identified in Texas, producers will be told to restrict the movement of anything that could spread the disease. These movement restrictions may last for many weeks. These movement restrictions will cover susceptible animals (e.g. cattle, sheep, goats, pigs, llamas, alpacas, and deer), as well as products (i.e. milk, meat, hides) from these animals. In addition, the movement of vehicles, including feed trucks, and personnel will also be restricted. People, other types of animals, vehicles, and equipment may only be allowed to move following an extensive disinfection process that involves the application of an appropriate chemical disinfectant and a mandatory wait period before coming into contact with susceptible animals.

[a] All bolded or italicized text are shown as they were used in the final survey instrument.

Questions were constructed to assess behavioral, control, and normative beliefs, moral norms, and risk perception, with responses measured on a 7-point Likert-like scale, with 1 representing “strongly disagree” and 7 representing “strongly agree.” For behavioral and control belief and moral norm questions, respondents were asked how strongly they agreed or disagreed with each belief or norm (**Table 2**) given the corresponding scenario (**Table 3**). For normative beliefs, respondents were presented with a list of people and agencies and asked for each, how strongly they would or would not expect the respondent to perform the behavior given the corresponding scenario. Questions were also written to assess trust in regulatory agencies. The first question asked how well the respondent felt the agencies listed would manage their role during an outbreak of FMD, with answer choices measured on a 7-point Likert-like scale, with 1 representing “extremely poorly” and 7 representing “extremely well.” The second and third questions included an introductory statement: “I believe that the following agencies <u>have the same goals that I have</u> (<u>or would act in my best interest</u>) in managing an outbreak of foot-and-mouth disease in Texas.” These statements were then followed by a list of agencies which would be involved in FMD detection and response, and respondents were asked how strongly they agreed or disagreed with the introductory statement for each of the listed agencies. Questions were also written to assess producers´ overall perception of the risk posed by FMD including: the risk of an outbreak of FMD in the US is very great, the risk of an outbreak of FMD in my operation is very great, an outbreak of FMD would be economically devastating for the US cattle industry, an outbreak of FMD would be economically devastating for my operation, the US is likely to experience an outbreak of FMD in the next 5 years, and my operation is likely to experience an outbreak of FMD in the next five years. For each of these statements, response categories were created on a 7-point Likert-like scale, with 1 representing "strongly disagree" and 7 representing "strongly agree." The final survey instruments were each 24-pages long. Survey 1 is presented in Appendix A.

Discussion

Foot-and-mouth disease (FMD) is an excellent example of a highly contagious disease that can spread quickly through naïve wild and domestic cloven-hoofed, animal populations if control and eradication measures are not immediately put into place. Effective planning, implementation, and evaluation of risk communication related to outbreaks of highly contagious diseases such as foot-and-mouth disease (FMD) requires an understanding of not only the behaviors to be encouraged, but also the underlying social and psychological processes influencing those behaviors.[26,27,53] The purpose of this phase of the study was to identify behaviors related to FMD detection and control for which producer compliance may be reduced, to elicit the salient beliefs which may affect producers´ intentions to perform these behaviors, and to use these to develop a quantitative questionnaire designed to assess the relative importance of these beliefs.

A qualitative approach was used for the study because it allows for an in depth examination of behavior and the underlying beliefs which influence how people behave. However, because we were interested in further exploring the relative importance of the factors with a quantitative study, a deductive approach to content analysis was used.[76] Numerous social-psychological theories have been designed to predict and understand health-related behavior (e.g. Health Belief Model[61], Protection Motivation Theory[62], or the Theory of Reasoned Action[63]). For the purposes of this study, the Theory of Planned Behavior[64] (**Figure 1**) was used as the foundation for the development of an appropriate social-psychological framework for understanding cattle producers' behavior during an outbreak of FMD. The components of the Theory of Planned Behavior were chosen to serve as the initial framework for our qualitative analysis for several reasons. The Theory of Planned Behavior has been used to examine a wide range of behaviors. Armitage and Conner[72] reviewed 185 studies in which the TPB was used and found that the model "accounted for, on average, 27% and 39% of the variance in behavior and intention, respectively." In comparisons of the motivational models commonly used to assess the social cognitive factors influencing behavior, the Theory of Planned Behavior has been shown to be the superior predictor of intentions and behavior, offering an improvement on the Health Belief Model, Social Cognitive Theory, and Protection Motivation Theory.[81] Additionally, Beck and Ajzen examined three dishonest behaviors: cheating, shoplifting, and lying, using the Theory of Planned Behavior. They found that the proportion of variance in behavioral intentions accounted for by the TPB ranged from 62 to 69%. The addition of either moral norms or past behavior accounted for an additional 3 to 7% of the variance.[82] For the purposes of our study, we were interested in examining producer behaviors which could be viewed as illegal or dishonest. The ability to use a model which has already been validated for dishonest actions adds confidence to our final framework. In addition, the Theory of Planned Behavior includes a measure of perceived behavioral control and has been shown to be more useful in predicting behaviors which are under less volitional control.[64,72,83,84] Perceived behavioral control is assumed to take into account perceptions about a variety of external influences on behavior, such as the availability of information, skills, resources, and barriers,[69] with considerable roots in Bandura´s concept of self-efficacy.[85] During an outbreak of FMD, cattle producers will have many constraints which may affect their intentions to behave, including limitations in knowledge and the availability of resources. The Theory of Planned Behavior allows for these constraints to be taken into account.

Lastly, the Theory of Planned Behavior allows for the prediction of a person's intention to perform a particular behavior. Behavioral intentions are commonly used as a proxy for behavior in situations where actual measures of behavior would be inappropriate or difficult to obtain.[86-88] Behavioral intentions are generally defined as a readiness to engage in a behavior, and are assumed to encompass concepts such as willingness, behavioral expectation, and trying.[69] A meta-analytic review of the Theory of Planned Behavior conducted in 2001 found that the theory accounted for on average, 27 percent of the variance in subsequent behavior and 39 percent of the variance in intention to behave.[72] However, careful construction of the measures used to assess the theory´s components have achieved much higher correlations of intention with behavior and accounted for much more variance in intention to behave.[89-91] In the instance of an outbreak of FMD in the United States, the ability to predict a producer's intention to comply or not comply with disease control measures prior to an actual outbreak has significant implications for emergency preparedness and risk communication.

The behaviors of reporting clinically sick cattle, gathering and holding cattle for testing, depopulation, or vaccination, and observing a movement ban were identified by study participants as key behaviors for which producer compliance could be reduced, and by the research team as behaviors which could be explored further using a quantitative questionnaire. Since FMD is not present in the US, measures of producers´ actual behavior are impossible to obtain, and behavioral intentions can serve as a useful proxy. According to Fishbein and Ajzen[69], the most important prerequisite for predictive validity of behavioral intentions is the level of compatibility between the measures of intention and the actual behavior in terms of their level of generality or specificity.[69] This has significant implications for our ability to predict producers´ behavior during an outbreak of FMD, based on measures of behavioral intention. For each behavioral intention measure, the target, action, context, and time must be clearly defined, and any additional factors measured for that behavior (beliefs, attitudes, subjective norms, and perceived behavioral control) must be measured with the same degree of specificity as the behavioral intention.[92] We found that, for our behaviors, defining the context of the behavior was particularly important. Since many producers may be unfamiliar with current emergency response plans for Texas, the context within which they would interpret the behaviors listed above could be highly varied. Similarly, information which producers do not currently have would be made widely available during an actual outbreak, and this information would likely have a serious impact on producers´ decision making. Based on these observations, we decided to introduce each behavioral intention question with a short scenario, which would define the context for the producer. Using the results from the qualitative analysis and discussions with personnel from animal health regulatory agencies involved in the survey design workshop, we developed scenarios which define the target, action, context, and time for each behavior of interest. All quantitative questionnaire items were then written to have the same degree of specificity as defined by the scenarios. Obviously, a disease outbreak is an evolving situation and at any point in time, producers could be faced with many different situations and contexts. We feel that the theoretical frameworks developed in this study are likely to be useful in predicting producers´ behavior in numerous situations that occur during an outbreak of FMD; however, the relative importance of any single construct could vary significantly based upon the specific situation. For example, an examination of levels of trust in the government, risk perception, and intention to adopt protective measures during the influenza A (H1N1) pandemic in the Netherlands, found that in the early phase of the pandemic intentions to adopt protective measures were associated with increased trust in the government, fear and worry, and perceived vulnerability. However, as the pandemic went on, intentions were associated only with the receipt of information.[93]

Although social-psychological models, such as the Theory of Planned Behavior, are often used for predicting behavior, they are also used to explain why people perform a behavior. For each of the key behaviors identified in this study, sets of salient or accessible beliefs were also identified. Not surprisingly, beliefs about the economic consequences of performing each behavior were noted for all behaviors. However, we also identified numerous emotional consequences to compliance, including concerns about the possibility of depopulation or animal suffering and that compliance can make producers feel better about how they manage their animals. These emotional consequences were included in our framework as relevant behavioral beliefs. Similar to the appeals of producers during the 2001 UK outbreak of FMD, participants pointed out that they wanted to know if their herd was infected or not, and the availability of a diagnosis could affect their willingness to gather and hold animals for slaughter, for example. Rapid, large-scale serological sampling was conducted during the 2000 outbreak of FMD in Japan, and it has been suggested that the assurance producers received from negative test results was important to the overall disease control process.[94] Continued improvements in FMD diagnostics, including the possibility of a decentralized laboratory network and pen-side tests, mean that producers´ expectations of test results prior to depopulation of infected or at-risk herds are likely to continue to increase.

The control beliefs identified during this study generally focused on the practical measures needed to comply with FMD detection and control. Reporting cattle to a veterinarian requires that a qualified veterinarian be available in that geographical area, and that the producer has a good relationship with the veterinarian. Producers need to know the clinical signs to watch for and who to call if disease is suspected. Interestingly, our analysis found that participants felt that they needed to know which cattle were most at risk of FMD, in order to better interpret the gravity of the appearance of certain clinical signs. Since many diseases which do occur in the US can have clinical signs consistent with FMD, producers may be dismissive of certain clinical signs based on their own estimation of the most likely cause. This is consistent with other studies that have found that producers´ perception of the risk of a foreign disease influences their interpretation of clinical signs and willingness to report sick livestock.[60,95] Our analysis also found that producers had concerns about the availability of the facilities, manpower, and finances necessary to gather and hold cattle, and the feed and space necessary to keep cattle in one location for a prolonged period of time. Not surprisingly, given the diversity of landscape and production practices in Texas, our analysis found that some participants believed that semi-feral cattle kept under extensive-rearing conditions would be very difficult to gather or hold. Participants were also concerned about the ability to set up appropriate disinfection measures for themselves in order to continue caring for animals that could not be moved.

Our analysis with respect to normative beliefs was focused on identifying a list of people who producers´ felt had expectations about their behavior. Animal health regulatory agencies, county extension agents, the surrounding community, professional organizations, other producers like themselves, leaders in the cattle industry, family, business partners/associates, veterinarians, and neighbors were all identified as sources of social pressure for compliance with FMD detection and control. Similar to recent reviews of the role of subjective norms in influencing behavior, our analysis suggests that both injunctive and descriptive norms are important influences of producers´ compliance with FMD detection and control.[71]

In addition to the traditional components of the Theory of Planned Behavior, the analysis indicated that moral norms were an important influence of producers´ behavior.

Numerous studies have suggested that the incorporation of moral norms strengthens the predictive ability of the Theory of Planned Behavior. In the study examining intentions regarding lying, shoplifting, and cheating, the authors found that moral norms were able to predict intentions independently, and that moral norms were able to predict later behavior independently of intentions or perceived behavioral control.[82] Moral norms combined with a measure of anticipated regret were found to explain an additional 10-15% of the variance in drivers´ intentions to commit traffic violations.[96] Moral norms have also been found to be a significant predictor of nurses´ intentions to report instances of inadequate patient care.[97] McIntosh et al.[59] examined the use of antimicrobials by feedlot veterinarians in four different situations (the treatment of acutely sick cattle, chronically sick cattle, at-risk cattle, and high-risk cattle). They found that moral norms were significantly correlated with veterinarians´ beliefs about the efficacy and perceived economic necessity of using antimicrobials in each of these clinical situations.[59] Given the complex interplay between animals and their caregivers in the agricultural context, moral norms are likely to play important roles in understanding producer behavior.

Trust in both regulatory agencies and other producers, as well as perceptions of the risk posed by FMD, were also influencers of cattle producers´ behavior. Trust and risk perception have been identified as influences affecting producer behavior related to biosecurity and disease reporting. Elbers et al. found that a lack of trust in government bodies influenced producer reporting of pigs with clinical signs of classical swine fever in the Netherlands.[60] A qualitative study of Australian sheep farmers found that farmers´

decisions regarding reporting and biosecurity measures were often based on the perceived risk to their operation, and that trust in others contributed significantly to perceived risk.[95] Heffernan et al. in a qualitative examination of UK cattle and sheep farmers´ attitudes and beliefs regarding biosecurity identified trust as an important influence affecting farmers willingness to adopt government recommended biosecurity measures.[79]

Understanding the behaviors related to FMD detection and control for which producer compliance may be reduced and the salient beliefs which may affect producers´ intentions to perform these behaviors allowed us to develop a theoretical framework aimed at predicting and explaining behavior. We were not able to make further assessments regarding the framework using the analysis of the qualitative interviews due to the purposive sampling scheme and open-ended, but guided interview format used. As a result, a second stage was required in order to assess the relative importance of each of the components of the final framework using a large-scale, mail-out survey. However, the overall theoretical framework developed in this phase of the study can be used to assess producers´ currently held beliefs prior to an actual outbreak, in order to identify areas where improved planning or communication can enhance producer cooperation. In addition, the framework could be applied during an outbreak to help identify barriers to disease detection and control which can be addressed through changes in policy, communication, or the allocation of resources.

The relative importance of the components of the theoretical framework developed in this study is likely to change over the course of an outbreak, particularly as disease control policy is adapted or changed. In particular, the emotions that producers experience during the outbreak response process could have significant effects on their behavior. Although this study identified some behavior-specific emotions as significant influences of behavior, generalized mood states, or affective states, such as sadness or happiness can also influence attitudes and behaviors.[98] In general, these influences can be seen as systematic effects in which positive moods make us view events more favorably, with positive outcomes more likely to occur; while conversely, unpleasant affective states would increase the likelihood and negative valence of undesirable outcomes.[69,99-101] These moods can influence the kinds of behavioral and normative beliefs which are readily accessible, the salience of control factors and overall perceptions of control, and motivation to comply.[102-104] However, the affective states may not always influence beliefs which are relevant to a given behavior, or they may not influence them strongly enough to affect global measures of attitude or perceived behavioral control, resulting in weak and inconsistent effects on intentions and behavior.[69] Studies have shown that qualitative studies focused on the solicitation of beliefs may not elicit emotional reactions.[75,105] This limitation is relevant for this phase of the study, which attempted to examine producer behavior relative to a disease which has been absent from the US for almost a century. As a result, it is possible that the theoretical framework could be strengthened by the inclusion of measures of affective states, particularly during an outbreak, which were not expressed by our study participants simply due to the approach which was taken to solicit beliefs.

Similar to the causal models used in epidemiology, theoretical models play a crucial role in our efforts to understand behavior, and any attempt to understand or explain behavior should have a theoretical basis.[106] The use of the Theory of Planned Behavior as a guide for the analysis of our interviews was beneficial. We found that using a well-established, validated theory helped to clarify the definition and identification of abstract psychological or sociological concepts. Although sociologists and behavioral scientists may not need this assistance, veterinary epidemiologists wishing to incorporate some aspects of theories from social-psychology into their research can benefit from these clear definitions and the abundance of examples in published literature. Similar to the pleas heard in other disciplines, the veterinary community needs to continue to improve the appropriate application and incorporation of methods from social psychology and other social sciences.[74] However, there are very few papers in the veterinary literature which describe or explain the process of developing a theoretical framework for explaining intentions or behavior utilizing qualitative methodology.

Gunn et al.[57] studied constraints to biosecurity among British farmers, veterinarians, and auxiliary industries. The analysis of their focus group discussions was based on a “disaggregated” version of the Theory of Reasoned Action. However, despite well-established criticisms regarding the adequacy of this model,[74] they did not adapt or extend the model. In addition, they were unable to quantitatively assess the overall model, despite the use of a postal survey. Elbers et al. [60] utilized focus group sessions in order to explore why pig farmers in the Netherlands decide to report or not report clinically suspect cases of notifiable diseases. Although numerous themes were identified, a theoretical framework was not developed which would allow for the exploration of the effect of the identified themes on farmer behavior. Ellis-Iversen et al.[107] presented the adaptation of a socio-ecological model into the Pathway to Disease Control Model, while assessing Welsh farmers´ implementation of zoonotic disease control measures. In their study, qualitative analysis of farmer interviews was used to develop the model, while a more quantitative approach to analysis of the same interviews was used to validate the model. Although it is not surprising that the model developed from interviews with a subset of farmers would be valid in the same subset of farmers, the validation results support the use of qualitative analysis in model development. In addition, as a result of their work, the Pathway to Disease Control Model can now be used to explore other disease control programs. The limitations noted in these studies, the present study included, highlight the challenge of incorporating methods from social-psychology into the exploration of animal health-related issues. Additional examples are needed in order to continue to improve the application of this methodology in the veterinary field.

Qualitative analysis of cattle producer interviews combined with a stakeholder workshop were useful tools for the development of a theoretically sound framework, which can be quantitatively assessed to examine both producers´ intentions to behave and the underlying beliefs influencing those intentions. In addition, the involvement of cattle producers, regulatory officials, industry organizations, and veterinarians allowed for the development of a stakeholder-driven questionnaire instrument. The behaviors which were identified for modeling included: requesting veterinary examination of cattle with clinical signs consistent with FMD before or during an outbreak, willingness to gather and hold cattle at a requested date and time, and compliance with a movement ban. Qualitative analysis identified important attitudes and beliefs as influencers of behavior, in addition to other factors such as trust in neighbors and regulatory agencies, moral norms, and risk perception. The final theoretical framework and quantitative questionnaire developed in this study can be useful tools for assessing currently held beliefs about FMD detection and control, as well as, identifying barriers to producer compliance during an actual outbreak. The results of this approach can be useful for improving emergency response planning, disease control policy, and communication with the cattle producer industry.

CHAPTER IV

COW-CALF PRODUCERS´ BELIEFS REGARDING REPORTING CLINICALLY SUSPECT CATTLE PRIOR TO AND DURING AN OUTBREAK OF FMD

Introduction

Foot-and-mouth disease is a highly contagious disease, affecting cloven-hoofed livestock. The disease was last eradicated from the United States (US) in 1929, and since then, livestock in the US have had no exposure to FMD or FMD vaccines, rendering them highly susceptible to infection.[3] Despite low mortality rates, the economic costs associated with an outbreak of FMD can be enormous in countries which have been previously free of the disease. In addition to losses in animal health and productivity, an outbreak of FMD in the US would result in immediate international trade embargoes for all susceptible species and related products.[29] Recent estimates from the North American Animal Disease-Spread Model indicate that even a relatively small outbreak confined to small pig farms would cost the US from 2 to over 4 billion dollars in total trade losses and control costs.[30] To help mitigate these consequences, any introduction of FMD into the US must be quickly identified and control and eradication measures immediately put into place.

The effective detection and control of an outbreak of FMD in the US will require a strong partnership between the animal agricultural industry, private veterinarians, and US state and federal governments. United States response plans for highly contagious diseases rely heavily on the willingness of livestock producers to serve important roles in the prevention, detection, response and eventual eradication of disease. For example, a significant component of the surveillance for FMD in Texas rests on livestock producers recognizing that something is wrong with their livestock and requesting that a veterinarian examine their animals.[31] This method of detecting the presence of FMD is commonly used in countries which are free of the disease, and one of the benefits of this type of surveillance with passive data collection is that it allows for the coverage of the entire susceptible animal population under owner or veterinary observation at a low cost.[108] However, when the disease has been absent from a country for a lengthy period of time, passive surveillance may not be effective in identifying a disease outbreak, especially as owners´ and veterinarians´ familiarity with clinical signs declines.[109] An analysis of all outbreaks of FMD in non-endemic countries from 1992-2003, found that of the outbreaks for which detailed information could be obtained regarding how the outbreak was detected, 53% were discovered as a result of a farmer alerting a private veterinarian or the authorities to a problem in their herd.[15] Reasons for delayed detection during these outbreaks ranged from misdiagnosis or a failure to detect mild clinical signs to concealment of sick livestock by producers. Carpenter et al. modeled the economic and epidemic impacts of a delayed diagnosis of FMD following introduction into a large dairy herd in California using a spatial, stochastic, individual-animal-based model. They found that as the delay in detection increased from 7 to 22 days, the median number of herds under quarantine increased from 680 to 6,200 and the number of animals slaughtered went from 8,700 to over 260,000. The median economic impact increased from $2.3 billion to $69.0 billion in national agricultural welfare losses. Assuming a 21 day detection delay, the authors found that each additional 1 hour delay in detection led to the slaughter of an additional 2,000 animals and an additional economic loss of $565 million. The authors concluded that given the interconnected nature of US cattle production, the early detection of FMD is essential to avoid dramatic losses in both livestock numbers and the economy.[110]

More recently, socio-psychological factors have been explored and identified as possible predictors of delayed reporting. A study examining the reporting of pigs with clinical signs of classical swine fever in the Netherlands found that factors such as a lack of knowledge of early clinical signs of the disease were important; however, additional factors such as farmers´ negative opinions of disease control measures, negative emotions associated with going through the reporting process such as guilt or shame, and a lack of trust in government bodies also appeared to play an important role in influencing reporting.[60] A qualitative study of Australian sheep farmers found that farmers´ decisions regarding reporting and biosecurity measures were often based on the perceived risk to their operation, and that trust in others contributed significantly to perceived risk.[95] A qualitative examination of UK cattle and sheep farmers´ attitudes and beliefs regarding biosecurity and current/proposed disease prevention and control legislation found that less than 50% of the farmers interviewed indicated that the recommended biosecurity measures were desirable. Study results suggested that the distrust of government bodies led farmers to perceive government-derived messages as untrustworthy or lacking in credibility. Farmers were dismissive of biosecurity measures, in part because they felt the blame for foreign diseases was largely related to ineffective regulations and inadequate border control, rather than to farm management practices they could actually influence.[79]

The purpose of this chapter is to describe and compare Texas cow-calf producers´ current beliefs about the consequences of, barriers to, and social pressures for asking a veterinarian to examine cattle with clinical signs of FMD, prior to and during an outbreak of FMD. Based on the qualitative interviews presented in the previous chapter, producers may view the act of reporting clinically suspect cattle differently before or during an outbreak of FMD. A strong understanding of cattle producers´ currently held beliefs can help to improve communication and education and enhance the early detection of highly contagious diseases.

Materials and Methods

Survey Design

As described in Chapter III, quantitative surveys were developed based on qualitative analysis of interviews with Texas cattle producers, regulatory animal health officials, private veterinarians, sociologists, and veterinary epidemiologists. Interviews were used to identify behaviors where producer compliance may be reduced, as well as behavioral beliefs (beliefs about the consequences of performing a behavior), control beliefs (beliefs about the ease or difficulty of performing a behavior), and normative beliefs (belief about what others expect you to do) which interviewees suggested may influence producer behavior. A two-day stakeholder workshop was held to evaluate the initial questionnaire drafts for relevancy and accuracy and to develop the final wording of the questionnaires.

The first survey included questions related to the behavior of gathering and holding cattle at the date and time requested by authorities when an outbreak has been identified, while the second survey included questions related to the behavior of maintaining cattle in their current location during an outbreak of FMD in Texas. The final section of each survey solicited basic demographic information on the respondents including age, gender, operation size, education level, and prior experience with disease control programs. The questions regarding each behavior were introduced with a short scenario which defined the target, action, context, and time of the behavior of interest (**Table 3**).

Survey Distribution

Cow-calf producers were identified from a comprehensive list of active cattle producers in Texas maintained by the National Agricultural Statistics Service (NASS). Cow-calf producers were defined as those who keep one or more beef cows. Producers were stratified on the basis of National Agricultural Statistics Service (NASS) district and herd size within district. A map of the 15 Texas NASS districts is available online[111] and printed in Appendix D. Herd size categories included 1-9 head, 10-19 head, 20-49 head, 50 to 99 head, 100-199 head, 200 to 499 head, and 500 head or greater. A total of 2,018 producers were randomly selected to receive Survey 1 and 2,022 producers received Survey 2. The samples were drawn and all questionnaire-related material mailed by NASS. All personally identifiable information was removed from the survey forms that were returned in accordance with NASS's confidentiality standards.

A four-part mail out of the surveys using a modified tailored design method[112] began on October 28, 2008. Producers received a pre-survey letter informing them that they had been selected to participate in the study. This letter was followed by the actual survey and accompanying cover letter mailed on November 19, 2008. Reminder postcards were sent on December 3, 2008. A final survey and second cover letter was sent to non-responders on January 6, 2009. The final cutoff date for receipt of survey responses was May 31st, 2009. Data were entered twice by hand by two independent data entry workers into commercially available database software and compared for accuracy.

Statistical Analysis

All data were analyzed by use of a commercial statistical software package (STATA-IC version 11.0 for Windows, StataCorp LP, College Station, TX) to provide the frequencies of responses to each question while taking into account the complex survey sampling design. Survey response codes were created for each category of survey response (invalid address, completed survey, does not wish to participate, no longer involved in cattle industry), and a one-way analysis of variance by ranks (Kruskall-Wallis test) was used to assess differences in the median across response categories between survey 1 and 2.

Data were declared to be survey data with a single sampling stage, and each district/herd size combination was considered a stratum for a total of 105 strata. Initial sampling weights were calculated as the inverse of the probability for selection for each stratum. Sampling weights were then adjusted for unit non-response by partitioning the data based on stratum and calculating the response rate for each stratum. The reciprocal of the stratum response rates (number sampled per stratum/responses per stratum) were then multiplied by the initial weight to determine the non-response adjusted weight.[113] Response proportions and confidence intervals for each response category (on the Likert-like scale) for the belief statements were determined using the proportion command of STATA. Standard errors were calculated using the analytically-derived variance estimator.[114] Since questions related to normative beliefs included "does not apply" as an answer choice, the total number of respondents who answered each question was noted. Since most of the belief responses resulted in non-normally distributed, ordinal data, the un-weighted Kruskall-Wallis test was used to assess differences in the median across answer categories between scenarios. Values of $p < 0.05$ were considered significant.

Results

Of the 2,018 producers selected to receive Survey 1, 58 (3%) producers no longer had valid Texas addresses. For Survey 2, of the 2,022 producers selected, 41 (2%) no longer had valid Texas addresses. Consequently, Survey 1 was delivered to 1,960 producers with 833 (43%) surveys returned, while Survey 2 was delivered to 1,981 producers with 832 (42%) returned. Among the surveys returned for Survey 1, 226 (12%) indicated that they did not wish to participate in the survey, and 83 (4%) indicated that they were no longer involved in the cattle industry. For Survey 2, 188 (9%) indicated that they did not wish to participate in the survey, and 73 (4%) indicated that they were no longer involved in the cattle industry. As a result, 524 of the 1,960 (27%) producers who received Survey 1, and 574 of the 1,981 (29%) of the producers who received Survey 2, indicated that they were involved in the cattle industry, completed the survey, and were included in the analysis. A one-way analysis of variance by ranks (Kruskall-Wallis test) revealed no significant difference (p value = 0.14) in frequencies of responses within the four response categories (invalid address, completed survey, does not wish to participate, no longer involved in cattle industry) between the two surveys.

Demographic Variables

The demographics of survey respondents were determined for both Survey 1 and 2 (**Table 4** and **Table 5**). In general, the characteristics of respondents were very similar for both surveys. Five districts[111] (Cross Timbers, Blacklands, North East Texas, South East Texas, and South Central) accounted for 71% and 73% of the proportion of respondents for Survey 1 and 2, respectively. This distribution is consistent with the distribution of beef cattle in Texas, when the large feedlot area in northern Texas is excluded.[115] The majority of respondents kept less than 50 head of beef cows, while only 17% of respondents in each survey kept more than 100 head, and approximately 75% of respondents kept less than 20 head of steers or stockers. A high proportion of respondents characterized their production practices as “conventional cow-calf” (93% and 87% for Survey 1 and 2), while 10% of respondents in both surveys indicated they were seedstock producers. Among the less common production practices, grass finishing cattle was the most commonly reported (20 and 21% for Survey 1 and 2), followed by age-and-source verification (6% and 5% for Survey 1 and 2) and natural or non-certified organic production (4% and 7% for Survey 1 and 2.)

Table 4 – Characteristics of respondents´ cattle operations for Survey 1 and 2. Weighted proportion of responses to demographic questions regarding the respondents´ operation for Survey 1 (n=524) and 2 (n=574).

		Weighted Proportion of Responses				**Weighted Proportion of Responses**	
Attribute	**Levels**	**Survey 1[a]**	**Survey 2**	**Attribute**	**Levels**	**Survey 1**	**Survey 2**
District	North. High Plains	2%	2%	Number of Steers/ Stocker	None	26%	19%
	South. High Plains	1%	1%		1-9 head	32%	40%
	North. Low Plains	2%	2%		10-19 head	17%	15%
	South. Low Plains	3%	3%		20-49 head	14%	14%
	Cross Timbers	11%	9%		50-99 head	6%	6%
	Blacklands	11%	18%		100-199 head	3%	3%
	North East Texas	15%	12%		200 head or more	2%	3%
	South East Texas	12%	8%				
	Trans-Pecos	1%	1%	Production Practices[a]			
	Edwards Plateau	9%	9%		Conventional Cow-calf	93%	87%
	South Central	22%	26%		Seedstock	10%	10%
	Coastal Bend	1%	1%		Age-and-source verification	6%	5%
	Upper Coast	6%	5%		Branded Beef Program	4%	2%
	South Texas	4%	4%		Natural or non-certified organic	4%	7%
	Lower Valley	1%	1%		Integrated resource management	1%	3%
Operation Size	1-9 head	15%	16%		Stocker	13%	11%
	10-19 head	18%	20%		Grass-finished	20%	21%
	20-49 head	33%	32%		Certified organic	0%	0%
	50-99 head	17%	16%		Holistic Resource Management	1%	1%
	100-199 head	9%	9%		Beef Quality Assurance	4%	4%
	200-499 head	6%	5%				
	500 head or more	2%	2%				

Survey 1 contained questions related to the behavior of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak, and Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas.

[a] Proportions represent the proportion of respondents who indicated that the factor described some aspect of their current production practices.

Target population size for weighted proportions is 94,783 producers.

Table 5 – Characteristics of cow-calf producer respondents for Survey 1 and 2. Weighted proportion of responses regarding characteristics of the respondents for Survey 1 (n=524) and 2 (n=574).

		Weighted Proportion of Responses				Weighted Proportion of Responses	
Attribute	Levels	Survey 1	Survey 2	Attribute	Levels	Survey 1	Survey 2
Gender	Male	88%	91%	Live at same property where cattle are	No	33%	39%
	Female	12%	9%		Yes	67%	61%
Age (years)	Mean	61	61	Time (years) in current operation	Mean	25	27
	(Range)	(20-93)	(28-92)		(Range)	(1-93)	(1-87)
Race	White	96%	96%	Time (years) in cattle industry	Mean	31	33
	Hispanic	4%	4%		(Range)	(1-93)	(3-87)
Education				Member of cattle producer organization	No	72%	71%
	Less than high school	7%	4%		Yes	28%	29%
	High school diploma	36%	35%	Officer in cattle producer organization	No	92%	96%
	Vocational school	6%	6%		Yes	2%	4%
	2-year college degree	12%	15%	Primary motivation for raising or owning cattle			
	4-year college degree	28%	21%		Primary source of income	6%	7%
	Graduate degree	9%	13%		Supplemental source of income	42%	42%
	Professional degree	2%	5%		Pleasure or lifestyle	20%	22%
Percentage of income derived from cattle					Control of excess forage	6%	4%
	<10%	51%	56%		Property tax advantages	15%	16%
	10-19%	22%	19%		Family tradition/ obligation	10%	8%
	20-29%	10%	6%	Prior experience with disease control programs			
	30-39%	4%	9%	Brucellosis	No	60%	58%
					Yes	40%	42%
	40-49%	2%	2%	Bovine tuberculosis	No	88%	88%
					Yes	12%	12%
	50% or greater	11%	8%				

Survey 1 contained questions related to the behavior of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak, and Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas.
Target population size for weighted proportions is 94,783 producers.

The majority of respondents were male (88% and 91% for Survey 1 and 2, respectively), with at least a high school education (93% and 96% for Survey 1 and 2, respectively). The mean age of respondents for both surveys was 61 years with a median age of 59, with a range in ages from the 20´s to the 90´s. Over 50% of respondents in both surveys indicated that less than 10% of their income came from cattle production, while only 11% and 8% indicated that greater than 50% of their income came from cattle production for Survey 1 and 2, respectively. The majority of respondents lived in the same location as where their cattle were held (67% and 61% for Survey 1 and 2.) Respondents had worked on average, 25 and 27 years in their current livestock operation, and 31 and 33 years in the cattle industry overall for Survey 1 and 2, respectively. Less than 30% of respondents were members of a cattle producer organization, and 2% and 4% reported having served as an officer in a cattle producer organization for Survey 1 and 2, respectively. The most common motivation for raising or owning cattle was as a supplemental source of income (42% in both surveys), followed by the pleasure or lifestyle of owning cattle (20% and 22%, for Survey 1 and 2, respectively) and property tax advantages of owning or raising cattle (15% and 16% for Survey 1 and 2, respectively.) In Survey 1, 40% of respondents had previous experience with the federal bovine brucellosis eradication program with 42% reporting previous experience for Survey 2. Only 12% of respondents had prior experience with the bovine tuberculosis eradication program for both surveys.

Behavioral Beliefs

The proportion of responses for each response category (from strongly disagree to strongly agree) for producers´ beliefs were tabulated (**Tables 6 - 8**). Producers´ beliefs about the consequences of requesting veterinary examination for cattle with clinical signs consistent with FMD are shown in **Table 6**. In the absence of a known outbreak (Survey 1), 45% and 36% of respondents strongly agreed and 5% and 4% of producers strongly disagreed that requesting veterinary examination would reduce the economic impact on: 1) their operation and 2) the US cattle industry, respectively. When asked if requesting veterinary examination would: 1) reduce the spread of disease among their cattle or 2) among the cattle in their area, 36% and 51% of producers strongly agreed, and 3% and 2% of producers strongly disagreed, respectively, with these potential consequences. Over 60% of respondents strongly agreed that requesting veterinary examination would allow them to know the cause of disease in the herd, with only 4% strongly disagreeing. When asked if requesting veterinary examination would: 1) improve the well being of their cattle, 2) the productivity of their cattle, and 3) the profitability of their operation, 56%, 47%, and 39% of respondents strongly agreed, respectively. Only 3% of respondents strongly disagreed with these consequences. Over 50% of respondents strongly agreed that requesting veterinary examination would make them feel better about how they manage their cattle, and 28% strongly agreed that requesting veterinary examination would delay their ability to sell cattle.

Table 6 – Cattle producers´ behavioral beliefs about the consequences of requesting veterinary examination of cattle with clinical signs of FMD in the absence of (pre-outbreak) and during a hypothetical outbreak of FMD in Texas.

			Weighted Proportion of Responses (95% Confidence Interval)							
Behavioral Belief		**n**	**Strongly Disagree**	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**	**P value[a]**
Reduce the economic impact on my operation	*Pre-outbreak[b]*	519	5% (2-8%)	2% (0-4%)	2% (0-4%)	7% (3-10%)	11% (7-16%)	28% (22-34%)	45% (38-52%)	
	During outbreak	566	12% (8-16%)	8% (4-12%)	3% (1-5%)	10% (6-13%)	11% (7-16%)	25% (19-32%)	31% (25-37%)	<0.01
Reduce the economic impact on the US cattle industry	*Pre-outbreak*	518	4% (2-6%)	2% (0-4%)	3% (0-5%)	10% (6-13%)	19% (13-24%)	27% (20-33%)	36% (30-43%)	
	During outbreak	567	7% (3-10%)	2% (0-3%)	4% (1-7%)	9% (4-13%)	14% (9-18%)	27% (21-33%)	38% (32-45%)	0.01
Stop the spread of disease within my operation	*Pre-outbreak*	517	3% (1-5%)	2% (0-0.4%)	3% (1-5%)	10% (6-13%)	19% (13-24%)	27% (20-33%)	36% (30-43%)	
	During outbreak	565	7% (4-10%)	6% (3-10%	3% (1-5%)	5% (2-8%)	14% (8-19%)	21% (15-26%)	44% (37-51%)	<0.01
Stop the spread of disease among cattle in my area	*Pre-outbreak*	519	2% (1-4%)	2% (0-3%)	3% (1-5%)	3% (1-5%)	13% (9-18%)	26% (20-33%)	51% (44-58%)	
	During outbreak	568	4% (1-7%)	3% (0-5%)	2% (0-4%)	4% (2-6%)	15% (9-20%)	29% (22-35%)	44% (37-50%)	0.96
Allow me to know the cause of disease in my herd	*Pre-outbreak*	519	4% (1-6%)	1% (0-3%)	1% (0-1%)	1% (0-2%)	5% (2-8%)	26% (20-32%)	62% (55-69%)	
	During outbreak	566	5% (1-8%	2% (0-3%)	2% (0-3%)	7% (4-10%)	16% (10-21%)	27% (21-33%)	43% (36-49%)	<0.01
Improve the well being of my cattle	*Pre-outbreak*	518	3% (1-5%)	0% (0-0.2%)	2% (0-3%)	3% (1-6%)	9% (5-13%)	27% (21-34%)	56% (49-63%)	
	During outbreak	568	7% (4-10%)	2% (0-3%)	5% (2-8%)	10% (6-13%)	15% (9-20%)	25% (19-32%)	37% (30-43%)	<0.01
Improve the productivity of my cattle	*Pre-outbreak*	518	3% (0-5%)	1% (0-2%)	1% (0-2%)	7% (3-10%)	12% (8-16%)	29% (23-36%)	47% (40-54%)	
	During outbreak	566	9% (6-13%)	5% (2-8%)	5% (2-7%)	17% (12-23%)	13% (8-17%)	20% (15-26%)	30% (24-37%)	<0.01
Improve the profitability of my operation	*Pre-outbreak*	519	3% (1-5%)	2% (0-3%)	5% (2-8%)	10% (6-14%)	13% (8-18%)	28% (22-34%)	39% (32-46%)	
	During outbreak	567	9% (6-12%)	10% (6-14%)	8% (4-12%)	15% (10-20%)	11% (6-16%)	21% (15-27%)	26% (20-32%)	<0.01
Make me feel better about how I manage my cattle	*Pre-outbreak*	519	3% (1-5%)	0% (0-1%)	2% (0-3%)	4% (2-7%)	9% (5-13%)	29% (22-35%)	53% (46-60%)	
	During outbreak	567	5% (2-8%)	2% (0-2)	2% (0-3%)	7% (4-10%)	14% (9-19%)	30% (24-37%)	40% (34-47%)	<0.01
Delay my ability to sell cattle	*Pre-outbreak*	518	5% (2-7%)	5% (1-8%)	5% (2-9%)	19% (13-24%)	18% (13-23%)	20% (14-26%)	28% (22-35%)	
	During outbreak	564	3% (0-5%)	2% (0-4%)	2% (0-4%)	12% (7-16%)	12% (7-16%)	23% (18-29%)	45% (38-52%)	<0.01

[a] P-values determined by using one-way analysis of variance by ranks (Kruskall-Wallis Test) comparing beliefs pre-outbreak and during outbreak. Questions related to the two scenarios were administered on two separate surveys. Target population size for weighted proportions is 94,783 producers.

Table 7 – Cattle producers′ control beliefs about the barriers to requesting veterinary examination of cattle with clinical signs of FMD prior to and during a hypothetical outbreak of FMD in Texas.

			Weighted Proportion of Responses (95% Confidence Interval)							
Control Belief		**n**	**Strongly Disagree**	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**	**P-value[a]**
I have a good relationship with a livestock veterinarian.	*Pre-outbreak*	516	2% (0-4%)	2% (0-5%)	1% (0-3%)	7% (3-11%)	13% (7-19%)	20% (13-26%)	56% (47-65%)	
	During outbreak	569	1% (0-2%)	1% (0-2%)	6% (1-11%)	8% (4-13%)	13% (8-18%)	23% (16-30%)	48% (40-56%)	0.64
A veterinarian qualified to treat cattle is available in my area.	*Pre-outbreak*	516	1% (0-2%)	1% (0-2%)	0% (0-0%)	1% (0-1%)	8% (3-13%)	26% (18-33%)	65% (56-73%)	
	During outbreak	568	1% (0-2%)	1% (0-2%)	3% (0-8%)	4% (1-7%)	7% (3-11%)	26% (19-33%)	57% (50-65%)	0.68
I know the clinical signs associated with serious livestock diseases.	*Pre-outbreak*	516	3% (0-5%)	3% (1-5%)	7% (2-11%)	9% (5-13%)	34% (24-43%)	29% (21-36%)	15% (10-21%)	
	During outbreak	568	2% (0-3%)	4% (1-7%)	8% (4-13%)	10% (6-15%)	28% (21-34%)	30% (23-38%)	16% (12-21%)	0.35
I know that certain cattle are at greater risk of having disease.	*Pre-outbreak*	516	0% (0-1%)	5% (1-8%)	4% (1-8%)	20% (10-31%)	23% (17-30%)	30% (22-37%)	17% (11-23%)	
	During outbreak	567	1% (0-1%)	2% (0-4%)	4% (2-7%)	31% (23-39%)	22% (16-28%)	24% (18-31%)	16% (11-21%)	0.04
I have a clear understanding of who to call if I suspect a disease outbreak in my operation.	*Pre-outbreak*	516	1% (0-1%)	4% (0-7%)	2% (0-4%)	2% (1-3%)	14% (9-19%)	22% (15-29%)	56% (47-65%)	
	During outbreak	570	2% (0-5%)	1% (0-1%)	3% (0-5%)	4% (1-8%)	9% (4-13%)	31% (24-39%)	50% (43-58%)	0.24
I can restrain my cattle in order to inspect them closely for signs of disease.	*Pre-outbreak*	516	1% (0-2%)	2% (0-5%)	1% (0-2%)	1% (0-2%)	12% (7-18%)	28% (20-35%)	55% (47-64%)	
	During outbreak	569	0% (0-1%)	3% (0-5%)	2% (0-4%)	5% (1-8%)	11% (7-17%)	23% (16-30%)	56% (49-64%)	0.71

[a] P-values determined by using one-way analysis of variance by ranks (Kruskall-Wallis Test) comparing beliefs in the absence of a known outbreak and during outbreak. Questions related to the two scenarios were administered on two separate surveys.
Target population size for weighted proportions is 94,783 producers.

