FACTORS AFFECTING RESPIRATORY VACCINATION OF BEEF CATTLE IN OKLAHOMA

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FACTORS AFFECTING RESPIRATORY

VACCINATION OF BEEF CATTLE IN OKLAHOMA

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Abstract: Respiratory disease is a leading cause of calf death loss among beef cow-calf operations in the US. Between 25 to 30 percent of cattle and calves lost in Oklahoma due to nonpredator causes are lost due to respiratory problems which is higher than the national average for beef cattle operations (USDA, 2015). Respiratory vaccines are available. This study is based on analysis of the 2022 Oklahoma Beef Cow-Calf Biosecurity Survey. Survey responses indicate that about 54 percent of beef producers are vaccinating their breeding herd and about 76 percent of producers are vaccinating their calves for respiratory disease in Oklahoma. Using probit regression to examine the likelihood of adopting a respiratory vaccine program, results indicate that herd size and the use of other vaccinations had a significant influence on a producer's decision to vaccinate their calves for respiratory disease. When it came to vaccinating the breeding herd for respiratory disease, a producer's decision was influenced by education, the use of other vaccinations, their perception of disease in the industry, and their perception of costs associated with biosecurity. Understanding what affects a producer's decision to vaccinate their herd for respiratory disease will better help extension educators, animal health authorities, and veterinarians discuss the use of respiratory vaccinations with beef cattle producers.

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CHAPTER I

PROBLEM IDENTIFICATION AND EXPLANATION

Cattle[1] producers make herd management decisions such as castration, dehorning, vaccination, weaning timing, and supplemental feeding every year. These decisions in turn impact their profits when they sell weaned or feeder calves, replacement breeding cattle, and culls. Producers have a wide variety of management strategies at hand to aid in their herd management. These tools include vaccinating regularly against common diseases, following certified calf management protocols, and ensuring safe and clean biosecurity practices are used. When vaccinating, there are costs to consider such as the extra labor from processing cattle to administer the vaccine or potential adverse reactions the cattle may have from the vaccine, which can cause a decrease in gain. When not vaccinating, there can be a loss of cattle due to a disease outbreak or even an increased risk of abortions, but the severity can be lowered with the use of vaccinations.

Diseases that commonly plague the beef industry can cause detrimental outcomes on the health and profitability of a herd, so vaccines were created to provide herd immunity. Callan and Garry

[1] The term cattle in this paper will be used for the breeding herd and calves combined.

(2002) described vaccines as a tool for lowering the occurrence or severity of a disease for the recipient so they "are better viewed as disease modifiers then absolute preventative agents." Diseases such as bovine respiratory disease (BRD), foot and mouth disease (FMD), bovine viral diarrhea (BVD), and many more have been shown to have significant negative consequences in cattle, yet vaccines have been available for many years to fight against those diseases. This study will focus on respiratory disease, specifically BRD. BRD is the most expensive and prevalent disease in the United States according to Richeson, Hughes, Broadway, and Carrol (2019).

Many cow-calf beef producers select specific management strategies because they will receive a market discount if they are not completed at the time calves are sold. The United States Department of Agriculture (USDA) National Animal Health Monitoring System (NAHMS) (2020b) reported nearly 75 percent of operations vaccinated their beef cattle or calves nationally in 2017 with nearly 58 percent of those calves being vaccinated for respiratory diseases, and nearly 58 percent of those cattle being vaccinated for BVD. Several Oklahoma studies have explored vaccination rates. According to the 2017 Oklahoma Beef Management and Marketing Survey, cow-calf producers adopted management practices for calves at all the following rates: castration – 82 percent; deworming – 87 percent; horn management (dehorning and polled genetics) – 77 percent; weaning 45 days or more – 63 percent; and vaccinations – 49 percent (Raper and Peel, 2017). Williams, DeVuyst, Peel, and Raper (2014) found 35 percent of the cattle producers in Oklahoma were vaccinating their calves with 14 percent of those vaccinating producers participating in a VAC-45 calf health management certification program. They also found it takes 1.5 minutes per head to vaccinate these cattle making labor costs manageable depending on the hourly wage of the workers (Williams, 2014). According to Mallory, DeVuyst, Raper, Peel, and Mourer (2016), 48.8 percent of producers vaccinate their cattle. When producers fail to vaccinate their calves regularly or at all, the feeding operation manager may assume the role of vaccinating the calves upon entry to the feedlot.