Table 8 – Cattle producers´ normative beliefs about how strongly other people or agencies expect or do not expect them to request veterinary examination of cattle with clinical signs of FMD before and during a hypothetical outbreak of FMD in Texas.

			Weighted Proportion of Responses (95% Confidence Interval)							
Normative Belief		**n[b]**	**Strongly Do Not Expect**	**Mostly Do Not Expect**	**Somewhat Do Not Expect**	**Neither Expect nor Do Not Expect**	**Somewhat Expect**	**Mostly Expect**	**Strongly Expect**	**P-value[a]**
Animal health regulatory agencies	*Pre-outbreak*	493	2% (0-4%)	2% (0-4%)	0% (0-0%)	8% (4-11%)	9% (4-13%)	20% (13-26%)	58% (49-67%)	
	During outbreak	548	1% (0-3%)	1% (0-3%)	0% (0-0%)	5% (2-9%)	8% (4-11%)	19% (13-25%)	63% (56-71%)	<0.01
Your county extension agent(s)	*Pre-outbreak*	495	2% (0-3%)	5% (1-10%)	2% (0-4%)	8% (5-11%)	12% (8-17%)	22% (15-28%)	48% (39-57%)	
	During outbreak	545	2% (0-4%)	2% (0-4%)	2% (0-4%)	5% (3-8%)	13% (9-18%)	24% (18-30%)	48% (40-55%)	<0.01
Your surrounding community	*Pre-outbreak*	492	5% (1-8%)	2% (0-5%)	2% (0-4%)	11% (7-15%)	22% (16-29%)	25% (18-31%)	29% (19-39%)	
	During outbreak	550	4% (0-7%)	2% (0-4%)	2% (0-3%)	11% (7-15%)	17% (12-23%)	29% (22-36%)	32% (25-39%)	<0.01
Your professional organizations	*Pre-outbreak*	447	1% (0-3%)	3% (0-7%)	2% (0-4%)	13% (8-18%)	11% (6-15%)	20% (13-26%)	37% (27-47%)	
	During outbreak	508	2% (0-4%)	1% (0-1%)	0% (0-1%)	13% (9-18%)	14% (8-19%)	19% (12-25%)	39% (32-46%)	0.07
Other cattle producers like yourself	*Pre-outbreak*	499	1% (0-2%)	4% (0-8%)	0% (0-0%)	4% (2-6%)	16% (11-22%)	32% (24-40%)	40% (30-49%)	
	During outbreak	558	1% (0-2%)	1% (0-3%)	0% (0-1%)	5% (2-7%)	15% (10-21%)	27% (20-34%)	48% (41-56%)	<0.01
Leaders in the cattle industry	*Pre-outbreak*	491	1% (0-2%)	4% (0-7%)	1% (0-3%)	6% (3-8%)	10% (6-14%)	23% (16-30%)	52% (43-61%)	
	During outbreak	550	1% (0-2%)	1% (0-3%)	0% (0-1%)	8% (4-11%)	10% (5-14%)	18% (12-23%)	61% (53-67%)	0.04
Your family	*Pre-outbreak*	488	0% (0-2%)	3% (0-6%)	0% (0-0%)	6% (3-10%)	12% (8-16%)	26% (19-33%)	48% (39-58%)	
	During outbreak	549	0% (0-1%)	0% (0-0%)	1% (0-1%)	9% (5-14%)	11% (7-16%)	20% (15-26%)	54% (47-62%)	0.08
Your business partner(s)/ associate(s)	*Pre-outbreak*	386	1% (0-3%)	2% (0-8%)	0% (0-0%)	10% (5-15%)	5% (3-8%)	16% (11-22%)	37% (27-47%)	
	During outbreak	414	0% (0-0%)	0% (0-0%)	0% (0-0%)	9% (5-14%)	4% (1-7%)	14% (9-19%)	41% (34-49%)	<0.01
Your veterinarian(s)	*Pre-outbreak*	499	0% (0-0%)	1% (0-4%)	0% (0-0%)	5% (2-8%)	8% (4-12%)	20% (14-26%)	64% (56-72%)	
	During outbreak	558	0% (0-1%)	1% (0-4%)	0% (0-0%)	5% (2-9%)	6% (3-10%)	18% (13-24%)	68% (61-75%)	0.06
Your neighbor(s)	*Pre-outbreak*	493	1% (0-3%)	3% (0-6%)	2% (0-3%)	12% (5-17%)	11% (7-16%)	26% (19-33%)	40% (30-50%)	
	During outbreak	554	1% (0-2%)	1% (0-4%)	0% (0-1%)	7% (3-11%)	13% (8-17%)	27% (21-34%)	48% (40-56%)	<0.01

[a] P-values determined by using one-way analysis of variance by ranks (Kruskall-Wallis Test) comparing beliefs pre-outbreak and during outbreak. Questions related to the two scenarios were administered on two separate surveys.
[b] N was calculated as the total number of respondents minus the number of respondents who selected "does not apply." Target population size for weighted proportions is 94,783 producers.

When presented with the scenario where an outbreak was already identified (Survey 2), 31% of respondents strongly agreed and 12% strongly disagreed that requesting veterinary examination would reduce the economic impact on their operation, and 38% of respondents strongly agreed and 7% strongly disagreed that doing so would reduce the economic impact on the US cattle industry. When asked if requesting veterinary examination would: 1) reduce the spread of disease among their cattle or 2) among the cattle in their area once an outbreak was identified, 44% of producers strongly agreed with both statements, and 7% and 4% of producers strongly disagreed, respectively, with these potential consequences. Fully 43% of respondents strongly agreed that requesting veterinary examination would allow them to know the cause of disease in the herd, with only 5% strongly disagreeing. When asked if requesting veterinary examination would improve: 1) the well being of their cattle, 2) the productivity of their cattle, and 3) the profitability of their operation, 37%, 30%, and 26% of respondents strongly agreed, respectively, while 7%, 9%, and 9% of respondents strongly disagreed, respectively, with these consequences. Only 40% of respondents strongly agreed that requesting veterinary examination would make them feel better about how they manage their cattle, with 5% of respondents strongly disagreeing. Interestingly, 45% of respondents strongly agreed and 3% strongly disagreed that requesting veterinary examination would delay their ability to sell cattle.

In the absence of a known outbreak, producers were more likely to agree with the positive consequences of disease reporting, including reducing the economic impact on their operation or the US cattle industry, improving cattle productivity, improving their operation´s profitability, or making them feel better about how they manage their cattle. However, once an outbreak had been identified in Texas, producers were less likely to agree with these positive consequences. Producer´s agreement that reporting cattle with signs of FMD would stop the spread of disease among cattle in their area did not differ by scenario (p value= 0.96), while their agreement with the belief that requesting veterinary examination would delay their ability to sell cattle increased during an outbreak (p value= 0.01).

Control Beliefs

Respondents were also asked to express their level of agreement with beliefs about potential barriers to requesting veterinary examination (**Table 7**). In the absence of a known outbreak (Survey 1), 54% of producers strongly agreed that they had a good relationship with a livestock veterinarian and 64% strongly agreed that a qualified veterinarian was available in their area. Only 17% of producers strongly agreed that they know the clinical signs associated with serious livestock diseases, with another 63% somewhat to mostly agreeing, while 29% of respondents strongly agreed that they know that certain cattle are at greater risk of having disease. When asked if they had a clear understanding of who to call if they suspected a disease outbreak in their operation, 52% of producers strongly agreed, with another 38% somewhat to mostly agreeing. Although 53% of producers strongly agreed that they could restrain their cattle in order to inspect them closely for signs of disease, only 1% of respondents strongly disagreed.

When presented with the scenario where an outbreak was already identified (Survey 2), 51% of producers strongly agreed that they had a good relationship with a livestock veterinarian and 62% strongly agreed that a qualified veterinarian was available in their area. Only 18% of producers strongly agreed that they know the clinical signs associated with serious livestock diseases, with another 58% somewhat to mostly agreeing, while 17% of respondents strongly agreed that they know that certain cattle are at greater risk of having disease. Similar to the results prior to an outbreak, when asked if they had a clear understanding of who to call if they suspected a disease outbreak in their operation, 52% of producers strongly agreed, with another 39% somewhat to mostly agreeing. Almost 60% of producers strongly agreed that they could restrain their cattle in order to inspect them closely for signs of disease when an outbreak was known to be present.

The majority of beliefs about potential barriers did not differ significantly based on whether or not a FMD outbreak was known to be present, including the availability of a livestock veterinarian in their area, having a good relationship with a livestock veterinarian, knowing the clinical signs associated with serious livestock diseases, the ability to physically restrain their cattle to inspect them closely for signs of disease, and knowing who to contact if a disease outbreak was suspected. However, producers were less likely to agree (p value=0.025) that they knew that certain cattle are at greater risk of having disease once an outbreak was known to be present.

Normative Beliefs

Lastly, producers were asked how strongly they agreed with a series of belief statements concerning how strongly other people and groups expect them to behave (normative beliefs). The proportion of responses for each response category (from strongly disagree to strongly agree) were tabulated (**Table 8**). Cattle producers indicated that in the absence of a known outbreak of FMD (Survey 1), animal health regulatory agencies and their own veterinarians were the groups who most strongly expected them to request veterinary examination of animals with signs of FMD, while the surrounding community and other cattle producers like themselves were the groups who would least strongly expect them to. Once an outbreak had been identified (Survey 2), animal health regulatory agencies, leaders in the cattle industry, and veterinarians were the groups whom producers´ believed would most strongly expect them to request veterinary examination, while the surrounding community was the group who would least strongly expect them to. For all of the groups and people listed, producers´ perceptions of how strongly others expect them to request veterinary examination of cattle with clinical signs consistent with FMD increased when an outbreak was known to be present (p value= 0.02).

Discussion

The importance of early detection of introductions of highly contagious diseases has been repeatedly emphasized;[4,15,60,110,116] however, little research has been done to examine factors which may influence cattle producers´ willingness to report clinically suspect animals.[57,79,117] The purpose of this chapter was to describe and compare Texas cattle producers´ beliefs regarding the consequences of, barriers to, and social pressures for requesting veterinary examination of cattle with clinical signs consistent with FMD, both prior to and during a hypothetical outbreak of FMD. Drawing from the TPB, we know that behavioral intentions are specific to a target, action, context, and time.[64] This would suggest that producer intentions regarding reporting sick cattle to a veterinarian may vary depending on the context of the situation. Based on the qualitative work described in the previous chapter, interview participants suggested that producers′ responses could vary depending on whether or not an outbreak of FMD was already known to be present. So, in addition to describing producers′ currently held beliefs regarding reporting cattle with clinical signs of FMD, we also felt it was necessary to compare these beliefs prior to and during a hypothetical outbreak of FMD.

A strength of this study is that it used a complex sampling strategy to ensure that all areas of Texas and herd sizes within those areas were represented, and the incorporation of sampling weights in the analysis was used to take this sampling strategy into account. Due to the length of the survey instrument (approximately 12 pages/behavior), we decided to create two separate surveys and send them to two separate samples, so that each producer received a survey 24-pages in length. The two behaviors reported in this study were placed on separate surveys in order to avoid repetitiveness within the same survey instrument, since the questions were the same and only the scenario changed. Prior to comparing the results of the two surveys, we analyzed the pattern of response rates within four response categories (invalid address, completed survey, does not wish to participate, no longer involved in cattle industry) for the two surveys, and compared the demographics. No significant differences in response patterns (p value=0.14) were found. Visual comparison of the demographics for the two surveys revealed a remarkable similarity in the characteristics of the respondents. Based on these results, we felt it was appropriate to compare the results from the two surveys overall and more specifically, that the differences seen in the respondents´ answers could be attributed to the differences in scenario used to introduce the questions.

Prior to an outbreak, the majority of producers agreed that requesting veterinary examination would result in positive consequences, such as stopping the spread of disease, improving the productivity and profitability of their operation, and making them feel better about how they manage their cattle. Once an outbreak of FMD had been detected in Texas, producers were less likely to agree with many of these positive consequences. In both scenarios, a large proportion of producers agreed that requesting veterinary examination would stop disease spread in their area, a critical goal of any disease reporting system. However, prior to a disease outbreak, only 66% of producers somewhat to strongly agreed that reporting sick animals to a veterinarian would result in a delay in their ability to sell cattle. This proportion increased to 80%, once the disease was known to be present in the area. These results suggest producers understand the overall aims of reporting FMD. They feel there are both emotional and economic benefits to reporting clinically suspect cattle, and that their intention to request veterinary examination is likely to reduce disease spread among their own animals and in the surrounding area. However, the fact that respondents are less likely to agree with the consequence of delayed sale of livestock suggests there is some confusion about the specific chain of events which may be initiated by a request for veterinary examination. In both of the scenarios employed in this study, the clinical signs listed, while not conclusive for FMD, were certainly highly suggestive. In both scenarios, the delayed sale of any livestock should be expected, particularly since limiting the movement of animals while disease is suspected is a critical step in limiting the size of an outbreak.[15] Producers who do not understand, or cannot anticipate, the chain of events that would follow a request for veterinary examination of animals with signs of FMD may feel uncertain, confused, and/or distrustful of both the veterinarian and the regulatory authorities when they begin to take action. A similar situation was identified in the Netherlands in relation to reporting suspect cases of classical swine fever.[60] As suggested by the Dutch study, increased transparency in both the reporting process and what to expect in the time between when a report is made and a farm is declared free of the disease, would be helpful in both preparing producers and veterinarians for the process and for building and maintaining trust among all the actors involved.[26]

Despite on-going concerns about the lack of rural veterinarians in the US, this study found that 84% of producers somewhat to strongly agreed they have a good relationship with a livestock veterinarian, and 91% somewhat to strongly agreed that veterinary services are available in their area. Although these results are encouraging, the lack of availability of veterinary services for just 9% of the Texas cattle producer population would represent approximately 8,500 producers without veterinary services in their area, based on population sizes from the 2007 NASS Agricultural Census.[118] Our study results suggest that availability of veterinary services, the ability to restrain cattle for inspection, and knowing who to call when a disease outbreak is suspected are not the primary barriers to FMD reporting. Regardless of scenario, less than 20% of respondents strongly agreed they knew the clinical signs associated with serious cattle diseases, and less than 30% agreed they knew which cattle were at greater risk of disease. These results are similar to the results obtained by the 2007-2008 USDA, National Animal Health Monitoring System (NAHMS) nationwide study of beef cow-calf health and management practices. Producers on approximately one-third of operations reported they were fairly knowledgeable about FMD, bovine spongiform encephalopathy, and bovine viral diarrhea (32.5, 26.0, and 31.6% of operations respectively.) The NAHMS study found that for FMD, 33.0% of producers reported they recognized the name but not much else.[117] Given the importance of early detection, producers need to be familiar with the clinical signs that should signal the need to call their veterinarian. Since the early clinical signs of many foreign diseases may be indistinguishable from diseases which are present in the US, producers also need to understand which animals are most at risk of foreign disease introduction. Studies suggest that producers´ perception of the risk of a foreign disease influences their interpretation of clinical signs and willingness to report sick livestock.[60,95] Although educational materials, such as pamphlets and websites, are important tools for raising awareness of disease risk, veterinarians are uniquely situated to help producers understand these materials in the context of the producer´s own livestock operation. Veterinarians can help producers understand which aspects of their livestock operation are most vulnerable to disease introduction, thereby allowing producers to base their perception of the risk on both the epidemiology of the disease and their management practices.

Cattle producers indicated they experience social pressure for reporting cattle with clinical signs consistent with FMD from all of the groups listed on the survey, while veterinarians and regulatory animal health authorities in particular have very strong expectations of reporting. Unfortunately, veterinarians may be reluctant to discuss disease reporting with their clients. Elbers et al. found that veterinarians perceived the consequences of a false alarm to be much more negative on the relationship between a farmer and veterinarian, than the farmer did.[60] An examination of constraints to improved biosecurity in the UK found that veterinarians did not see themselves as significant providers of biosecurity information, and veterinarians were aware of and sympathized with producers´ negative attitudes toward the efficacy and practicality of biosecurity measures.[57] The results of our study supports the role of veterinarians as an important source of perceived social pressure for reporting, and would suggest that in Texas at least, cattle producers already expect pressure from veterinarians to report suspect cases. In contrast to veterinarians, the surrounding community and other cattle producers similar to the respondents were the groups perceived to least strongly expect reporting. Since these groups are the ones with whom producers would interact most frequently, risk communication efforts aimed at raising awareness of the community consequences of disease and the effects of disease outbreaks on "the average operation" may help to augment perceived pressure from these groups.

Texas beef cattle producers´ beliefs regarding the consequences of, barriers to, and social pressures for requesting veterinary examination of cattle with clinical signs consistent with FMD provide important insights into factors which may shape producers´ willingness to report clinically suspect cattle. Our results suggest that producers´ beliefs may vary depending on whether or not an outbreak is already known to be present, and risk communication approaches and strategies should be tailored to the specific situation. However, for both scenarios examined in this study, several common communication needs were identified. Further work is needed to help producers better understand the chain of events which would follow the reporting of a suspect case of FMD, to become more familiar with the clinical signs associated with serious livestock diseases, and to better understand which cattle are most at risk of disease introduction. Veterinarians are seen as a significant source of social pressure for disease reporting, which should be leveraged to create opportunities for improved client communication and education.

CHAPTER V

COW-CALF PRODUCERS´ BELIEFS REGARDING GATHERING AND HOLDING THEIR CATTLE AND OBSERVING ANIMAL MOVEMENT RESTRICTIONS DURING AN OUTBREAK OF FMD

Introduction

Foot-and-mouth disease, as a highly contagious disease of cloven-hoofed animals, can spread rapidly through a naïve population, with commensurate losses in production and international trade. Studies of several past outbreaks of FMD have revealed that the size and severity of an outbreak of FMD are associated with many factors, such as: the time to detection of the introduction of the virus [15,42,43,110], the density of surrounding livestock and herds, the extent of early disease spread, the effectiveness of disease control measures[43-45,119,120], the patterns of animal movements[46,47], the initial species infected (cattle vs. sheep vs. pigs), and the characteristics of the virus itself.[28,121-123]

Many of these epidemiologic factors are beyond the influence of veterinary authorities or livestock producers. However, some of these factors can be directly impacted by the behavior of livestock producers, such as disease reporting and preventing the movement of animals. These behaviors represent important targets for risk communication, since enhanced cooperation can reduce the size and severity of an outbreak. As discussed in the previous chapter, some efforts have been made to understand producers´ beliefs about disease reporting[60,79,95,124] and the consequences of reporting on the severity of an outbreak.[20,110] However, other producer behaviors which could impact the severity of a disease outbreak have received minimal attention.

During an outbreak of FMD, the primary control strategies used are movement restrictions and the rapid slaughter of infected and exposed livestock.[15,42] In some countries, the application of vaccination, with or without the subsequent destruction of vaccinates, has also been applied or explored.[125-129] Two producer behaviors - gathering and holding cattle for testing or slaughter and movement ban compliance - are directly linked to these control strategies, and the success of these strategies rests in part, on the willingness of producers to gather and present their livestock for testing, slaughter, or vaccination, and to obey movement restrictions.

Although gathering and holding cattle may not be problematic in some areas or production systems, cow-calf production in Texas uses predominantly extensive-rearing practices. In addition, due to forage quality or availability, cattle may be stocked at very low stocking densities, allowing the cattle to spread out over huge sections of land. As discussed in Chapter III, gathering cattle on these large properties can require the use of cowboys, dogs, and/or helicopters. Other areas in Texas are covered by thick brush which can make finding and moving cattle very difficult. As a result, producer cooperation in gathering and holding cattle kept under these conditions is essential. During the 2001 outbreak of FMD in the UK, a large number of livestock owners (over 200 in Devon alone) turned to the legal system in order to prevent the death of their animals due to the contiguous culling policy that was in force.[6] Some producers barricaded their farm entrances and refused access to their land, which ultimately required police intervention to resolve.[7] As described in Chapter III, cattle producers´ refusal to gather their cattle for testing continues to be one of the major barriers to the control of the *Boophilus* tick in Texas. Producers may refuse authorities access to their cattle until a judge requires them to comply, which may take up to nine months to resolve.

FMD has traditionally been very difficult to control and eradicate due to the numerous ways which the disease can spread.[29] However, the most common mode of transmission involves the movement of infected animals followed by direct transmission to susceptible animals.[130] Animal movements have been implicated as contributing to the extremely large magnitude of the epidemics in both the UK and Taiwan.[42,120,131] The outbreak in the UK in particular was characterized by the widespread movement of animals through livestock markets prior to disease detection,[4] and some researchers have hypothesized that the movement of animals through markets is the factor most likely to be associated with an extremely large outbreak.[123]

Movement restrictions are used during an outbreak to reduce the spread of disease, and more recently, they have been used prior to an outbreak in order to change the structure of normal animal movement with the hope of limiting the size of future outbreaks.[19] However, cattle producers in the US rely heavily on the ability to move livestock in response to changing feed, weather, and market conditions. Results from a survey examining beef cattle movements in California found that respondents kept cattle at up to five different locations throughout the year. Beef cattle were moved between states more than two times annually, and more than 40% of the reported movements were to sale yards or auction barns.[48] A separate study, focused on exhibitors of livestock at the California State Fair, found that the state livestock fair brought together animals from almost every county within the state, with 97% of the animals participating in the fair expected to return home afterwards. The survey also found that the animals had participated in a median of three events during the past year, and in general, the reported biosecurity practices of the respondents were minimal.[49]

During an outbreak of FMD, movement restrictions can result in significant economic losses for producers as cattle gain past their ideal market weight or deteriorate due to lack of feed or space. Several recent, large-scale outbreaks have highlighted the secondary effects that movement restrictions can have on animal well-being, and the economic costs associated with the killing of animals for welfare reasons.[4,131,132] During the 2001 outbreak of FMD in the UK, at least two and half million animals were slaughtered in response to welfare concerns.[133] Feed and bedding were identified as the scarcest resources,[5] while over 250,000 licenses for movement were issued between March and September of 2001 in order to alleviate crowding and feeding shortages.[134] Despite the impressive efforts of the veterinary services to keep the average response time for license requests under 5 days, the illegal movement of livestock was still feared and suspected.[135] Similarly, during the 2007 outbreak of FMD in the UK, the illegal movement of animals was also reported in the press.[136]

As a result of the complex market structure of the US cattle industry and the potential for animal suffering, producers may experience economic, social, or emotional pressure to move their animals during an outbreak or to resist orders to gather and hold livestock for inspection, depopulation, or vaccination. This purpose of this chapter is to describe cattle producers´ beliefs and perceived pressures for or against movement ban compliance and gathering and holding cattle for testing or inspection. An improved understanding of these beliefs can help to strengthen emergency response planning and communication efforts aimed at enhancing producer cooperation.

Materials and Methods

Survey Design

As described in Chapter III, quantitative surveys were developed based on qualitative analysis of interviews with Texas cattle producers, regulatory animal health officials, private veterinarians, sociologists, and veterinary epidemiologists. Interviews were used to identify behaviors where producer compliance may be reduced, as well as behavioral beliefs (beliefs about the consequences of performing a behavior), control beliefs (beliefs about the ease or difficulty of performing a behavior), and normative beliefs (belief about what others expect you to do) which interviewees suggested may influence producer behavior. A two-day stakeholder workshop was held to evaluate the initial questionnaire drafts for relevancy and accuracy and to develop the final wording of the questionnaires.

The first survey included questions related to the behavior of gathering and holding cattle at the date and time requested by authorities when an outbreak has been identified, while the second survey included questions related to the behavior of maintaining cattle in their current location during an outbreak of FMD in Texas. The final section of each survey solicited basic demographic information on the respondents including age, gender, operation size, education level, and prior experience with disease control programs. The questions regarding each behavior were introduced with a short scenario which defined the target, action, context, and time of the behavior of interest (**Table 3**).

Survey Distribution

As described in Chapter IV, cow-calf producers were identified from a comprehensive list of active cattle producers in Texas maintained by the National Agricultural Statistics Service (NASS). Cow-calf producers were defined as those who keep one or more beef cows. Producers were stratified on the basis of National Agricultural Statistics Service (NASS) district and herd size within district. Herd size categories included 1-9 head, 10-19 head, 20-49 head, 50 to 99 head, 100-199 head, 200 to 499 head, and 500 head or greater. A total of 2,018 producers were selected to receive Survey 1 and 2,022 producers received Survey 2. The samples were drawn and all questionnaire-related material mailed by NASS. All personally identifiable information was removed from the survey forms that were returned in accordance with NASS's confidentiality standards.

A four-part mail-out of the surveys using a modified tailored design method[112] began on October 28, 2008. Producers received a pre-survey letter informing them that they had been selected to participate in the study. This letter was followed by the actual survey and accompanying cover letter mailed on November 19, 2008. Reminder postcards were sent on December 3, 2008. A final survey and second cover letter was sent to non-responders on January 6, 2009. The final cutoff date for receipt of survey responses was May 31st, 2009. Data were entered twice by hand by two independent data entry workers into Microsoft Access and compared for accuracy.

Statistical Analysis

All data were analyzed using a commercial statistical software package (Intercooled STATA version 11.0 for Windows, StataCorp LP, College Station, TX) to provide the frequencies of responses to each question while taking into account the survey sampling design. Data were considered to be survey data with a single sampling stage, and each district/herd size combination was considered a stratum. Initial sampling weights were calculated as the inverse of the probability for selection for each stratum. Sampling weights were then adjusted for unit non-response as described in Chapter IV. Response proportions and confidence intervals for each response category (on the Likert-like scale) for the belief statements were determined. Standard errors were calculated using the analytically derived variance estimator associated with the sample proportion.[114] Since questions related to normative beliefs included “does not apply” as an answer choice, the total number of respondents who answered each question was noted.

Results

Survey Response

Detailed information regarding the survey response rates has been presented in the previous chapter. To summarize, 524 of the 1,960 (27%) producers who received Survey 1, and 574 of the 1,981 (29%) of the producers who received Survey 2, indicated that they were involved in the cattle industry, completed the survey, and were included in the analysis.

Demographic Variables

The demographics of survey respondents were determined for both Survey 1 and 2 (**Table 4** and **Table 5**), and have been described in the previous chapter.

Behavioral Beliefs - Gathering and Holding

The proportion of responses for each response category (from strongly disagree to strongly agree) for producers´ beliefs about the consequences of gathering and holding their cattle at the date and time requested by authorizes were tabulated (**Table 9**). Fully 43% and 44% of respondents strongly agreed and 4% and 1% of producers strongly disagreed that gathering and holding their cattle would reduce the economic impact on: 1) their operation and 2) the US cattle industry, respectively. When asked if gathering and holding their cattle would: 1) stop the spread of disease among their cattle or 2) among the cattle in their area, 53% and 52% of producers strongly agreed, and 3% and 1% of producers strongly disagreed, respectively, with these potential consequences. Over 70% of respondents strongly agreed that gathering and holding their cattle would allow them to know if their herd is infected as well, with only 1% strongly disagreeing. Only 48% of respondents strongly agreed that gathering and holding their cattle would make them feel better about how they manage their cattle, while 15% neither agreed nor disagreed, and 1% strongly disagreed. When asked if gathering and holding would: 1) cause their cattle to suffer or 2) reduce the value of their cattle, 10% and 16% respectively, strongly agreed with these consequences, 30% and 33% neither agreed nor disagreed, while 19% and 14% strongly disagreed, respectively. Over 10% of producers strongly agreed that gathering and holding their cattle would result in their cattle being killed or their neighbor´s cattle being killed, approximately 40% of producers neither agreed nor disagreed, and over 10% strongly disagreed with both of these consequences.

Table 9 – Cattle producers´ behavioral beliefs about the consequences of gathering and holding their cattle at the date and time requested during a hypothetical outbreak of FMD in Texas. Response proportions are weighted to account for sampling and survey response.

		Weighted Proportion of Responses (95% Confidence Interval)													
Behavioral Belief	**n**	**Strongly Disagree**		**Mostly Disagree**		**Somewhat Disagree**		**Neither Agree nor Disagree**		**Somewhat Agree**		**Mostly Agree**		**Strongly Agree**	
Reduce the economic impact on my operation	512	4%	(2-6%)	3%	(1-6%)	2%	(0-4%)	15%	(9-21%)	10%	(6-14%)	24%	(16-31%)	43%	(33-52%)
Reduce the economic impact on the US cattle industry	511	1%	(0-1%)	1%	(0-2%)	1%	(0-2%)	14%	(8-19%)	15%	(10-20%)	25%	(17-32%)	44%	(34-54%)
Stop the spread of disease within my operation	512	3%	(1-5%)	2%	(0-3%)	2%	(0-3%)	6%	(3-10%)	11%	(6-15%)	24%	(17-31%)	53%	(44-62%)
Stop the spread of disease among cattle in my area	512	1%	(0-3%)	0%	(0-1%)	2%	(0-3%)	5%	(2-7%)	14%	(8-20%)	26%	(19-33%)	52%	(43-61%)
Allow me to know if my herd is infected as well	509	1%	(0-2%)	0%	(0-1%)	0%	(0-1%)	1%	(0-3%)	7%	(3-11%)	17%	(11-23%)	73%	(66-81%)
Cause my cattle to suffer	511	19%	(9-30%)	12%	(7-18%)	11%	(6-16%)	30%	(22-38%)	9%	(6-13%)	8%	(5-11%)	10%	(6-14%)
Make me feel better about how I manage my cattle	512	2%	(0-3%)	0%	(0-1%)	0%	(0-1%)	15%	(9-22%)	10%	(6-14%)	24%	(17-31%)	48%	(39-58%)
Reduce the value of my cattle	511	14%	(4-25%)	8%	(3-12%)	6%	(3-9%)	33%	(25-41%)	11%	(6-16%)	12%	(9-17%)	16%	(10-22%)
Result in my cattle being killed	511	13%	(2-23%)	10%	(3-16%)	6%	(2-10%)	37%	(29-45%)	11%	(5-16%)	10%	(6-15%)	14%	(9-19%)
Result in my neighbors´ cattle being killed	511	14%	(9-19%)	10%	(4-17%)	5%	(1-8%)	42%	(33-50%)	12%	(6-17%)	8%	(4-12%)	10%	(6-14%)

Target population size for weighted proportions is 94,783 producers.

Control Beliefs - Gathering and Holding

The proportion of responses for each response category (from strongly disagree to strongly agree) for producers´ beliefs about the barriers to gathering and holding their cattle at the date and time requested by authorizes were tabulated (**Table 10**). Over 50% of producers strongly agreed that 1) they would have the facilities needed to gather and hold their cattle, 2) they live close enough to their cattle to be able to gather and hold them, and 3) their cattle are tame enough to gathered and held, with only 1%, 3%, and 1% of producers strongly disagreeing, respectively with these barriers. When asked if they would have the manpower needed to gather and hold their cattle, 40% of producers strongly agreed, with an additional 41% somewhat to mostly agreeing, and 13% somewhat to strongly disagreeing. In addition, 34% of producers strongly agreed that they would have the finances needed to gather and hold their cattle, with 18% of respondents somewhat to strongly disagreeing.

Normative Beliefs- Gathering and Holding

Lastly, producers were asked how strongly they agreed with a series of belief statements concerning how strongly other people and groups expect them to behave (normative beliefs). The proportion of responses for each response category (from strongly disagree to strongly agree) were tabulated (**Table 11**). Animal health regulatory agencies and veterinarians were identified as the groups which producers believe most strongly expect them to gather and hold their cattle for testing and inspection at the date and time requested.

Table 10 – Cattle producers´ control beliefs about the barriers to gathering and holding their cattle at the date and time requested during a hypothetical outbreak of FMD in Texas. Response proportions are weighted to account for sampling and survey response.

		Weighted Proportion of Responses (95% Confidence Interval)						
Control Belief	**n**	**Strongly Disagree**	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**
I have the facilities needed to gather and hold my cattle for testing and inspection.	515	1% (0-1%)	2% (0-4%)	1% (0-2%)	2% (0-4%)	17% (11-24%)	25% (18-32%)	51% (42-61%)
I have the manpower needed to gather and hold my cattle for testing and inspection.	515	4% (1-7%)	4% (1-6%)	5% (2-7%)	5% (3-8%)	20% (13-27%)	21% (15-28%)	40% (31-50%)
I have the finances needed to gather and hold my cattle for testing and inspection.	514	3% (1-5%)	8% (3-13%)	7% (3-10%)	10% (6-15%)	20% (13-27%)	18% (12-23%)	34% (24-44%)
I live close enough to my cattle to be able to gather and hold my cattle for testing and inspection.	515	3% (0-5%)	1% (0-2%)	3% (1-6%)	3% (1-6%)	13% (7-18%)	19% (13-25%)	58% (50-67%)
My cattle are tame enough to be gathered and held for testing and inspection.	514	1% (0-2%)	1% (0-3%)	1% (0-3%)	4% (1-6%)	15% (9-21%)	25% (18-32%)	52% (43-61%)

Target population size for weighted proportions is 94,783 producers.

Table 11 – Cattle producers´ normative beliefs about the social pressures for gathering and holding all of their cattle at the date and time requested by state or federal authorities. Proportion of responses weighted to account for sampling strategy and survey response.

		Weighted Proportion of Responses (95% Confidence Interval)						
Normative Belief	**n[a]**	**Strongly Do Not Expect**	**Mostly Do Not Expect**	**Somewhat Do Not Expect**	**Neither Expect nor Do Not Expect**	**Somewhat Expect**	**Mostly Expect**	**Strongly Expect**
Animal health regulatory agencies	500	0% (0-0%)	0% (0-0%)	0% (0-0%)	4% (2-7%)	6% (2-9%)	23% (16-30%)	66% (57-74%)
Your county extension agent(s)	498	2% (0-5%)	1% (0-2%)	1% (0-2%)	8% (5-11%)	8% (4-13%)	22% (15-28%)	56% (47-65%)
Your surrounding community	498	3% (0-6%)	1% (0-1%)	1% (0-2%)	15% (9-20%)	12% (7-17%)	28% (21-35%)	38% (28-48%)
Your professional organizations	447	3% (0-6%)	0% (0-1%)	1% (0-2%)	13% (9-18%)	10% (4-15%)	29% (20-37%)	44% (34-55%)
Other cattle producers like yourself	501	2% (0-5%)	0% (0-1%)	0% (0-0%)	9% (5-13%)	8% (4-12%)	32% (24-40%)	46% (37-56%)
Leaders in the cattle industry	493	2% (0-5%)	0% (0-1%)	0% (0-0%)	10% (6-15%)	6% (2-9%)	25% (17-32%)	54% (45-63%)
Your family	490	0% (0-1%)	0% (0-1%)	1% (0-3%)	10% (5-14%)	4% (2-6%)	24% (17-31%)	57% (49-66%)
Your business partner(s)/ associate(s)	375	0% (0-1%)	0% (0-1%)	1% (0-2%)	11% (6-16%)	2% (1-4%)	17% (11-23%)	40% (30-50%)
Your veterinarian(s)	501	0% (0-0%)	0% (0-0%)	0% (0-0%)	6% (2-10%)	5% (2-9%)	19% (13-26%)	67% (59-75%)
Your neighbor(s)	500	1% (0-1%)	0% (0-1%)	1% (0-2%)	13% (7-18%)	7% (4-11%)	31% (23-38%)	44% (35-54%)

[a] n was calculated as the total number of respondents minus the number of respondents who selected "does not apply." Target population size for weighted proportions is 94,783 producers.

These two groups were followed closely by county extension agents, leaders in the cattle industry, and the cattle producer´s family as groups which producers indicated had strong expectations that the producer would gather and hold his or her cattle. The groups which the producers believed least strongly expected them to gather and hold their cattle were the surrounding community and their business partners.

Behavioral Beliefs – Animal Movement Restrictions

The proportion of responses for each response category (from strongly disagree to strongly agree) for producers′ beliefs about the consequences of keeping their cattle at their current location during an outbreak of FMD were tabulated (**Table 12**). Approximately 40% of respondents strongly agreed and 5% and 1% of producers strongly disagreed that keeping their cattle in their current location during an outbreak of FMD would reduce the economic impact on: 1) their operation and 2) the US cattle industry, respectively. When asked if keeping their cattle at their current location would: 1) stop the spread of disease among their cattle or 2) among the cattle in their area, 40% and 49% of producers strongly agreed, and 5% and 1% of producers strongly disagreed, respectively, with these potential consequences. However, only 16% of respondents strongly agreed that maintaining their cattle at their current location would be adequate to protect their cattle from FMD, with 21% neither agreeing nor disagreeing, and 3% strongly disagreeing. In terms of negative consequences, 20% of producers strongly agreed and 6% strongly disagreed that keeping cattle in their current location would result in feed shortages, while 15% strongly agreed and 9% strongly disagreed that keeping cattle in their current location would cause the animals to suffer. Fully 48% of respondents strongly agreed that keeping their cattle in their current location would delay their ability to sell cattle with only 3% strongly disagreeing. Over 30% of respondents strongly agreed that keeping their cattle in their current location would mean that they would not be blamed for the spread of the disease, and 36% strongly agreed that it would make them feel better about how they manage their cattle.

Table 12 – Cattle producers´ behavioral beliefs about the consequences of keeping their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Response proportions are weighted to account for sampling and survey response.

		Weighted Proportion of Responses (95% Confidence Interval)						
Behavioral Belief	**n**	**Strongly Disagree**	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**
Reduce the economic impact on my operation	566	5% (2-8%)	6% (2-9%)	6% (2-11%)	11% (7-16%)	14% (8-19%)	20% (13-26%)	38% (31-45%)
Reduce the economic impact on the US cattle industry	568	1% (0-2%)	2% (0-4%)	1% (0-2%)	14% (9-19%)	18% (11-26%)	21% (15-26%)	43% (35-50%)
Stop the spread of disease within my operation	566	5% (2-7%)	6% (2-9%)	5% (2-8%)	7% (4-11%)	12% (7-18%)	25% (18-32%)	40% (33-47%)
Stop the spread of disease among cattle in my area	569	1% (0-3%)	0% (0-1%)	1% (0-3%)	6% (3-9%)	15% (10-21%)	27% (20-35%)	49% (41-56%)
Will result in feed shortages for my cattle	569	6% (3-9%)	12% (6-17%)	9% (5-14%)	23% (17-30%)	20% (14-26%)	10% (6-14%)	20% (14-26%)
Will cause my cattle to suffer	568	9% (5-13%)	13% (8-18%)	9% (5-14%)	28% (20-35%)	15% (10-20%)	11% (7-16%)	15% (9-20%)
Will be adequate to protect my cattle from FMD	566	3% (1-4%)	8% (4-12%)	10% (6-15%)	21% (15-27%)	24% (17-30%)	19% (12-25%)	16% (11-21%)
I will not be blamed for the spread of the disease	567	3% (0-5%)	1% (0-2%)	4% (0-7%)	20% (15-26%)	20% (13-27%)	21% (14-27%)	31% (24-38%)
Will make me feel better about how I manage my cattle	568	2% (0-3%)	0% (0-1%)	2% (0-5%)	11% (7-15%)	19% (13-25%)	30% (22-37%)	36% (29-43%)
Will delay my ability to sell cattle	568	3% (0-5%)	1% (0-1%)	1% (0-2%)	8% (4-12%)	16% (10-23%)	24% (18-30%)	48% (40-55%)

Target population size for weighted proportions is 94,783 producers.

Control Beliefs – Animal Movement Restrictions

The proportion of responses for each response category (from strongly disagree to strongly agree) for producers´ beliefs about the barriers to keeping their cattle in their current location during an outbreak of FMD were tabulated (**Table 13**).

Table 13 – Cattle producers´ control beliefs about the barriers to keeping their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Response proportions are weighted to account for sampling and survey response.

		Weighted Proportion of Responses (95% Confidence Interval)						
Control Belief	**n**	**Strongly Disagree**	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**
I expect that feed can be delivered	564	2% (0-4%)	3% (1-5%)	3% (1-5%)	18% (10-25%)	13% (8-18%)	28% (22-35%)	32% (25-39%)
I own/have access to adequate feed to keep my cattle at their current location(s)	563	6% (1-11%)	4% (1-7%)	11% (6-16%)	5% (3-8%)	23% (16-30%)	24% (18-30%)	27% (20-33%)
I will be responsible for paying for additional feed needed to maintain my cattle if they cannot be moved	564	3% (1-5%)	4% (0-9%)	5% (2-9%)	14% (8-19%)	12% (8-17%)	30% (22-36%)	32% (25-39%)
Keeping my cattle in their current location will cause them to become crowded	563	16% (11-22%)	20% (14-26%)	18% (11-24%)	18% (12-23%)	13% (8-18%)	7% (4-11%)	8% (3-14%)
Keeping my cattle in their current location will cause environmental damage	558	20% (15-26%)	20% (14-25%)	17% (11-23%)	24% (16-31%)	8% (5-12%)	6% (3-9%)	5% (2-8%)
Keeping my cattle in their current location will cause them to be killed during the control of the disease	563	13% (8-18%)	15% (9-20%)	12% (7-17%)	37% (29-45%)	10% (5-14%)	6% (3-10%)	7% (3-11%)
If needed, I have facilities to keep all calves born on my property for an extended length of time	563	5% (2-7%)	6% (3-8%)	12% (6-19%)	7% (4-10%)	25% (18-32%)	24% (18-30%)	21% (15-28%)
I can set up appropriate disinfection procedures for myself and my employees/hands	563	4% (1-8%)	8% (3-12%)	6% (2-10%)	11% (7-14%)	20% (13-26%)	25% (18-31%)	27% (20-34%)

Target population size for weighted proportions is 94,783 producers.

Approximately 30% of producers strongly agreed that 1) they expect that feed can be delivered, 2) they own or have access to adequate feed to keep their cattle at their current location, and 3) that they will be responsible for paying for additional feed if needed if the cattle cannot be moved, with 2%, 6%, and 3% of producers strongly disagreeing. When asked if keeping their cattle in their current location would 1) cause them to become crowded, 2) cause environmental damage, or 3) cause their cattle to be killed during the control of the disease, only 8%, 5%, and 7% of producers strongly agreed, respectively, with 16%, 20%, and 13% strongly disagreeing. Over 20% of producers strongly agreed that they had the facilities needed to keep all of the calves born on their property for an extended period of time, with another 49% somewhat to mostly agreeing and 5% strongly disagreeing. Similarly, 27% of producers strongly agreed that they could set up disinfection procedures for themselves and their workers with another 45% somewhat to mostly agreeing and 4% strongly disagreeing.

Normative Beliefs- Movement Ban

Lastly, producers were asked how strongly they agreed with a series of belief statements concerning how strongly other people and groups expected them to behave (normative beliefs). The proportion of responses for each response category (from strongly disagree to strongly agree) were tabulated (**Table 14**). Animal health regulatory agencies and veterinarians were identified as the groups which producers believe most strongly expect them to keep their cattle in their current location, with over 60% of respondents indicating that these groups strongly expected them to obey animal movement restrictions. These two groups were followed by county extension agents, leaders in the cattle industry, their business partner(s)/associates, and the cattle producer´s family as groups which producers indicated had strong expectations that the producer would maintain his or her cattle in their current location(s). The groups which the producers believed least strongly expected them to obey animal movement restrictions were their surrounding community (45% strongly expect) and their professional organizations (42% strongly expect).

Table 14 – Cattle producers´ normative beliefs about the social pressures for keeping all of their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Response proportions weighted to account for sampling and survey response.

		Weighted Proportion of Responses (95% Confidence Interval)						
Normative Belief	**n[a]**	**Strongly Do Not Expect**	**Mostly Do Not Expect**	**Somewhat Do Not Expect**	**Neither Expect nor Do Not Expect**	**Somewhat Expect**	**Mostly Expect**	**Strongly Expect**
Animal health regulatory agencies	542	0% (0-0%)	1% (0-3%)	1% (0-1%)	6% (2-10%)	5% (2-9%)	18% (13-24%)	66% (58-73%)
Your county extension agent(s)	539	3% (1-5%)	0% (0-1%)	2% (0-3%)	10% (5-15%)	9% (5-14%)	19% (13-24%)	54% (46-61%)
Your surrounding community	542	1% (0-3%)	1% (0-2%)	2% (0-4%)	13% (8-18%)	13% (8-18%)	21% (15-28%)	45% (37-52%)
Your professional organizations	501	1% (0-2%)	1% (0-0%)	1% (0-3%)	14% (9-19%)	6% (3-9%)	20% (14-26%)	42% (34-49%)
Other cattle producers like yourself	547	1% (0-2%)	0% (0-0%)	1% (0-3%)	7% (3-11%)	13% (8-17%)	28% (21-35%)	48% (40-54%)
Leaders in the cattle industry	544	1% (0-3%)	0% (0-0%)	1% (0-3%)	10% (5-15%)	6% (3-9%)	23% (17-30%)	55% (48-63%)
Your family	537	0% (0-0%)	0% (0-0%)	1% (0-3%)	12% (7-17%)	8% (3-13%)	22% (16-28%)	50% (42-57%)
Your business partner(s)/ associate(s)	399	0% (0-1%)	0% (0-0%)	1% (0-4%)	17% (10-24%)	9% (2-17%)	20% (14-27%)	51% (42-61%)
Your veterinarian(s)	548	0% (0-1%)	0% (0-0%)	1% (0-2%)	8% (2-13%)	5% (2-9%)	20% (14-26%)	63% (55-71%)
Your neighbor(s)	540	1% (0-3%)	0% (0-0%)	0% (0-0%)	10% (6-15%)	16% (9-22%)	23% (17-29%)	48% (40-55%)

[a] n was calculated as the total number of respondents minus the number of respondents who selected “does not apply.”
Target population size for weighted proportions is 94,783 producers.

Discussion

Reducing the size and severity of an outbreak is an important goal of the early emergency response process. While many factors have been identified which can influence final outbreak size and severity, there are only a few which can be directly influenced by the behavior of livestock producers. These factors include the time to detection of the introduction of the virus[110] and the extent of early disease spread, which is related to the effectiveness of early disease control measures and the pattern of animal movements.[15,19,43-47,119,120,137] Considering these factors, producer compliance with the two behaviors addressed in this chapter can have an important impact on the severity and size of an outbreak of FMD. The unwillingness of producers to gather and hold cattle can allow for disease to spread further or delay the implementation of disease control measures, while similarly, non-compliance with movement restrictions can enhance disease spread and make decisions regarding optimal control strategies difficult.

The behavior of gathering and holding cattle at the date and time requested by authorities can be seen as a very complicated behavior, in which numerous factors and influences all come into play. Producers may be asked to gather and hold their cattle for veterinary inspection, which may or may not be accompanied by diagnostic testing. In addition, following the determination of disease or risk status of the herd and the current status of disease control policy, the animals may receive vaccination or the entire herd may be depopulated. The specific chain of events which results from an order to gather and hold cattle is difficult to predict without knowing many of the variables associated with the outbreak, such as the extent of disease spread and number of farms infected. In this study, we chose to introduce this behavior with a scenario that said an FMD outbreak was present in the producer´s area, and that the presence of infection would result in the depopulation of their herd and their neighbor´s herds. Discussions with regulatory animal health officials during the survey development phase of this study suggested that vaccination was seen as a desirable but impractical alternative, due to limitations in vaccine availability and logistical challenges in vaccine administration. Since officials felt that depopulation was still the most likely outcome for an infected or at-risk herd during an outbreak of FMD, we chose to include this outcome in our scenario.

We found that, in general, Texas cattle producers agreed with what could be seen as the positive consequences of gathering and holding their cattle for testing and/or depopulation, including: reducing the economic impact on their operation and the US cattle industry, stopping the spread of disease within their operation and the US cattle industry, making them feel better about how they manage their cattle, and allowing them to know if their herd is infected as well. However, respondents expressed much more uncertainty when asked about the negative consequences of gathering and holding their cattle. At least 30% of respondents neither agreed nor disagreed that gathering and holding their cattle would cause their cattle to suffer, reduce the value of the cattle, and result in their cattle being killed, while 42% neither agreed nor disagreed that gathering and holding their cattle would result in their neighbors´ cattle being killed. This uncertainty can be seen as ambivalence, or the coexistence of positive and negative reactions to a behavioral outcome.[69]

Research examining attitude strength has found that some attitudes are strong, durable, and impactful, while others are weak and transitory. Although numerous attributes have been found to affect attitude strength, ambivalence has been found to be an important factor.[138] Since behavioral beliefs represent a component of attitudes, ambivalence in producers´ beliefs about the negative consequences of gathering and holding their cattle suggests that producers´ attitudes toward gathering and holding may not be strong. This has implications for risk communication and emergency response. Ambivalent attitudes may change over time, may be more susceptible to persuasive appeals, and less likely to influence behavior.[81,139] During the course of an outbreak, producers´ beliefs about the advantages and disadvantages, or consequences of, gathering and holding their cattle may change. The experience of the UK in 2001 would suggest that effective and timely risk communication has an important role to play in influencing producers´ beliefs, and that inadequate communication may have serious repercussions for compliance. The Lessons to be Learned Inquiry found that inadequate communication created distrust in both the public and farming community, which eventually led to a loss of support in disease control policy.[4] Ambivalence in Texas cattle producers´ currently held beliefs about the consequences of gathering and holding their cattle would suggest that this is an area where communication will be very important and may have substantial effects on producers´ attitudes and subsequent compliance during an outbreak of FMD.

An examination of producers´ current beliefs about barriers to gathering and holding their cattle would suggest that the availability of facilities, distance between the producer and animals, and the disposition of the cattle (e.g., tame vs. feral) are not significant barriers to gathering and holding, while the availability of manpower and financial resources to gather cattle may be important limiting factors. Among respondents, 13% indicated that they may not have adequate manpower to gather and hold their cattle, while 18% suggested that they may not have adequate financial resources. Following on qualitative discussions with producers presented in Chapter II, these results are not surprising. Many of the producers we interviewed felt that manpower would be limited, particularly if many operations were trying to gather cattle at one time, as would be likely during an outbreak. Similarly, several producers mentioned that the cost of gathering their cattle would be substantial, and they may not have that amount of money immediately available to them. It is difficult to predict what the effect of these limitations would be in the face of an outbreak, since the number of producers being asked to gather and hold their cattle at any one time would vary based on disease spread, veterinarian availability, and disease control policy. A worst-case scenario involving state-wide spread of the disease would suggest that as many as 12,000 producers may not have the manpower needed to gather and hold their cattle, and over 17,000 may not have adequate financial resources, based on population sizes from the 2007 NASS agricultural census.[118] These estimates may help to inform disease spread models to better take into account not only limitations in official response capacity, but also in the capacity of producers to comply.

In terms of social pressure to gather and hold cattle at the date and time requested, respondents indicated that all of the groups and individuals identified as sources of social pressure during the qualitative phase of this study expected them to gather and hold their animals during an outbreak of FMD. Veterinarians and regulatory agencies were the groups identified as most strongly expecting producers to gather and hold their cattle when requested by authorities. The influence of these normative beliefs on behavior is difficult to predict. A meta-analysis of the effects of subjective norms on behavior suggests that normative beliefs may not have as strong an influence on behaviors that have strong social approval or behaviors that are more utilitarian than pleasant to perform. However, social norms may have a stronger influence on behavior when the behavior is likely to be performed in the future, especially as the length of time between intentions and behavior increases.[71]

Similar to gathering and holding, respondents agreed with the positive consequences of observing animal movement restrictions, including stopping the spread of disease and reducing the economic impact of a FMD outbreak. However, only 16% of respondents felt that observing an animal movement ban would be adequate to protect their animals from FMD, while 21% neither agreed nor disagreed with this statement. Since the majority of Texas producers may have limited experience with movement restrictions, this uncertainty or ambivalence is reasonable. Producers´ beliefs about the efficacy of movement restrictions may change significantly over the course of an outbreak, depending on their perceptions of others´ compliance, disease spread, and media coverage of affected operations. Over 70% of respondents believed that obeying animal movement restrictions would help them avoid blame for the spread of the disease, and 85% indicated that it would make them feel better about how they manage their cattle. Belief in these positive emotional consequences may be tempered by concerns about animal welfare, including animal suffering and feed shortages, which can be caused by strict movement restrictions. Over 40% of respondents somewhat to strongly agreed that observing animal movement restrictions would cause their cattle to suffer, and 50% somewhat to strongly agreed that an animal movement ban would result in feed shortages for their animals. Similar to what was seen during the 2001 outbreak of FMD in the UK, lack of feed and housing and inability to receive veterinary care for sick or injured animals can all contribute to animal suffering.[5] Emergency response planning should address plans to help distribute feeds and maintain the availability of basic veterinary care, while avoiding the spread of the disease. Programs created to assist with the movement and distribution of feeds to drought-affected areas may provide useful templates,[140] which can be altered to include enhanced disinfection and biosecurity procedures for use during an FMD outbreak.

Numerous perceived barriers to producer´s willingness to comply with animal movement restrictions were identified in the qualitative phase of this study, including concerns about feed availability and cost, crowding and environmental damage, the death of animals due to disease control policy, and the ability to maintain adequate disinfection procedures. Over 70% of respondents somewhat to strongly agreed that feed delivery would be available during an outbreak, that they own or would have access to adequate amounts of feed to maintain their cattle, and that they would be responsible for any additional costs associated with feeding their cattle while they cannot be moved. These results combined with producers´ beliefs about movement restrictions resulting in feed shortages would suggest that many producers feel that feed shortages are likely; however, the ability to have feed delivered, the presence or absence of personal stores of feed, and financial resources to purchase feed may mediate the effects of movement restrictions on feed shortages. Another barrier to producers´ willingness to keep cattle in their current location(s) during an outbreak of FMD is space. Cattle may become crowded as the resources (i.e., food, water, shade) available to them are diminished or as the herd size increases during calving season, which may result in environmental damage such as overgrazing. Among respondents, 28% somewhat to strongly agreed that keeping their cattle in place during an outbreak would result in crowding, and 19% somewhat to strongly agreed that it would result in environmental damage. Over 20% of respondents somewhat to strongly disagreed that they would have the space needed to keep the calves born on their property. Producers who do not feel like they have the space to maintain their cattle during a movement ban may feel pressured to move the animals to another location. Regulations which allow for the licensed movement of animals due to crowding may help to reduce illegal movements of animals, as long as the systems for these movement license requests are efficient and operational. Fear of depopulation is another potential barrier to producers´ maintaining their cattle in place during an outbreak of FMD. Fully 23% of respondents somewhat to strongly agreed that keeping their cattle in their current location(s) during an outbreak of FMD would result in their cattle being killed during the control of the disease. This belief could be linked to other beliefs about the efficacy of movement restrictions to stop the spread of disease or to personal beliefs about the ability to maintain adequate biosecurity. Only 27% of respondents strongly agreed that they could set up appropriate disinfection procedures for themselves and their employees.

Similar to the beliefs seen with gathering and holding, respondents indicated that all of the groups identified during the qualitative phase of this study would expect them to keep their cattle in place during an outbreak of FMD. However, professional organizations and the surrounding community were identified as the groups with the lowest expectations of compliance with animal movement restrictions. During an actual outbreak of FMD, the perceived pressure from these groups may increase as they increase their communication activities. Overall, results of this study would suggest that social pressure for obeying animal movement restrictions is high.

During an outbreak of FMD, producers can reduce the extent of disease spread by gathering and holding cattle at the date and time requested for testing and/or depopulation and by obeying animal movement restrictions. An understanding of producers´ currently held beliefs regarding these behaviors can strengthen risk communication planning and help to inform disease spread models and emergency response planning. Producers are currently unsure about the potential negative consequences of gathering and holding their cattle when requested by authorities. During an outbreak, risk communication related to the consequences of gathering and holding cattle, both good and bad, is likely to play an important role in shaping producer´s attitudes and their subsequent behavior. Lack of manpower and/or financial resources to gather and hold cattle are the most important barriers to producers´ cooperation, which may require adjustments in disease control policy or resource allocation, particularly during a widely-disseminated outbreak. With regards to animal movement restrictions, producers may be unsure about the efficacy of movement restrictions to prevent the spread of FMD and concerned about possible feed shortages or animal suffering. However, there are emotional benefits to complying with movement restrictions including avoiding blame for disease spread and feeling better about how cattle are managed, which may strengthen risk communication messaging during an outbreak. Producers´ beliefs about the barriers to compliance with animal movement restrictions suggest that they need information about how to set up adequate disinfection procedures and options to ensure adequate feed and space for cattle. In general, perceived social pressure for both of these behaviors is high, which may help to encourage producer cooperation during an outbreak.

CHAPTER VI

PREDICTING COW-CALF PRODUCERS´ INTENT TO PARTICIPATE IN FMD DETECTION AND CONTROL

Introduction

The introduction of FMD into the US would have highly detrimental economic and societal effects on the livelihoods and sustainability of affected livestock producers.[11,30] Despite advances in research and technology, responses to large-scale outbreaks outside of the US have been problematic, and although the disease was eventually eradicated, the process had long-lasting impacts on the relationship between regulatory agencies and livestock producers.[4,36,39] Many of the difficulties encountered during the control and eradication of FMD have been related to the inadequate communication of policy and measures needed to control and contain an outbreak of FMD, and the failure of regulatory agencies to understand the perceptions, beliefs, and behaviors of agricultural producers.[38,141,142]

Planning and implementing effective risk communication both prior to and during an outbreak of FMD requires an understanding of not only what producers are likely to do, but also the underlying beliefs and perceptions that may influence that behavior.[69] Risk communication can be broadly seen as having three goals: to share information, to change beliefs, and to change behavior.[143] Given the enormous consequences an outbreak of FMD would have on the entire agricultural industry both economically and socially, the full cooperation and participation of livestock producers in detecting and controlling any disease introduction is essential. Risk communication with the goal of just getting the information out there, without regard to how the message is received or understood, is unlikely to minimize the impacts of the disease and may have serious repercussions in terms of lost trust and cooperation.[4] Risk communication with livestock producers needs to focus on sharing risk and benefit information in a way that addresses and corrects beliefs and perceptions, ultimately resulting in increased cooperation.[27,143]

Studies based on the Theory of Planned Behavior can offer important insights into the beliefs and perceptions that influence behavior, and identifying and measuring salient beliefs among cow-calf producers can identify the factors which influence their decisions and actions both prior to or during an outbreak of FMD.[69] The TPB has been used to guide the design of interventions for a variety of behaviors including performing testicular self-exam[144,145], safer- sex practices among adolescents[146], driving over the speed limit[147], and exercise program participation.[148] The use of this theory, expanded to include measures of trust, risk perception, and moral norms, has several advantages for developing a foundation for effective risk communication. This approach focuses on understanding the determinants of a single behavior, and further posits that a relatively small number of variables are necessary to understand and change a given behavior.[69] In addition, there are numerous validated approaches for measuring the theory´s component variables and for identifying the kinds of factors which need to be changed to effect behavior change.[27,69]

The previous chapters have focused on eliciting and understanding the salient beliefs which may influence producers´ behavior. This chapter presents the remaining factors included in the theoretical framework presented in Chapter III, and examines models to predict producers´ intentions to request veterinary examination of cattle both prior to and during an outbreak of FMD, to gather and hold their cattle at the date and time requested by authorities, and to obey animal movement restrictions. The results of this chapter provide an important foundation for the development of risk communication messages by highlighting the beliefs and perceptions which need to be targeted to achieve behavior change.

Materials and Methods

Questionnaire Design

As described in Chapter III, questionnaires were developed based on qualitative analysis of interviews with Texas cattle producers, regulatory animal health officials, private veterinarians, sociologists, and veterinary epidemiologists. Interviews were used to identify behaviors where producer compliance may be reduced, as well as behavioral beliefs (beliefs about the consequences of performing a behavior), control beliefs (beliefs about the ease or difficulty of performing a behavior), and normative beliefs (belief about what others expect you to do) which interviewees suggested may influence producer behavior. A theoretical framework based on the Theory of Planned Behavior[64] was developed for each of the behaviors of interest: requesting veterinary examination of cattle with clinical signs consistent with FMD in the absence of a known outbreak or during an outbreak of FMD (**Figure 2**), gathering and holding cattle at the date and time requested by authorities, and keeping cattle in their current location during an outbreak of FMD. A two-day stakeholder workshop was held to evaluate the questionnaire drafts for relevancy and accuracy and to develop the final wording of the questionnaires.

Two separate questionnaires were developed. Each questionnaire contained questions related to two behaviors. The first questionnaire (Survey 1) addressed the behaviors of 1) requesting veterinary examination when an outbreak of FMD was not known to be present and 2) gathering and holding cattle at the date and time requested by authorities when an outbreak has been identified. The second questionnaire (Survey 2) included questions related to the behaviors of 1) requesting veterinary examination of cattle with clinical signs consistent with FMD during an outbreak of FMD, and 2) maintaining cattle in their current location during an outbreak of FMD in Texas.

Intentions

The questions regarding each behavior were introduced with a short scenario which defined the target, action, context, and time of the behavior of interest (**Table 3**). Producers were asked how strongly, on a scale from 1 to 7 with 1 being strongly disagree and 7 being strongly agree, they agreed with the statement that given the above scenario, they would perform the behavior (behavioral intention). Each behavioral intention question was followed by a series of questions designed to assess each aspect of the theoretical framework (see **Figure 2**).

Attitudes

Attitudes were assessed directly using a 7-point Likert-like scale, and a list of bipolar adjectives: bad-good, unpleasant-pleasant, ineffective-effective, harmful-beneficial, difficult-easy, and inconvenient-convenient. On the scale, 1 corresponds to the "very" negative adjective, 4 would indicate ambivalence, while 7 corresponds to the "very" positive adjective. Attitudes were also assessed indirectly through individual beliefs about the consequences of performing the behavior (behavioral beliefs) measured on a 7-point Likert-like scale, with 1 representing "strongly disagree" and 7 representing "strongly agree," and their corresponding belief evaluations measured on a scale from -3 to 3, with -3 being "extremely undesirable" and 3 being "extremely desirable."

Subjective Norms

Subjective norms were assessed directly using a series of four questions: 1) People who are important to me think that I should…, 2) I would feel under social pressure to…, 3) Other producers I admire would…, and 4) Other producers like myself would… The first two statements assess injunctive norms, while the last two address descriptive norms.[71] Responses were asked how strongly they agree with each question on a scale from 1 to 7, with 1 representing "strongly disagree" and 7 representing "strongly agree." Subjective norms were also assessed indirectly through individual beliefs about how strongly a list of other people or groups expect the respondent to perform the behavior (normative beliefs) measured on a scale from -3 to 3, with -3 representing "strongly do not expect" and 3 representing "strongly expect," and their corresponding belief evaluations about how important the expectations of each person or group is to the respondent, measured on a scale from 1 to 7, with 1 being "very unimportant" and 3 being "very important."

Perceived Behavioral Controls

Perceived behavioral control was assessed directly using two questions: 1) Based on the scenario, I am confident that I could…, and 2) Whether I … or not, is entirely under my control. Responses were asked how strongly they agree with each question on a scale from 1 to 7, with 1 representing "strongly disagree" and 7 representing "strongly agree." Perceived behavioral control was also assessed indirectly through individual beliefs about the barriers to performing the behavior (control beliefs) measured on a 7-point Likert-like scale, with 1 representing "strongly disagree" and 7 representing "strongly agree," and their corresponding belief evaluations about how each barrier would affect their likelihood of performing the behavior, measured on a scale from -3 to 3, with -3 being "extremely less likely" and 3 being "extremely more likely."

Moral Norms

Moral norms, personal feelings of responsibility to perform or not perform a behavior regardless of what other people think[80], were measured directly using 2 or more statements which are unique to each behavior, on a 7-point Likert-like scale, with 1 representing "strongly disagree" and 7 representing "strongly agree." For the behaviors of requesting veterinary examination of cattle with clinical signs of FMD in the absence of or during an outbreak of FMD, respondents were asked how strongly they agreed with the statements: "Based on the scenario, I have a moral duty to ask a veterinarian to examine my animals" and "I have a moral duty to request veterinary care for sick animals." For gathering and holding, respondents were asked how strongly they agreed with the statement, "In scenario 2, I have a moral duty to gather and hold my cattle at the date and time requested." For movement ban compliance, respondents were asked how strongly they agreed with the statements: "I have a moral duty to ensure that my cattle have access to adequate feed and water," "I have a moral duty to protect my cattle from exposure to diseases animals" and "I have a moral duty to prevent the spread of disease from my cattle to someone else´s cattle."

Risk Perception

In order to assess producers´ perceptions of the risk posed by FMD, we asked respondents how strongly they agreed with the following six questions: 1) The risk of an outbreak of foot-and-mouth disease in the USA is very great. 2) The risk of an outbreak of foot-and-mouth disease in my operation is very great. 3) An outbreak of foot-and-mouth disease would be economically devastating for my operation. 4) An outbreak of foot-and-mouth disease would be economically devastating for the US cattle industry. 5) I believe that the United States is likely to experience an outbreak of foot-and-mouth disease in the next five years. 6) I believe that my operation is likely to experience an outbreak of foot-and-mouth disease in the next five years. Responses were measured on a 7-point Likert-like scale, with 1 representing "strongly disagree" and 7 representing "strongly agree."

Trust

Trust in other producers was measured as the strength of belief that other producers (both in the same geographical area as the respondent as well as in Texas as a whole) would perform the behavior and that other producers would consider the consequences of their actions on the respondent´s operation into account. Responses were measured on a 7-point Likert-like scale, with 1 representing “strongly disagree” and 7 representing “strongly agree.”

Three aspects of trust in regulatory agencies were assessed: competency, caring, and shared goals. Producers were asked how well the following regulatory agencies would manage their role on a scale from 1 to 7 (with 1 being “extremely poorly” and 7 being “extremely well”) during an outbreak of FMD: US Department of Agriculture (USDA), Texas Department of Agriculture (TDA), Texas Animal Health Commission (TAHC), US Department of Homeland Security (DHS), US Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), Texas Health and Human Services, Texas Commission on Environmental Quality (TCEQ), US Department of Health and Human Services. Producers were then asked how strongly they believed that the same agencies would act in their best interest during an outbreak of FMD, with 1 being “strongly disagree” and 7 being “strongly agree.” Lastly, producers were asked how strongly they believed that the same agencies would have the same goals that the producer has in managing an outbreak of FMD, with 1 being “strongly disagree” and 7 being “strongly agree.”

Demographics

The final section of each survey solicited demographic information on the respondent´s operation including: largest number of beef cows or beef cow replacements (weaned or older, including first calf heifers) kept during the year, and the largest number of steers and/or stockers (weaned or older) located on their operation during the year. Producers were asked to select from the following list the terms which best describe their current production practices: conventional cow-calf, seedstock, age-and-source verification, branded beef program (such as certified angus beef), natural or non-certified organic, integrated resource management, stocker, grass-finished, certified organic, holistic resource management, and/or beef quality assurance.

Demographics solicited on the respondent included: age, race, gender, highest education level, percentage income from cattle, prior experience with tuberculosis and brucellosis disease control programs (yes/no), if they live where their cattle are held (yes/no), the time they have worked in their current operation, the time they have worked in the cattle industry, if they belong to any cattle producer organizations (yes/no), and if they have served as an officer in a cattle producer organization (yes/no). Producers were also asked to select their primary motivation for raising or owning cattle from the following list: primary source of income, supplemental source of income, pleasure or lifestyle, control of excess forage, property tax advantage, or family tradition/obligation.

Survey Distribution

As described in Chapter IV, cow-calf producers were identified from a comprehensive list of active cattle producers in Texas maintained by the National Agricultural Statistics Service (NASS). Cow-calf producers were defined as those who keep one or more beef cows. Producers were stratified on the basis of National Agricultural Statistics Service (NASS) district and herd size within district. Herd size categories included 1-9 head, 10-19 head, 20-49 head, 50 to 99 head, 100-199 head, 200 to 499 head, and 500 head or greater. A total of 2,018 producers were selected to receive Survey 1 and 2,022 producers received Survey 2. The samples were drawn and all questionnaire-related material mailed by NASS. All personally identifiable information was removed from the survey forms that were returned in accordance with NASS's confidentiality standards.

A four-part mail-out of the surveys using a modified tailored design method[112] began on October 28, 2008. Producers received a pre-survey letter informing them that they had been selected to participate in the study. This letter was followed by the actual survey and accompanying cover letter mailed on November 19, 2008. Reminder postcards were sent on December 3, 2008. A final survey and second cover letter was sent to non-responders on January 6, 2009. The final cutoff date for receipt of survey responses was May 31st, 2009. Data were entered twice by hand by two independent data entry workers into Microsoft Access and compared for accuracy.

Statistical Analysis

Descriptive Statistics

All data were analyzed using STATA version 11 to provide the weighted proportion of responses to each question while taking into account the survey sampling design. Data were considered to be survey data with a single sampling stage, and each district/herd size combination was considered a stratum. Initial sampling weights were calculated as the inverse of the probability for selection for each stratum. Sampling weights were then adjusted for unit non-response as described in chapter IV. The weighted proportion of responses was determined for all of the demographic variables, as well as the median for the direct measures of attitudes, subjective norms, and perceived behavioral control for each behavior. Response proportions and confidence intervals for each response category (on the Likert-like scale) for questions related to intentions, moral norms, and trust were determined using the proportion command of STATA. Standard errors were calculated using the analytically-derived variance estimator.[114] Response proportions and confidence intervals for all of the belief-based measures were determined and are presented in chapters III and IV.

Outcome Variables

Producers intentions for each of the four behaviors were considered the outcome variable of interest for each of the four models. Due to low cell counts, the intention variables were re-coded into three-level variables, where strongly, mostly, and somewhat disagree where combined into disagree, neither agree nor disagree was unchanged, and strongly, mostly, and somewhat agree where combined into agree.

Explanatory Variables

Variables were examined and reverse-coded if necessary using the STATA module REVRS[149] to ensure that all variables had the same positive/negative interpretation (i.e. selecting 7 would always represent strongly agreeing with a positive outcome). Indirect (belief-based) measures of attitudes, subjective norms, and perceived behavioral controls were created by multiplying the response to each belief statement by the response to the corresponding evaluation statement (motivation to comply for the normative beliefs, the power of control beliefs, and the outcome evaluation for behavioral beliefs).

Exploratory factor analysis was performed for indirect (belief-based) measures of attitudes, subjective norms, and perceived behavioral control, as well as, direct measures of attitudes, risk perception, and trust. Factors were extracted using the principle-factor method. The number of factors to retain was determined by using multiple methods, including retaining factors with an Eigenvalue greater than 1 (the Kaiser criterion), graphing the factors against their respective Eigenvalues and keeping only those that occur before the drop in the Eigenvalues starts to level-off (the "scree test" method); and keeping the number of factors that are required to account for a given proportion of the variance observed in the original variables.[150] If more than one factor was retained, factors were rotated using a Varimax orthogonal rotation to improve interpretability and to ensure that the resulting factors were completely independent of one another. If rotation did not improve interpretability, correlation between the resulting factors was assessed by examining the correlation matrix. If no significant correlations were identified (none greater than 0.2), the non-rotated factors were retained for further analysis. Factor loadings > 0.40 were used in the interpretation of the factors. The suitability of individual variables for use in the factor analysis was evaluated using the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy.[151] The KMO measure of sampling adequacy compares the correlations and the partial correlations between variables in order to determine whether or not a low-dimensional representation of the data is possible.[152] The measure of sampling adequacy is a value between 0 and 1, which represents the extent to which a variable ‘‘belongs to the family’’ of the larger group of variables. Values <0.5 are generally considered unacceptable, and factor analysis should not be pursued.[153] In addition, during preliminary analysis, any of the variables found to load poorly or to have a very high uniqueness were excluded from the final factor model, and their relationship with producers´ intent to behave was analyzed directly. Once the final factor model was selected, factor scores with approximately mean zero and standard deviation of 1 were calculated for respondents who provided complete information on all variables included in the factor. These scores were then evaluated as predictors in a model-based ordinal logistic regression analysis to determine their association with the related behavioral intention.

Direct measures of perceived behavioral control, subjective norms, and moral norms were evaluated as predictors in a model-based ordinal logistic regression analysis to determine their association with the related behavioral intention without performing factor analysis, since in general only two questions were asked for each of these measures. Due to low cell counts, these variables were re-coded into 5 categories, where somewhat to mostly disagree were combined, and somewhat to mostly agree were also combined.

Age, income derived from cattle, and number of steers were categorized and evaluated as predictors using dummy variables. Based on the results of the bivariable analysis of these variables, they were then coded hierarchically and explored further in order to identify cut points or threshold values which were associated with producers´ intent to behave. All other demographic variables were also assessed as possible predictors.

Bivariable Analysis

All continuous predictors were evaluated in order to determine if the relationship between the predictor and the outcome was linear in the log odds by grouping the observations into quartiles or standard deviations from the mean and using bivariable analysis with ordinal logistic regression to assess the relationship. Variables which did not meet this criterion were categorized and analyzed using dummy variables for the remainder of the analysis. Bivariable, ordinal logistic regression analyses were conducted with each of the explanatory variables and their corresponding intention in order to make a preliminary evaluation of their relationship.

Regression Analysis

The theoretical model developed in Chapter III was used to guide the data analysis. All variables included in the theoretical framework were assessed using multivariable modeling. Demographic variables which were unconditionally associated with the outcome at p value<0.20 were selected for further analysis. Multivariable ordinal logistic regression models were constructed using a forward step-wise selection approach. Variables with p value<0.05 were considered significant and retained in the model. Significant variables were evaluated for low cell counts and re-coded or excluded from the model if estimated coefficients were exceedingly large or unstable. Evidence of confounding (indicated by a >20% change in the coefficient) was noted and when present, confounding variables were forced into the final model, even if found to be none significant. The parallel-regression assumption was verified using the OMODEL approximate likelihood ratio test of STATA.[154] Assessment of the fit of the model was achieved through evaluation of scalar measures of fit including a likelihood ratio test of the hypothesis that all coefficients except the intercepts are zero through comparison of the log-likelihood of the full and intercept only model (Chi-squared test) and pseudo-R^2´s (adjusted McFadden´s R^2, and McKevley and Zavoina´s R^2). The adjusted McFadden´s R^2 is based on the ratio of the log-likelihood of the intercept-only model compared to a model with all parameters, and includes a penalty for parameters which do not contribute significantly to the model. McKelvey´s and Zavoina´s R^2 can be interpreted as the ratio of the explained sum of squares to the combined explained and unexplained sum of squares, which provides an estimate of the amount of variation explained by the model.[155] Measures of fit of individual observations, such as individual and outlier analysis, are not currently available for ordinal outcomes.[156] Although there are numerous ways in which the results from this model can be interpreted (standardized coefficients, predicted probabilities, and odds ratios), odds ratios were selected to explain the effects of the various factors on intentions due to their ubiquitous use in veterinary epidemiology and ease of interpretation. Odds ratios for a standard deviation change in the explanatory variable were calculated for all continuous variables included in the final model, while odds ratios for a unit change in the variable were used for categorical predictors.

Results

Survey Response and Respondent Demographics

Detailed information regarding the survey response rates has been presented in Chapter III. However, in summary, 524 of the 1,960 (27%) producers who received Survey 1, and 574 of the 1,981 (29%) of the producers who received Survey 2, indicated that they were involved in the cattle industry, completed the survey, and were included in the analysis. The demographics of survey respondents were determined for both Survey 1 and 2 (**Table 4** and **Table 5**), and have been described in Chapter III.

Behavioral Intentions

Weighted proportions of responses to the behavioral intention questions are shown in **Table 15**. The target, action, context, and time for each behavior were specified using an introductory scenario shown in **Table 3**. In the absence of a known outbreak, 6% of producers strongly disagreed that they would ask a veterinarian to examine cattle with clinical signs consistent with FMD. This proportion dropped to 1% when an outbreak was known to be present. In the absence of an outbreak, 65% of respondents strongly agreed that they would ask a veterinarian to examine cattle with signs of FMD, and this proportion increased to 70% when an outbreak was known to be present. Fully 7% of producers strongly disagreed that they would gather and hold their cattle at the date and time requested by authorities, while 71% strongly agreed that they would. Compliance with a stop movement order for animals was very high, with only 1% of producers somewhat to strongly disagreeing, and 77% of producers strongly agreeing.

Table 15 – Cow-calf producers´ behavioral intentions. Weighted proportions of responses to behavioral intention questions for requesting veterinary examination of cattle with clinical signs consistent with FMD in the absence of or during a hypothetical outbreak of FMD in Texas, gathering and holding cattle for testing or depopulation, and maintaining cattle in their current location during a hypothetical outbreak of FMD in Texas.

		Weighted Proportion of Responses (95% Confidence Interval)				
Behavioral Intention	**n**	**Strongly Disagree[a]**	**Mostly Disagree**	**Neither Agree nor Disagree**	**Mostly Agree**	**Strongly Agree**
[In the absence of an outbreak of FMD][b] I would ask a veterinarian to examine my cattle.	490	6% (2-9%)	2% (1-5%)	0% (0-0%)	24% (17-31%)	68% (60-76%)
[During an outbreak of FMD], I would ask a veterinarian to examine my cattle.	569	1% (0-3%)	2% (0-4%)	3% (0-5%)	24% (17-30%)	70% (63-78%)
I would gather and hold all of my cattle for testing and inspection at the requested date and time.	494	7% (3-11%)	1% (0-1%)	1% (0-2%)	20% (13-26%)	71% (64-78%)
I would maintain all of my cattle in their current location(s) [during an outbreak of FMD.]	568	0% (0-1%)	1% (0-3%)	1% (0-1%)	20% (14-26%)	77% (71-83%)

[a] The number of categories was reduced from 7 to 5 by combining somewhat and mostly disagree (shown as mostly disagree) and somewhat to mostly agree (shown as mostly agree.)
[b] Information in brackets was not included in the original survey question, but has been added to help clarify the intention question, as presented in this table. In the original survey instrument, each intention question was introduced using a scenario which defined the context for the intention question. Scenarios used to introduce each intention question are shown in Table 3.
Survey 1 contained questions related to requesting veterinary examination in the absence of a known outbreak and gathering and holding cattle for testing or depopulation. Survey 2 contained questions related to requesting veterinary examination during an outbreak of FMD and compliance with animal movement restrictions.
Target population size for weighted proportions is 94,783 producers.

Attitudes

Weighted proportion of responses to producers´ attitudes toward each of the behaviors are shown in **Table 16** and **Table 17**. Regardless of whether an outbreak was known to present, 70% of producers indicated that asking a veterinarian to examine their animals was good, while at least 50% indicated that it was effective and beneficial. However, in the absence of known outbreak of FMD, only 34%, 42% and 33% of respondents indicated that asking a veterinarian to examine their cattle was pleasant, easy, or convenient, respectively. Similarly, when presented with a scenario where an outbreak of FMD was already present, 36%, 37%, and 28% of respondents suggested that asking a veterinarian to examine their cattle was pleasant, easy, or convenient, respectively.

Weighted proportion of responses to producers´ attitudes toward gathering and holding their cattle at the date and time requested by authorities and maintaining their cattle in their current location(s) during an outbreak of FMD are shown in **Table 17**. Producers´ attitudes towards gathering and holding their cattle are generally favorable, with 82% of respondents indicating that gathering and holding their cattle was somewhat to very good. Over 40% indicated that gathering and holding their cattle at the date and time requested was effective and beneficial. However, only 15%, 23%, and 17% of respondents felt that gathering and holding their cattle was pleasant, easy or convenient, respectively, and 11%, 8% and 13% felt that it was very unpleasant, difficult, and inconvenient, respectively.

Table 16 – Cow-calf producers´ attitudes toward requesting veterinary examination of cattle with clinical signs consistent with FMD. Weighted proportion of responses regarding cattle producers´ attitudes towards requesting veterinary examination of cattle with clinical signs consistent with FMD in the absence of (*behavior 1*) or during a hypothetical outbreak (*behavior 2*) of FMD in Texas. Questions related to the two behaviors were administered on different surveys.

	Weighted Proportion of Responses (95% Confidence Interval)							
Attitudes	**Very**	**Mostly**	**Somewhat**	**Neither**	**Somewhat**	**Mostly**	**Very**	
Behavior 1 (n=471)								
Bad	2% (0-4%)	1% (0-2%)	0% (0-1%)	5% (1-10%)	6% (3-9%)	16% (10-21%)	70% (63-78%)	**Good**
Unpleasant	5% (2-8%)	4% (1-7%)	4% (0-7%)	12% (7-17%)	19% (12-26%)	22% (15-29%)	34% (27-42%)	**Pleasant**
Ineffective	2% (0-5%)	1% (0-3%)	2% (0-3%)	5% (2-7%)	10% (4-16%)	30% (22-38%)	50% (42-58%)	**Effective**
Harmful	5% (1-10%)	2% (0-4%)	0% (0-1%)	7% (2-22%)	8% (3-30%)	23% (16-30%)	55% (46-6%)	**Beneficial**
Difficult	3% (1-6%)	8% (3-12%)	4% (1-8%)	11% (6-16%)	11% (6-16%)	20% (14-26%)	42% (34-50%)	**Easy**
Inconvenient	6% (2-10%)	6% (2-10%)	4% (1-8%)	13% (8-19%)	14% (9-20%)	23% (16-30%)	33% (25-41%)	**Convenient**
Behavior 2 (n=532)								
Bad	0% (0-1%)	0% (0-1%)	0% (0-1%)	3% (2-5%)	8% (4-12%)	17% (11-24%)	70% (63-78%)	**Good**
Unpleasant	6% (4-9%)	3% (1-6%)	9% (3-14%)	17% (10-23%)	10% (6-15%)	19% (13-25%)	36% (28-43%)	**Pleasant**
Ineffective	0% (0-1%)	1% (0-2%)	1% (0-2%)	7% (2-12%)	9% (4-14%)	26% (18-33%)	56% (48-64%)	**Effective**
Harmful	2% (1-4%)	1% (0-2%)	0% (0-1%)	6% (3-9%)	9% (4-15%)	27% (19-34%)	55% (47-63%)	**Beneficial**
Difficult	5% (2-7%)	4% (1-7%)	5% (1-10%)	12% (7-17%)	14% (7-20%)	24% (17-31%)	37% (29-44%)	**Easy**
Inconvenient	5% (2-7%)	6% (1-11%)	7% (4-11%)	13% (8-18%)	13% (8-19%)	27% (20-35%)	28% (22-35%)	**Convenient**

Target population size for weighted proportions is 94,783 producers.

Table 17 – Cow-calf producers´ attitudes toward gathering and holding cattle and maintaining cattle in their current location during a hypothetical outbreak of FMD in Texas. Weighted proportion of responses regarding cattle producers´ attitudes towards gathering and holding cattle for testing or depopulation at the date and time requested by authorities (*behavior 3*), and maintaining cattle in their current location during a hypothetical outbreak of FMD in Texas (*behavior 4*). Questions related to the two behaviors were administered on different surveys.

Weighted Proportion of Responses (95% Confidence Interval)								
Attitudes	**Very**	**Mostly**	**Somewhat**	**Neither**	**Somewhat**	**Mostly**	**Very**	
***Behavior 3* (*n*=465)**								
Bad	3% (0-6%)	2% (0-4%)	2% (0-3%)	12% (6-17%)	10% (6-14%)	21% (14-27%)	51% (42-59%)	**Good**
Unpleasant	11% (7-16%)	6% (3-8%)	10% (6-14%)	23% (16-30%)	17% (11-24%)	17% (11-24%)	15% (10-21%)	**Pleasant**
Ineffective	3% (0-6%)	1% (0-1%)	2% (0-4%)	10% (5-15%)	12% (8-16%)	31% (23-38%)	42% (34-50%)	**Effective**
Harmful	3% (1-6%)	5% (1-8%)	1% (0-3%)	11% (7-16%)	12% (7-17%)	25% (17-32%)	42% (34-50%)	**Beneficial**
Difficult	8% (2-13%)	3% (1-6%)	8% (5-12%)	15% (9-21%)	21% (14-28%)	20% (14-27%)	23% (16-31%)	**Easy**
Inconvenient	13% (7-19%)	9% (5-12%)	7% (4-10%)	15% (10-21%)	18% (12-25%)	20% (14-27%)	17% (11-23%)	**Convenient**
***Behavior 4* (*n*=523)**								
Bad	1% (0-1%)	2% (0-4%)	1% (0-2%)	8% (3-14%)	7% (4-11%)	20% (13-26%)	61% (53-69%)	**Good**
Unpleasant	8% (5-12%)	4% (1-7%)	4% (2-7%)	19% (13-26%)	19% (13-25%)	18% (12-25%)	27% (20-34%)	**Pleasant**
Ineffective	1% (0-2%)	1% (0-2%)	1% (0-2%)	12% (7-17%)	13% (7-19%)	29% (21-36%)	44% (36-52%)	**Effective**
Harmful	3% (0-5%)	1% (0-2%)	2% (1-4%)	10% (6-15%)	12% (6-18%)	26% (19-33%)	46% (38-53%)	**Beneficial**
Difficult	5% (3-8%)	4% (2-6%)	8% (3-12%)	13% (8-19%)	13% (7-19%)	27% (20-34%)	31% (23-38%)	**Easy**
Inconvenient	10% (6-14%)	7% (2-12%)	4% (3-6%)	13% (8-18%)	12% (8-16%)	26% (18-33%)	27% (20-34%)	**Convenient**

Target population size for weighted proportions is 94,783 producers.

When asked about maintaining their cattle in their current location(s) during an outbreak of FMD, respondents indicated that it was good (61%), effective (44%), and beneficial (46%), with very few respondents disagreeing (1%, 1%, and 3% respectively.) However, similar to gathering and holding, only 27%, 31%, and 27% of respondents felt that maintaining their cattle in their current location(s) was pleasant, easy or convenient, respectively, and 8%, 5% and 10% felt that it was very unpleasant, difficult, and inconvenient, respectively. Proportion of responses to belief-based measures (behavioral beliefs) underlying attitudes were presented and discussed in Chapters III and IV.

Subjective Norms

Direct measures of subjective norms for each behavior were determined using a series of four questions, and the weighted proportion of responses to each question for each behavior are shown in **Table 18**. Producers were more likely to strongly agree that they would feel social pressure to ask a veterinarian to examine cattle with clinical signs of FMD if an outbreak was known to be present (11% vs. 25%, respectively.) Approximately, 70% of respondents indicated that people who are important to them would expect them to ask a veterinarian to examine their cattle, other cattle producers they admire would ask a veterinarian to examine their cattle, and other cattle producers like themselves would ask a veterinarian to examine their cattle either in the absence of or during an outbreak of FMD. However, 15% and 10% of respondents strongly disagreed that they would feel under social pressure to request veterinary examination of their cattle in the absence of or during an outbreak of FMD, respectively.

Table 18 – Direct measures of subjective norms for each behavioral intention. Weighted proportion of cow-calf producers´ responses to perceived social pressure to ask a veterinarian to examine their cattle in the absence of (*behavior 1*) or during an outbreak of FMD (*behavior 2*), and gather and hold their cattle (*behavior 3*) or keep their cattle in their current location(s) during an outbreak of FMD (*behavior 4*).

	Weighted Proportion of Responses (95% Confidence Interval)				
Subjective Norms	**Strongly Disagree**[a]	**Mostly Disagree**	**Neither Agree nor Disagree**	**Mostly Agree**	**Strongly Agree**
Behavior1 (n=492)					
I would feel under social pressure to …[b]	15% (4-25%)	12% (7-17%)	23% (15-30%)	40% (31-49%)	11% (6-15%)
Most people who are important to me think that I should …	10% (0-21%)	5% (2-9%)	17% (11-23%)	38% (30-47%)	30% (22-38%)
Other cattle producers I admire would …	1% (0-1%)	6% (2-9%)	10% (6-14%)	55% (46-64%)	28% (20-36%)
Other cattle producers like myself, would …	1% (0-1%)	6% (2-10%)	8% (5-12%)	52% (43-61%)	33% (25-41%)
Behavior2 (*n*=565)					
I would feel under social pressure to …	10% (6-14%)	7% (4-11%)	16% (10-22%)	41% (34-49%)	25% (18-32%)
Most people who are important to me think that I should …	1% (0-2%)	5% (2-8%)	16% (10-22%)	43% (35-50%)	35% (28-42%)
Other cattle producers I admire would …	2% (0-3%)	3% (1-5%)	14% (9-19%)	43% (36-51%)	37% (30-45%)
Other cattle producers like myself, would …	1% (0-2%)	4% (1-7%)	8% (5-11%)	49% (41-56%)	38% (31-46%)
Behavior3 (*n*=488)					
I would feel under social pressure to …	12% (1-23%)	8% (4-13%)	21% (14-30%)	37% (29-45%)	21% (14-28%)
Most people who are important to me think that I should …	1% (0-2%)	3% (0-6%)	19% (8-30%)	43% (34-52%)	34% (26-43%)
Other cattle producers I admire would …	0% (0-1%)	3% (0-5%)	12% (7-17%)	47% (38-57%)	37% (27-48%)
Other cattle producers like myself, would …	0% (0-1%)	2% (1-5%)	12% (7-17%)	50% (41-60%)	35% (24-45%)
Behavior4 (*n*=554)					
I would feel under social pressure to …	2% (1-3%)	3% (1-4%)	18% (12-23%)	49% (41-57%)	29% (22-35%)
Most people who are important to me think that I should …	0% (0-1%)	0% (0-1%)	18% (12-23%)	46% (39-54%)	35% (28-42%)
Other cattle producers I admire would …	1% (0-2%)	2% (1-4%)	20% (13-26%)	51% (44-59%)	26% (20-32%)
Other cattle producers like myself, would …	1% (0-2%)	2% (0-4%)	17% (11-22%)	54% (46-61%)	27% (21-33%)

[a] The number of categories was reduced from 7 to 5 by combining somewhat and mostly disagree (shown as mostly disagree) and somewhat to mostly agree (shown as mostly agree.)
[b] The complete statement included on the survey can be created by inserting the corresponding behavior. For example, the first statement is: "I would feel under social pressure to ask a veterinarian to examine my cattle."
Behaviors 1 and 3 were assessed on one survey, and behaviors 2 and 4 were assessed on a separate survey.
Target population size for weighted proportions is 94,783 producers.

Similarly, 10% strongly disagreed that people who are important to them would expect them to request veterinary examination of their cattle in the absence of an outbreak, although this percentage dropped to 1% when an outbreak was known to be present. Respondents also indicated that they perceived strong social expectations to gather and hold cattle at the date and time requested by authorities during an outbreak of FMD. Over 50% of respondents mostly to strongly agreed that they would feel under social pressure to gather and hold their cattle, with 12% strongly disagreeing with this statement.

Respondents also mostly to strongly agreed that people who are important to them would expect them to gather and hold their cattle (77%), other cattle producers they admire would gather and hold their cattle (80%), and other cattle producers like themselves would gather and hold their cattle (85%).

When asked about compliance with movement restrictions during an outbreak of FMD, 78% of respondents mostly to strongly agreed that they would feel social pressure to keep their animals in their current location(s). Approximately 80% somewhat to strongly agreed that the people who are important to them would expect them to keep their cattle in their current location(s), other cattle producers they admire would keep their cattle in their current location(s), and other cattle producers like themselves would keep their cattle in their current location(s). Proportion of responses to belief-based measures (normative beliefs) underlying subjective norms were presented and discussed in Chapters IV and V.

Perceived Behavioral Control

Weighted proportions of respondents´ perceived behavioral control for each of the behaviors of interest are shown in **Table 19**. In general, respondents indicated a strong sense of behavioral control for requesting veterinary examination of cattle with clinical signs consistent with FMD, both in the absence of and during an outbreak of FMD. Over 70% of respondents mostly to strongly agreed, regardless of scenario, that they were confident they could ask a veterinarian to examine their cattle, and asking a veterinarian to examine their cattle was under their control. Similarly, over 70% of respondents mostly to strongly agreed that they were confident that they could gather and hold their cattle, and that gathering and holding their cattle was completely under their control. When asked about their confidence in their ability to keep their animals in their current location(s) during an outbreak of FMD, over 90% of respondents mostly to strongly agreed that they were confident of their ability to perform this behavior. However, only 64% mostly to strongly agreed that keeping their cattle in their current location(s) was entirely under their control, and 21% mostly to strongly disagreed with this statement. Proportion of responses to belief-based measures (control beliefs) underlying perceived behavioral control were presented and discussed in Chapters IV and V.

Table 19 – Direct measures of perceived behavioral control for each behavioral intention. Weighted proportion of cow-calf producers´ responses to their perceived behavioral control for asking a veterinarian to examine their cattle in the absence of (*behavior 1*) or during an outbreak of FMD (*behavior 2*), and gathering and holding their cattle (*behavior 3*) or keeping their cattle in their current location(s) during an outbreak of FMD (*behavior 4*).

	Weighted Proportion of Responses (95% Confidence Interval)				
Perceived Behavioral Control	**Strongly Disagree[a]**	**Mostly Disagree**	**Neither Agree nor Disagree**	**Mostly Agree**	**Strongly Agree**
Behavior1 (n=490)					
I am confident that I could ask a veterinarian to examine my cattle.	1% (0-1%)	1% (0-1%)	1% (0-3%)	24% (17-31%)	74% (66-81%)
Whether I ask that my cattle are examined by a veterinarian or not, is entirely under my control.	2% (1-5%)	0% (0-0%)	6% (2-10%)	36% (27-45%)	56% (46-65%)
Behavior2 (*n*=568)					
I am confident that I could ask a veterinarian to examine my cattle.	0% (0-0%)	3% (0-7%)	2% (0-4%)	22% (16-29%)	72% (65-79%)
Whether I ask that my cattle are examined by a veterinarian or not, is entirely under my control.	6% (3-9%)	6% (3-8%)	14% (8-21%)	33% (26-40%)	41% (34-49%)
Behavior3 (*n*=489)					
I am confident that I could gather and hold my cattle at the date and time requested.	0% (0-0%)	2% (0-4%)	5% (2-9%)	36% (28-45%)	56% (47-65%)
Whether I gather and hold my cattle at the date and time requested or not, is entirely under my control.	6% (2-9%)	10% (5-14%)	11% (6-15%)	29% (21-37%)	45% (35-55%)
Behavior4 (*n*=555)					
During an outbreak of FMD, I am confident that I could keep my cattle in their current location(s).	0% (0-1%)	3% (1-6%)	3% (1-4%)	41% (34-49%)	52% (44-60%)
Whether I keep my cattle in their current location(s) or not, is entirely under my control.	10% (6-13%)	11% (8-15%)	15% (10-19%)	32% (24-40%)	32% (25-40%)

[a] The number of categories was reduced from 7 to 5 by combining somewhat and mostly disagree (shown as mostly disagree) and somewhat to mostly agree (shown as mostly agree.)
Behaviors 1 and 3 were assessed on one survey, and behaviors 2 and 4 were assessed on a separate survey.
Target population size for weighted proportions is 94,783 producers.

Moral Norms

Each survey contained unique questions related to a sense of moral duty to perform each of the behaviors, and the weighted proportions of their responses are shown in **Table 20**. In general, respondents expressed a very strong sense of moral obligation to perform each of the behaviors. At least 90% of respondents indicated that they mostly to strongly agreed that they had a moral duty to request veterinary examination for cattle with clinical signs of FMD either in the absence of or during an outbreak of FMD, to request veterinary care for sick animals, and to gather and hold their cattle when requested during an outbreak of FMD. During an outbreak when movement restriction are in place, 99% of respondents mostly to strongly agreed that they have a moral duty to ensure that their cattle have access to adequate feed and water, 100% mostly to strongly agreed that they have a moral duty to protect their animals from exposure to diseased animals, and 99% mostly to strongly agreed that they have a moral duty to prevent the spread of disease from their cattle to someone else´s cattle.

Table 20 – Moral norms related to producers´ intentions to request veterinary examination, gather and hold their cattle, and obey animal movement restrictions. Weighted proportion of cow-calf producers´ responses to moral norms related to asking a veterinarian to examine their cattle in the absence of (*behavior 1*) or during an outbreak of FMD (*behavior 2*), and gathering and holding their cattle (*behavior 3*) or keeping their cattle in their current location(s) during an outbreak of FMD (*behavior 4*).

	Weighted Proportion of Responses (95% Confidence Interval)				
Moral Norms	**Strongly Disagree**[a]	**Mostly Disagree**	**Neither Agree nor Disagree**	**Mostly Agree**	**Strongly Agree**
Behavior1 (n=496)					
I have a moral duty to ask a veterinarian to examine my cattle [in the described situation].[b]	1% (0-3%)	4% (1-7%)	6% (0-11%)	45% (36-55%)	43% (34-52%)
I have a moral duty to request veterinary care for sick cattle.	2% (0-3%)	2% (0-4%)	6% (1-11%)	42% (33-51%)	48% (38-58%)
Behavior2 (*n*=572)					
I have a moral duty to ask a veterinarian to examine my cattle [in the described situation].	1% (0-2%)	1% (0-2%)	3% (1-5%)	31% (24-39%)	64% (57-71%)
I have a moral duty to request veterinary care for sick cattle.	1% (0-2%)	2% (1-3%)	5% (2-8%)	37% (30-44%)	55% (47-62%)
Behavior3 (*n*=489)					
I have a moral duty to gather and hold my cattle at the date and time requested.	1% (0-2%)	1% (0-3%)	4% (1-7%)	39% (30-48%)	56% (46-65%)
Behavior4 (*n*=557)					
I have a moral duty to ensure that my cattle have access to adequate feed and water.	0% (0-1%)	0% (0-1%)	1% (0-2%)	20% (13-26%)	79% (72-85%)
I have a moral duty to protect my cattle from exposure to diseased animals.	0% (0-0%)	0% (0-0%)	0% (0-1%)	24% (17-31%)	76% (69-83%)
I have a moral duty to prevent the spread of disease from my cattle to someone else's cattle.	0% (0-0%)	1% (0-2%)	1% (0-1%)	21% (14-28%)	78% (71-85%)

[a] The number of categories was reduced from 7 to 5 by combining somewhat and mostly disagree (shown as mostly disagree) and somewhat to mostly agree (shown as mostly agree.)
[b] The original survey instrument contained a reference back to the scenario used to introduce the behavior. The information in brackets has been added to clarify the context of the question for this table.
Behaviors 1 and 3 were assessed on one survey, and behaviors 2 and 4 were assessed on a separate survey.
Target population size for weighted proportions is 94,783 producers.

Risk Perception

Questions designed to assess producer´s perceptions of the risk posed by FMD were included in each survey, and the weighted proportion of responses to each question for Survey 1 and 2 are shown in **Table 21**. Producer responses on both surveys were very similar. Regardless of survey, over 30% of respondents somewhat to strongly agreed that the risk of an outbreak of FMD in the US is great, while 38% neither agreed nor disagreed, and 33% somewhat to strongly disagreed with the same statement. Depending on the survey, 11-17% of respondents somewhat to strongly agreed and 44% somewhat to strongly disagreed that an outbreak of FMD in the US is likely in the next five years. In contrast, 9-10% of producers somewhat to strongly agreed and 69-70% somewhat to strongly disagreed that the risk of an outbreak in their operation was great. Over 70% of respondents somewhat to strongly disagreed that an outbreak of FMD was likely in their operation in the next five years. Depending on the survey 85-90% of respondents somewhat to strongly agreed that an outbreak of FMD would be economically devastating to the US cattle industry, while 81-83% indicated that an outbreak would be economically devastating to their operation.

Table 21 – Weighted proportion of responses to how strongly producers agree with a series of statements regarding the risk posed by FMD. Identical questions were included on each survey (Survey 1, *n*=490; and Survey 2, *n*=550) and were not specific to any particular behavior. Survey 1 contained questions related to the behaviors of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak and gathering and holding cattle at the date and time requested during an outbreak of FMD. Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during an outbreak of FMD and keeping cattle in their current location(s) during an outbreak of FMD.

		Weighted Proportion of Responses (95% Confidence Interval)													
	Survey	**Strongly Disagree**		**Mostly Disagree**		**Somewhat Disagree**		**Neither Agree nor Disagree**		**Somewhat Agree**		**Mostly Agree**		**Strongly Agree**	
The risk of an outbreak of foot-and-mouth disease **in the USA** is very great.	*1*	7%	(3-12%)	10%	(6-14%)	16%	(5-27%)	35%	(26-43%)	18%	(12-24%)	8%	(5-12%)	5%	(2-8%)
	2	7%	(3-11%)	20%	(14-27%)	10%	(6-14%)	38%	(30-46%)	18%	(13-24%)	4%	(2-6%)	2%	(1-3%)
The risk of an outbreak of foot-and-mouth disease **in my operation** is very great.	*1*	29%	(18-39%)	27%	(19-35%)	14%	(8-19%)	20%	(13-26%)	5%	(2-8%)	2%	(0-5%)	3%	(0-5%)
	2	30%	(23-37%)	26%	(19-33%)	13%	(8-18%)	22%	(15-28%)	7%	(3-10%)	1%	(0-2%)	1%	(0-2%)
An outbreak of foot-and-mouth disease would be economically devastating for my operation.	*1*	1%	(0-2%)	5%	(1-10%)	1%	(0-1%)	10%	(4-15%)	10%	(15-16%)	16%	(11-22%)	57%	(48-66%)
	2	4%	(1-7%)	6%	(2-10%)	3%	(0-5%)	6%	(3-5%)	14%	(9-19%)	22%	(15-29%)	45%	(38-53%)
An outbreak of foot-and-mouth disease would be economically devastating for the US cattle industry.	*1*	1%	(0-3%)	2%	(0-6%)	2%	(0-4%)	10%	(4-16%)	10%	(5-14%)	23%	(16-30%)	52%	(42-61%)
	2	1%	(0-2%)	3%	(0-7%)	0%	(0-1%)	6%	(9-20%)	15%	(9-20%)	28%	(20-35%)	47%	(40-55%)
I believe that **the United States** is likely to experience an outbreak of foot-and-mouth disease in the next five years.	*1*	19%	(8-30%)	11%	(7-16%)	14%	(8-20%)	40%	(30-48%)	10%	(6-15%)	4%	(0-6%)	3%	(1-6%)
	2	13%	(8-18%)	18%	(12-23%)	12%	(7-16%)	47%	(40-55%)	8%	(4-11%)	2%	(1-3%)	1%	(0-2%)
I believe that **my operation** is likely to experience an outbreak of foot-and-mouth disease in the next five years.	*1*	40%	(30-50%)	24%	(17-31%)	10%	(5-14%)	23%	(16-30%)	2%	(0-3%)	1%	(0-2%)	1%	(0-2%)
	2	38%	(31-46%)	25%	(18-31%)	9%	(5-13%)	25%	(18-32%)	3%	(1-5%)	0%	(0-1%)	0%	(0-1%)

Target population size for calculation of weighted proportions and standard errors is 94,783 producers.

Trust in Neighbors and Other Producers

Respondents´ trust in other producers was assessed using a series of two-part questions, which asked what the respondent believed that other neighbors, producers in their area, or other producers in Texas would do, and whether or not the respondent felt that these groups would take consequences to the respondent´s operation into account. Weighted proportions of responses to each set of questions were determined for each of the behaviors, and they are shown in **Table 22** and **Table 23**. The majority of respondents were mostly to extremely sure that their neighbors, other cattle producers in their area, and other cattle producers in Texas would ask a veterinarian to examine cattle with clinical signs consistent with FMD regardless of whether an outbreak of FMD was known to be present or not. In addition, the majority of respondents were also mostly to extremely sure that these groups would take into consideration the consequences to the respondent´s operation when deciding whether or not to ask a veterinarian to examine their cattle, regardless of whether an outbreak was known to be present or not. The combination of these results would indicate that in general, respondents had high levels of trust in their neighbors, other cattle producers in their area, and other cattle producers in Texas to request veterinary examination of cattle with clinical signs of FMD.

Table 22 – Trust in neighbors, other producers in area, and other producers in Texas in regards to requesting veterinary examination of cattle with clinical signs consistent with FMD. Weighted proportion of responses to how sure respondents are that others would request veterinary examination of cattle with clinical signs of FMD either in the absence of (*n*=472) or during (*n*=551) an outbreak of FMD, and whether or not the respondent felt that these groups would take into consideration the consequences to the respondent´s operation when deciding whether to request veterinary examination or not.

		Weighted Proportion of Responses (95% Confidence Interval)									
How sure are you that:	**Scenario[a]**	**Extremely Unsure[b]**		**Mostly Unsure**		**Neither Sure nor Unsure**		**Mostly Sure**		**Extremely Sure**	
your neighbors would ask a veterinarian to examine their cattle?	***Pre-outbreak***	2%	(1-4%)	8%	(4-12%)	17%	(11-23%)	56%	(45-66%)	18%	(6-30%)
	During outbreak	5%	(1-10%)	11%	(7-15%)	11%	(7-15%)	59%	(51-66%)	14%	(9-19%)
other producers in your area would ask a veterinarian to examine their cattle?	***Pre-outbreak***	1%	(0-1%)	6%	(2-10%)	14%	(8-20%)	60%	(49-70%)	20%	(8-31%)
	During outbreak	2%	(0-3%)	10%	(5-16%)	13%	(8-18%)	60%	(52-67%)	15%	(10-21%)
other producers in Texas would ask a veterinarian to examine their cattle?	***Pre-outbreak***	1%	(0-2%)	8%	(3-13%)	24%	(13-35%)	58%	(48-68%)	9%	(4-14%)
	During outbreak	1%	(0-2%)	9%	(3-14%)	19%	(13-25%)	59%	(51-66%)	13%	(8-18%)
your neighbors would take into consideration the consequences to your operation ?	***Pre-outbreak***	3%	(1-5%)	11%	(6-17%)	24%	(13-35%)	53%	(43-63%)	8%	(4-13%)
	During outbreak	8%	(2-13%)	9%	(6-13%)	20%	(14-26%)	48%	(41-56%)	15%	(10-20%)
other producers in your area would take into consideration the consequences to your operation ?	***Pre-outbreak***	2%	(0-3%)	10%	(5-15%)	23%	(12-34%)	56%	(46-66%)	10%	(5-14%)
	During outbreak	8%	(2-14%)	9%	(5-14%)	18%	(13-24%)	51%	(43-59%)	13%	(8-18%)
other producers in Texas would take into consideration the consequences to your operation ?	***Pre-outbreak***	2%	(1-3%)	11%	(6-16%)	29%	(18-40%)	50%	(40-60%)	8%	(4-12%)
	During outbreak	8%	(2-14%)	11%	(6-15%)	22%	(16-28%)	47%	(39-55%)	12%	(7-16%)

[a] These behaviors were assessed on two separate surveys. Survey 1 contained questions related to the behaviors of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak (pre-outbreak), while Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas (during outbreak).
[b] The number of categories was reduced from 7 to 5 by combining somewhat and mostly unsure (shown as mostly unsure) and somewhat to mostly sure (shown as mostly sure.)
Target population size for weighted proportions is 94,783 producers.

Table 23 – Trust in neighbors, other producers in area, and other producers in Texas in regards to requesting veterinary examination of cattle with clinical signs consistent with FMD. Weighted proportion of responses to how sure respondents are that other neighbors, producers in their area, or other producers in Texas would gather and hold their cattle (n=482), or maintain their cattle in their current location(s) (n=540), during an outbreak of FMD, and whether or not the respondent felt that these groups would take into consideration the consequences to the respondent´s operation when deciding whether or not to gather and hold their cattle or move their cattle.

		Weighted Proportion of Responses (95% Confidence Interval)									
How sure are you that:	**Behavior[a]**	**Extremely Unsure[b]**		**Mostly Unsure**		**Neither Sure nor Unsure**		**Mostly Sure**		**Extremely Sure**	
your neighbors would:	**Gather and hold**	3%	(0-5%)	5%	(2-8%)	11%	(8-15%)	63%	(53-73%)	18%	(7-29%)
	Maintain cattle	4%	(1-7%)	10%	(5-16%)	16%	(11-22%)	53%	(45-61%)	16%	(10-22%)
other producers in your area would:	**Gather and hold**	2%	(0-4%)	5%	(2-8%)	12%	(8-17%)	60%	(50-71%)	20%	(9-31%)
	Maintain cattle	3%	(1-5%)	10%	(4-15%)	18%	(12-24%)	59%	(52-62%)	10%	(6-14%)
other producers in Texas would:	**Gather and hold**	1%	(0-3%)	5%	(2-8%)	26%	(15-37%)	60%	(50-70%)	8%	(4-12%)
	Maintain cattle	5%	(0-10%)	8%	(5-12%)	25%	(18-32%)	54%	(46-62%)	8%	(4-11%)
your neighbors would take into consideration the consequences to your operation ?	**Gather and hold**	3%	(1-6%)	9%	(4-15%)	15%	(9-20%)	55%	(46-65%)	17%	(7-28%)
	Maintain cattle	5%	(2-8%)	15%	(9-22%)	20%	(14-26%)	47%	(39-54%)	13%	(8-18%)
other producers in your area would take into consideration the consequences to your operation?	**Gather and hold**	3%	(0-5%)	8%	(3-13%)	22%	(15-30%)	47%	(38-56%)	20%	(9-31%)
	Maintain cattle	4%	(1-6%)	12%	(6-18%)	23%	(17-30%)	50%	(43-58%)	10%	(6-15%)
other producers in Texas would take into consideration the consequences to your operation?	**Gather and hold**	2%	(0-4%)	10%	(5-16%)	24%	(17-32%)	46%	(37-56%)	17%	(6-28%)
	Maintain cattle	8%	(2-13%)	11%	(6-15%)	25%	(19-32%)	47%	(40-55%)	9%	(5-13%)

[a] These behaviors were assessed on two separate surveys. Survey 1 contained questions related to the behaviors of gathering and holding cattle at the date and time requested by authorities, while Survey 2 contained questions related to maintaining cattle in their current location(s) during a hypothetical outbreak of FMD in Texas.
[b] The number of categories was reduced from 7 to 5 by combining somewhat and mostly unsure (shown as mostly unsure) and somewhat to mostly sure (shown as mostly sure.)
Target population size for weighted proportions is 94,783 producers.

In the absence of a known outbreak, only 2% of respondents indicated that they were extremely unsure whether or not their neighbors would ask a veterinarian to examine cattle with clinical signs of FMD, while 5% indicated they were extremely unsure about their neighbors requesting veterinary examination of cattle with clinical signs of FMD when an outbreak was known to be present. When an outbreak was known to be present, respondents became either more unsure (e.g. 3% vs 8% extremely unsure that neighbors would take into account the consequences to the respondent´s operation prior to or during an outbreak of FMD, respectively) or more sure (e.g. 8% vs 15% extremely sure that neighbors would take into account the consequences to the respondent´s operation prior to or during an outbreak of FMD, respectively) that each of these groups would take into consideration the consequences to the respondent´s operation when deciding whether to request veterinary examination or not.

In regards to gathering and holding cattle at the date and time requested by authorities during an outbreak of FMD, the majority of respondents were mostly to extremely sure that their neighbors, other cattle producers in their area, and other cattle producers in Texas would gather and hold their cattle when requested. In addition, the majority of respondents felt that these groups would take into consideration the consequences to the respondent´s operation when making a decision about gathering and holding their cattle. Again, these results combined indicate that respondents had high levels of trust in their neighbors and other cattle producers to gather and hold their cattle at the date and time requested by authorities. Similar results were found for levels of trust in others to maintain their cattle in their current location(s) during an outbreak of

FMD. Over 60% of respondents were mostly to extremely sure that their neighbors and other cattle producers in their area and in Texas would obey animal movement restrictions, while over 50% of respondents were mostly to extremely sure that these groups would take into consideration the consequences to the respondent´s operation when deciding whether or not to move their cattle.

Trust in Regulatory Agencies

Trust in regulatory agencies was assessed through the use of three statements designed to assess producers´ beliefs about the competency, caring, and shared goals of the agencies with the producer. Weighted proportions of responses for each statement and each agency were determined and are shown in **Tables 24-26**. Regardless of survey, the majority of respondents (70% or greater) felt that the USDA, TDA, and the TAHC would handle their role during an outbreak of FMD somewhat to extremely well. For the remaining agencies, 50% or less of respondents indicated that they would handle their role somewhat to extremely well. FEMA and the EPA were the agencies with the highest proportion of respondents indicating that they would handle their role during an outbreak of FMD somewhat to extremely poorly (33% and 35% for FEMA, and 43% and 35% for EPA, for survey 1 and 2 respectively).

Table 24 – Cattle producers´ trust in agencies to manage their role during an outbreak of FMD. Weighted proportion of responses to producers´ beliefs about how well agencies would manage their role during an outbreak of FMD. Identical questions were included on each survey (Survey 1, n=421; and Survey 2, n=483) and were not specific to any particular behavior.

		Weighted Proportion of Responses (95% Confidence Interval)													
	Survey	Extremely Poorly		Very Poorly		Somewhat Poorly		Neither Well nor Poorly		Somewhat Well		Very Well		Extremely Well	
US Department of Agriculture	*1*	1%	(0-3%)	3%	(1-5%)	9%	(4-14%)	14%	(8-20%)	30%	(22-38%)	23%	(16-30%)	19%	(12-26%)
	2	5%	(2-8%)	3%	(0-6%)	7%	(3-10%)	14%	(7-20%)	27%	(20-35%)	28%	(21-35%)	17%	(11-23%)
Texas Department of Agriculture	*1*	1%	(0-1%)	1%	(0-3%)	5%	(1-8%)	13%	(7-19%)	26%	(19-34%)	29%	(21-37%)	25%	(17-32%)
	2	3%	(0-5%)	1%	(0-2%)	6%	(2-9%)	12%	(6-9%)	22%	(15-29%)	37%	(29-45%)	20%	(14-26%)
Texas Animal Health Commission	*1*	1%	(0-1%)	1%	(0-3%)	5%	(2-8%)	13%	(7-19%)	26%	(19-34%)	26%	(19-33%)	27%	(20-35%)
	2	1%	(0-3%)	2%	(0-4%)	6%	(2-9%)	14%	(7-21%)	21%	(15-27%)	32%	(24-40%)	24%	(17-30%)
US Department of Homeland Security	*1*	10%	(6-14%)	9%	(3-15%)	10%	(5-14%)	30%	(22-38%)	16%	(11-22%)	14%	(8-20%)	11%	(5-17%)
	2	11%	(5-17%)	6%	(3-9%)	10%	(6-14%)	25%	(18-32%)	25%	(18-32%)	13%	(7-18%)	9%	(5-13%)
US Environmental Protection Agency	*1*	14%	(9-19%)	8%	(2-13%)	11%	(6-17%)	28%	(20-35%)	17%	(11-23%)	12%	(7-17%)	11%	(5-17%)
	2	14%	(8-19%)	8%	(4-11%)	13%	(7-20%)	26%	(18-33%)	13%	(8-17%)	17%	(10-24%)	10%	(5-15%)
Federal Emergency Management Agency	*1*	17%	(11-22%)	10%	(4-15%)	16%	(9-22%)	26%	(18-33%)	13%	(8-18%)	10%	(5-15%)	8%	(3-14%)
	2	15%	(9-22%)	9%	(5-13%)	11%	(7-15%)	30%	(22-39%)	16%	(11-22%)	10%	(5-14%)	8%	(4-13%)
Texas Health and Human Services	*1*	9%	(4-14%)	8%	(3-12%)	10%	(4-15%)	29%	(21-36%)	16%	(10-22%)	16%	(11-22%)	12%	(6-18%)
	2	9%	(3-15%)	5%	(2-9%)	12%	(7-16%)	23%	(16-29%)	25%	(18-31%)	16%	(10-22%)	10%	(5-14%)
Texas Commission on Environmental Quality	*1*	10%	(5-15%)	10%	(3-16%)	11%	(6-15%)	27%	(19-35%)	17%	(11-23%)	13%	(8-18%)	12%	(6-18%)
	2	14%	(7-20%)	4%	(2-6%)	11%	(7-16%)	25%	(18-33%)	20%	(13-27%)	16%	(10-22%)	10%	(5-14%)
US Department of Health and Human Services	*1*	14%	(8-19%)	9%	(3-15%)	10%	(6-15%)	27%	(19-34%)	15%	(9-20%)	14%	(9-20%)	12%	(6-17%)
	2	9%	(5-13%)	9%	(4-15%)	9%	(5-13%)	27%	(20-35%)	21%	(14-28%)	14%	(8-19%)	11%	(6-16%)

[a] Survey 1 contained questions related to the behaviors of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak and gathering and holding cattle at the date and time requested during an outbreak of FMD. Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during an outbreak of FMD and keeping cattle in their current location(s) during an outbreak of FMD.
Target population size for weighted proportions is 94,783 producers.

Table 25 – Cattle producers´ trust in agencies to act in the producer´s best interest in managing an outbreak of FMD. Weighted proportion of responses to how strongly producers agree that agencies would act in the producer´s best interest in managing an outbreak of FMD. Identical questions were included on each survey (Survey 1, *n*=426; and Survey 2, *n*=486) and were not specific to any particular behavior.

		Weighted Proportion of Responses (95% Confidence Interval)													
	Survey	**Strongly Disagree**		**Mostly Disagree**		**Somewhat Disagree**		**Neither Agree nor Disagree**		**Somewhat Agree**		**Mostly Agree**		**Strongly Agree**	
US Department of Agriculture	*1*	10%	(3-15%)	4%	(1-6%)	9%	(4-15%)	12%	(5-18%)	22%	(15-29%)	18%	(12-24%)	26%	(14-37%)
	2	8%	(4-12%)	5%	(2-9%)	8%	(3-14%)	10%	(6-14%)	25%	(17-33%)	25%	(18-31%)	18%	(12-25%)
Texas Department of Agriculture	*1*	5%	(1-10%)	4%	(1-7%)	8%	(3-13%)	11%	(5-17%)	20%	(13-26%)	23%	(16-30%)	29%	(18-41%)
	2	5%	(2-9%)	3%	(1-6%)	3%	(1-4%)	12%	(7-17%)	24%	(16-31%)	32%	(24-40%)	21%	(14-27%)
Texas Animal Health Commission	*1*	6%	(1-10%)	4%	(1-6%)	7%	(2-12%)	14%	(7-21%)	15%	(10-20%)	25%	(18-32%)	29%	(17-40%)
	2	4%	(1-7%)	3%	(1-5%)	5%	(2-8%)	12%	(7-17%)	29%	(21-37%)	23%	(16-29%)	24%	(18-31%)
US Department of Homeland Security	*1*	19%	(12-26%)	9%	(5-13%)	8%	(3-13%)	22%	(15-29%)	15%	(9-20%)	9%	(4-15%)	18%	(5-30%)
	2	14%	(8-21%)	10%	(6-14%)	8%	(4-12%)	31%	(23-39%)	18%	(11-25%)	11%	(6-15%)	8%	(4-13%)
US Environmental Protection Agency	*1*	22%	(15-29%)	8%	(4-11%)	10%	(4-16%)	23%	(16-30%)	13%	(8-18%)	6%	(2-9%)	19%	(7-31%)
	2	17%	(11-24%)	7%	(4-10%)	9%	(5-13%)	31%	(23-39%)	17%	(11-23%)	10%	(6-14%)	9%	(4-14%)
Federal Emergency Management Agency	*1*	24%	(16-31%)	9%	(4-14%)	9%	(4-14%)	22%	(15-29%)	12%	(7-17%)	9%	(4-13%)	15%	(2-27%)
	2	17%	(10-23%)	9%	(5-12%)	13%	(8-18%)	29%	(21-37%)	15%	(9-21%)	9%	(5-13%)	8%	(4-13%)
Texas Health and Human Services	*1*	16%	(9-22%)	8%	(4-12%)	9%	(4-13%)	21%	(14-28%)	16%	(10-22%)	11%	(6-16%)	20%	(7-32%)
	2	11%	(5-18%)	6%	(3-8%)	10%	(6-15%)	31%	(23-38%)	19%	(12-26%)	14%	(9-19%)	10%	(5-15%)
Texas Commission on Environmental Quality	*1*	18%	(11-24%)	9%	(4-13%)	7%	(3-11%)	23%	(15-30%)	16%	(10-22%)	9%	(5-13%)	19%	(7-31%)
	2	13%	(6-19%)	9%	(5-12%)	10%	(5-14%)	24%	(17-31%)	22%	(14-29%)	15%	(9-20%)	8%	(4-12%)
US Department of Health and Human Services	*1*	19%	(12-26%)	10%	(5-14%)	5%	(1-9%)	23%	(15-30%)	14%	(8-19%)	11%	(6-16%)	19%	(6-31%)
	2	15%	(8-21%)	5%	(3-8%)	8%	(4-13%)	32%	(24-40%)	18%	(12-24%)	13%	(8-18%)	9%	(5-36%)

[a] Survey 1 contained questions related to the behaviors of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak and gathering and holding cattle at the date and time requested during an outbreak of FMD. Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during an outbreak of FMD and keeping cattle in their current location(s) during an outbreak of FMD.
Target population size for weighted proportions is 94,783 producers.

Table 26 – Cattle producers´ trust in agencies to have the same goals that the producer has in managing an outbreak of FMD. Weighted proportion of responses to how strongly producers agree that the following agencies would have the same goals as the producer in managing an outbreak of FMD. Identical questions were included on each survey (Survey 1, *n*=429; and Survey 2, *n*=492) and were not specific to any particular behavior.

		Weighted Proportion of Responses (95% Confidence Interval)						
	Survey	**Strongly Disagree**	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**
US Department of Agriculture	*1*	3% (1-6%)	2% (1-3%)	4% (1-7%)	9% (3-15%)	21% (14-28%)	26% (18-34%)	34% (23-46%)
	2	4% (1-6%)	3% (1-6%)	5% (0-10%)	10% (5-14%)	20% (13-26%)	29% (21-37%)	29% (22-36%)
Texas Department of Agriculture	*1*	2% (0-4%)	1% (0-3%)	1% (0-2%)	10% (4-16%)	17% (11-23%)	29% (21-38%)	39% (27-50%)
	2	3% (0-5%)	2% (0-3%)	2% (1-4%)	9% (5-13%)	19% (12-26%)	35% (27-43%)	31% (24-38%)
Texas Animal Health Commission	*1*	2% (1-4%)	1% (0-2%)	1% (0-2%)	11% (5-18%)	18% (11-24%)	30% (22-39%)	37% (26-48%)
	2	2% (0-4%)	2% (0-3%)	2% (0-3%)	12% (6-19%)	15% (9-21%)	33% (25-41%)	34% (27-42%)
US Department of Homeland Security	*1*	12% (7-18%)	9% (3-14%)	9% (4-14%)	24% (16-32%)	11% (7-16%)	17% (10-24%)	18% (6-30%)
	2	14% (8-21%)	5% (3-7%)	11% (6-16%)	27% (19-34%)	13% (8-19%)	15% (9-21%)	14% (9-20%)
US Environmental Protection Agency	*1*	17% (10-23%)	8% (4-13%)	6% (2-11%)	24% (16-31%)	12% (7-16%)	16% (9-23%)	18% (6-30%)
	2	17% (10-24%)	6% (3-8%)	11% (6-15%)	26% (18-34%)	14% (9-20%)	12% (7-17%)	14% (9-20%)
Federal Emergency Management Agency	*1*	17% (10-23%)	9% (5-14%)	8% (3-13%)	23% (16-31%)	11% (6-16%)	14% (8-21%)	18% (6-30%)
	2	16% (9-22%)	7% (4-9%)	10% (6-15%)	28% (20-36%)	13% (8-19%)	13% (8-19%)	13% (7-18%)
Texas Health and Human Services	*1*	11% (6-16%)	8% (3-14%)	6% (1-10%)	20% (13-27%)	14% (9-19%)	21% (14-29%)	19% (7-31%)
	2	11% (5-18%)	5% (3-8%)	7% (3-11%)	24% (16-31%)	20% (13-26%)	16% (11-22%)	16% (10-22%)
Texas Commission on Environmental Quality	*1*	13% (7-16%)	8% (3-13%)	6% (2-11%)	21% (14-28%)	15% (9-20%)	18% (11-25%)	20% (8-32%)
	2	11% (5-18%)	7% (4-10%)	7% (4-11%)	25% (18-32%)	20% (12-27%)	14% (9-19%)	16% (10-21%)
US Department of Health and Human Services	*1*	12% (7-18%)	9% (4-14%)	6% (1-11%)	24% (16-32%)	18% (11-25%)	18% (11-25%)	19% (7-31%)
	2	13% (7-20%)	6% (3-9%)	9% (5-13%)	27% (20-35%)	14% (8-19%)	15% (10-21%)	15% (9-21%)

[a] Survey 1 contained questions related to the behaviors of asking a veterinarian to examine cattle with clinical signs consistent with FMD in the absence of a known outbreak and gathering and holding cattle at the date and time requested during an outbreak of FMD. Survey 2 contained questions related to asking a veterinarian to examine cattle with clinical signs consistent with FMD during an outbreak of FMD and keeping cattle in their current location(s) during an outbreak of FMD.
Target population size for weighted proportions is 94,783 producers.

The extent to which the listed agencies were perceived to care about the producer was assessed by asking how strongly respondents agreed or disagreed with the statement that each agency would act in their best interest in managing an outbreak of FMD. The majority of respondents somewhat to strongly agreed that USDA, TDA, and the TAHC would act in their best interest (66% and 68% for USDA, 72% and 77% for TDA, and 69% and 76% for the TAHC, for survey 1 and 2, respectively). For the remaining agencies, 50% or less of respondents somewhat to strongly agreed that they would act in their best interest in managing an outbreak of FMD. FEMA and EPA were the agencies with the highest proportion of respondents indicating that they somewhat to strongly disagreed that they would act in their best interest in managing an outbreak of FMD (40% and 33% for FEMA and 42% and 39% for EPA, for Survey 1 and 2, respectively.)

Another aspect of trust which was assessed was the extent to which the listed agencies would have the same goals as producers while managing an outbreak of FMD. The majority of producers somewhat to strongly agreed that the USDA, TDA, and TAHC would have the same goals as the respondents while managing an outbreak of FMD (81% and 78% for USDA, 85% and 85% for TDA, and 85% and 82% for the TAHC, for Survey 1 and 2, respectively.) Approximately half of all respondents somewhat to strongly agreed that the Texas Health and Human Services, TCEQ, and US Department of Health and Human Services would have the same goals as they would in managing an outbreak of FMD (54% and 52% for Texas Health and Human Services, 53% and 50% for TCEQ, and 55% and 44% for the US Department of Health and Human Services, for Survey 1 and 2, respectively.) At least 30% of respondents somewhat to strongly disagreed that the DHS, FEMA, and the EPA would share the same goals as the respondent in managing an outbreak of FMD (30% and 30% for DHS, 31% and 34% for FEMA, and 34% and 33% for EPA, for Survey 1 and 2, respectively.)

Exploratory Factor Analysis

Exploratory factor analysis was performed for indirect (belief-based) measures of attitudes, perceived behavioral control, and subjective norms, as well as, direct measures of attitudes and the measures assessing trust in other producers, for each of the behaviors of interest. Tables showing the factor loadings and scoring coefficients of the factor analyses are presented in Appendix B.

Requesting Veterinary Examination of Cattle with Clinical Signs Consistent with FMD in the Absence of a Known Outbreak (Behavior 1) - Factor analysis of the behavioral beliefs shown in **Table 6** weighted by their belief evaluations for behavior 1 produced a single factor (Eigenvalue 6.12, KMO 0.90), which explained 94% of the variance in behavioral beliefs. The behavioral belief that requesting veterinary examination would result in a delay in their ability to sell cattle did not load well on any factor and had a very high uniqueness (0.98), so it was excluded from the factor analysis, and its relationship with the behavioral intention analyzed directly. Factor analysis of control beliefs shown in **Table 7** weighted by their belief evaluation produced a single factor (Eigenvalue 2.83, KMO 0.81), which explained 100% of the variance in control beliefs. Factor analysis of normative beliefs shown in **Table 8** weighted by their belief evaluation resulted in a single factor (Eigenvalue 6.34, KMO 0.92), which explained 93% of the variance in normative beliefs. Factor analysis was also performed on direct measures of attitudes shown in **Table 16**, which resulted in the extraction of one factor (Eigenvalue 3.39, KMO 0.84), which explained 100% of the variance in attitudes. A series of six questions were used to assess producers´ trust in other producers, which asked about how sure the respondent was that their neighbors, other cattle producers in their area, and other cattle producers in Texas would ask a veterinarian to examine their cattle and that these groups would take into consideration the consequences to the respondent´s operation when deciding whether to contact a veterinarian or not. Factor analysis of these questions resulted in a single factor (Eigenvalue 3.86, KMO 0.78), which explained 89% of the variance in these beliefs.

Requesting Veterinary Examination of Cattle with Clinical Signs Consistent with FMD During a Hypothetical Outbreak of FMD (Behavior 2) - Factor analysis of behavioral beliefs shown in **Table 6** weighted by their belief evaluations, towards behavior 2 produced one factor (Eigenvalue 5.44, KMO 0.88), which explained 90% of the variance in behavioral beliefs. As seen with requesting veterinary examination in the absence of a known outbreak, the behavioral belief that requesting veterinary examination would result in a delay in the ability to sell cattle did not load well on any factor and had a very high uniqueness (0.87), so it was excluded from the factor analysis, and its relationship with behavioral intention analyzed directly. One factor (Eigenvalue 3.17, KMO 0.82) was also extracted following factor analysis of control beliefs shown in **Table 7** weighted by their belief evaluation for behavior 2. This factor accounted for 98% of the variance in control beliefs. Factor analysis of normative beliefs shown in **Table 8** weighted by their belief evaluation also resulted in one factor (Eigenvalue 6.53, KMO 0.94), which explained 96% of the variance in normative beliefs. The six questions used to assess attitudes toward requesting veterinary examination during a hypothetical outbreak shown in **Table 16** were also analyzed using factor analysis. A single factor was extracted (Eigenvalue 2.82, KMO 0.81), which accounted for 96% of the variance in attitudes towards behavior 2. Factor analysis of the questions used to assess producers´ trust in neighbors and other producers resulted in a single factor (Eigenvalue 4.03, KMO 0.75), which explained 86%% of the variance in these beliefs.

Gathering and Holding Cattle at the Date and Time Requested by Authorities (Behavior 3) – Factor analysis of behavioral beliefs shown in **Table 9** weighted by their belief evaluations for behavior 3 resulted in the extraction of two factors (KMO 0.73). Beliefs about reducing the economic impact on the producer and the US cattle industry, stopping the spread of disease among the producer´s cattle and the US cattle industry, knowing if the producer´s herd in infected, and feeling better about how the producer manages their cattle loaded on the first factor (Eigenvalue 2.50). This factor accounted for 40% of the variance in behavioral beliefs for behavior 3. Beliefs about cattle suffering, the death of the producer´s cattle or their neighbor´s cattle, and reducing the value of the producer´s cattle loaded on the second factor (Eigenvalue 2.16), which accounted for an additional 35% of the variance in behavioral beliefs. Factor analysis of control beliefs shown in **Table 10** weighted by their belief evaluations for behavior 3 resulted in the extraction of a single factor (Eigenvalue 3.53, KMO 0.85), which explained 100% of the variance in control beliefs. Similarly, factor analysis of normative beliefs shown in **Table 11** weighted by their belief evaluations resulted in a single factor

(Eigenvalue 6.39, KMO 0.93), which accounted for 95% of the variance in normative beliefs. The direct measures of attitudes toward behavior 3 shown in **Table 17** were also factor analyzed, which resulted in the extraction of a single factor (Eigenvalue 3.31, KMO 0.81), which accounted for 95% of the variance in attitudes toward behavior 3. Factor analysis of the questions used to assess producers´ trust in neighbors and other producers resulted in a single factor (Eigenvalue 4.14, KMO 0.77), which explained 88%% of the variance in these beliefs.

Maintaining Cattle in Their Current Location(s) During a Hypothetical Outbreak of FMD (Behavior 4) – Factor analysis of behavioral beliefs shown in **Table 12** weighted by their evaluations for behavior 4 resulted in the extraction of two factors (KMO 0.73). Beliefs about reducing the economic impact on the producer and the US cattle industry, stopping the spread of disease among the producer´s cattle and the US cattle industry, the adequacy of the movement restriction to stop the spread of FMD, not being blamed for the spread of FMD, and feeling better about how the producer manages his/her cattle loaded on the first factor (Eigenvalue 3.40). Beliefs about movement restrictions causing feed shortages or cattle suffering loaded on the second factor (Eigenvalue 1.46). Similar to what was seen with the first two behaviors, the belief about delaying the producer´s ability to sell cattle did not load well on any factor and had a high uniqueness (0.84), so it was excluded from the factor analysis. Factor analysis of control beliefs shown in **Table 13** weighted by their evaluations for behavior 4 resulted in two factors (KMO 0.68). Beliefs about the availability, delivery, and payment for feed, adequate facilities for calves which cannot be moved, and the ability to set up disinfection procedures loaded on one factor (Eigenvalue 2.19). Beliefs about the negative consequences of not moving animals (crowding, environmental damage, death due to disease control measures) loaded on the second factor (Eigenvalue 1.69). The first factor described 59% of the variance, while the second factor explained 46% of the variance in control beliefs for behavior 4. Factor analysis of normative beliefs shown in **Table 14** weighted by their evaluations for behavior 4 resulted in a single factor (Eigenvalue 6.58, KMO 0.91), which accounted for 92% of the variance in normative beliefs. Unlike for the other behaviors, factor analysis of attitudes for behavior 4 shown in **Table 17** resulted in two factors (KMO 0.77). The first factor (Eigenvalue 3.02) contained the attitude pairs unpleasant-pleasant, difficult-easy, and inconvenient-convenient, which describe the experience of observing animal movement restrictions (experiential attitudes). This factor explained 85% of the variance in attitudes towards behavior 4. The second factor (Eigenvalue 0.92) contained the attitude pairs bad-good, ineffective-effective, and harmful-beneficial, and explained 26% of the variance in attitudes. This factor addressed the outcomes of observing a movement ban and can be considered instrumental attitudes. Factor analysis of the questions used to assess producers´ trust in neighbors and other producers resulted in a single factor (Eigenvalue 4.59, KMO 0.80), which explained 92% of the variance in these beliefs.

Risk Perception – Factor analyses of the risk perception measures on each survey shown in **Table 21** were performed. Factor analysis of these questions resulted in two factors, regardless of survey (KMO 0.66 and 0.61 for Survey 1 and 2, respectively.) The first factor (Eigenvalue 2.07 and 2.17, for Survey 1 and 2, respectively) contained beliefs about the overall risk posed by FMD to the producer and the US cattle industry, as well as the likelihood of an outbreak of FMD in the producer´s operation and the US cattle industry. The second factor (Eigenvalue 0.89 and 1.02, for Survey 1 and 2, respectively) contained beliefs about the consequences of an outbreak of FMD for the producer and the US cattle industry. Producers´ belief about whether or not an outbreak would be economically devastating for their operation loaded weakly on factor 1 and predominantly on factor 2 (0.45 and 0.71 factor loadings for Survey 1 and 2, respectively) for Survey 2.

Trust in Regulatory Agencies – Three sets of questions were used in each survey to assess different aspects of trust (competency, caring, and shared goals) in regulatory agencies. For both surveys, factor analysis of questions regarding the competency of the listed agencies shown in **Table 24** resulted in two factors (KMO 0.92 and 0.91 for Survey 1 and 2, respectively). Producers´ beliefs about how well DHS, EPA, FEMA, Texas Dept of Health and Human Services, TCEQ, and the US Department of Health and Human Services would manage their role during an outbreak of FMD loaded on the first factor (Eigenvalue 6.67 and 6.30 for Survey 1 and 2, respectively). Beliefs related to the USDA´s managing of their role during an outbreak also loaded to a small extent on this factor (0.50 and 0.49 factor loading for Survey 1 and 2, respectively). Beliefs related to the primary agricultural agencies (USDA, TDA, and TAHC) loaded onto factor 2 (Eigenvalue 0.84 and 0.98 for Survey 1 and 2, respectively). Factor 1 explained 90% and 87% of the variance for Survey 1 and 2, respectively, in producers´ beliefs about how well each agency would manage their role during an outbreak of FMD, while factor 2 explained 11% and 14% of the variance for Survey 1 and 2, respectively. Similar factor loadings were seen for questions related to producers´ beliefs about whether or not the agencies would act in the producer´s best interest ("caring") in managing an outbreak of FMD shown in **Table 25**. Factor analysis of the "caring" measures resulted in two factors (KMO 0.91 and 0.90 for Survey 1 and 2, respectively). Factor 1 (Eigenvalue 7.02 and 6.72 for Survey 1 and 2, respectively) contained beliefs about how strongly producers agreed that DHS, EPA, FEMA, Texas Dept of Health and Human Services, TCEQ, and the US Department of Health and Human Services would act in their best interest. Beliefs related to the USDA acting in the producer´s best interest during an outbreak also loaded to a small extent on this factor (0.50 and 0.46 factor loading for Survey 1 and 2, respectively). This factor explained 88% and 86% of the variance in these beliefs for Survey 1 and 2, respectively. The second factor (Eigenvalue 0.95 and 1.02 for Survey 1 and 2, respectively) contained beliefs related to the primary agricultural agencies (USDA, TDA, TAHC) acting in the producer´s best interest, and this factor explained 12% and 13% of the variance in these beliefs for Survey 1 and 2, respectively. The last set of questions assessed producers´ beliefs that the listed agencies would have the same goals as the producer in managing an outbreak of FMD shown in **Table 26.** Factor analysis of these beliefs for Survey 1 resulted in a two factor solution (KMO 0.91). The first factor (Eigenvalue 6.52) contained beliefs relating to how strongly producers agreed that DHS, EPA, FEMA, Texas Dept of Health and Human Services, TCEQ, and the US Department of Health and Human Services would have the same goals as the producer in managing an outbreak of FMD. This factor explained 83%

of the variance in producer´s beliefs. The second factor (Eigenvalue 1.41) contained the same beliefs related to the primary agricultural agencies (USDA, TDA, TAHC), and explained 17% of the variance in producers´ beliefs. Factor analysis of these questions in survey 2 resulted in the same two factors; however, the analysis resulted in a boundary solution (Heywood solution) in which the estimated communalities exceeded 1. The occurrence of a Heywood solution casts doubt on the fit of the model produced by factor analysis and indicates that the geometric assumptions underlying the likelihood ratio test are violated.[114] Although it is possible to use the results of the factor analysis with cautious interpretation, it can lead to instability in multivariate models. Given the consistency of the loadings in all of the trust in agencies variables´ factor analyses, as well as the results of the factor analysis in Survey 1, we elected to use the two variables in Survey 2 that had the highest loadings for factor 1 and 2 from the factor analysis of Survey 1, as possible predictors (surrogate variables) in the multivariate models for Survey 2. FEMA has the highest factor loadings for factor 1 (0.93), and TDA had the highest factor loadings for factor 2 (0.92).

Bivariable Analysis

Bivariable analysis using ordinal logistic regression was performed for all of the predictors and demographics. Tables showing the results of the bivariable analyses for each behavior are presented in Appendix C.

Requesting Veterinary Examination of Cattle with Clinical Signs Consistent with FMD in the Absence of a Known Outbreak (Behavior 1*, **Table C1*) – The variables which were unconditionally associated with a p-value <0.20 with an intent to request veterinary examination of cattle with clinical signs consistent with FMD in the absence of a known outbreak were: behavioral beliefs, normative beliefs, risk perception related to the magnitude of consequences, moral obligation to request veterinary examination of cattle with clinical signs consistent with FMD, moral obligation to request veterinary examination of sick cattle, and trust in government agencies related to shared goals. In addition, the following demographic variables were also associated (p value=0.20) with an intent to request veterinary examination: age, education, gender, prior experience with the brucellosis eradication program, number of steers owned, percentage of income derived from cattle, reason for raising or owning cattle, specific production practices (age and source verification, natural or non-certified organic production, holistic resource management, participation in beef quality assurance program, and organic production), and serving as an officer in a cattle producer organization.

Requesting Veterinary Examination of Cattle with Clinical Signs Consistent with FMD During a Hypothetical Outbreak of FMD (Behavior 2,* Table C2*) – The variables which were unconditionally associated with a p-value <0.20 with an intent to request veterinary examination of cattle with clinical signs consistent with FMD during an outbreak of FMD were: behavioral beliefs (overall factor and belief about delays in the ability to sell cattle), control beliefs, perceived behavioral control, moral norms related to requesting veterinary examination of cattle with clinical signs of FMD and sick animals in general, descriptive subjective norms, risk perception related to overall risk and probability as well as the magnitude of the consequences posed by the risk, and trust in agricultural agencies related to how well they will manage their role during an outbreak. In addition, age, education, race, prior experience with the federal bovine tuberculosis eradication program, membership in a cattle producer organization, the reason for raising or owning cattle, and specific production practices (integrated resourced management, organic production practices, holistic resource management, participation in a beef quality assurance program, seedstock production, participation in branded beef programs, and age and source verification), and the number of steers owned were also associated (p value=0.20) with behavior 2.

Gathering and Holding Cattle at the Date and Time Requested by Authorities (Behavior 3*, **Table C3)* – The explanatory variables unconditionally associated with behavior 3 (p value=0.20) were: behavioral beliefs related to the positive consequences of gathering and holding cattle; control beliefs; normative beliefs; attitudes; risk perception related to the perception of the magnitude of the consequences of an outbreak of FMD; perceived behavioral control; moral obligation to gather and hold cattle; trust in other producers; trust in government agencies based on perceptions of competency in managing their role during an outbreak of FMD; whether or not the agencies care about the producer, and shared goals in managing an outbreak of FMD; and injunctive and descriptive subjective norms. Demographic variables which were associated (p value=0.20) with behavior 3 included race, number of beef cows, percentage income derived from cattle, reason for raising or owning cattle, and specific production practices (natural or non-certified organic production, integrated resource management, stockers, grass-finished cattle, organic production, conventional cow-calf production, and participation in a branded beef program.)

Maintaining Cattle in Their Current Location(s) During a Hypothetical Outbreak of FMD (Behavior 4*, **Table C4)* – All of the belief-based measures were unconditionally associated (p value=0.20) with an intention to obey animal movement restrictions during an outbreak of FMD. In addition, direct measures of attitudes, perceived behavioral control, and descriptive subjective norms, risk perception related to the perception of the magnitude of the consequences associated with FMD, trust in other producers to obey animal movement restrictions, and trust in agricultural agencies related to perceptions of their competency to manage their role during an outbreak of FMD, whether they care about the producer, and shared goals in managing an outbreak of FMD, were also unconditionally associated with behavior 4 at p value=0.20. The demographic variables which were unconditionally associated with behavior 4 were: gender, education, race, percentage of income derived from cattle, reason for owning or raising cattle, number of steers owned, and the specific production practices (integrated resource management, organic production, holistic resource management, participation in beef quality assurance program, and conventional cow-calf production).

Multivariable Regression Analysis

Requesting Veterinary Examination of Cattle with Clinical Signs Consistent with FMD in the Absence of a Known Outbreak (Behavior 1) – The results of the ordinal logistic regression for behavior 1 are presented in **Table 27**. Producers´ beliefs about the consequences of requesting veterinary examination was significantly associated with their intent to do so. Producers who felt that requesting veterinary examination will reduce the economic impact of FMD, stop the spread of disease, allow them to know the cause of disease in their herd, improve the well-being and productivity of their cattle, improve the profitability of their operation, and make them feel better about their cattle were significantly more likely to intend to request veterinary examination (OR 10.34, p value<0.001). In addition, producers´ who believed that other producers like themselves would request veterinary examination of their cattle in the same situation were more likely to intend to request veterinary examination (OR 2.84 for producers who strongly agreed, p value<0.05). Producers with the highest levels of trust in agricultural government agencies (USDA, TDA, and TAHC), as indicated by their beliefs in how well these agencies would manage their role during an outbreak of FMD, were also more likely to intend to request veterinary examination of their cattle (OR 1.24 for highest category of trust, p value<0.05). Conversely, as producers´ perceptions of the magnitude of the consequences associated with FMD increased, they were less likely to intend to request veterinary examination of cattle with clinical signs consistent with FMD (OR 0.04 for highest category, p value<0.001). Prior experience with either the federal brucellosis or bovine tuberculosis eradication programs, or the presence of 50 or greater head of steers on an operation also increased the odds that a producer would intend to request veterinary examination (OR 9.11 and 9.10 for federal programs and >50 head of steer, respectively, p value<0.01). The proportional odds assumption was met for this model (p value=0.578).

Table 27 – Final, multivariable ordinal logistic regression model of factors associated with Texas cow-calf producers´ intent to request veterinary examination of cattle with clinical signs consistent with FMD in the absence of a known outbreak of FMD. Sampling weights were included in the analysis in order to take into account complex sampling strategy and survey response.

Predictor	Level of variable	OR	(SE)	P-value
Factor of Behavioral beliefs[a]	---	10.34[a]	(6.57)	0.000
Subjective norm- other producers like themselves would request vet examination	Strongly disagree	0.10	(0.25)	
	Mostly disagree	0.21	(0.22)	
	Neither agree nor disagree	---	---	
	Mostly agree	2.84	(2.27)	
	Strongly agree	1.22	(1.14)	0.044
Trust – competency of agricultural agencies	< -1 s.d. from mean	---	---	
	Within -1 s.d. from mean	0.09	(0.08)	
	Within 1 s.d. from the mean	0.55	(0.49)	
	> 1 s.d. from mean	1.24	(1.70)	0.038
Risk perception – magnitude of the consequences	< -1 s.d. from mean	---	---	
	Within -1 s.d. from mean	1.64	(1.50)	
	Within 1 s.d. from the mean	5.05	(4.57)	
	> 1 s.d. from mean	0.04	(0.05)	0.000
Experience with either brucellosis or bovine tuberculosis federal eradication programs	No	---	---	
	Yes	9.11	(6.64)	0.002
Largest number of steers or stockers located on operation during the year	Less than 50 head	---	---	
	50 head or more	9.09	(7.62)	0.008

[a] This variable was linear in the log odds and entered into the model as a continuous variable. The reported odds ratio represents the factor change in the odds for a standard deviation increase in behavioral beliefs.

s.d. = standard deviation

Log-likelihood of full model compared to intercept only model (13 d.f.) = 27626.81, p value<0.001

McFadden´s adjusted R^2 = 0.625

McKelvey and Zavoina´s R^2=0.998

n=390, target population size for weighted estimates is 94,783 producers

Requesting Veterinary Examination of Cattle with Clinical Signs Consistent with FMD During a Hypothetical Outbreak of FMD (Behavior 2) – The results of the ordinal logistic regression for behavior 2 are shown in **Table 28**. Similar to requesting veterinary examination of animals in the absence of an outbreak, producers´ beliefs about the consequences of requesting veterinary examination was significantly associated with their intention to do so, and the more strongly producers believe in the positive consequences of requesting veterinary examination, the more likely they are to intend to contact a veterinarian (OR 14.38, 12.43, and 24.55 for each category, p value<0.01). Producers, who perceived that the risk posed by FMD to their operation and the US cattle industry was great, and that the probability of an outbreak of FMD in the next 5 years was high, were more likely to intend to request veterinary examination of cattle with clinical signs of FMD during a disease outbreak (OR 3.81, 29.47, and 1.2 for each category of risk perception, p value<0.01). Producers who did not feel that the consequences of an FMD outbreak would be large for themselves or the US cattle industry were less likely to request veterinary examination (OR 0.19, p value<0.05). Prior experience with either bovine tuberculosis or brucellosis eradication campaigns decreased the odds that a producer would request veterinary examination of cattle with clinical signs of FMD during an outbreak of FMD (OR 0.15, p value<0.01). Producers over the age of 50 were also significantly less likely to request veterinary examination of their cattle (OR 0.07, p value<0.01). The proportional odds assumption was met for this model (p value=0.08).

Table 28 – Final, multivariable ordinal logistic regression model of factors associated with Texas cow-calf producers´ intent to request veterinary examination of cattle with clinical signs consistent with FMD during an outbreak of FMD. Sampling weights were included in the analysis in order to take into account complex sampling strategy and survey response.

Predictor	Level of variable	OR	(SE)	P-value
Factor of behavioral beliefs	< -1 s.d. from mean	---		
	Within -1 s.d. from mean	14.81	(13.77)	
	Within 1 s.d. from the mean	13.04	(7.69)	
	> 1 s.d. from mean	24.91	(20.93)	0.000
Risk perception – overall risk and probability	< -1 s.d. from mean	---	---	
	Within -1 s.d. from mean	3.72	(2.87)	
	Within 1 s.d. from the mean	24.94	(22.78)	
	> 1 s.d. from mean	1.19	(0.86)	0.004
Risk perception – magnitude of the consequences	< -1 s.d. from mean	---	---	
	Within -1 s.d. from mean	0.19	(0.15)	
	Within 1 s.d. from the mean	1.06	(0.90)	0.012
Experience with brucellosis or bovine tuberculosis federal eradication programs	No	---	---	
	Yes	0.15	(0.08)	0.000
Age	Less than 50 years of age	---	---	
	50 years of age or greater	0.07	(0.05)	0.000

s.d.= standard deviation

Log-likelihood of full model compared to intercept only model (10 d.f.) = 23089.28, p value<0.001

McFadden´s adjusted $R^2 = 0.420$

McKelvey and Zavoina´s R^2=0.997

n=500, target population size for weighted estimates is 94,783 producers

Gathering and Holding Cattle at the Date and Time Requested by Authorities (Behavior 3) –The results of the ordinal logistic regression for gathering and holding cattle are presented in **Table 29**. The more strongly that producers believed that gathering and holding their cattle would: reduce the economic impact on the producer and the US cattle industry, stop the spread of disease among the producer´s cattle and the US cattle industry, allow them to know if their herd in infected, and make them feel better about how they manage their cattle, the more likely they are to gather and hold their cattle when requested (OR 2.90, p value<0.01). Producers who felt that they had the facilities, manpower, and financial resources necessary to gather and hold their cattle, who lived close enough to their cattle, and whose cattle were tame enough to be gather and held were also more likely to intend to gather and hold them at the date and time requested (OR 2.89, p value<0.01). Trust in other producers to gather and hold their cattle and to take into account the consequences to the respondent´s operation was also significantly associated (OR 2.33, p value<0.01) with the intention to gather and hold cattle during an outbreak of FMD. Risk perception related to the magnitude of the consequences of FMD had an inverse relationship to producers´ intentions to gather and hold their cattle. As the perception of the risk increased, the odds of a producer intending to gather and hold their cattle decreased (OR 0.25 for highest category, p value<0.02). The proportional odds assumption was met for this model (p value=0.10).

Table 29 – Final, multivariable ordinal logistic regression model of factors associated with Texas cow-calf producers´ intent to gather and hold their cattle at the date and time requested during an outbreak of FMD. Sampling weights were included in the analysis in order to take into account complex sampling strategy and survey response.

Predictor	Level of variable	OR	(SE)	P-value
Factor of behavioral beliefs[a, b]	---	2.46[a]	(0.97)	0.001
Factor of control beliefs[a]	---	2.62[a]	(0.98)	0.002
Trust – other producers[a]	---	2.27[a]	(0.58)	0.001
Risk perception – magnitude of the consequences	< -1 s.d. from mean	---	---	
	Within -1 s.d. from mean	3.27	(2.67)	
	Within 1 s.d. from the mean	0.32	(0.22)	
	> 1 s.d. from mean	0.25	(0.34)	0.011

[a] These variables were linear in the log odds and entered into the model as continuous variables. The reported odds ratio represents the factor change in the odds for a standard deviation increase in the explanatory variable.
[b] This factor only contained beliefs about reducing the economic impact on the producer and the US cattle industry, stopping the spread of disease among the producer´s cattle and the US cattle industry, knowing if the producer´s herd in infected, and feeling better about how the producer manages his or her cattle.
s.d. = standard deviation
Log-likelihood of full model compared to intercept only model (6 d.f.) = 17030.771, p value<0.001
McFadden´s adjusted R^2 = 0.409
McKelvey and Zavoina´s R^2=0.996
n=449, target population size for weighted estimates is 94,783 producers

Maintaining Cattle in Their Current Location(s) During a Hypothetical Outbreak of FMD (Behavior 4) – The results of the ordinal logistic regression for maintaining cattle in their current location(s) during an outbreak of FMD are presented in **Table 30**. Producer attitudes about the experience of obeying animal movement restrictions were a significant predictor of their intention to comply. The less unpleasant, difficult, or inconvenient the producer felt that maintaining their cattle in place during an outbreak would be, the greater the odds that they would intend to do so (OR 13.48 for highest category, p value<0.05). In addition, producers who believed that they owned or had access to adequate feed, had facilities for calves born, and were able to set up appropriate disinfection procedures for themselves and their employees were more likely to intend to comply with animal movement restrictions (OR 88.02 for the highest category, p value<0.001). Producers beliefs about what other producers like themselves would do in the same situation also had a significant effect on their intention to comply, and the odds of intending to comply were over 6 times greater for producers who agreed that other producers like themselves would comply with the movement restrictions (p value<0.001) in comparison to those who neither agreed nor disagreed. Increased perception of the risk posed by FMD in terms of the overall risk and probability of an outbreak was associated with a decreased intention to obey movement restrictions during an outbreak (OR for highest category 0.55, p value<0.05). The proportional odds assumption was met for this model (p value=0.42).

Table 30 – Final, multivariable ordinal logistic regression model of factors associated with Texas cow-calf producers´ intent to obey animal movement restrictions during an outbreak of FMD. Sampling weights were included in the analysis in order to take into account sampling and survey response.

Predictor	**Level of variable**	**OR**	**(SE)**	**P-value**
Factor of attitudes – unpleasant-pleasant, difficult-easy, inconvenient-convenient	< -1 s.d. from mean	---	---	
	Within -1 s.d. of the mean	2.61	(2.21)	
	From the mean to >1 s.d. from the mean	13.55	(13.78)	0.037
Factor of control beliefs – feed, facilities, and disinfection	Less than -1 s.d. from mean	---	---	
	-1 s.d. to the mean	14.88	(11.71)	
	From the mean to >1 s.d. from the mean	87.56	(100.78)	0.001
Normative beliefs – other producers like myself would	Somewhat to strongly disagree	0.06	(0.07)	
	Neither agree nor disagree	---	---	
	Somewhat to strongly agree	6.12	(4.78)	0.000
Risk perception – overall risk and probability	Less than -1 s.d. from mean	---	---	
	-1 s.d. to the mean	17.71	(19.26)	
	0 to 1 s.d. from the mean	1.88	(1.54)	
	>1 s.d. from the mean	0.55	(0.60)	0.011

s.d. = standard deviation
Log-likelihood of full model compared to intercept only model (9 d.f.) = 7149.654, p value<0.001
McFadden´s adjusted R^2 = 0.403
McKelvey and Zavoina´s R^2=0.996
n=483, target population size for weighted estimates is 94,783 producers.

Discussion

The overall purpose of this study was to identify key behaviors related to FMD detection and control for which producer compliance could potentially be reduced, and to identify the factors (salient beliefs and other social or psychological factors) which may influence producers´ intentions to comply with disease detection and control. In general, a high proportion of producers intend to request veterinary examination of cattle with clinical signs consistent with FMD (92% - 94% mostly to strongly agree), to gather and hold their cattle at the date and time requested by authorities (91% mostly to strongly agree), and to observe animal movement restrictions (97% mostly to strongly agree). This finding is consistent with the experiences shared by Texas regulatory animal health authorities during the qualitative phase of this study, who suggested that less than 10% of cattle producers would refuse to gather and hold their cattle for inspection. Similarly, a NAHMS report, based on the Beef 2007-08 study conducted in 24 US states and representing almost 80% of US cattle producers, reported that 95.5% of operations would contact a private veterinarian if an animal was suspected of having FMD.[117] This high level of anticipated compliance indicates that Texas cow-calf producers strongly support the detection and control of FMD, despite the potential for serious economic consequences for their own operations.

The correlation between the level of intentions reported in this study and actual performance of the behaviors is unknown. Hrubes, Ajzen, and Daigle[89] found greater than 60% correlation between reported intentions and self-reported hunting behavior, while Giles and Cairns[91] reported a correlation of 75% for intent to donate blood with actual blood donation. Numerous studies have reported much smaller correlations.[72,82,157,158] Within the context of the Theory of Planned Behavior, behavior is assumed to be influenced by both intentions to perform the behavior and the person´s actual behavioral control over performing the behavior.[27] Simply intending to perform a behavior is unlikely to result in behavioral performance if a person lacks the knowledge, skills, or resources to carry out their intention. In this study, producers´ perceived behavioral control for each of the behaviors was relatively high. Greater than 90% of respondents mostly to strongly agreed that they were confident they could perform each of the studied behaviors; however, producers were less likely to agree that the performance of the behaviors was completely under their control. As a result, we would anticipate that the intentions reported in this study would correlate well with behavior. However, final performance of these behaviors will be influenced by additional factors affecting behavioral control such as resources, skills, and knowledge.

Producer attitudes toward reporting cattle with clinical signs consistent with FMD to a veterinarian in the absence of a known outbreak were generally favorable, with approximately 80% of producers indicating that it was mostly to very good, effective, or beneficial, while 10% indicated that it was mostly to very inconvenient, unpleasant, or difficult. Social pressure, both perceived social pressure and beliefs about what other producers would do, and perceived behavioral control for reporting clinically suspect cattle to a veterinarian, were relatively high. The majority of producers felt a moral obligation to request veterinary care, both in the specific situation included in this study, as well as for sick animals in general. Trust in other producers to report clinically suspect cattle and to take into account the considerations to a producer´s operation was high, and did not differ based on whether an outbreak was known to be present or not.

The theoretical framework developed for this study proved to be relevant for explaining producers´ intentions to request veterinary examination of cattle with clinical signs of FMD, with many of the proposed constructs unconditionally associated with intent to request veterinary examination. When examined using multivariable modeling, the level of producers´ intentions to request veterinary examination was determined by their behavioral beliefs about the consequences of this action (indirect measure of attitudes), descriptive norms about what other producers would do, trust in agricultural agencies ability to manage their role during an outbreak, and their perception of the risk of FMD related to the potential magnitude of the consequences of an outbreak. In addition, producers who had previous experience with either of the federal brucellosis or bovine tuberculosis eradication campaigns or who had more than 50 head of steers were more likely to report cattle with clinical signs consistent with FMD to a veterinarian.

Cow-calf producers are less likely to disagree with the intention to report clinically suspect cattle to a veterinarian when an outbreak of FMD is known to be present (8% mostly to strongly disagree vs. 3% mostly to strongly disagree for reporting in the absence of or during an outbreak of FMD, respectively.) Attitudes towards, perceived behavioral control for, and trust in others for reporting clinically suspect cattle were similar whether an outbreak was present or not. However, perceived social pressure for reporting increased during an outbreak (11% vs. 25%, prior to and during an outbreak of FMD.) Similarly, when an outbreak was known to be present, producers were more likely to feel a moral obligation to seek veterinary care (43% vs. 64% strongly agree prior to and during an outbreak of FMD, respectively.) During an outbreak, the level of producers′ intentions to request veterinary examination was determined only by their behavioral beliefs about the consequences of this action (indirect measure of attitudes), and their perception of the risk posed by FMD, related to both overall risk and probability as well as the magnitude of the consequences. The effect of prior experience with federal disease eradication programs was reversed during an outbreak, so that producers who indicated that they had experience were less likely to report clinically suspect animals, while producers over the age of 50 were also less likely to report.

Both prior to and during an outbreak of FMD, producers who felt that requesting veterinary examination will reduce the economic impact of FMD, stop the spread of disease, allow them to know the cause of disease in their herd, improve the well-being and productivity of their cattle, improve the profitability of their operation, and make them feel better about how they manage their cattle were significantly more likely to intend to request veterinary examination. For both of these models, behavioral beliefs (an indirect measure of attitude) were a better predictor of behavior than direct measures of attitudes. The reason for this distinction in unclear, although behavioral beliefs have been shown to be a better predictor of behavior in other studies.[82] Research examining the effects of prejudicial attitudes on discriminatory behavior also found that attitudes were not a good predictor of behavior.[159] Studies suggested that although prejudice was still very much present, it had become subtle and perhaps even unconscious. This led to the idea that attitude scales which captured explicit attitudes about prejudice and stereotypes were incapable of capturing the implicit attitudes that influenced actual behavior.[159,160] Given the recent emphasis on producer education for FMD in the US, and the extensive media coverage of large and costly outbreaks of FMD in other countries, producers´ explicit attitudes toward the behaviors investigated in this study may not correspond with their implicit attitudes. This may explain why underlying beliefs, rather than a global measure of attitudes more accurately predicts intentions.

The significance of behavioral beliefs in influencing intentions to report suspicious cases to a veterinarian suggests that risk communication aimed at encouraging reporting needs to address beliefs about the consequences of reporting. As discussed previously, producers who do not understand what would happen once they contact a veterinarian may be reluctant to call the veterinarian in the first place.[60] Trust in agricultural agencies related to their ability to manage their role during an outbreak was also a determinant of producers´ intentions to report clinically suspect cattle prior to an outbreak. Palmer et al.[95] examined the effect of trust on biosecurity and reporting of disease among West Australian farmers using qualitative analysis of in-depth interviews. They found that trust was a key contributor to perceived risk, and perceived risk influenced farmers´ decisions regarding reporting diseased animals. Lack of trust in government officials was also identified as a limitation affecting the reporting of pigs with clinical signs of classical swine fever in the Netherlands[60], and an important factor influencing farmers´ trust in government-derived messages regarding biosecurity.[79] Our findings suggest that increased transparency in both the reporting process and what to expect in the time between when a report is made and a farm is declared free of the disease is important not only for building and maintaining trust among all the actors involved, but also for strengthening behavioral intentions.

In addition to behavioral beliefs, risk perception was also found to be an important determinant of intentions to report cattle with signs of FMD. Producers′ perceptions of the magnitude of the consequences posed by an outbreak of FMD affected reporting both prior to and during an outbreak. Prior to an outbreak, low to moderate levels of risk perception related to the magnitude of the consequences increased the intent to report, while high levels of risk perception related to the magnitude of the consequences decreased reporting. During an outbreak, risk perception related to both the overall risk and probability of an outbreak, as well as the magnitude of the consequences, increased intent to report.

The reason for the differential effect of risk perception prior to an outbreak is unclear. Examination of the relationship between the individual variables which comprise this risk factor and reporting intentions was complicated by low cell counts in some categories, which would not allow the model to estimate standard errors. However, over 70% of respondents in both surveys indicated that an outbreak of FMD would be economically devastating for the US cattle industry and for their operation in particular, so it seems unlikely that the differential effect is to due to differences in the two variables that comprised this factor. In general, increased risk perception has been found to correlate with increased behavioral performance (or behavioral intentions) for behaviors which reduce the perceived risk.[61,161] Among health behaviors, risk perception is often conceptualized as some combination of perceived likelihood, perceived susceptibility, and perceived severity of the consequences.[162] A meta-analytic review of the effect of each of these measures on vaccination behavior among adults found that perceived severity of the consequences had the least predictive validity (r=0.16) of the three measures.[161] However, producer behavior related to an outbreak of FMD is very different than many of the common behaviors for which risk perception has been studied extensively, such as vaccination, climate change, or radon testing of homes. Based on the results of the models presented here, we can speculate that producers who view economic devastation as a potential outcome of an outbreak of FMD are more likely to report clinically suspect cattle. However, if economic devastation is seen as a certainty, producers are less likely to report. Once an outbreak has been identified, increased risk perception related to overall risk, probability, and consequences, leads to increased reporting. This finding is relevant to the design of effective risk communication practices. While fear may be the emotion most conducive to action, hopelessness can lead to inaction.[163] In the past, many emergency response plans seemed written to induce hopelessness – all animals would be destroyed, farms would be shut down and isolated, and businesses and livelihoods left to recover on their own whether they had the disease or not. However, increasing effort has been made to incorporate the idea of business continuity into emergency response plans, focusing on ways to reduce the economic losses suffered by livestock producers during an outbreak. Current US response plans for FMD describe business continuity as allowing “critical agricultural and food industries to maintain typical business, or quickly return to business during a disease response, after the risk of disease spread or threat to public health has been effectively managed."[1] The results of our study would suggest that risk communication designed to encourage the reporting of suspicious cases prior to an outbreak may be more successful as business continuity planning, as part of FMD outbreak response, becomes more well-known.

Prior experience with the federal brucellosis or bovine tuberculosis programs was also an important determinant of producers´ intent to report both prior to and during an outbreak of FMD. In the absence of a known outbreak, experience with federal programs increased reporting, while the opposite effect was seen if an outbreak was already on-going. Again, the reason for this differential effect is not clear based on the information we collected; however, consistent with other studies, it is clear that how disease control and eradication programs are handled in the past can have serious implications for the behavior of producers in the future.[79,95,124] Unfortunately, what happened during these disease control programs is now in the past, and it would be difficult to target communications based on whether or not a producer had previous experience. Instead, communications aimed at improving trust are more likely to be effective in influencing producers´ intentions to report clinically suspect cattle.

Other demographic variables which were identified in the intent to report models included greater than 50 head of steers owned and whether or not the producer was over 50 years of age. The influence of steer number is particularly interesting. Drawing upon the qualitative work done in the first stage of this study, producers often perceive steers to be at higher risk for FMD due to their frequent movements and commingling with animals from other herds. This perception is confirmed in the multivariable model, with producers who own more than 50 head of steers significantly more likely to request veterinary examination of cattle with clinical signs consistent with FMD. During an outbreak, presumably the additional risk posed by steers would diminish as movement restrictions are put into place, and accordingly, we found that steer number was no longer significant when the scenario used to introduce the intention question indicated that an outbreak was already present.

Producer attitudes toward gathering and holding their cattle at the date and time requested by authorities during an outbreak of FMD were mixed, with approximately 70% of producers indicating that it was mostly to very good, effective, or beneficial, while 10-20% indicated that it was mostly to very inconvenient, unpleasant, or difficult. Social pressure, both perceived social pressure and beliefs about what other producers would do, and perceived behavioral control for gathering and holding cattle, were relatively high. The majority of producers felt a moral obligation to gather and hold their cattle. Trust in other producers to gather and hold their cattle and to take into account the considerations to a producer´s operation was also high, although respondents expressed slightly higher levels of trust in their neighbors or producers in their area versus other producers in Texas.

The level of producers´ intentions to gather and hold their cattle was determined by their behavioral beliefs about the consequences of this action (indirect measure of attitudes), control beliefs about the barriers to this action (indirect measure of perceived behavioral control), trust in other producers to gather and hold their cattle and take into the consequences to the respondent´s operation, and their perception of the risk of FMD related to the magnitude of the consequences. The more strongly producers believe in the positive consequences of gathering and holding their cattle such as reducing the economic impact on their operation and the US cattle industry, stopping the spread of disease within their operation and the US cattle industry, making them feel better about how they manage their cattle, and allowing them to know if their herd is infected as well, the more likely they are to intend to gather and hold their cattle. Beliefs about the negative consequences of gathering and holding were not a significant predictor of behavior, possibly due to the high degree of uncertainty related to these beliefs. Beliefs about the availability of manpower, financial resources, and facilities to gather cattle, distance between the producer and animals, and the disposition of the cattle (tame vs. feral) are also important determinants of the intent to gather and hold cattle. These beliefs, both behavioral and control beliefs, represent key targets for risk communication, and strengthening these beliefs can improve cooperation. However, during an outbreak, disease control measures may run counter to reinforcing these beliefs. For example, the scale of disease spread may mean that diagnostic testing of individual herds is not possible, which may reduce producers´ belief that gathering and holding their cattle will allow them to know if their herd is infected as well. Failure to communicate the reasons why diagnostic testing is not possible and how that decision was reached could negatively impact producers´ cooperation in gathering and holding their cattle.

Producers´ trust in other producers to gather and hold their cattle was also a significant determinant of their intention to gather and hold their cattle. During an outbreak, livestock owners can become isolated, cut off from the social network that is an integral part of farming.[6,10] One of the communication challenges that may be encountered during an outbreak is how to maintain the communication within and mutual support of the wider agricultural community, which can lead to increased trust in what other producers are doing. Media reports may focus on producers who are not complying, which can amplify the sense that producers in general do not support the disease control measures.[6,135,136] These reports may need to be balanced by other communication sources and means. Arranging for community meetings of livestock producers and other interested groups can help to facilitate communication and maintain trust within the agricultural community. Given the biosecurity challenges faced during an outbreak of FMD, virtual meetings using online networking tools may provide a useful alternative to the traditional meeting or event. Social networking sites could also provide a useful forum for producers to share their experiences, while decreasing the sense of isolation.

Similar to reporting prior to an outbreak, risk perception related to the magnitude of the consequences was associated with a decrease in the intent to gather and hold cattle. Again we would conclude that not only communicating plans for business continuity, but having them active and in place during an outbreak, will play an important role in promoting producer cooperation.

As seen with gathering and holding, producer attitudes toward obeying animal movement restrictions during an outbreak of FMD were mixed, with over 70% of producers indicating that it was mostly to very good, effective, or beneficial, while 10-20% indicated that it was mostly to very inconvenient, unpleasant, or difficult. Social pressure, both perceived social pressure and beliefs about what other producers would do, and perceived behavioral control for keeping cattle in place during an outbreak, were relatively high. Over 90% of respondents mostly to strongly agreed that they had a moral obligation to ensure adequate feed and water for their cattle, protect their cattle from exposure to diseased animals, and prevent the spread of disease from their cattle to someone else´s cattle. Trust in other producers to obey animal movement restrictions and to take into account the considerations to a producer´s operation was somewhat high with greater than 60% of respondents mostly to extremely sure that other producers would obey animal movement restrictions and 50-60% mostly to extremely sure that other would take into account the consequences to the respondent´s operation when deciding whether or not to obey movement restrictions. The level of producers´ intentions to obey animal movement restrictions was determined by: their attitudes related to how unpleasant, difficult, and inconvenient it would be; control beliefs about the availability of feed, facilities for calves, and the ability to establish disinfection procedures for themselves and their employees; beliefs about what other producers like themselves would do; and perception of the risk posed by FMD related to the overall risk and probability of an outbreak.

Animal movement restrictions play an important role in reducing the spread of disease during an outbreak;[164] however, these restrictions are likely to result in difficulties for producers in terms of feed availability, space, and the movement of people and goods. Not surprisingly, producer attitudes related to how inconvenient, unpleasant, and difficult obeying the restrictions will be are an important predictor of their intent to comply. Although some degree of inconvenience and difficulty is inevitable, timely communication in the early stages of an outbreak can help producers prepare for the consequences of movement restrictions, while efforts to support communication related to a producer´s social network can help to alleviate the sense of isolation and unpleasantness that comes from movement restrictions. In addition, since normative beliefs related to what "other producers like myself" would do are also a significant predictor of intent to obey movement restrictions, maintaining communication and interaction among the agricultural community is again important. As discussed in the previous chapter, emergency response plans need to include plans to help distribute feeds, maintain the availability of basic veterinary care, and allow for the movement of animals due to crowding or feed shortages, while avoiding the spread of the disease.

Risk perception was also associated with producers´ intentions to obey animal movement restrictions, and as seen with previous behaviors, increased perception of the risk related to the overall risk and probability of an outbreak resulted in decreased intentions to obey movement restrictions. The reasons for this effect are not clear based on this analysis. Palmer et al.[95] in their examination of biosecurity and reporting practices among West Australian farmers found that trust in government agencies seemed to influence producers´ perceptions of the risk posed by various diseases, and that their risk perception in turn affected their behavior. In the current study, it is possible that the effect of risk perception reflects underlying effects of trust. When risk perception was included in the model, none of the factors related to trust were significant. Further analyses are needed to better understand the relationship between trust and risk perception in this data.

Consistent with the Theory of Planned Behavior, each of the behaviors identified during this study as key behaviors for producer cooperation in the detection and control of FMD were predicted by a relatively small number of predictors. Unfortunately, we were not able to adjust the estimates in each of the models by common socio-demographic variables such as age, gender, and education. When these factors were forced into the model, the model estimates became unstable and in some instances, the model would not converge. This result was probably due to a combination of factors. Overall, the number of producers who do not intend to perform the behaviors was small, and with the addition of more categorical variables to the model, small cell counts quickly become an issue. In addition, due to the sensitivity of the ordinal logistic regression model to the proportional odds assumption, adding non-significant predictors to the model can lead to a violation of this assumption and questionable validity of the model overall. The effect of these socio-demographic variables on intentions may need to be explored separately, apart from the other predictors, or by using an alternative analytical approach.

Although the number of producers who indicated that they do not intend to comply with the behaviors examined is noteworthy, it is difficult to predict what the effect of their non-compliance would be in the face of an outbreak. The response rate for this study was only 27-29%, depending on survey. Although a low response rate was anticipated due to the use of a lengthy postal survey and oversampling was used to ensure an adequate number of completed questionnaires, caution is warranted in interpreting the results in general. As in any survey, the potential for response bias is great. Since response bias is a form of selection bias, we cannot predict whether the estimates of producer compliance are too low or too high. However, as current disease spread models often assume that producers can and will comply our results would suggest that behavioral factors should be included in and explored with disease spread modeling.

Intuitively and based on identified factors known to influence outbreak size and severity, producer behavior should have a significant effect on the extent and length of an outbreak. A better understanding of the effects of producer behavior during disease outbreaks can allow for the more effective use of limited surveillance and movement enforcement resources. The models developed during this study identify key beliefs and perceptions that need to be addressed through planning and communication. Understanding the factors which are most likely to affect producer cooperation can help clarify communication objectives and serve as a foundation for message development.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to identify key behaviors during an outbreak of FMD for which producer compliance may be reduced, to examine currently held beliefs about the consequences of, barriers to, and social pressures for each of the identified key behaviors, and to determine which of the identified beliefs and factors are most significantly associated with producers´ intentions to perform these key behaviors. Understanding the factors and beliefs influencing cattle producers´ behavior during an outbreak of FMD can provide a useful foundation for risk communication strategies. However, risk communication is not a substitute for effective policy, planning, and implementation of emergency response plans. Just as producers´ beliefs can highlight where communication is adequate or lacking, they also indicate where plans are inadequate or inappropriate.

Based on the results of this study and best practices in risk communication, the following recommendations are made for both emergency response planning and risk communication:

1. **To enhance reporting of suspect cases of FMD:**
    a. Tailor risk communication messages and strategies to the specific situation, since producers´ beliefs may vary depending on whether or not an outbreak is already known to be present in the area.

b. Address beliefs about the consequences of reporting. Increased transparency in both the reporting process and what to expect in the time between when a report is made and a farm is declared free of the disease can help prepare producers for the process and build and maintain trust between everyone involved in the identification of an outbreak of FMD.

c. Ensure that producers are familiar with the clinical signs that should signal the need to call their veterinarian and that they understand which animals may be at greatest risk for FMD introduction.

d. Raise awareness of the community consequences of FMD and the effects of disease outbreaks on “the average operation” in order to augment perceived pressure from the surrounding community and other producers for reporting of suspect cases of FMD.

e. Plan for and communicate plans for business continuity during an outbreak of FMD in order to inform producers´ perception of the risk posed by FMD. Make information about compensation for herds depopulated during the control of FMD widely available during an outbreak in order to reduce the perception that an outbreak is economically devastating for an operation.

2. To improve the rate of producers gathering and holding cattle at the date and time requested:

a. Devote time and resources to communicating about the consequences (positive and negative) of gathering and holding cattle during an outbreak of FMD. This is an area where communication will be very important and may have substantial effects on producers´ attitudes and subsequent compliance during an outbreak of FMD.

b. Openly acknowledge and sympathize with the negative consequences of gathering and holding cattle. Allow producers to highlight the positive consequences of gathering and holding cattle such as reducing the economic impact of FMD and stopping the spread of disease both within a producers operation as well as for the cattle industry as a whole, and the positive emotional consequences such as feeling better about how cattle are managed and the relief of knowing whether a herd is infected or not.
c. Plan for and communicate the availability of resources to help with shortages of manpower, financial resources, and facilities to gather cattle.
d. Plan for and communicate plans for business continuity during an outbreak of FMD in order to inform producers´ perception of the risk posed by FMD. Make information about compensation for herds depopulated during the control of FMD widely available during an outbreak in order to reduce the perception that an outbreak is economically devastating for an operation.
e. On a local level, ask that high-trust, unbiased partners help to foster and maintain communication among the agricultural community through meetings, discussion groups, and social networking sites, utilizing technology whenever possible in order to minimize disease spread.

3. To strengthen movement ban compliance:

a. Help producers prepare for the consequences of movement restrictions in the early stages of an outbreak. Restrictions are always unpleasant, but knowing what to expect can make them much more bearable. Telling people what to expect also allows them be emotionally prepared. Producers may feel depressed and isolated, or they may feel pressured to move animals to alleviate crowding or feed shortages. Telling producers that these emotions are expected validates the emotions, while providing information about where to find help (counseling/support hotlines, information about movement permits, and hotlines for updates on disease control policy, for example) can help producers cope with the unpleasant reality of movement restrictions.

b. On a local level, ask that high-trust, unbiased partners help to foster and maintain communication among the agricultural community through meetings, discussion groups, and social networking sites, utilizing technology whenever possible in order to minimize disease spread. This can alleviate the sense of isolation and increase understanding that other producers are going through the same thing.

c. Plan for and communicate plans to help distribute feeds, maintain the availability of basic veterinary care, and allow for the movement of animals due to crowding or feed shortages, while avoiding the spread of the disease.

4. **General recommendations:**

    a. Agricultural agencies are generally perceived to be trustworthy by cow-calf producers, and they are likely to be an important source of information during an outbreak. Other agencies that need to communicate with producers about certain aspects of the disease control process may need to partner with an agricultural agency in order for their messages to be perceived as more reliable and trustworthy.

    b. Veterinarians should take a greater role in educating producers about the risk posed by foreign animal diseases including which animals may be at greatest risk for disease introduction. Veterinarians should capitalize on producers´ current expectations to encourage reporting of animals with clinical signs consistent with foreign animal diseases.

    c. Communications should respect and acknowledge the strong sense of moral obligation that producers feel in caring for their cattle. Overemphasis of economic factors at the expense of moral and ethical issues involved in disease control may offend some cow-calf producers.

    d. Risk communication messages should be respectful of and transparent about the processes leading to risk management decisions. Producers are likely to have strong beliefs about the role of diagnostic tests, vaccination, and slaughter in FMD control, and any decisions which are made regarding these strategies will come under scrutiny. Allowing producers to have a voice in the decision making process is ideal, but at the very least, producers should clearly know how the decision was reached and what economic, political, and societal forces came into consideration.

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APPENDIX A

SURVEY 1 & 2

Questionnaires (Surveys 1 & 2) developed for cow-calf producers. Some formatting of the surveys has been changed in order to accommodate the formatting of this dissertation.

Texas Cattle Producers' Perspectives on Foot-and-Mouth Disease

Creating a Resource for Policymakers to Better Meet the Needs of Texas Cattle Producers

Instructions:

This survey booklet is divided into three sections. The first two sections each ask questions about a specific scenario or situation that a cattle producer might be faced with. The last section asks questions about your business or yourself that will help us understand the types of people who responded to our survey.

Please answer these questions based on the reality of your operation and how you do business. If you have multiple businesses or operations, please answer them for your cow-calf or stocker operation only. This will allow us to combine your answers with other cattle producers like yourself.

Thank you very much for your time and help in completing this survey!

If for some reason you received this survey in error—you no longer work with cattle or are not involved in cattle production, or if you wish not to participate in this study— simply indicate that below and return the survey left blank in the postage-paid envelope provided.

- ☐ **I am not involved in the cattle industry.**
- ☐ **I do not wish to participate in this survey.**

Please return surveys in the postage-paid envelope provided to:
Texas A&M University
College of Veterinary Medicine and Biomedical Sciences
Veterinary Integrative Biosciences
4458 TAMUS
College Station, TX 77843-4458

Imagine yourself in the following situation.   **Situation #1**
It has come to your attention that **<u>many</u>** of the cattle in your herd appear depressed and seem reluctant to move. Several of the animals are noticeably lame. Some of the depressed animals appear to be drooling.

Based on your own experiences and the demands of your cattle operation, please answer the following questions regarding <u>situation #1.</u>

Q1. Please indicate how strongly you agree or disagree with the following statement.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I would ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7

The following questions measure the strength of your beliefs and concerns about the consequences of asking a veterinarian to examine your cattle in situation #1.

Q2. Please indicate how strongly you agree or disagree with the following statements.

In situation #1, if I ask a veterinarian to examine my cattle:	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. It will reduce the economic impact of disease **on my operation**.	1	2	3	4	5	6	7
b. It will reduce the economic impact of disease **on the US cattle industry**.	1	2	3	4	5	6	7
c. It will help stop the spread of disease within **my cattle operation**.	1	2	3	4	5	6	7
d. It will help stop the spread of disease among **cattle in my area**.	1	2	3	4	5	6	7
e. It will allow me to know the cause of disease in my herd.	1	2	3	4	5	6	7
f. It will improve the well being of my cattle.	1	2	3	4	5	6	7

g. It will improve the productivity of my cattle.	1	2	3	4	5	6	7
h. It will improve the profitability of my operation.	1	2	3	4	5	6	7
i. It will make me feel better about how I manage my cattle.	1	2	3	4	5	6	7
j. It will delay my ability to sell cattle.	1	2	3	4	5	6	7

Q3. Please indicate how desirable or undesirable the following outcomes are for you personally. Desirable outcomes are those that you would be willing to invest time and/or financial resources to achieve.

	Extremely Undesirable	Mostly Undesirable	Somewhat Undesirable	Neither Desirable nor Undesirable	Somewhat Desirable	Mostly Desirable	Extremely Desirable
a. Reducing the economic impact of disease **on my operation** is:	-3	-2	-1	0	1	2	3
b. Reducing the economic impact of disease **on the US cattle industry** is:	-3	-2	-1	0	1	2	3
c. Stopping the spread of disease within **my cattle operation** is:	-3	-2	-1	0	1	2	3
d. Stopping the spread of disease among **cattle in my area** is:	-3	-2	-1	0	1	2	3
e. Knowing the cause of disease in my herd is:	-3	-2	-1	0	1	2	3
f. Improving the well being of my cattle is:	-3	-2	-1	0	1	2	3
g. Improving the productivity of my cattle is:	-3	-2	-1	0	1	2	3
h. Improving the profitability of my operation is:	-3	-2	-1	0	1	2	3
i. Feeling better about how I manage my cattle is:	-3	-2	-1	0	1	2	3
j. Delaying my ability to sell cattle is:	-3	-2	-1	0	1	2	3

The following questions ask about factors that may influence your decision to ask a veterinarian to examine your cattle in situation #1.

Q4. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. I have a good relationship with a livestock veterinarian.	1	2	3	4	5	6	7
b. A veterinarian qualified to treat cattle is available in my area.	1	2	3	4	5	6	7
c. I know the clinical signs associated with serious cattle diseases.	1	2	3	4	5	6	7
d. I know that certain cattle are at greater risk of having disease.	1	2	3	4	5	6	7
e. I have a clear understanding of who to call if I suspect a disease outbreak in my operation.	1	2	3	4	5	6	7
f. I can restrain my cattle in order to inspect them closely for signs of disease.	1	2	3	4	5	6	7

Q5. Please indicate how the following conditions impact your *likelihood* of asking a veterinarian to inspect your cattle in situation #1.							
	Extremely Less Likely	Less Likely	Somewhat Less Likely	Neither More nor Less Likely	Somewhat More Likely	Mostly More Likely	Extremely More Likely
a. Having a good relationship with a livestock veterinarian	-3	-2	-1	0	1	2	3
b. A veterinarian qualified to treat cattle is available in your area	-3	-2	-1	0	1	2	3
c. Knowing the clinical signs associated with serious livestock diseases	-3	-2	-1	0	1	2	3
d. Knowing that certain cattle are at greater risk of disease	-3	-2	-1	0	1	2	3
e. Knowing who to call if you suspect an outbreak of disease in your operation	-3	-2	-1	0	1	2	3
f. Having the ability to restrain your cattle and inspect them closely for signs of disease	-3	-2	-1	0	1	2	3

Q6. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I am confident that I could ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
b. Whether I ask that my cattle are examined by a veterinarian or not, is entirely under my control.	1	2	3	4	5	6	7

The following questions ask about what you feel obligated to do regardless of others' expectations, as well as what other people would expect you to do in situation #1.

In question #10, we will ask you about how important it is to you that you meet these expectations.

Q7. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I have a moral duty to ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
b. I have a moral duty to request veterinary care for sick cattle.	1	2	3	4	5	6	7

Q8. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I would feel under social pressure to ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
b. In situation #1, most people who are important to me think that I should ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
c. In situation #1, other cattle producers I admire would ask a veterinarian to examine their cattle.	1	2	3	4	5	6	7
d. In situation #1, other cattle producers like myself, would ask a veterinarian to examine their cattle.	1	2	3	4	5	6	7

Q9. In situation #1, please indicate which of the following individuals or groups would expect or not expect you to ask a veterinarian to examine your cattle.

	Does Not Apply	Strongly Do Not Expect	Mostly Do Not Expect	Somewhat Do Not Expect	Neither Expect nor Do Not Expect	Somewhat Expect	Mostly Expect	Strongly Expect
a. Animal Health Regulatory Agencies	☐	-3	-2	-1	0	1	2	3
b. Your County Extension Agent(s)	☐	-3	-2	-1	0	1	2	3
c. Your Surrounding Community	☐	-3	-2	-1	0	1	2	3
d. Your Professional Organization(s)	☐	-3	-2	-1	0	1	2	3
e. Other Cattle Producers Like Yourself	☐	-3	-2	-1	0	1	2	3
f. Leaders in the Cattle Industry	☐	-3	-2	-1	0	1	2	3
g. Your Family	☐	-3	-2	-1	0	1	2	3
h. Your Business Partner(s)/Associate(s)	☐	-3	-2	-1	0	1	2	3
i. Your Veterinarian(s)	☐	-3	-2	-1	0	1	2	3
j. Your Neighbor(s)	☐	-3	-2	-1	0	1	2	3

Q10. In situation #1, please indicate how important the expectations of the following individuals or groups are to you.

	Does Not Apply	Very Unimportant	Mostly Unimportant	Somewhat Unimportant	Neither Important nor Unimportant	Somewhat Important	Mostly Important	Very Important
a. Animal Health Regulatory Agencies	☐	1	2	3	4	5	6	7
b. Your County Extension Agent(s)	☐	1	2	3	4	5	6	7
c. Your Surrounding Community	☐	1	2	3	4	5	6	7
d. Your Professional Organization(s)	☐	1	2	3	4	5	6	7
e. Other Cattle Producers Like Yourself	☐	1	2	3	4	5	6	7
f. Leaders in the Cattle Industry	☐	1	2	3	4	5	6	7
g. Your Family	☐	1	2	3	4	5	6	7
h. Your Business Partner(s)/Associate(s)	☐	1	2	3	4	5	6	7
i. Your Veterinarian(s)	☐	1	2	3	4	5	6	7
j. Your Neighbor(s)	☐	1	2	3	4	5	6	7

Q11. Please indicate how sure you are that the following individuals would ask a veterinarian to examine their cattle if they were in situation #1.

	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q12. Please indicate how sure you are that the following individuals would take into consideration <u>the consequences to your operation</u> when deciding in situation #1 whether or not to ask a veterinarian to examine their cattle.								
	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q13. Overall, given situation #1, asking that a veterinarian examine my cattle is:								
Bad	1	2	3	4	5	6	7	**Good**
Unpleasant	1	2	3	4	5	6	7	**Pleasant**
Ineffective	1	2	3	4	5	6	7	**Effective**
Harmful	1	2	3	4	5	6	7	**Beneficial**
Difficult	1	2	3	4	5	6	7	**Easy**
Inconvenient	1	2	3	4	5	6	7	**Convenient**

Imagine yourself in the following situation.

Situation #2

Foot-and-mouth disease is a very easily spread, viral disease that affects cattle, sheep, goats, pigs, llamas, alpacas, and deer. It does not affect humans.

An outbreak of foot-and-mouth disease has been reported in your area. Cattle which reside within a certain distance from the infected herd must be inspected and tested for the disease. Herds that have an animal test positive for foot-and-mouth disease, as well as their neighboring herds, will be killed in order to control the spread of the disease. All susceptible animals including cattle, sheep, goats, pigs, llamas, alpacas, and deer may be killed.

You are contacted by state or federal authorities and asked **to gather and hold your cattle** for inspection and testing at a date and time designated by the authorities.

Based on your own experiences and the demands of your cattle operation, please answer the following questions regarding situation #2.

Q1. Please indicate how strongly you agree or disagree with the following statement.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #2, I would gather and hold all of my cattle for testing and inspection at the requested date and time.	1	2	3	4	5	6	7

The following questions measure the strength of your beliefs and concerns about the consequences of gathering and holding your cattle at the date and time requested in situation #2.

Q2. Please indicate how strongly you agree or disagree with the following statements.

In situation #2, if I gather and hold my cattle for testing and inspection at the requested date and time:	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. It will reduce the economic impact of foot-and-mouth disease **on my operation**.	1	2	3	4	5	6	7
b. It will reduce the economic impact of foot-and-mouth disease **on the US cattle industry**.	1	2	3	4	5	6	7
c. It will help stop the spread of foot-and-mouth disease within **my cattle operation**.	1	2	3	4	5	6	7
d. It will help stop the spread of foot-and-mouth disease among **cattle in my area**.	1	2	3	4	5	6	7
e. It will allow me to know if my herd is infected as well.	1	2	3	4	5	6	7
f. It will cause my cattle to suffer.	1	2	3	4	5	6	7
g. It will make me feel better about how I manage my cattle.	1	2	3	4	5	6	7
h. It will reduce the value of my cattle.	1	2	3	4	5	6	7
i. It will result in my cattle being killed.	1	2	3	4	5	6	7
j. It will result in my neighbors' cattle being killed.	1	2	3	4	5	6	7

Q3. Please indicate how desirable or undesirable the following outcomes are for you personally. Desirable outcomes are those that you would be willing to invest time and/or financial resources to achieve.

	Extremely Undesirable	Mostly Undesirable	Somewhat Undesirable	Neither Desirable nor Undesirable	Somewhat Desirable	Mostly Desirable	Extremely Desirable
a. Reducing the economic impact of foot-and-mouth disease **on my operation** is:	-3	-2	-1	0	1	2	3
b. Reducing the economic impact of foot-and-mouth disease **on the US cattle industry** is:	-3	-2	-1	0	1	2	3
c. Stopping the spread of foot-and-mouth disease within **my cattle operation** is:	-3	-2	-1	0	1	2	3
d. Stopping the spread of foot-and-mouth disease among **cattle in my area** is:	-3	-2	-1	0	1	2	3
e. Knowing if my herd is infected is:	-3	-2	-1	0	1	2	3
f. Causing my cattle to suffer is:	-3	-2	-1	0	1	2	3
g. Feeling better about how I manage my cattle is:	-3	-2	-1	0	1	2	3
h. Reducing the value of my cattle is:	-3	-2	-1	0	1	2	3
i. Having my cattle killed during the control of foot-and-mouth disease is:	-3	-2	-1	0	1	2	3
j. Having my neighbors' cattle killed during the control of foot-and-mouth disease is:	-3	-2	-1	0	1	2	3

The following questions ask about factors that may influence your decision to gather and hold your cattle in situation #2.

Q4. Please indicate how strongly you agree or disagree with the following statements.	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. I have the facilities needed to gather and hold my cattle for testing and inspection.	1	2	3	4	5	6	7
b. I have the manpower needed to gather and hold my cattle for testing and inspection.	1	2	3	4	5	6	7
c. I have the finances needed to gather and hold my cattle for testing and inspection.	1	2	3	4	5	6	7
d. I live close enough to my cattle to be able to gather and hold my cattle for testing and inspection.	1	2	3	4	5	6	7
e. My cattle are tame enough to be gathered and held for testing and inspection.	1	2	3	4	5	6	7

Q5. Please indicate how the following conditions impact your *likelihood* of gathering and holding your cattle in situation #2.	Extremely Less Likely	Less Likely	Somewhat Less Likely	Neither More nor Less Likely	Somewhat More Likely	Mostly More Likely	Extremely More Likely
a. Having the facilities needed to gather and hold your cattle	-3	-2	-1	0	1	2	3
b. Having the manpower needed to gather and hold your cattle	-3	-2	-1	0	1	2	3
c. Having the finances needed to gather and hold your cattle	-3	-2	-1	0	1	2	3
d. Living close enough to your cattle to gather and hold your cattle	-3	-2	-1	0	1	2	3
e. Having cattle which are tame enough to be gathered and held	-3	-2	-1	0	1	2	3

Q6. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #2, I am confident that I could gather and hold my cattle at the date and time requested.	1	2	3	4	5	6	7
b. Whether I gather and hold my cattle or not, is entirely under my control.	1	2	3	4	5	6	7

The following questions ask about what you feel obligated to do regardless of others' expectations, as well as what other people would expect you to do in situation #2.

In question #10, we will ask you about how important it is to you that you meet these expectations.

Q7. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #2, I have a moral duty to gather and hold my cattle at the date and time requested.	1	2	3	4	5	6	7

Q8. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #2, I would feel social pressure to gather and hold my cattle at the date and time requested.	1	2	3	4	5	6	7
b. In situation #2, most people who are important to me think that I should gather and hold my cattle at the date and time requested.	1	2	3	4	5	6	7
c. In situation #2, other cattle producers I admire would gather and hold their cattle at the date and time requested.	1	2	3	4	5	6	7
d. In situation #2, other cattle producers like myself, would gather and hold their cattle at the date and time requested.	1	2	3	4	5	6	7

Q9. In situation #2, please indicate which of the following individuals or groups would expect you to gather and hold your cattle at the date and time requested.

	Does Not Apply	Strongly Do Not Expect	Mostly Do Not Expect	Somewhat Do Not Expect	Neither Expect nor Do Not Expect	Somewhat Expect	Mostly Expect	Strongly Expect
a. Animal Health Regulatory Agencies	☐	-3	-2	-1	0	1	2	3
b. Your County Extension Agent(S)	☐	-3	-2	-1	0	1	2	3
c. Your Surrounding Community	☐	-3	-2	-1	0	1	2	3
d. Your Professional Organization(s)	☐	-3	-2	-1	0	1	2	3
e. Other Cattle Producers Like Yourself	☐	-3	-2	-1	0	1	2	3
f. Leaders in the Cattle Industry	☐	-3	-2	-1	0	1	2	3
g. Your Family	☐	-3	-2	-1	0	1	2	3
h. Your Business Partner(s)/Associate(s)	☐	-3	-2	-1	0	1	2	3
i. Your Veterinarian(s)	☐	-3	-2	-1	0	1	2	3
j. Your Neighbor(s)	☐	-3	-2	-1	0	1	2	3

Q10. In situation #2, please indicate how important the expectations of the following individuals or groups are to you.								
	Does Not Apply	Very Unimportant	Mostly Unimportant	Somewhat Unimportant	Neither Important nor Unimportant	Somewhat Important	Mostly Important	Very Important
a. Animal Health Regulatory Agencies	☐	1	2	3	4	5	6	7
b. Your County Extension Agent(S)	☐	1	2	3	4	5	6	7
c. Your Surrounding Community	☐	1	2	3	4	5	6	7
d. Your Professional Organization(s)	☐	1	2	3	4	5	6	7
e. Other Cattle Producers Like Yourself	☐	1	2	3	4	5	6	7
f. Leaders in the Cattle Industry	☐	1	2	3	4	5	6	7
g. Your Family	☐	1	2	3	4	5	6	7
h. Your Business Partner(s)/Associate(s)	☐	1	2	3	4	5	6	7
i. Your Veterinarian(s)	☐	1	2	3	4	5	6	7
j. Your Neighbor(s)	☐	1	2	3	4	5	6	7

Q11. Please indicate how sure you are that the following individuals would gather and hold their cattle at the date and time requested if they were in situation #2.								
	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q12. Please indicate how sure you are that the following individuals would take into consideration the consequences to your operation when deciding in situation #2 whether or not to gather and hold their cattle at the date and time requested.								
	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q13. Overall, given situation #2, gathering and holding your cattle at the date and time requested is:								
Bad	1	2	3	4	5	6	7	**Good**
Unpleasant	1	2	3	4	5	6	7	**Pleasant**
Ineffective	1	2	3	4	5	6	7	**Effective**
Harmful	1	2	3	4	5	6	7	**Beneficial**
Difficult	1	2	3	4	5	6	7	**Easy**
Inconvenient	1	2	3	4	5	6	7	**Convenient**

The following questions ask about the various agencies which may be involved in the response to an outbreak of foot-and-mouth disease, as well as the risk that foot-and-mouth disease poses.

14. Given the scenarios above, please indicate how you feel the following agencies would manage their role during an outbreak of foot-and-mouth disease in Texas.

	Does Not Apply	Extremely Poorly	Very Poorly	Somewhat Poorly	Neither Well nor Poorly	Somewhat Well	Very Well	Extremely Well
a. US Department of Agriculture (USDA)	☐	1	2	3	4	5	6	7
b. Texas Department of Agriculture (TDA)	☐	1	2	3	4	5	6	7
c. Texas Animal Health Commission (TAHC)	☐	1	2	3	4	5	6	7
d. US Department of Homeland Security (DHS)	☐	1	2	3	4	5	6	7
e. US Environmental Protection Agency (EPA)	☐	1	2	3	4	5	6	7
f. Federal Emergency Management Agency (FEMA)	☐	1	2	3	4	5	6	7
g. Texas Health and Human Services (HHS)	☐	1	2	3	4	5	6	7
h. Texas Commission on Environmental Quality (TCEQ)	☐	1	2	3	4	5	6	7
i. US Department of Health and Human Services (HHS)	☐	1	2	3	4	5	6	7

15. Given the scenarios above, please indicate how strongly you agree or disagree with the following statement:

I believe that the following agencies would act in my best interest in managing an outbreak of foot-and-mouth disease in Texas.

	Does Not Apply	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. US Department of Agriculture (USDA)	☐	1	2	3	4	5	6	7
b. Texas Department of Agriculture (TDA)	☐	1	2	3	4	5	6	7
c. Texas Animal Health Commission (TAHC)	☐	1	2	3	4	5	6	7
d. US Department of Homeland Security (DHS)	☐	1	2	3	4	5	6	7
e. US Environmental Protection Agency (EPA)	☐	1	2	3	4	5	6	7
f. Federal Emergency Management Agency (FEMA)	☐	1	2	3	4	5	6	7
g. Texas Health and Human Services (HHS)	☐	1	2	3	4	5	6	7
h. Texas Commission on Environmental Quality (TCEQ)	☐	1	2	3	4	5	6	7
i. US Department of Health and Human Services (HHS)	☐	1	2	3	4	5	6	7

16. Given the scenarios above, please indicate how strongly you agree or disagree with the following statement:

I believe that the following agencies <u>have the same goals that I have</u> in managing an outbreak of foot-and-mouth disease in Texas.

	Does Not Apply	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. US Department of Agriculture (USDA)	☐	1	2	3	4	5	6	7
b. Texas Department of Agriculture (TDA)	☐	1	2	3	4	5	6	7
c. Texas Animal Health Commission (TAHC)	☐	1	2	3	4	5	6	7
d. US Department of Homeland Security (DHS)	☐	1	2	3	4	5	6	7
e. US Environmental Protection Agency (EPA)	☐	1	2	3	4	5	6	7
f. Federal Emergency Management Agency (FEMA)	☐	1	2	3	4	5	6	7
g. Texas Health and Human Services (HHS)	☐	1	2	3	4	5	6	7
h. Texas Commission on Environmental Quality (TCEQ)	☐	1	2	3	4	5	6	7
i. US Department of Health and Human Services (HHS)	☐	1	2	3	4	5	6	7

17. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. The risk of an outbreak of foot-and-mouth disease **in the USA** is very great.	1	2	3	4	5	6	7
b. The risk of an outbreak of foot-and-mouth disease **in my operation** is very great.	1	2	3	4	5	6	7
c. An outbreak of foot-and-mouth disease would be economically devastating for my operation.	1	2	3	4	5	6	7
d. An outbreak of foot-and-mouth disease would be economically devastating for the US cattle industry.	1	2	3	4	5	6	7
e. I believe that **the United States** is likely to experience an outbreak of foot-and-mouth disease in the next five years.	1	2	3	4	5	6	7
f. I believe that **my operation** is likely to experience an outbreak of foot-and-mouth disease in the next five years.	1	2	3	4	5	6	7

The following questions are used to summarize the general demographic features of the types of people that responded to our survey.

Please answer the following questions about your operation.		
a. Largest number of beef cows and beef cow replacements (weaned or older, including first calf heifers) located on your operation during the year:	☐ None ☐ 1 to 9 ☐ 10 to 19 ☐ 20 to 49 ☐ 50 to 99 ☐ 100 to 199	☐ 200 to 499 ☐ 500 to 999 ☐ 1,000 to 2,499 ☐ 2,500 to 4,999 ☐ 5,000 or more
b. Largest number of steers and/or stockers (weaned or older) located on your operation during the year:	☐ None ☐ 1 to 9 ☐ 10 to 19 ☐ 20 to 49 ☐ 50 to 99 ☐ 100 to 199	☐ 200 to 499 ☐ 500 to 999 ☐ 1,000 to 2,499 ☐ 2,500 to 4,999 ☐ 5,000 or more
c. Which of the following best describes your current production practices? **<u>Check all that apply.</u>**	☐ Conventional cow-calf ☐ Seedstock ☐ Age-and-source verification ☐ Branded Beef Program (such as certified Angus Beef) ☐ Natural or non-certified organic ☐ Integrated Resource Management	☐ Stocker ☐ Grass-finished ☐ Certified organic (operation certified by the USDA) ☐ Holistic Resource Management ☐ Beef Quality Assurance ☐ Other (please specify ________________)
d. Number of separate and distinct properties where you currently keep cattle?	☐ 1 ☐ 2 ☐ 3	☐ 4 ☐ 5 ☐ >5
e. Percentage of land that is used to raise or graze cattle that is owned or leased?	% owned ________________ % leased ________________	

Please answer the following questions about yourself.		
f. Male or female:	☐ Male	☐ Female
g. Age (in years):	________________ (years)	
h. Racial or ethnic identity:	☐ White ☐ Black or African American ☐ American Indian or Alaska Native ☐ Native Hawaiian or Pacific Islander	☐ Asian ☐ Hispanic, Latino, or Spanish origin or background
i. Highest Level of Education:	☐ Less than high school diploma ☐ High school diploma ☐ Vocational (trade) school ☐ 2-year college degree ☐ 4-year college degree ☐ Graduate or postgraduate degree (MS, PhD, etc.) ☐ Professional degree (MD, DVM, etc.)	
j. Length of time worked in current operation (in years):	________________ (years)	
k. Length of time worked in cattle industry (in years):	________________ (years)	
l. Do you currently live at the same property where your cattle are held? If not, what is the approximate distance between your residence and the location of your cattle?	☐ Yes ☐ No If no, ________________ (miles)	

Please answer the following questions about yourself.		
m. Primary motivation for raising or owning cattle? **Check only one.**	☐ Primary source of income ☐ Supplemental source of income ☐ Pleasure or lifestyle ☐ Control of excess forage ☐ Property tax advantages ☐ Family tradition/obligation ☐ Other (please specify	
n. Percentage of income derived from your cattle?	☐ <10% ☐ 10-19% ☐ 20-29% ☐ 30-39% ☐ 40-49% ☐ 50-59%	☐ 60-69% ☐ 70-79% ☐ 80-89% ☐ 90-99% ☐ 100%

Please answer the following questions about yourself.	
o. Current member of any cattle producer organization(s)?	☐ Yes ☐ No
p. If yes, have you served as an officer or committee chair/member within a cattle producer organization?	☐ Yes ☐ No
q. Which federal or state disease control/eradication program(s) have you been directly involved with? **Check all that apply.**	☐ Brucellosis eradication program ☐ Cattle tuberculosis eradication program ☐ Johne's control program ☐ Fever tick eradication program ☐ Scrapie eradication program ☐ Other (please specify ____________________________)

Thank you for taking the time to answer this questionnaire!

We would welcome any comments you may have on this questionnaire. Please feel free to write your comments or thoughts on situation #1 or #2 in the space below or on the back cover of the questionnaire. If there are any additional influences that would affect your decisions in situation #1 or #2 that we did not address, please include those in your comments. Many thanks.

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Texas Cattle Producers' Perspectives on Foot-and-Mouth Disease

Creating a Resource for Policymakers to Better Meet the Needs of Texas Cattle Producers

Instructions:

This survey booklet is divided into three sections. The first two sections each ask questions about a specific scenario or situation that a cattle producer might be faced with. The last section asks questions about your business or yourself that will help us understand the types of people who responded to our survey.

Please answer these questions based on the reality of your operation and how you do business. If you have multiple businesses or operations, please answer them for your cow-calf or stocker operation only. This will allow us to combine your answers with other cattle producers like yourself.

Thank you very much for your time and help in completing this survey!

☐ **I am not involved in the cattle industry.**

☐ **I do not wish to participate in this survey.**

If for some reason you received this survey in error—you no longer work with cattle or are not involved in cattle production, or if you wish not to participate in this study—simply indicate that below and return the survey left blank in the postage-paid envelope provided.

Please return surveys in the postage-paid envelope provided to:
Texas A&M University
College of Veterinary Medicine and Biomedical Sciences
Veterinary Integrative Biosciences
4458 TAMUS
College Station, TX 77843-4458

Imagine yourself in the following situation.

Situation #1

An outbreak of foot-and-mouth disease has been detected in Texas. Herds that have an animal test positive for foot-and-mouth disease, as well as their neighboring herds, will be killed in order to control the spread of the disease. All susceptible animals including cattle, sheep, goats, pigs, llamas, alpacas, and deer may be killed.

The clinical signs of foot-and-mouth disease are drooling, lameness, fever, loss of appetite, and the formation of blisters in the mouth or at the top of the hooves.

It is brought to your attention that **many** of the cattle in your herd appear depressed and seem reluctant to move. Several of the animals are noticeably lame. Some of the depressed animals appear to be drooling.

Based on your own experiences and the demands of your cattle operation, please answer the following questions regarding situation #1.

Q1. Please indicate how strongly you agree or disagree with the following statement.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I would ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7

The following questions measure the strength of your beliefs and concerns about the consequences of asking a veterinarian to examine your cattle in situation #1.

Q2. Please indicate how strongly you agree or disagree with the following statements.

In situation #1, if I ask a veterinarian to examine my cattle:	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. It will reduce the economic impact of foot-and-mouth disease **on my operation**.	1	2	3	4	5	6	7
b. It will reduce the economic impact of foot-and-mouth disease **on the US cattle industry**.	1	2	3	4	5	6	7
c. It will help stop the spread of foot-and-mouth disease within **my cattle operation**.	1	2	3	4	5	6	7
d. It will help stop the spread of foot-and-mouth disease among **cattle in my area**.	1	2	3	4	5	6	7
e. It will allow me to know the cause of disease in my herd.	1	2	3	4	5	6	7
f. It will improve the well being of my cattle.	1	2	3	4	5	6	7
g. It will improve the productivity of my cattle.	1	2	3	4	5	6	7
h. It will improve the profitability of my operation.	1	2	3	4	5	6	7
i. It will make me feel better about how I manage my cattle.	1	2	3	4	5	6	7
j. It will delay my ability to sell cattle.	1	2	3	4	5	6	7

Q3. Please indicate how desirable or undesirable the following outcomes are for you personally. Desirable outcomes are those that you would be willing to invest time and/or financial resources to achieve.

	Extremely Undesirable	Mostly Undesirable	Somewhat Undesirable	Neither Desirable nor Undesirable	Somewhat Desirable	Mostly Desirable	Extremely Desirable
a. Reducing the economic impact of foot-and-mouth disease **on my operation** is:	-3	-2	-1	0	1	2	3
b. Reducing the economic impact of foot-and-mouth disease **on the US cattle industry** is:	-3	-2	-1	0	1	2	3
c. Stopping the spread of foot-and-mouth disease within **my cattle operation** is:	-3	-2	-1	0	1	2	3
d. Stopping the spread of foot-and-mouth disease among **cattle in my area** is:	-3	-2	-1	0	1	2	3
e. Knowing the cause of disease in my herd is:	-3	-2	-1	0	1	2	3
f. Improving the well being of my cattle is:	-3	-2	-1	0	1	2	3
g. Improving the productivity of my cattle is:	-3	-2	-1	0	1	2	3
h. Improving the profitability of my operation is:	-3	-2	-1	0	1	2	3
i. Feeling better about how I manage my cattle is:	-3	-2	-1	0	1	2	3
j. Delaying my ability to sell cattle is:	-3	-2	-1	0	1	2	3

The following questions ask about factors that may influence your decision to ask a veterinarian to examine your cattle in situation #1.

Q4. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. I have a good relationship with a livestock veterinarian.	1	2	3	4	5	6	7
b. A veterinarian qualified to treat cattle is available in my area.	1	2	3	4	5	6	7
c. I know the clinical signs associated with serious cattle diseases.	1	2	3	4	5	6	7
d. I know that certain cattle are at greater risk of having disease.	1	2	3	4	5	6	7

e. I have a clear understanding of who to call if I suspect a disease outbreak in my operation.	1	2	3	4	5	6	7
f. I can restrain my cattle in order to inspect them closely for signs of disease.	1	2	3	4	5	6	7

Q5. Please indicate how the following conditions impact your *likelihood* of asking a veterinarian to inspect your cattle in situation #1.

	Extremely Less Likely	Less Likely	Somewhat Less Likely	Neither More nor Less Likely	Somewhat More Likely	Mostly More Likely	Extremely More Likely
a. Having a good relationship with a livestock veterinarian	-3	-2	-1	0	1	2	3
b. A veterinarian qualified to treat cattle is available in your area	-3	-2	-1	0	1	2	3
c. Knowing the clinical signs associated with serious livestock diseases	-3	-2	-1	0	1	2	3
d. Knowing that certain cattle are at greater risk of disease	-3	-2	-1	0	1	2	3
e. Knowing who to call if you suspect an outbreak of disease in your operation	-3	-2	-1	0	1	2	3
f. Having the ability to restrain your cattle and inspect them closely for signs of disease	-3	-2	-1	0	1	2	3

Q6. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I am confident that I could ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
b. Whether I ask that my cattle are examined by a veterinarian or not, is entirely under my control.	1	2	3	4	5	6	7

The following questions ask about what you feel obligated to do regardless of others' expectations, as well as what other people would expect you to do in situation #1.

In question #10, we will ask you about how important it is to you that you meet these expectations.

Q7. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I have a moral duty to ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
b. I have a moral duty to request veterinary care for sick cattle.	1	2	3	4	5	6	7

Q8. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. In situation #1, I would feel under social pressure to ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
b. In situation #1, most people who are important to me think that I should ask a veterinarian to examine my cattle.	1	2	3	4	5	6	7
c. In situation #1, other cattle producers I admire would ask a veterinarian to examine their cattle.	1	2	3	4	5	6	7
d. In situation #1, other cattle producers like myself, would ask a veterinarian to examine their cattle.	1	2	3	4	5	6	7

Q9. In situation #1, please indicate which of the following individuals or groups would expect or not expect you to ask a veterinarian to examine your cattle.

	Does Not Apply	Strongly Do Not Expect	Mostly Do Not Expect	Somewhat Do Not Expect	Neither Expect nor Do Not Expect	Somewhat Expect	Mostly Expect	Strongly Expect
a. Animal Health Regulatory Agencies	☐	-3	-2	-1	0	1	2	3
b. Your County Extension Agent(s)	☐	-3	-2	-1	0	1	2	3
c. Your Surrounding Community	☐	-3	-2	-1	0	1	2	3
d. Your Professional Organization(s)	☐	-3	-2	-1	0	1	2	3
e. Other Cattle Producers Like Yourself	☐	-3	-2	-1	0	1	2	3
f. Leaders in the Cattle Industry	☐	-3	-2	-1	0	1	2	3
g. Your Family	☐	-3	-2	-1	0	1	2	3
h. Your Business Partner(s)/Associate(s)	☐	-3	-2	-1	0	1	2	3
i. Your Veterinarian(s)	☐	-3	-2	-1	0	1	2	3
j. Your Neighbor(s)	☐	-3	-2	-1	0	1	2	3

Q10. In situation #1, please indicate how important the expectations of the following individuals or groups are to you.

	Does Not Apply	Very Unimportant	Mostly Unimportant	Somewhat Unimportant	Neither Important nor Unimportant	Somewhat Important	Mostly Important	Very Important
a. Animal Health Regulatory Agencies	☐	1	2	3	4	5	6	7
b. Your County Extension Agent(s)	☐	1	2	3	4	5	6	7
c. Your Surrounding Community	☐	1	2	3	4	5	6	7
d. Your Professional Organization(s)	☐	1	2	3	4	5	6	7
e. Other Cattle Producers Like Yourself	☐	1	2	3	4	5	6	7
f. Leaders in the Cattle Industry	☐	1	2	3	4	5	6	7
g. Your Family	☐	1	2	3	4	5	6	7
h. Your Business Partner(s)/Associate(s)	☐	1	2	3	4	5	6	7
i. Your Veterinarian(s)	☐	1	2	3	4	5	6	7
j. Your Neighbor(s)	☐	1	2	3	4	5	6	7

Q11. Please indicate how sure you are that the following individuals would ask a veterinarian to examine their cattle if they were in situation #1.

	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q12. Please indicate how sure you are that the following individuals would take into consideration the consequences to your operation when deciding in situation #1 whether or not to ask a veterinarian to examine their cattle.

	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q13. Overall, given situation #1, asking that a veterinarian examine my cattle is:

Bad	1	2	3	4	5	6	7	**Good**
Unpleasant	1	2	3	4	5	6	7	**Pleasant**
Ineffective	1	2	3	4	5	6	7	**Effective**
Harmful	1	2	3	4	5	6	7	**Beneficial**
Difficult	1	2	3	4	5	6	7	**Easy**
Inconvenient	1	2	3	4	5	6	7	**Convenient**

Imagine yourself in the following situation.

Situation #2

Once foot-and-mouth disease is identified in Texas, producers will be told to restrict the movement of anything that could spread the disease. These movement restrictions may last for many weeks.

These movement restrictions will cover susceptible animals (e.g. cattle, sheep, goats, pigs, llamas, alpacas, and deer), as well as products (i.e. milk, meat, hides) from these animals. In addition, the movement of vehicles, including feed trucks, and personnel will also be restricted.

People, other types of animals, vehicles, and equipment may only be allowed to move following an extensive disinfection process that involves the application of an appropriate chemical disinfectant and a mandatory wait period before coming into contact with susceptible animals.

Based on your own experiences and the demands of your cattle operation, please answer the following questions regarding <u>situation #2.</u>

Q1. Please indicate how strongly you agree or disagree with the following statement.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. During an outbreak of foot-and-mouth disease, I would keep all of my cattle at their current location(s).	1	2	3	4	5	6	7

The following questions measure the strength of your beliefs and concerns about the consequences of keeping your cattle at their current location(s) during a foot-and-mouth disease outbreak.

Q2. Please indicate how strongly you agree or disagree with the following statements.

During an outbreak of foot-and-mouth disease, if I keep my cattle at their current location(s):	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. It will reduce the economic impact of foot-and-mouth disease **on my operation**.	1	2	3	4	5	6	7
b. It will reduce the economic impact of foot-and-mouth disease **on the US cattle industry**.	1	2	3	4	5	6	7
c. It will help stop the spread of foot-and-mouth disease within **my cattle operation**.	1	2	3	4	5	6	7
d. It will help stop the spread of foot-and-mouth disease among **cattle in my area**.	1	2	3	4	5	6	7
e. It will result in feed shortages for my cattle.	1	2	3	4	5	6	7
f. It will cause my cattle to suffer.	1	2	3	4	5	6	7
g. It will be adequate to protect my cattle from foot-and-mouth disease.	1	2	3	4	5	6	7
h. I will not be blamed for the spread of foot-and-mouth disease.	1	2	3	4	5	6	7
i. It will make me feel better about how I manage my cattle.	1	2	3	4	5	6	7
j. It will delay my ability to sell cattle.	1	2	3	4	5	6	7

Q3. Please indicate how desirable or undesirable the following outcomes are for you personally. Desirable outcomes are those that you would be willing to invest time and/or financial resources to achieve.							
	Extremely Undesirable	Mostly Undesirable	Somewhat Undesirable	Neither Desirable nor Undesirable	Somewhat Desirable	Mostly Desirable	Extremely Desirable
a. Reducing the economic impact of foot-and-mouth disease **on my operation** is:	-3	-2	-1	0	1	2	3
b. Reducing the economic impact of foot-and-mouth disease **on the US cattle industry** is:	-3	-2	-1	0	1	2	3
c. Stopping the spread of foot-and-mouth disease within **my cattle operation** is:	-3	-2	-1	0	1	2	3
d. Stopping the spread of foot-and-mouth disease among **cattle in my area** is:	-3	-2	-1	0	1	2	3
e. Having a shortage of feed for my cattle is:	-3	-2	-1	0	1	2	3
f. Causing my cattle to suffer is:	-3	-2	-1	0	1	2	3
g. Protecting my cattle from foot-and-mouth disease is:	-3	-2	-1	0	1	2	3
h. Not being blamed for the spread of foot-and-mouth disease:	-3	-2	-1	0	1	2	3
i. Feeling better about how I manage my cattle is:	-3	-2	-1	0	1	2	3
j. Delaying my ability to sell cattle is:	-3	-2	-1	0	1	2	3

The following questions ask about factors that may influence your decision to keep your cattle at their current location(s) during an outbreak of foot-and-mouth disease.							
Q4. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	**Mostly Disagree**	**Somewhat Disagree**	**Neither Agree nor Disagree**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**
a. During an outbreak of foot-and-mouth disease, I expect that feed can be delivered to my cattle if needed.	1	2	3	4	5	6	7
b. I own/have access to adequate feed to keep my cattle at their current location(s).	1	2	3	4	5	6	7
c. I will be responsible for paying for additional feed needed to maintain my cattle if they can not be moved.	1	2	3	4	5	6	7
d. Keeping my cattle in their current location(s) will cause them to become crowded.	1	2	3	4	5	6	7
e. Keeping my cattle in their current location(s) will cause environmental damage.	1	2	3	4	5	6	7
f. Keeping my cattle in their current location(s) will cause them to be killed during the control of the disease.	1	2	3	4	5	6	7
g. If needed, I have facilities to keep all calves born on my property for an extended length of time.	1	2	3	4	5	6	7
h. I can set up appropriate disinfection procedures for myself and my employees/hands.	1	2	3	4	5	6	7

Q5. Please indicate how the following conditions impact your *likelihood* of keeping your cattle at their current location(s) during an outbreak of foot-and-mouth disease.							
	Extremely Less Likely	Less Likely	Somewhat Less Likely	Neither More nor Less Likely	Somewhat More Likely	Mostly More Likely	Extremely More Likely
a. Having the ability to have feed delivered	-3	-2	-1	0	1	2	3
b. Having access to adequate feed to maintain your cattle	-3	-2	-1	0	1	2	3
c. Having the responsibility of paying for additional feed to maintain your cattle	-3	-2	-1	0	1	2	3
d. Worries that your cattle may cause environmental damage	-3	-2	-1	0	1	2	3
e. Worries that your cattle may become crowded	-3	-2	-1	0	1	2	3
f. Knowing that your cattle are likely to be killed during the disease control process	-3	-2	-1	0	1	2	3
g. Having the facilities to keep all calves born on your property for an extended length of time	-3	-2	-1	0	1	2	3
h. Being able to set up appropriate disinfection procedures	-3	-2	-1	0	1	2	3

Q6. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. During an outbreak of foot-and-mouth disease, I am confident that I could keep my cattle at their current location(s).	1	2	3	4	5	6	7
b. Whether I keep my cattle at their current location(s) or not, is entirely under my control.	1	2	3	4	5	6	7

The following questions ask about what you feel obligated to do regardless of others' expectations, as well as what other people would expect you to do in situation #2.

In question #10, we will ask you about how important it is to you that you meet these expectations.

Q7. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. I have a moral duty to ensure that my cattle have access to adequate feed and water.	1	2	3	4	5	6	7
b. I have a moral duty to protect my cattle from exposure to diseased animals.	1	2	3	4	5	6	7
c. I have a moral duty to prevent the spread of disease from my cattle to someone else's cattle.	1	2	3	4	5	6	7

Q8. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. During an outbreak of foot-and-mouth disease, I would feel social pressure to keep my cattle at their current location(s).	1	2	3	4	5	6	7
b. During an outbreak of foot-and-mouth disease, most people who are important to me think that I should keep my cattle at their current location(s).	1	2	3	4	5	6	7
c. During an outbreak of foot-and-mouth disease, other cattle producers I admire would keep their cattle at their current location(s).	1	2	3	4	5	6	7
d. During an outbreak of foot-and-mouth disease, other cattle producers like myself, would keep their cattle at their current location(s).	1	2	3	4	5	6	7

Q9. During an outbreak of foot-and-mouth disease (Situation #2), please indicate which of the following individuals or groups would expect you to keep your cattle at their current location(s).

	Does Not Apply	Strongly Do Not Expect	Mostly Do Not Expect	Somewhat Do Not Expect	Neither Expect nor Do Not Expect	Somewhat Expect	Mostly Expect	Strongly Expect
a. Animal Health Regulatory Agencies	☐	-3	-2	-1	0	1	2	3
b. Your County Extension Agent(S)	☐	-3	-2	-1	0	1	2	3
c. Your Surrounding Community	☐	-3	-2	-1	0	1	2	3
d. Your Professional Organization(s)	☐	-3	-2	-1	0	1	2	3
e. Other Cattle Producers Like Yourself	☐	-3	-2	-1	0	1	2	3
f. Leaders in the Cattle Industry	☐	-3	-2	-1	0	1	2	3
g. Your Family	☐	-3	-2	-1	0	1	2	3
h. Your Business Partner(s)/Associate(s)	☐	-3	-2	-1	0	1	2	3
i. Your Veterinarian(s)	☐	-3	-2	-1	0	1	2	3
j. Your Neighbor(s)	☐	-3	-2	-1	0	1	2	3

Q10. During an outbreak of foot-and-mouth disease (Situation #2), please indicate how important the expectations of the following individuals or groups are to you.

	Does Not Apply	Very Unimportant	Mostly Unimportant	Somewhat Unimportant	Neither Important nor Unimportant	Somewhat Important	Mostly Important	Very Important
a. Animal Health Regulatory Agencies	☐	1	2	3	4	5	6	7
b. Your County Extension Agent(S)	☐	1	2	3	4	5	6	7
c. Your Surrounding Community	☐	1	2	3	4	5	6	7
d. Your Professional Organization(s)	☐	1	2	3	4	5	6	7
e. Other Cattle Producers Like Yourself	☐	1	2	3	4	5	6	7
f. Leaders in the Cattle Industry	☐	1	2	3	4	5	6	7
g. Your Family	☐	1	2	3	4	5	6	7
h. Your Business Partner(s)/Associate(s)	☐	1	2	3	4	5	6	7
i. Your Veterinarian(s)	☐	1	2	3	4	5	6	7
j. Your Neighbor(s)	☐	1	2	3	4	5	6	7

Q11. Please indicate how sure you are that the following individuals would keep their cattle in their current location(s) if they were in situation #2.

	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q12. Please indicate how sure you are that the following individuals would take into consideration <u>the consequences to your operation</u> when deciding in situation #2 whether or not to keep their cattle in their current location(s).								
	Does Not Apply	Extremely Unsure	Mostly Unsure	Somewhat Unsure	Neither Sure nor Unsure	Somewhat Sure	Mostly Sure	Extremely Sure
a. Your neighbor(s)	☐	1	2	3	4	5	6	7
b. Other cattle producers in your area	☐	1	2	3	4	5	6	7
c. Other cattle producers in Texas	☐	1	2	3	4	5	6	7

Q13. Overall, given situation #2, keeping my cattle in their current location(s) during an outbreak of foot-and-mouth disease is:								
Bad	1	2	3	4	5	6	7	**Good**
Unpleasant	1	2	3	4	5	6	7	**Pleasant**
Ineffective	1	2	3	4	5	6	7	**Effective**
Harmful	1	2	3	4	5	6	7	**Beneficial**
Difficult	1	2	3	4	5	6	7	**Easy**
Inconvenient	1	2	3	4	5	6	7	**Convenient**

The following questions ask about the various agencies which may be involved in the response to an outbreak of foot-and-mouth disease, as well as the risk that foot-and-mouth disease poses.

14. Given the scenarios above, please indicate how you feel the following agencies would manage their role during an outbreak of foot-and-mouth disease in Texas.

	Does Not Apply	Extremely Poorly	Very Poorly	Somewhat Poorly	Neither Well nor Poorly	Somewhat Well	Very Well	Extremely Well
a. US Department of Agriculture (USDA)	☐	1	2	3	4	5	6	7
b. Texas Department of Agriculture (TDA)	☐	1	2	3	4	5	6	7
c. Texas Animal Health Commission (TAHC)	☐	1	2	3	4	5	6	7
d. US Department of Homeland Security (DHS)	☐	1	2	3	4	5	6	7
e. US Environmental Protection Agency (EPA)	☐	1	2	3	4	5	6	7
f. Federal Emergency Management Agency (FEMA)	☐	1	2	3	4	5	6	7
g. Texas Health and Human Services (HHS)	☐	1	2	3	4	5	6	7
h. Texas Commission on Environmental Quality (TCEQ)	☐	1	2	3	4	5	6	7
i. US Department of Health and Human Services (HHS)	☐	1	2	3	4	5	6	7

15. Given the scenarios above, please indicate how strongly you agree or disagree with the following statement:

I believe that the following agencies <u>would act in my best interest</u> in managing an outbreak of foot-and-mouth disease in Texas.

	Does Not Apply	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. US Department of Agriculture (USDA)	☐	1	2	3	4	5	6	7
b. Texas Department of Agriculture (TDA)	☐	1	2	3	4	5	6	7
c. Texas Animal Health Commission (TAHC)	☐	1	2	3	4	5	6	7
d. US Department of Homeland Security (DHS)	☐	1	2	3	4	5	6	7
e. US Environmental Protection Agency (EPA)	☐	1	2	3	4	5	6	7
f. Federal Emergency Management Agency (FEMA)	☐	1	2	3	4	5	6	7
g. Texas Health and Human Services (HHS)	☐	1	2	3	4	5	6	7
h. Texas Commission on Environmental Quality (TCEQ)	☐	1	2	3	4	5	6	7
i. US Department of Health and Human Services (HHS)	☐	1	2	3	4	5	6	7

16. Given the scenarios above, please indicate how strongly you agree or disagree with the following statement:

I believe that the following agencies <u>have the same goals that I have</u> in managing an outbreak of foot-and-mouth disease in Texas.

	Does Not Apply	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. US Department of Agriculture (USDA)	☐	1	2	3	4	5	6	7
b. Texas Department of Agriculture (TDA)	☐	1	2	3	4	5	6	7
c. Texas Animal Health Commission (TAHC)	☐	1	2	3	4	5	6	7
d. US Department of Homeland Security (DHS)	☐	1	2	3	4	5	6	7
e. US Environmental Protection Agency (EPA)	☐	1	2	3	4	5	6	7
f. Federal Emergency Management Agency (FEMA)	☐	1	2	3	4	5	6	7
g. Texas Health and Human Services (HHS)	☐	1	2	3	4	5	6	7
h. Texas Commission on Environmental Quality (TCEQ)	☐	1	2	3	4	5	6	7
i. US Department of Health and Human Services (HHS)	☐	1	2	3	4	5	6	7

17. Please indicate how strongly you agree or disagree with the following statements.							
	Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Strongly Agree
a. The risk of an outbreak of foot-and-mouth disease **in the USA** is very great.	1	2	3	4	5	6	7
b. The risk of an outbreak of foot-and-mouth disease **in my operation** is very great.	1	2	3	4	5	6	7
c. An outbreak of foot-and-mouth disease would be economically devastating **for my operation.**	1	2	3	4	5	6	7
d. An outbreak of foot-and-mouth disease would be economically devastating **for the US cattle industry.**	1	2	3	4	5	6	7
e. I believe that **the United States** is likely to experience an outbreak of foot-and-mouth disease in the next five years.	1	2	3	4	5	6	7
f. I believe that **my operation** is likely to experience an outbreak of foot-and-mouth disease in the next five years.	1	2	3	4	5	6	7

The following questions are used to summarize the general demographic features of the types of people that responded to our survey.

Please answer the following questions about your operation.		
a. Largest number of beef cows and beef cow replacements (weaned or older, including first calf heifers) located on your operation during the year:	☐ None ☐ 1 to 9 ☐ 10 to 19 ☐ 20 to 49 ☐ 50 to 99 ☐ 100 to 199	☐ 200 to 499 ☐ 500 to 999 ☐ 1,000 to 2,499 ☐ 2,500 to 4,999 ☐ 5,000 or more
b. Largest number of steers and/or stockers (weaned or older) located on your operation during the year:	☐ None ☐ 1 to 9 ☐ 10 to 19 ☐ 20 to 49 ☐ 50 to 99 ☐ 100 to 199	☐ 200 to 499 ☐ 500 to 999 ☐ 1,000 to 2,499 ☐ 2,500 to 4,999 ☐ 5,000 or more
c. Which of the following best describes your current production practices? **Check all that apply.**	☐ Conventional cow-calf ☐ Seedstock ☐ Age-and-source verification ☐ Branded Beef Program (such as certified Angus Beef) ☐ Natural or non-certified organic ☐ Integrated Resource Management	☐ Stocker ☐ Grass-finished ☐ Certified organic (operation certified by the USDA) ☐ Holistic Resource Management ☐ Beef Quality Assurance ☐ Other (please specify ______________________)
d. Number of separate and distinct properties where you currently keep cattle?	☐ 1 ☐ 2 ☐ 3	☐ 4 ☐ 5 ☐ >5
e. Percentage of land that is used to raise or graze cattle that is owned or leased?	% owned ________________________ % leased ________________________	

Please answer the following questions about yourself.		
f. Male or female:	☐ Male	☐ Female
g. Age (in years):	________________ (years)	
h. Racial or ethnic identity:	☐ White ☐ Black or African American ☐ American Indian or Alaska Native ☐ Native Hawaiian or Pacific Islander	☐ Asian ☐ Hispanic, Latino, or Spanish origin or background
i. Highest Level of Education:	☐ Less than high school diploma ☐ High school diploma ☐ Vocational (trade) school ☐ 2-year college degree ☐ 4-year college degree ☐ Graduate or postgraduate degree (MS, PhD, etc.) ☐ Professional degree (MD, DVM, etc.)	
j. Length of time worked in current operation (in years):	________________ (years)	

Please answer the following questions about yourself.	
k. Length of time worked in cattle industry (in years):	________________ (years)
l. Do you currently live at the same property where your cattle are held? If not, what is the approximate distance between your residence and the location(s) of your cattle?	☐ Yes ☐ No If no, ________________ (miles)
m. Primary motivation for raising or owning cattle? **Check only one.**	☐ Primary source of income ☐ Supplemental source of income ☐ Pleasure or lifestyle ☐ Control of excess forage ☐ Property tax advantages ☐ Family tradition/obligation ☐ Other (please specify ________________________)
n. Percentage of income derived from your cattle?	☐ <10% ☐ 10-19% ☐ 20-29% ☐ 30-39% ☐ 40-49% ☐ 50-59% ☐ 60-69% ☐ 70-79% ☐ 80-89% ☐ 90-99% ☐ 100%
o. Current member of any cattle producer organization(s)?	☐ Yes ☐ No
p. If yes, have you served as an officer or committee chair/member within a cattle producer organization?	☐ Yes ☐ No
q. Which federal or state disease control/eradication programs have you been directly involved with? **Check all that apply.**	☐ Brucellosis eradication program ☐ Cattle tuberculosis eradication program ☐ Johne's control program ☐ Fever tick eradication program ☐ Scrapie eradication program ☐ Other (please specify

Thank you for taking the time to answer this questionnaire! We would welcome any comments you may have on this questionnaire. Please feel free to write your comments or thoughts on situation #1 or #2 in the space below. If there are any additional influences that would affect your decisions in situation #1 or #2 that we did not address, please include those in your comments. Many thanks.

APPENDIX B

FACTOR LOADINGS AND SCORING COEFFICIENTS FOR FACTOR ANALYSIS

The following tables present the factor loadings and scoring coefficients for all factor analyses performed. Questions related to behaviors 1 and 3 were included on Survey 1, while behaviors 2 and 4 were included in a separate survey (Survey 2). Identical questions regarding trust and risk perception were included on both Survey 1 and 2.

Behavior 1: Requesting veterinary examination of cattle with clinical signs consistent with FMD prior to a known outbreak of FMD

Table B1. Factor loadings and scoring coefficients for 1 factor extracted from 9 variables included in Survey 1 (*n*=493) assessing producers´ beliefs about the consequences of requesting veterinary examination of cattle with clinical signs consistent with FMD when an outbreak is not known to be present. The proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
It will reduce the economic impact on my operation.	0.76	0.08
It will reduce the economic impact on the US cattle industry.	0.72	0.12
It will stop the spread of disease within my operation.	0.89	0.18
It will stop the spread of disease among cattle in my area.	0.84	0.13
It will allow me to know the cause of disease in my herd.	0.85	0.12
It will improve the well being of my cattle.	0.89	0.16
It will improve the productivity of my cattle.	0.88	0.18
It will improve the profitability of my operation.	0.84	0.12
It will make me feel better about how I manage my cattle.	0.70	0.05

Table B2. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 1 (*n*=506) assessing producers´ control beliefs about the barriers to requesting veterinary examination of cattle with clinical signs consistent with FMD when an outbreak is not known to be present. The proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
I have a good relationship with a livestock veterinarian.	0.73	0.23
A veterinarian qualified to treat cattle is available in my area.	0.72	0.21
I know the clinical signs associated with serious livestock diseases.	0.63	0.17
I know that certain cattle are at greater risk of having disease.	0.58	0.15
I have a clear understanding of who to call if I suspect a disease outbreak in my operation.	0.80	0.30
I can restrain my cattle in order to inspect them closely for signs of disease.	0.65	0.15

Table B3. Factor loadings and scoring coefficients for 1 factor extracted from 10 variables included in Survey 1 (*n*=493) assessing producers´ beliefs about social pressure from each of the listed groups for requesting veterinary examination of cattle with clinical signs consistent with FMD when an outbreak is not known to be present. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Animal health regulatory agencies	0.74	0.09
Your county extension agent(s)	0.73	0.11
Your surrounding community	0.81	0.12
Your professional organizations	0.83	0.12
Other cattle producers like yourself	0.89	0.19
Leaders in the cattle industry	0.80	0.10
Your family	0.78	0.13
Your business partner(s)/ associate(s)	0.76	0.11
Your veterinarian(s)	0.82	0.12
Your neighbor(s)	0.80	0.10

Table B4. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 1 (*n*=471) assessing producers´ attitudes towards requesting veterinary examination of cattle with clinical signs consistent with FMD when an outbreak is not known to be present. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Bad – Good	0.60	0.10
Unpleasant – Pleasant	0.71	0.15
Ineffective – Effective	0.79	0.24
Harmful – Beneficial	0.79	0.22
Difficult – Easy	0.81	0.25
Inconvenient – Convenient	0.79	0.22

Table B5. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 1 (*n*=472) assessing producers´ trust in their neighbors, other producers in their area, and other producers in Texas to requesting veterinary examination of cattle with clinical signs consistent with FMD when an outbreak is not known to be present, and to take into consideration the consequences to the producer´s operation when deciding whether to call a veterinarian or not. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Would ask a veterinarian to examine their cattle		
Your neighbors	0.75	0.17
Other cattle producers in your area	0.83	0.21
Other cattle producers in Texas	0.77	0.15
Would take into consideration the consequences to your operation when deciding		
Your neighbors	0.81	0.17
Other cattle producers in your area	0.86	0.28
Other cattle producers in Texas	0.78	0.17

Behavior 2: Requesting veterinary examination of cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas

Table B6. Factor loadings and scoring coefficients for 1 factor extracted from 9 variables included in Survey 2 (*n*=540) assessing producers´ beliefs about the consequences of requesting veterinary examination of cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
It will reduce the economic impact on my operation.	0.73	0.11
It will reduce the economic impact on the US cattle industry.	0.66	0.11
It will stop the spread of disease within my operation.	0.78	0.11
It will stop the spread of disease among cattle in my area.	0.78	0.16
It will allow me to know the cause of disease in my herd.	0.71	0.08
It will improve the well being of my cattle.	0.88	0.19
It will improve the productivity of my cattle.	0.87	0.22
It will improve the profitability of my operation.	0.80	0.11
It will make me feel better about how I manage my cattle.	0.76	0.10

Table B7. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 2 (*n*=554) assessing producers´ control beliefs about the barriers to requesting veterinary examination of cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
I have a good relationship with a livestock veterinarian.	0.74	0.20
A veterinarian qualified to treat cattle is available in my area.	0.78	0.24
I know the clinical signs associated with serious livestock diseases.	0.72	0.21
I know that certain cattle are at greater risk of having disease.	0.64	0.14
I have a clear understanding of who to call if I suspect a disease outbreak in my operation.	0.82	0.28
I can restrain my cattle in order to inspect them closely for signs of disease.	0.64	0.12

Table B8. Factor loadings and scoring coefficients for 1 factor extracted from 10 variables included in Survey 2 (*n*=364) assessing producers´ beliefs about social pressure from each of the listed groups for requesting veterinary examination of cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Animal health regulatory agencies	0.77	0.10
Your county extension agent(s)	0.77	0.10
Your surrounding community	0.80	0.11
Your professional organizations	0.86	0.15
Other cattle producers like yourself	0.86	0.13
Leaders in the cattle industry	0.87	0.16
Your family	0.79	0.11
Your business partner(s)/ associate(s)	0.78	0.11
Your veterinarian(s)	0.76	0.09
Your neighbor(s)	0.80	0.12

Table B9. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 2 (*n*=533) assessing producers´ attitudes towards requesting veterinary examination of cattle with clinical signs consistent with FMD during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Bad – Good	0.59	0.16
Unpleasant – Pleasant	0.64	0.16
Ineffective – Effective	0.69	0.22
Harmful – Beneficial	0.72	0.20
Difficult – Easy	0.76	0.27
Inconvenient – Convenient	0.70	0.21

Table B10. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 2 (*n*=552) assessing producers´ trust in their neighbors, other producers in their area, and other producers in Texas to requesting veterinary examination of cattle with clinical signs consistent with FMD during an outbreak of FMD, and to take into consideration the consequences to the producer´s operation when deciding whether to call a veterinarian or not. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Would ask a veterinarian to examine their cattle		
Your neighbors	0.79	0.18
Other cattle producers in your area	0.84	0.21
Other cattle producers in Texas	0.79	0.15
Would take into consideration the consequences to your operation when deciding		
Your neighbors	0.80	0.14
Other cattle producers in your area	0.89	0.32
Other cattle producers in Texas	0.81	0.15

Behavior 3: Gather and hold cattle at date and time requested by authorities

Table B11. Factor loadings and scoring coefficients for 1 factor extracted from 10 variables included in Survey 1 (*n*=472) assessing producers´ beliefs about the consequences of gathering and holding their cattle at the date and time requested by authorities during a hypothetical outbreak of FMD in Texas. Factor loadings less than 0.4 are not shown. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1		Factor 2	
	Rotated factor loadings	Scoring Coefficients	Rotated factor loadings	Scoring Coefficients
It will reduce the economic impact of foot-and-mouth disease on my operation.	0.51	-0.06	-	-
It will reduce the economic impact of foot-and-mouth disease on the US cattle industry.	0.46	-0.13	-	-
It will help stop the spread of foot-and-mouth disease within my cattle operation.	0.85	0.49	-	-
It will help stop the spread of foot-and-mouth disease among cattle in my area.	0.83	0.45	-	-
It will allow me to know if my herd is infected as well.	0.53	0.08	-	-
It will cause my cattle to suffer.[a]	-	-	0.40	0.003
It will make me feel better about how I manage my cattle.	0.58	0.10	-	-
It will reduce the value of my cattle.[a]	-	-	0.51	-0.002
It will result in my cattle being killed.[a]	-	-	0.93	0.51
It will result in my neighbors' cattle being killed.[a]	-	-	0.93	0.46

[a] These beliefs were reverse coded in order to be consistent with the other beliefs (strongly agree always indicates agreeing with a positive outcome.)

Table B12. Factor loadings and scoring coefficients for 1 factor extracted from 5 variables included in Survey 1 (*n*=481) assessing producers´ control beliefs about the barriers to gathering and holding their cattle at the date and time requested by authorities during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
I have the facilities needed to gather and hold my cattle for testing and inspection.	0.88	0.25
I have the manpower needed to gather and hold my cattle for testing and inspection.	0.87	0.29
I have the finances needed to gather and hold my cattle for testing and inspection.	0.77	0.14
I live close enough to my cattle to be able to gather and hold my cattle for testing and inspection.	0.85	0.22
My cattle are tame enough to be gathered and held for testing and inspection.	0.82	0.20

Table B13. Factor loadings and scoring coefficients for 1 factor extracted from 10 variables included in Survey 1 (*n*=323) assessing producers´ beliefs about social pressure from each of the listed groups for gathering and holding their cattle at the date and time requested by authorities during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Animal health regulatory agencies	0.69	0.07
Your county extension agent(s)	0.71	0.07
Your surrounding community	0.85	0.16
Your professional organizations	0.85	0.13
Other cattle producers like yourself	0.89	0.17
Leaders in the cattle industry	0.88	0.18
Your family	0.80	0.11
Your business partner(s)/ associate(s)	0.75	0.10
Your veterinarian(s)	0.76	0.09
Your neighbor(s)	0.80	0.09

Table B14. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 1 (*n*=465) assessing producers´ attitudes towards gathering and holding their cattle at the date and time requested by authorities during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Bad – Good	0.65	0.13
Unpleasant – Pleasant	0.70	0.14
Ineffective – Effective	0.71	0.18
Harmful – Beneficial	0.75	0.21
Difficult – Easy	0.79	0.20
Inconvenient – Convenient	0.84	0.33

Table B15. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 1 (*n*=482) assessing producers´ trust in their neighbors, other producers in their area, and other producers in Texas to gather and hold their cattle at the date and time requested by authorities during an outbreak of FMD in Texas, and to take into consideration the consequences to the producer´s operation when deciding whether to gather and hold their cattle or not. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Would gather and hold their cattle		
Your neighbors	0.80	0.18
Other cattle producers in your area	0.84	0.22
Other cattle producers in Texas	0.76	0.12
Would take into consideration the consequences to your operation when deciding		
Your neighbors	0.82	0.14
Other cattle producers in your area	0.90	0.28
Other cattle producers in Texas	0.85	0.19

Behavior 4: Maintaining cattle in their current location(s) during a hypothetical outbreak of FMD in Texas

Table B16. Factor loadings and scoring coefficients for 1 factor extracted from 10 variables included in Survey 2 (*n*= 543) assessing producers´ beliefs about the consequences of maintaining their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
It will reduce the economic impact of foot-and-mouth disease on my operation.	0.70	0.18	-	-
It will reduce the economic impact of foot-and-mouth disease on the US cattle industry.	0.73	0.22	-	-
It will help stop the spread of foot-and-mouth disease within my cattle operation.	0.75	0.20	-	-
It will help stop the spread of foot-and-mouth disease among cattle in my area.	0.80	0.25	-	-
It will result in feed shortages for my cattle.[a]	-	-	0.83	0.46
It will cause my cattle to suffer.[a]	-	-	0.83	0.45
It will be adequate to protect my cattle from FMD.	0.63	0.13	-	-
I will not be blamed for the spread of FMD.	0.55	0.11	-	-
It will make me feel better about how I manage by cattle.	0.69	0.16	-	-

[a] These belief s were reverse coded in order to be consistent with the other beliefs (strongly agree always indicates agreeing with a positive outcome.)

Table B17. Factor loadings and scoring coefficients for 2 un-rotated factors extracted from 8 variables included in Survey 2 (*n*=533) assessing producers´ beliefs about the barriers to maintaining their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
During an outbreak of FMD, I expect that feed can be delivered to my cattle if needed.	0.63	0.20	-	-
I own/have access to adequate feed to keep my cattle at their current location(s).	0.73	0.34	-	-
I will be responsible for paying for additional feed needed to maintain my cattle if they cannot be moved.	0.58	0.16	-	-
Keeping my cattle in their current location(s) will cause them to become crowded.[a]	-	-	0.82	0.43
Keeping my cattle in their current location(s) will cause environmental damage.[a]	-	-	0.84	0.45
Keeping my cattle in their current location(s) will cause them to be killed during the control of the disease.[a]	-	-	0.46	0.10
If needed, I have facilities to keep all calves born on my property for an extended length of time.	0.67	0.26	-	-
I can set up appropriate disinfection procedures for myself and my employees/hands.	0.60	0.20	-	-

[a] These belief s were reverse coded in order to be consistent with the other beliefs (strongly agree always indicates agreeing with a positive outcome.)

Table B18. Factor loadings and scoring coefficients for 1 factor extracted from 10 variables included in Survey 2 (*n*=357) assessing producers´ beliefs about social pressure from each of the listed groups for maintaining their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Animal health regulatory agencies	0.70	0.07
Your county extension agent(s)	0.73	0.08
Your surrounding community	0.86	0.16
Your professional organizations	0.86	0.12
Other cattle producers like yourself	0.88	0.14
Leaders in the cattle industry	0.86	0.14
Your family	0.80	0.11
Your business partner(s)/ associate(s)	0.80	0.12
Your veterinarian(s)	0.80	0.12
Your neighbor(s)	0.82	0.11

Table B19. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 2 (*n*=524) assessing producers´ attitudes towards maintaining their cattle in their current location(s) during a hypothetical outbreak of FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
Bad – Good	-	-	0.63	0.24
Unpleasant – Pleasant	0.77	0.18	-	-
Ineffective – Effective	-	-	0.78	0.45
Harmful – Beneficial	-	-	0.73	0.35
Difficult – Easy	0.86	0.34	-	-
Inconvenient - Convenient	0.90	0.53	-	-

Table B20. Factor loadings and scoring coefficients for 1 factor extracted from 6 variables included in Survey 2 (*n*=541) assessing producers´ trust in their neighbors, other producers in their area, and other producers in Texas to maintain their cattle in their current location(s), and to take into consideration the consequences to the producer´s operation when deciding whether to move their cattle or not. Proportions of responses to each variable were weighted to account for sampling and survey response.

Variable	Factor 1	
	Factor loadings	Scoring Coefficients
Would ask a veterinarian to examine their cattle		
Your neighbors	0.86	0.18
Other cattle producers in your area	0.91	0.21
Other cattle producers in Texas	0.86	0.15
Would take into consideration the consequences to your operation when deciding		
Your neighbors	0.85	0.13
Other cattle producers in your area	0.92	0.28
Other cattle producers in Texas	0.84	0.15

Survey 1: Trust in agencies

Table B20. Factor loadings and scoring coefficients for 2 factors extracted from 9 variables included in Survey 1 (*n*=421) assessing producers´ beliefs about how well the listed agencies would manage their role during an outbreak of FMD. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Rotated Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
US Department of Agriculture	0.49	-0.06	0.71	0.19
Texas Department of Agriculture	-	-	0.88	0.66
Texas Animal Health Commission	-	-	0.83	0.34
US Department of Homeland Security	0.79	0.10	-	-
US Environmental Protection Agency	0.85	0.21	-	-
Federal Emergency Management Agency	0.86	0.21	-	-
Texas Health and Human Services	0.83	0.18	-	-
Texas Commission on Environmental Quality	0.85	0.25	-	-
US Department of Health and Human Services	0.89	0.32	-	-

Table B21. Factor loadings and scoring coefficients for 2 factors extracted from 9 variables included in Survey 1 (*n*=426) assessing producers´ beliefs about whether or not the listed agencies would act in the producer´s best interesting in managing an outbreak of FMD. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
US Department of Agriculture	0.49	-0.06	0.75	0.22
Texas Department of Agriculture	-	-	0.90	0.67
Texas Animal Health Commission	-	-	0.86	0.34
US Department of Homeland Security	0.85	0.13	-	-
US Environmental Protection Agency	0.90	0.30	-	-
Federal Emergency Management Agency	0.89	0.19	-	-
Texas Health and Human Services	0.86	0.21	-	
Texas Commission on Environmental Quality	0.87	0.19	-	
US Department of Health and Human Services	0.90	0.25	-	

Table B22. Factor loadings and scoring coefficients for 2 factors extracted from 9 variables included in Survey 1 (*n*=429) assessing producers´ beliefs about whether or not the listed agencies would have the same goals as the producer in managing an outbreak of FMD. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
US Department of Agriculture	-	-	0.80	0.20
Texas Department of Agriculture	-	-	0.92	0.64
Texas Animal Health Commission	-	-	0.88	0.29
US Department of Homeland Security	0.89	0.17	-	-
US Environmental Protection Agency	0.93	0.26	-	-
Federal Emergency Management Agency	0.93	0.21	-	-
Texas Health and Human Services	0.89	0.17	-	
Texas Commission on Environmental Quality	0.91	0.21	-	
US Department of Health and Human Services	0.91	0.17	-	

Survey 2: Trust in agencies

Table B23. Factor loadings and scoring coefficients for 2 factors extracted from 9 variables included in Survey 2 (*n*=483) assessing producers´ beliefs about how well the listed agencies would manage their role during an outbreak of FMD. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Rotated Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
US Department of Agriculture	0.48	-0.04	0.69	0.20
Texas Department of Agriculture	-	-	0.87	0.55
Texas Animal Health Commission	-	-	0.86	0.41
US Department of Homeland Security	0.83	0.17	-	-
US Environmental Protection Agency	0.88	0.26	-	-
Federal Emergency Management Agency	0.89	0.29	-	-
Texas Health and Human Services	0.75	0.09	-	-
Texas Commission on Environmental Quality	0.83	0.19	-	-
US Department of Health and Human Services	0.87	0.23	-	-

Table B24. Factor loadings and scoring coefficients for 2 factors extracted from 9 variables included in Survey 2 (*n*=486) assessing producers´ beliefs about whether or not the listed agencies would act in the producer´s best interesting in managing an outbreak of FMD. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
US Department of Agriculture	0.46	-0.08	0.75	0.29
Texas Department of Agriculture	-	-	0.88	0.53
Texas Animal Health Commission	-	-	0.86	0.39
US Department of Homeland Security	0.89	0.21	-	-
US Environmental Protection Agency	0.91	0.32	-	-
Federal Emergency Management Agency	0.91	0.29	-	-
Texas Health and Human Services	0.81	0.12	-	-
Texas Commission on Environmental Quality	0.85	0.14	-	-
US Department of Health and Human Services	0.87	0.16	-	-

Survey 1: Risk Perception

Table B25. Factor loadings and scoring coefficients for 2 factors extracted from 6 variables included in Survey 1 (*n*=515) assessing producers´ perceptions of the risk posed by FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Factor loadings	Scoring Coefficients	Factor loadings	Scoring Coefficients
The risk of an outbreak of foot-and-mouth disease in the USA is very great.	0.68	0.25	-	-
The risk of an outbreak of foot-and-mouth disease in my operation is very great.	0.72	0.30	-	-
An outbreak of foot-and-mouth disease would be economically devastating for my operation.	-	-	0.64	0.42
An outbreak of foot-and-mouth disease would be economically devastating for the US cattle industry.	-	-	0.63	0.42
I believe that the United States is likely to experience an outbreak of foot-and-mouth disease in the next five years.	0.69	0.26	-	-
I believe that my operation is likely to experience an outbreak of foot-and-mouth disease in the next five years.	0.66	0.24	-	-

Survey 2: Risk Perception

Table B26. Factor loadings and scoring coefficients for 2 factors extracted from 6 variables included in Survey 2 (*n*=551) assessing producers´ perceptions of the risk posed by FMD in Texas. Proportions of responses to each variable were weighted to account for sampling and survey response. Factor loadings less than 0.4 are not shown.

Variable	Factor 1		Factor 2	
	Rotated factor loadings	Scoring Coefficients	Rotated factor loadings	Scoring Coefficients
The risk of an outbreak of foot-and-mouth disease in the USA is very great.	0.72	0.27	-	-
The risk of an outbreak of foot-and-mouth disease in my operation is very great.	0.76	0.31	-	-
An outbreak of foot-and-mouth disease would be economically devastating for my operation.	0.45	0.016	0.71	0.44
An outbreak of foot-and-mouth disease would be economically devastating for the US cattle industry.	-	-	0.71	0.44
I believe that the United States is likely to experience an outbreak of foot-and-mouth disease in the next five years.	0.73	0.27	-	-
I believe that my operation is likely to experience an outbreak of foot-and-mouth disease in the next five years.	0.73	0.27	-	-

APPENDIX C

TABLES OF RESULTS OF BIVARIABLE ANALYSIS FOR ALL BEHAVIORS

The following tables present the results of the bivariable analyses performed for each behavior of interest: requesting veterinary examination of cattle with clinical signs of FMD in the absence of a known outbreak, requesting veterinary examination of cattle with clinical signs of FMD during an outbreak of FMD, gathering and holding cattle for testing and/or depopulation at the date and time requested by authorities during an outbreak of FMD, and compliance with animal movement restrictions during an outbreak of FMD.

Table C1 – Coefficients (Coef.), standards error (St. error), and p-values for bivariable ordinal logistic regression models for the association between measured socio-psychological factors and demographics and cattle producers´ intent to request veterinary examination of cattle with clinical signs consistent with FMD in the absence of a known outbreak of FMD. For categorical predictors, the overall p-value determined by a Wald test of all categories of the predictor is presented. For categorical predictors coded hierarchically, the p-value for each category of the predictor is shown.

Predictor	**Coef. (St error)**	**P-value**	**n**
Factor of behavioral beliefs			
Less than -1 s.d. from mean	---		
-1 s.d. from mean	1.94 (0.73)		
1 s.d. from mean	3.92 (0.87)	0.000	463
[No] delay in sale of cattle[a]	-0.02 (0.03)	0.292	477
Factor of control beliefs			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	0.57 (0.75)		
0 to 1 s.d. from mean	1.12 (0.66)		
Greater than 1 s.d. from mean	0.63 (0.97)	0.404	474
Factor of normative beliefs			
Less than -1 s.d. from mean	---		
-1 s.d. from mean	1.53 (0.91)		
1 s.d. from mean	2.60 (0.93)		
Greater than 1 s.d. from mean	1.01 (1.00)	0.050	313
Factor of attitudes			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	2.08 (0.98)		
0 to 1 s.d. from mean	0.86 (0.67)	0.097	464
Confident I can			
Strongly disagree	---		
Mostly disagree	-2.16 (1.8)		
Neither agree or disagree	17.25 (1.54)		
Mostly agree	0.29 (1.56)		
Strongly agree	0.59 (1.48)	0.000	483
Completely under my control			
Strongly disagree			
Mostly disagree	---		
Neither agree or disagree	-0.56 (1.37)		
Mostly agree	-0.14 (1.07)		
Strongly agree	0.13 (1.01)	0.915	483

Predictor	**Coef. (St error)**	**P-value**	**n**
Factor Caring (non-agricultural agencies)			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.10 (0.65)		
0 to 1 s.d. from mean	-1.06 (0.67)		
Greater than 1 s.d. from mean	-0.77 (1.03)	0.289	421
Factor Caring (agricultural agencies)			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.21 (0.76)		
0 to 1 s.d. from mean	-0.19 (0.72)		
Greater than 1 s.d. from mean	0.54 (0.79)	0.777	421
Factor Shared goals (non-agricultural agencies)			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.38 (0.67)		
0 to 1 s.d. from mean	-1.49 (0.64)		
Greater than 1 s.d. from mean	-0.73 (1.05)	0.101	424
Factor Shared goals (agricultural agencies)			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.30 (0.82)		
0 to 1 s.d. from mean	0.85 (0.72)		
Greater than 1 s.d. from mean	2.80 (1.19)	0.039	424
Factor Competency (non-agricultural agencies)			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.73 (0.78)		
0 to 1 s.d. from mean	0.35 (0.74)		
Greater than 1 s.d. from mean	-0.15 (1.11)		
		0.919	416
Factor Competency (agricultural agencies)			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.55 (0.67)		
0 to 1 s.d. from mean	0.53 (0.82)		
Greater than 1 s.d. from mean	0.15 (0.98)	0.549	416

Table C1 - continued

Predictor	Coef. (St error)	P-value	n	Predictor	Coef. (St error)	P-value	n
Moral obligation to request veterinary				Other producers like myself would			
exam	---			Strongly disagree	---		
Strongly disagree	2.37 (1.30)			Mostly disagree	1.97 (1.28)		
Mostly disagree	3.36 (1.29)			Neither agree or disagree	2.43 (1.07)		
Neither agree or disagree	4.68 (0.98)			Mostly agree	4.21 (0.96)		
Mostly agree	4.75 (0.94)	0.000	489	Strongly agree	4.28 (1.03)	0.000	486
Strongly agree							
Moral obligation to seek vet care for sick				Factor of trust in others to report and take into			
Strongly disagree	---			account consequences to my operation			
Mostly disagree	4.70 (1.03)			Less than -1 s.d. from mean	---		
Neither agree or disagree	3.91 (0.88)			-1 to 0 s.d. from mean	-1.21 (0.95)		
Mostly agree	2.87 (0.78)			0 to 1 s.d. from mean	-1.17 (0.81)		
Strongly agree	3.77 (0.76)	0.000	489	Greater than 1 s.d. from mean	-2.57 (0.87)	0.266	476
Would feel social pressure to				Factor Risk Perception – overall risk and			
Strongly disagree	---			likelihood of an outbreak			
Mostly disagree	-0.39 (1.03)			Less than -1 s.d. from mean	---		
Neither agree or disagree	0.29 (0.91)			-1 to 0 s.d. from mean	-0.11 (0.87)		
Mostly agree	0.65 (0.79)			0 to 1 s.d. from mean	0.35 (0.84)		
Strongly agree	1.37 (0.94)	0.438	488	Greater than 1 s.d. from mean	0.08 (0.97)	0.921	483
Most people think that I should				Factor Risk Perception – perceived			
Strongly disagree	---			magnitude of consequences of an outbreak			
Mostly disagree	-1.68 (1.25)			Less than -1 s.d. from mean	---		
Neither agree or disagree	-0.74 (1.03)			-1 to 0 s.d. from mean	-0.44 (0.89)		
Mostly agree	0.74 (1.05)			0 to 1 s.d. from mean	0.67 (0.86)		
Strongly agree	0.74 (1.05)	0.045	488	Greater than 1 s.d. from mean	-2.11 (1.20)	0.037	483
Other producers I admire would				Age[b]			
Strongly disagree	---			Less than 40	---	---	
Mostly disagree	1.99 (1,27)			40-49 years of age	2.62 (1.18)	0.027	
Neither agree or disagree	2.82 (1.07)			50-59 years of age	-2.10 (0.87)	0.017	
Mostly agree	4.19 (0.94)			60-69 years of age	-0.74 (0.69)	0.285	
Strongly agree	4.47 (1.04)	0.000	486	70 years or greater	0.80 (0.75)	0.286	476

Table C1 - continued

Predictor	Coef. (St error)	P-value	n	Predictor	Coef. (St error)	P-value	n
Education				Reason			
Less than high school	---			Primary source of income	---		
High school diploma	-0.62 (1.00)			Supplemental income	-0.32 (0.75)		
Vocational school	0.81 (1.10)			Pleasure or lifestyle	-0.12 (0.88)		
2-year college	-1.66 (0.96)			Control of excess forage	18.93 (0.82)		
4-year college	-0.15 (0.89)			Property tax advantage	-0.58 (1.31)		
Graduate school	-1.72 (0.98)	0.027	483	Family tradition	-0.36 (0.89)		
				Other	18.9 (0.84)	0.000	402
Race				Beef cow number			
White	---			1-9 head	---		
Hispanic	-0.90 (0.78)	0.251	474	10-99 head	-0.36 (0.93)		
				100-499 head	-0.27 (0.91)		
				500 or greater head	0.76 (1.19)	0.651	474
Prior experience with Tuberculosis				Steer number[b]			
program	---			None	---		
No	-0.31 (0.73)	0.669	490	1 – 9 steers	0.20 (0.75)	0.789	
Yes				10 – 19 steers	-0.77 (0.90)	0.395	
Prior experience with Brucellosis program				20 - 49 steers	1.17 (1.15)	0.309	
No	---			50 – 99 steers	0.03 (1.15)	0.977	
Yes	0.96 (0.56)	0.087	490	100 – 199 steers	-1.58 (0.84)	0.058	
Gender				200 – 499 steers	19.00 (0.55)	0.000	
Male	---			500 + steers	0.00 (0.38)	1.000	479
Female	18.57 (0.38)	0.000	484				
Cattle producer organization member				Percentage income from cattle			
No	---			Less than 10%	---	---	
Yes	-0.54 (0.59)	0.354	470	10 – 59%	-0.06 (0.68)	0.926	
Cattle producer organization officer				60 – 79%	-1.24 (0.87)	0.154	
No	---			80 – 89%	0.86 (1.01)	0.433	
Yes	2.03 (1.10)	0.064	455	90 – 100%	19.11 (0.98)	0.000	476
Time in current operation (years)	-0.00 (0.02)	0.944	471	Live in same location as cattle			
				No	---		
Time in cattle industry (years)	-0.01 (0.01)	0.240	473	Yes	-0.24 (0.51)	0.630	482

Table C1 - continued

Predictor	Coef. (St error)	P-value	n	Predictor	Coef. (St error)	P-value	n
Production practices				Production Practices, continued			
Conventional cow-calf				Stocker			
No	---			No	---		
Yes	1.26 (0.70)	0.073	490	Yes	0.48 (0.80)	0.544	490
Seedstock				Grass-finished			
No	---			No	---		
Yes	0.07 (0.87)	0.935	490	Yes	-0.11 (0.73)	0.880	490
Age-and-source verification				Certified organic			
No	---			No	---		
Yes	1.83 (0.88)	0.038	490	Yes	15.56 (1.04)	0.000	490
Branded beef program				Holistic resource management			
No	---			No	---		
Yes	1.15 (1.14)	0.309	490	Yes	17.52 (0.64)	0.000	490
Natural, non-certified organic				Beef Quality Assurance			
No	---			No	---		
Yes	18.17 (0.48)	0.000	490	Yes	3.06 (1.06)	0.004	490
Integrated resource management							
No	---						
Yes	-1.42 (1.16)	0.224	490				

[a] This variable was reverse coded to be consistent with the other behavioral belief questions. The original question asked how strongly respondents agreed or disagreed that requesting veterinary examination would result in a delay in their ability to sell cattle. This variable was linear in the log odds and assessed as a continuous variable.

[b] These variables were coded hierarchically so that each category can be removed from the analysis independently of the remaining categories. Accordingly, Wald test p-values are reported for each category of the variable.

Table C2 – Coefficients (Coef.), standards error (St. error), and p-values for bivariable ordinal logistic regression models for the association between measured socio-psychological factors and demographics and cattle producers´ intent to request veterinary examination of cattle with clinical signs consistent with FMD during an outbreak of FMD in Texas. For categorical predictors, the overall p-value determined by a Wald test of all categories of the predictor is presented. For categorical predictors coded hierarchically, the p-value for each category of the predictor is shown.

Predictor	**Coef. (St error)**	**P-value**	**n**	**Predictor**	**Coef. (St error)**	**P-value**	**n**
Factor of behavioral beliefs				Factor Caring (non-agricultural agencies)			
Less than -1 s.d. from mean	---			Less than -1 s.d. from mean	---		
-1 s.d. from mean	2.46 (0.64)			-1 to 0 s.d. from mean	-0.74 (0.70)		
1 s.d. from mean	2.60 (0.81)			0 to 1 s.d. from mean	-0.65 (0.72)		
	1.69 (1.09)	0.000	535	Greater than 1 s.d. from mean	-0.40 (1.06)	0.746	482
[No] delay in sale of cattle[a]	-0.05 (0.03)	0.069	553	Factor Caring (agricultural agencies)			
Factor of control beliefs				Less than -1 s.d. from mean	---		
Less than -1 s.d. from mean	---			-1 to 0 s.d. from mean	-0.55 (0.69)		
-1 to 0 s.d. from mean	1.36 (0.64)			0 to 1 s.d. from mean	-0.09 (0.68)		
0 to 1 s.d. from mean	1.61 (0.78)			Greater than 1 s.d. from mean	-0.72 (0.92)	0.771	482
Greater than 1 s.d. from mean	-0.23 (0.81)	0.041	545	Factor Shared goals (FEMA)			
Factor of normative beliefs				Strongly disagree	---		
Less than -1 s.d. from mean	---			Mostly disagree	0.60 (0.56)		
-1 s.d. from mean	0.06 (0.80)			Neither agree or disagree	0.03 (0.48)		
1 s.d. from mean	0.57 (0.82)			Mostly agree	0.12 (0.49)		
Greater than 1 s.d. from mean	0.04 (1.07)	0.912	359	Strongly agree	0.60 (0.64)	0.671	501
Factor of attitudes				Factor Shared goals (TDA)			
Less than -1 s.d. from mean	---			Strongly disagree	---		
-1 to 0 s.d. from mean	0.44 (0.71)			Mostly disagree	1.85 (0.94)		
0 to 1 s.d. from mean	-0.15 (0.59)	0.674	525	Neither agree or disagree	0.80 (0.71)		
Confident I can				Mostly agree	1.70 (0.64)		
Strongly disagree	---			Strongly agree	1.75 (0.66)	0.049	501
Mostly disagree	17.37 (3325)			Factor Competency (non-agricultural agencies)			
Neither agree or disagree	19.05 (3325)			Less than -1 s.d. from mean	---		
Mostly agree	19.17 (3325)			-1 to 0 s.d. from mean	0.02 (0.74)		
Strongly agree	19.93 (3325)	0.000	561	0 to 1 s.d. from mean	-0.69 (0.68)		
Completely under my control				Greater than 1 s.d. from mean	-1.05 (0.88)	0.448	479
Strongly disagree	---						
Mostly disagree	0.76 (1.08)			Factor Competency (agricultural agencies)			
Neither agree or disagree	0.18 (1.04)			Less than -1 s.d. from mean	---		
Mostly agree	0.94 (0.96)			-1 to 0 s.d. from mean	-0.04 (0.67)		
Strongly agree	1.20 (1.04)	0.647	560	0 to 1 s.d. from mean	0.16 (0.62)	0.098	479
				Greater than 1 s.d. from mean	2.08 (0.87)		

Table C2 - continued

Predictor	Coef. (St error)	P-value	n
Moral obligation to request veterinary exam			
Strongly disagree	---		
Mostly disagree	-2.64 (1.30)		
Neither agree or disagree	0.27 (0.95)		
Mostly agree	2.11 (0.88)		
Strongly agree	1.01 (0.84)	0.000	564
Moral obligation to seek vet care for sick			
Strongly disagree	---		
Mostly disagree	-0.19(1.02)		
Neither agree or disagree	0.19 (0.89)		
Mostly agree	1.34 (0.78)		
Strongly agree	0.42 (0.77)	0.202	564
Would feel social pressure to			
Strongly disagree	---		
Mostly disagree	-0.46 (1.07)		
Neither agree or disagree	-0.49 (0.84)		
Mostly agree	0.75 (0.85)		
Strongly agree	-0.6 (0.95)	0.417	562
Most people think that I should			
Strongly disagree	---		
Mostly disagree	0.41 (1.28)		
Neither agree or disagree	-0.30 (1.19)		
Mostly agree	1.17 (1.21)		
Strongly agree	0.08 (1.20)	0.267	560
Other producers I admire would			
Strongly disagree	---		
Mostly disagree	-1.25 (1.41)		
Neither agree or disagree	-0.11 (1.21)		
Mostly agree	1.45 (1.22)		
Strongly agree	0.78 (1.26)	0.032	561
Other producers like myself would			
Strongly disagree	---		
Mostly disagree	1.62 (1.28)		
Neither agree or disagree	0.18 (1.10)		
Mostly agree	1.87 (0.96)		
Strongly agree	1.61 (1.15)	0.053	561
Factor of trust in others to report and take into account consequences to my operation			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.12 (0.78)		
0 to 1 s.d. from mean	0.72 (0.84)		
Greater than 1 s.d. from mean	0.20 (0.99)	0.639	544
Factor Risk Perception – overall risk and likelihood of an outbreak			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	1.51 (0.72)		
0 to 1 s.d. from mean	2.36 (0.73)		
Greater than 1 s.d. from mean	0.69 (0.78)	0.008	544
Factor Risk Perception – perceived magnitude of consequences of an outbreak			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	-0.94 (0.86)		
0 to 1 s.d. from mean	0.36 (0.84)	0.078	544
Age[b]			
Less than 40	---	---	
40-49 years of age	0.35 (1.13)	0.759	
50-59 years of age	-1.09 (0.99)	0.269	
60-69 years of age	0.31 (0.76)	0.685	
70 years or greater	-1.47 (0.61)	0.016	534

Table C2 - continued

Predictor	Coef. (St error)	P-value	n
Education			
Less than high school	---		
High school diploma	1.91 (.98)		
Vocational school	0.45 (1.16)		
2-year college	5.54 (1.24)		
4-year college	1.31 (0.84)		
Graduate school	0.92 (0.89)	0.004	551
Race			
White	---		
Hispanic	1.77 (0.76)	0.004	538
Prior experience with Tuberculosis program	---		
No	-0.97 (0.73)	0.019	568
Yes			
Prior experience with Brucellosis program	---		
No	-0.89 (0.53)	0.181	568
Yes			
Gender			
Male	---		
Female	-0.69 (0.75)	0.358	549
Cattle producer organization member			
No	---		
Yes	-0.95 (0.58)	0.099	541
Cattle producer organization officer			
No	---		
Yes	0.00 (0.76)	0.996	407
Time in current operation (years)	-0.02 (0.02)	0.303	541
Time in cattle industry (years)	-0.02 (0.02)	0.261	533

Predictor	Coef. (St error)	P-value	n
Reason			
Primary source of income	---		
Supplemental income	-0.40 (0.70)		
Pleasure or lifestyle	-1.25 (0.84)		
Control of excess forage	21.91 (0.73)		
Property tax advantage	-1.90 (0.80)		
Family tradition	-1.07 (0.80)		
Other	21.90 (0.71)	0.000	478
Beef cow number			
1-9 head	---		
10-99 head	0.13 (0.74)		
100-499 head	0.46 (0.80)		
500 or greater head	-0.06 (0.90)	0.899	535
Steer number[b]			
None	---		
1 – 9 steers	1.48 (0.75)	0.046	
10 – 19 steers	-0.54 (0.94)	0.568	
20 - 49 steers	0.26 (0.93)	0.782	
50 – 99 steers	0.23 (0.76)	0.761	
100 – 199 steers	0.77 (1.06)	0.466	
200 – 499 steers	-0.87 (1.09)	0.430	
500 + steers	0.63 (1.20)	0.601	548
Percentage income from cattle			
Less than 10%	---	---	
10 – 59%	0.33 (0.62)	0.597	
60 – 79%	0.83 (0.75)	0.274	
80 – 89%	0.62 (1.18)	0.600	
90 – 100%	-0.62 (1.33	0.642	528
Live in same location as cattle			
No	---		
Yes	-0.11 (0.60)	0.845	542

Table C2 - continued

Predictor	Coef. (St error)	P-value	n	Predictor	Coef. (St error)	P-value	n
Production practices				Production Practices, continued			
Conventional cow-calf				Stocker			
No	---			No	---		
Yes	0.57 (0.72)	0.421	568	Yes	-0.23 (0.78)	0.771	568
Seedstock				Grass-finished			
No	---			No	---		
Yes	-1.10 (0.77)	0.153	568	Yes	-0.77 (0.60)	0.198	568
Age-and-source verification				Certified organic			
No	---			No	---		
Yes	-2.41 (0.68)	0.005	568	Yes	14.36 (0.92)	0.000	568
Branded beef program				Holistic resource management			
No	---			No	---		
Yes	-2.31 (1.00)	0.021	568	Yes	2.19 (1.39)	0.115	568
Natural, non-certified organic				Beef Quality Assurance			
No	---			No	---		
Yes	-0.56 (0.92)	0.547	568	Yes	18.21(0.39)	0.000	568
Integrated resource management							
No	---						
Yes	2.04 (1.19)	0.087	568				

[a] This variable was reverse coded to be consistent with the other behavioral belief questions. The original question asked how strongly respondents agreed or disagreed that requesting veterinary examination would result in a delay in their ability to sell cattle. This variable was linear in the log odds and assessed as a continuous variable.

[b] These variables were coded hierarchically so that each category can be removed from the analysis independently of the remaining categories. Accordingly, Wald test p-values are reported for each category of the variable.

Table C3 – Coefficients (Coef.), standards error (St. error), and p-values for bivariable ordinal logistic regression models for the association between measured socio-psychological factors and demographics and cattle producers′ intent to gather and hold their cattle at the date and time requested by authorities during an outbreak of FMD. For categorical predictors, the overall p-value determined by a Wald test of all categories of the predictor is presented. For categorical predictors coded hierarchically, the p-value for each category of the predictor is shown.

Predictor	**Coef. (St error)**	**P-value**	**n**	**Predictor**	**Coef. (St error)**	**P-value**	**n**
Factor of behavioral beliefs – positive				Factor Caring (non-agricultural agencies)			
consequences[a]				Less than -1 s.d. from mean	---		
Less than -1 s.d. from mean	---			-1 to 0 s.d. from mean	0.27 (0.85)		
-1 s.d. from mean	2.21 (0.88)			0 to 1 s.d. from mean	-0.63 (0.84)		
1 s.d. from mean	3.29 (0.71)			Greater than 1 s.d. from mean	2.21 (1.23)	0.117	424
Greater than 1 s.d. from mean	19.55 (0.60)	0.000	471				
Factor of behavioral beliefs – negative				Factor Caring (agricultural agencies)			
consequences[a]				Less than -1 s.d. from mean	---		
Less than -1 s.d. from mean	---			-1 to 0 s.d. from mean	0.23 (1.06)		
-1 s.d. from mean	-0.69 (0.95)			0 to 1 s.d. from mean	1.35 (0.99)		
1 s.d. from mean	0.07 (1.00)			Greater than 1 s.d. from mean	0.34 (1.07)	0.444	424
Greater than 1 s.d. from mean	-0.18 (1.10)	0.738	471	Factor Shared goals (non-agricultural			
Factor of control beliefs				agencies)			
Less than -1 s.d. from mean	---			Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	1.59 (0.66)			-1 to 0 s.d. from mean	-0.78 (0.81)		
0 to 1 s.d. from mean	4.11 (1.01)			0 to 1 s.d. from mean	-0.76 (0.81)		
Greater than 1 s.d. from mean	20.74 (0.47)	0.000	480	Greater than 1 s.d. from mean	-2.21 (1.18)	0.061	428
Factor of normative beliefs				Factor Shared goals (agricultural agencies)			
Less than -1 s.d. from mean	---			Less than -1 s.d. from mean	---		
-1 s.d. from mean	1.91 (0.83)			-1 to 0 s.d. from mean	-0.54 (0.95)		
1 s.d. from mean	2.16 (1.22)			0 to 1 s.d. from mean	2.16 (1.03)		
Greater than 1 s.d. from mean	20.98 (0.68)	0.000	321	Greater than 1 s.d. from mean	0.71 (1.19)	0.012	428
Factor of attitudes				Factor Competency (non-agricultural agencies)			
Less than -1 s.d. from mean	---			Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	1.43 (0.72)			-1 to 0 s.d. from mean	-0.20 (0.89)		
0 to 1 s.d. from mean	2.89 (1.07)			0 to 1 s.d. from mean	1.95 (1.01)		
Greater than 1 s.d. from mean	20.94 (0.55)	0.000	464	Greater than 1 s.d. from mean	19.91 (0.73)	0.000	419
Confident I can[b]				Factor Competency (agricultural agencies)			
Mostly to strongly disagree	---			Less than -1 s.d. from mean	---		
Neither agree nor disagree	0.03 (0.87)			-1 to 0 s.d. from mean	-1.92 (0.75)		
Mostly to strongly agree	2.61 (0.79)	0.000	487	0 to 1 s.d. from mean	-0.02 (0.82)		
				Greater than 1 s.d. from mean	-0.37 (1.14)	0.041	419

Table C3 - continued

Predictor	Coef. (St error)	P-value	n
Completely under my control			
Mostly to strongly disagree	---		
Neither agree or disagree	-0.31 (0.90)		
Mostly to strongly agree	0.92 (0.79)	0.194	489
Moral obligation to gather and hold			
Strongly disagree	---		
Mostly disagree	1.13 (1.85)		
Neither agree or disagree	5.27 (1.54)		
Mostly agree	6.09 (1.37)		
Strongly agree	7.28 (1.60)	0.000	487
Would feel social pressure to			
Strongly disagree	---		
Mostly disagree	-3.88 (1.04)		
Neither agree or disagree	-1.76 (0.98)		
Mostly agree	-1.38 (0.94)		
Strongly agree	-2.49 (1.05)	0.002	487
Most people think that I should			
Strongly disagree	---		
Mostly disagree	-1.36 (1.05)		
Neither agree or disagree	1.40 (0.97)		
Mostly agree	2.43 (0.82)		
Strongly agree	1.74 (0.94)	0.000	487
Other producers I admire would			
Strongly disagree	---		
Mostly disagree	-1.87 (1.08)		
Neither agree or disagree	0.54 (0.96)		
Mostly agree	1.64 (0.92)		
Strongly agree	2.61 (1.31)	0.000	487
Other producers like myself would			
Strongly disagree	---		
Mostly disagree	-1.94 (1.12)		
Neither agree or disagree	0.22 (1.07)		
Mostly agree	1.54 (0.93)		
Strongly agree	21.01 (0.82)	0.000	488
Factor of trust in others to gather and hold their cattle and take into account consequences to my operation	---		
Less than -1 s.d. from mean	1.15 (0.78)		
-1 to 0 s.d. from mean	3.34 (1.01)		
0 to 1 s.d. from mean	21.90 (0.74)	0.000	480
Greater than 1 s.d. from mean			
Factor Risk Perception – overall risk and likelihood of an outbreak	---		
Less than -1 s.d. from mean	0.87 (0.87)		
-1 to 0 s.d. from mean	1.06 (0.90)		
0 to 1 s.d. from mean	0.46 (1.02)	0.649	488
Factor Risk Perception – perceived magnitude of consequences of an outbreak	---		
Less than -1 s.d. from mean	1.12 (1.03)		
-1 to 0 s.d. from mean	0.52 (0.79)		
0 to 1 s.d. from mean	-1.93 (1.39)	0.188	488

Table C3 - continued

Predictor	Coef. (St error)	P-value	n	Predictor	Coef. (St error)	P-value	n
Education[c]				Reason			
High school	---			Primary source of income	---		
2-year college	-0.08 (0.95)			Supplemental income	-1.07 (0.97)		
4-year college	0.43 (0.74)			Pleasure or lifestyle	-0.94 (1.11)		
Graduate school	-1.40 (0.86)	0.222	488	Control of excess forage	19.49 (0.99)		
				Property tax advantage	19.49 (0.99)		
				Family tradition	-1.22 (1.11)		
				Other	-0.24 (1.42)	0.000	407
Race				Beef cow number			
White	---			1-9 head	---		
Hispanic	3.67 (0.09)	0.000	479	10-99 head	-0.02 (1.15)		
				100-499 head	-0.42 (1.21)		
				500 or greater head	0.49 (1.36)	0.820	488
Prior experience with Tuberculosis				Steer number[d]			
program	---			None	---		
No	-0.62 (0.75)	0.401	494	1 – 9 steers	-0.08 (0.85)	0.924	
Yes				10 – 19 steers	1.01 (1.10)	0.361	
Prior experience with Brucellosis program	---			20 - 49 steers	-1.61 (1.11)	0.149	
No	0.25 (0.60)	0.682	494	50 – 99 steers	1.49 (1.26)	0.236	
Yes				100 – 199 steers	0.28 (1.28)	0.824	
Gender	---			200 – 499 steers	-2.15 (1.03)	0.036	
Male	0.17 (1.01)	0.862	489	500 + steers	1.48 (1.07)	0.166	484
Female							
Cattle producer organization member							
No	---			Age[e]	-0.02 (0.02)	0.412	494
Yes	-0.51 (0.63)	0.420	475				
Cattle producer organization officer				Time in current operation (years)	-0.00 (0.02)	0.876	476
No	---						
Yes	-0.25 (1.01)	0.809	458	Time in cattle industry (years)	-0.01 (0.01)	0.632	478

Table C3 - continued

Predictor	Coef. (St error)	P-value	n
Percentage income from cattle[d]			
Less than 10%	---	---	
10 – 59%	-0.97 (0.78)	0.206	
60 – 79%	-0.72 (1.03)	0.483	
80 – 89%	1.51 (1.49)	0.309	
90 – 100%	15.42 (1.24)	0.000	481
Live in same location as cattle			
No	---		
Yes	0.18 (0.63)	0.779	487
Production practices			
Conventional cow-calf			
No	---		
Yes	1.57 (0.72)	0.030	494
Seedstock			
No	---		
Yes	0.63 (0.72)	0.377	494
Age-and-source verification			
No	---		
Yes	1.83 (0.88)	0.038	494
Branded beef program			
No	---		
Yes	18.35 (0.53)	0.000	494
Natural, non-certified organic			
No	---		
Yes	18.34 (0.47)	0.000	494

Predictor	Coef. (St error)	P-value	n
Production Practices, continued			
Stocker			
No	---		
Yes	-0.54 (0.78)	0.471	494
Grass-finished			
No	---		
Yes	1.22 (0.66)	0.063	494
Certified organic			
No	---		
Yes	14.18 (1.05)	0.000	494
Holistic resource management			
No	---		
Yes	-0.24 (1.19)	0.839	494
Beef Quality Assurance			
No	---		
Yes	0.83 (1.08)	0.442	494
Integrated resource management			
No	---		
Yes	17.19 (0.55)	0.000	494

[a] The first factor for behavioral beliefs contained the variables ….
[b] Due to low cell counts, this variable was re-coded by combining somewhat, mostly and strongly disagree (mostly to strongly disagree) and somewhat, mostly, and strongly agree (mostly to strongly agree.)
[c] The categories of less than high school diploma and high school diploma as well as vocational school and two-year college were combined due to low cell counts when cross-tabulated with intention to gather and hold, which did not allow the model to converge.
[d] These variables were coded hierarchically so that each category can be removed from the analysis independently of the remaining categories. Accordingly, Wald test p-values are reported for each category of the variable.
[e] Age was shown to be linear in the log odds, and so was assessed as a continuous predictor.

Table C4 – Coefficients (Coef.), standards error (St. error), and p values for bivariable ordinal logistic regression models for the association between measured socio-psychological factors and demographics and cattle producers′ intent to maintain their cattle in their current location(s) during an outbreak of FMD. For categorical predictors, the overall p-value determined by a Wald test of all categories of the predictor is presented. For categorical predictors coded hierarchically, the p-value for each category of the predictor is shown.

Predictor	**Coef. (St error)**	**P-value**	**n**	**Predictor**	**Coef. (St error)**	**P-value**	**n**
Factor of behavioral beliefs – positive				Factor of attitudes - experiential[c]			
consequences[a]				Less than -1 s.d. from mean	---		
Less than -1 s.d. from mean	---			-1 to 0 s.d. from mean	-1.29 (0.75)		
-1 s.d. from mean	1.42 (0.77)			0 to 1 s.d. from mean	0.83 (0.79)		
1 s.d. from mean	1.77 (0.74)			Greater than 1 s.d. from mean	1.48 (0.97)	0.002	519
Greater than 1 s.d. from mean	18.18 (0.66)	0.000	541	Factor of attitudes - instrumental[c]			
Factor of behavioral beliefs – negative				Less than -1 s.d. from mean	---		
consequences[a]				-1 to 0 s.d. from mean	1.65 (0.71)		
Less than -1 s.d. from mean	---			0 to 1 s.d. from mean	3.00 (0.69)		
-1 s.d. from mean	0.90 (0.74)			Greater than 1 s.d. from mean	19.10 (0.56)	0.000	519
1 s.d. from mean	2.19 (0.78)			Factor Competency (non-agricultural			
Greater than 1 s.d. from mean	1.17 (1.19)	0.037	541	agencies)			
Factor of control beliefs – feed, facilities,				Less than -1 s.d. from mean	---		
and disinfection procedures[b]	---			-1 to 0 s.d. from mean	0.61 (0.88)		
Less than -1 s.d. from mean	0.71 (0.71)			0 to 1 s.d. from mean	1.01 (0.86)		
-1 to 0 s.d. from mean	1.72 (0.82)			Greater than 1 s.d. from mean	0.67 (1.24)	0.701	479
0 to 1 s.d. from mean	19.59 (0.59)	0.000	528	Factor Competency (agricultural agencies)			
Greater than 1 s.d. from mean				Less than -1 s.d. from mean	---		
Factor of control beliefs – crowding,				-1 to 0 s.d. from mean	1.89 (0.75)		
environmental damage, death of cattle[b]	---			0 to 1 s.d. from mean	2.18 (0.99)		
Less than -1 s.d. from mean	-1.29 (0.92)			Greater than 1 s.d. from mean	1.91 (0.88)	0.016	479
-1 to 0 s.d. from mean	-0.63 (1.03)			Factor Caring (non-agricultural agencies)			
0 to 1 s.d. from mean	16.93 (0.88)	0.000	528	Less than -1 s.d. from mean	---		
Greater than 1 s.d. from mean				-1 to 0 s.d. from mean	-0.18 (0.99)		
Factor of normative beliefs				0 to 1 s.d. from mean	-0.20 (0.98)		
Less than -1 s.d. from mean	---			Greater than 1 s.d. from mean	-0.06 (1.33)	0997	482
-1 s.d. from mean	2.37 (0.78)			Factor Caring (agricultural agencies)			
1 s.d. from mean	3.31 (1.13)			Less than -1 s.d. from mean	---		
Greater than 1 s.d. from mean	0.89 (1.00)	0.002	355	-1 to 0 s.d. from mean	1.09 (0.70)		
				0 to 1 s.d. from mean	1.53 (0.91)		
				Greater than 1 s.d. from mean	2.76 (1.18)	0.086	482

Table C4 - continued

Predictor	Coef. (St error)	P-value	n
Factor Shared goals (FEMA)			
Strongly disagree	---		
Mostly disagree	-1.00 (1.13)		
Neither agree or disagree	-1.27 (0.99)		
Mostly agree	1.11 (1.04)		
Strongly agree	0.95 (1.17)	0.015	503
Factor Shared goals (TDA)			
Strongly disagree	---		
Mostly disagree	0.64 (0.86)		
Neither agree or disagree	0.87 (0.79)		
Mostly agree	0.80 (0.96)		
Strongly agree	0.34 (1.19)	0.011	542
Confident I can			
Mostly disagree	---		
Strongly disagree	1.12 (1.18)		
Neither agree nor disagree	2.32 (1.11)		
Mostly agree	3.06 (1.08)		
Strongly agree	4.23 (1.13)	0.001	553
Completely under my control			
Mostly disagree	---		
Strongly disagree	-1.85 (1.04)		
Neither agree nor disagree	-1.98 (1.98)		
Mostly agree	-0.53 (1.19)		
Strongly agree	0.65 (1.01)	0.045	551
Moral obligation to provide feed and water[d]	---	---	553
Moral obligation to protect cattle from disease exposure[d]	---	---	553
Moral obligation to prevent spread of disease[d]	---	---	553

Predictor	Coef. (St error)	P-value	n
Would feel social pressure to			
Strongly disagree	---		
Mostly disagree	0.15 (1.29)		
Neither agree or disagree	0.14 (1.17)		
Mostly agree	1.32 (1.24)		
Strongly agree	0.49 (1.20)	0.609	542
Most people think that I should[e]			
Mostly to Strongly disagree	---		
Neither agree or disagree	-1.11 (1.16)		
Mostly to Strongly agree	-0.17 (1.15)	0.246	550
Other producers I admire would			
Strongly disagree	---		
Mostly disagree	-0.47 (1.49)		
Neither agree or disagree	1.57 (1.33)		
Mostly agree	2.64 (1.39)		
Strongly agree	1.65 (1.38)	0.035	551
Other producers like myself would[e]			
Mostly to Strongly disagree	---		
Neither agree or disagree	2.15 (0.94)		
Mostly to Strongly agree	2.97 (0.92)	0.001	551
Factor of trust in others to not move their cattle and take into account consequences to my operation			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	0.23 (0.81)		
0 to 1 s.d. from mean	0.37 (0.81)		
Greater than 1 s.d. from mean	18.66 (0.69)	0.000	536

Table C4 - continued

Predictor	Coef. (St error)	P - value	n
Factor Risk Perception – overall risk and			
likelihood of an outbreak	---		
Less than -1 s.d. from mean	1.44 (0.98)		
-1 to 0 s.d. from mean	-0.92 (0.90)		
0 to 1 s.d. from mean	-1.11 (1.03)	0.003	546
Factor Risk Perception – perceived magnitude of consequences of an outbreak			
Less than -1 s.d. from mean	---		
-1 to 0 s.d. from mean	0.87 (0.84)		
0 to 1 s.d. from mean	-0.70 (0.75)	0.553	546
Gender			
Male	---		
Female	2.97 (1.08)	0.006	552
Education[f]			
High school	---		
2-year college	-0.08 (0.95)		
4-year college	0.43 (0.74)		
Graduate school	-1.40 (0.86)	0.222	554
Race			
White	---		
Hispanic	0.30 (0.21)	0.163	541
Time in current operation (years)	-0.01 (0.02)	0.619	544
Time in cattle industry (years)	-0.00 (0.02)	0.812	537
Prior experience with Tuberculosis program			
No	---		
Yes	-0.77 (0.83)	0.354	569
Prior experience with Brucellosis program			
No	---		
Yes	-0.37 (0.60)	0.532	569
Live in same location as cattle			
No	---		
Yes	-0.15 (0.62)	0.806	546

Predictor	Coef. (St error)	P - value	n
Cattle producer organization member			
No	---		
Yes	0.45 (0.63)	0.476	544
Cattle producer organization officer			
No	---		
Yes	0.67 (1.10)	0.540	411
Reason			
Primary source of income	---		
Supplemental income	-0.28 (0.73)		
Pleasure or lifestyle	2.02 (1.18)		
Control of excess forage	18.66 (0.79)		
Property tax advantage	18.66 (0.63)		
Family tradition	-0.66 (0.88)		
Other	-3.24 (1.35)	0.000	480
Steer number[g]			
None	---		
1 – 9 steers	2.90 (1.16)	0.013	
10 – 19 steers	-3.33 (1.20)	0.005	
20 - 49 steers	0.59 (1.21)	0.624	
50 – 99 steers	-0.50 (1.21)	0.683	
100 – 199 steers	-0.24 (0.95)	0.798	
200 – 499 steers	-0.40 (0.95)	0.673	
500 + steers	-0.97 (1.26)	0.443	551
Beef cow number			
1-9 head	---		
10-99 head	---		
100-499 head	---		
500 or greater head	---	---	537
Age			
20-39 years of age	---		
40-49 years of age	0.43 (1.01)		
50-59 years of age	1.89 (1.07)		
60 – 69 years of age	0.26 (0.91)		
70+ years of age	0.58 (0.97)	0.377	538

Table C4 - continued

Predictor	Coef. (St error)	P - value	n	Predictor	Coef. (St error)	P - value	n
Percentage income from cattle[g]				Production Practices, continued			
Less than 10%	---	---		Grass-finished			
10 – 59%	-1.96 (0.70)	0.005		No	---		
60 – 79%	0.87 (0.76)	0.254		Yes	0.20 (0.61)	0.747	569
80 – 89%	15.30 (0.70)	0.000		Certified organic			
90 – 100%	-16.13 (1.08)	0.000	531	No	---		
Production practices				Yes	12.38 (0.93)	0.000	569
Conventional cow-calf				Holistic resource management			
No	---			No	---		
Yes	1.15 (0.63)	0.066	569	Yes	15.96 (0.98)	0.000	569
Seedstock				Beef Quality Assurance			
No	---			No	---		
Yes	0.55 (0.82)	0.503	569	Yes	18.61 (0.39)	0.000	569
Age-and-source verification				Integrated resource management			
No	---			No	---		
Yes	0.19 (0.77)	0.803	569	Yes	15.72 (0.64)	0.000	569
Branded beef program				Natural, non-certified organic			
No	---			No	---		
Yes	1.06 (1.13)	0.372	569	Yes	1.23 (1.08)	0.005	569
Stocker							
No	---						
Yes	-0.03 (0.98)	0.976	569				

[a] Factor 1 contained the variables related to reducing the economic impact of the disease, stopping the spread of the disease and protecting cattle, preventing blame for disease spread, and feeling better about how cattle are managed. Factor 2 contained variables related to beliefs that movement restrictions would result in feed shortages and cattle suffering.

[b] Factor 1contained variables related to beliefs about the availability of feed and facilities for calves born, and the ability to set up appropriate disinfection procedures. Factor 2 contained variables related to beliefs about the possibility of crowding, environmental damage, and the death of cattle during the disease control process.

[c] Factor 1 contained attitudes related to the experience of obeying animal movement restrictions (unpleasant-pleasant, difficult-easy, inconvenient-convenient), while factor 2 contained attitudes about the how bad-good, ineffective-effective, and harmful-beneficial this behavior is (experiential).

[d] Analysis of the association of these variables with the outcome of interest was not possible due to small cell counts resulting from a lack of respondents disagreeing with these statements.

[e] Due to low cell counts, these variables were re-coded by combining somewhat, mostly, and strongly disagree (mostly to strongly disagree) and somewhat, mostly, strongly agree (mostly to strongly agree.)

[f] The categories of less than high school diploma and high school diploma (high school) as well as vocational school and two-year college (2-year college) were combined.

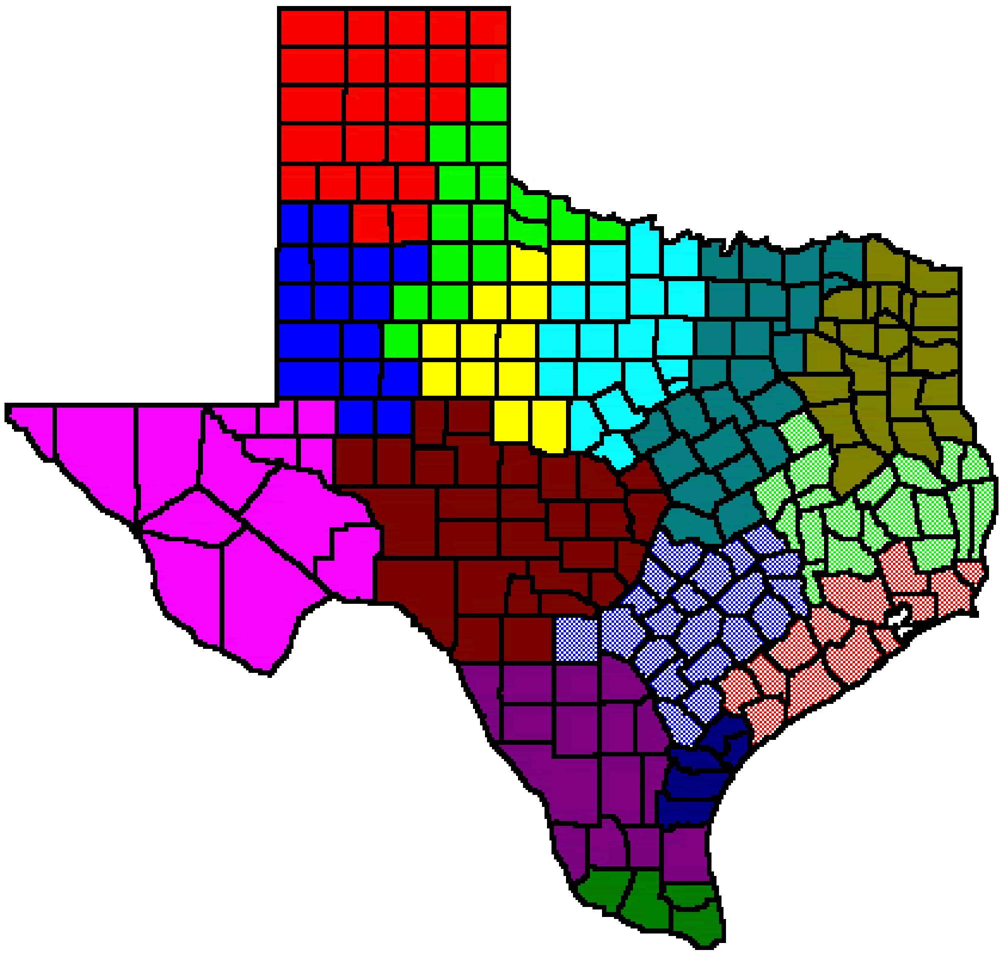
[g] These variables were coded hierarchically so that each category can be removed from the analysis independently of the remaining categories. Accordingly, Wald test p-values are reported for each category of the variable.

APPENDIX D

MAP - NASS DISTRICTS IN TEXAS

Map showing all of the National Agricultural Statistics Service districts in Texas. There are a total of 15 districts.

National Agricultural Statistics Service - Texas Districts[111]



* Key located on following page.

Key	Code	Numeric Name	Geographic Name
	11	District 1-North	Northern High Plains
	12	District 1-South	Southern High Plains
	21	District 2-North	Northern Low Plains
	22	District 2-South	Southern Low Plains
	30	District 3	Cross Timbers
	40	District 4	Blacklands
	51	District 5-North	North East Texas
	52	District 5-South	South East Texas
	60	District 6	Trans-Pecos
	70	District 7	Edwards Plateau
	81	District 8-North	South Central
	82	District 8-South	Coastal Bend
	90	District 9	Upper Coast
	96	District 10-North	South Texas
	97	District 10-South	Lower Valley

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