Failure to vaccinate can lead to higher production losses, both in terms of increased death rate (mortality) and lower rates of gain due to illness (morbidity). According to the USDA Animal and Plant Health Inspection Service (APHIS) (2015) report of "Death Loss in U.S. Cattle and Calves Due to Predator and Nonpredator Causes," 26.6 percent of nonpredator breeding cattle losses and 30 percent of nonpredator calf losses in Oklahoma was from respiratory problems. This is higher than the national averages from the same study, where beef operations lost 15.9 percent of their breeding[2] cattle and 23 percent of their calves to nonpredator causes of respiratory problems.

[2] The term breeding cattle in this paper will be used for replacement heifers, breeding cows, and breeding bulls.

CHAPTER II

RESEARCH OBJECTIVE

The objective of this study is to understand factors affecting cow-calf producer decision-making on respiratory vaccination adoption in Oklahoma. An improved understanding of factors affecting vaccination will help animal health authorities, veterinarians, and extension educators to potentially target educational efforts to address those primary factors and address the impact of vaccination on cattle herd health and producer profitability. There have been various studies interested in cattle vaccination rates for specific diseases, but there have not been much literature findings on the drivers of producer decisions for respiratory vaccinations in breeding cattle and calves in Oklahoma.

CHAPTER III

LITERATURE REVIEW

Vaccines

There are many cattle diseases affecting the cattle industry for which vaccines are available. The most common vaccines implemented in cow-calf operations in the United States are bovine respiratory syncytial virus (BRSV), bovine viral diarrhea virus (BVDV) Type 1 and 2, infectious bovine rhinotracheitis virus (IBR), and parainfluenza-3 virus (PI-3V) (Richeson et al., 2019). In the United States, the most common time to vaccinate calves is at branding, before weaning, or after weaning, and the most common time combination to vaccinate calves is at branding (1-3 months of age) and weaning (41 percent) (Raper and Peel 2017).

Zimmerman et al. (2012) stated respiratory vaccinated cattle at Superior Livestock Auctions were preferred over non-vaccinated cattle. They found steers received a premium of $2 to $4 per cwt and heifers received $1 to $2 per cwt when receiving the VAC-45 health protocol for vaccinations (Zimmerman et al., 2012). Mallory et al., (2016) found vaccination had a positive estimate in their study.

A few studies have explored reasons affecting vaccination adoption. In the United States, weather factors such as temperature changes were found to be significant in BRD occurrences in feedlots with varying levels of effect depending on the body weight of the cattle according to Cernicchiaro, et al. (2012). An East African study on Virulent Newcastle disease (VND) vaccinations in chickens found that producers with a higher education or smaller flock size had a higher willingness to pay for a VND vaccination as compared to lower educated producers or those with larger flocks (Campbell et al., 2019).

Livestock vaccination adoption and effectiveness have been the subject of studies around the world, although more work has been done on high-consequence, highly contagious diseases than on more common production diseases like BVD and BRD. The top diseases being vaccinated against in China are Foot and Mouth Disease (FMD), Brucellosis, and Bovine Ephemeral Fever (BEF) with about 97 percent, 42 percent, and 25 percent vaccine rates respectively for Yak farms (Chen et al., 2021). A study on Chinese livestock (dairy, beef, and yak) managers found a need for education and outreach to address the problem of low vaccine adoption for brucellosis, bovine ephemeral fever, bovine haemorrhagic septicaemia, anthrax, clostridium, infectious bovine rhinotracheitis, and bovine viral diarrhea (Chen, et al., 2021). Both Chen et al. (2021) and Campbell et al. (2019) found their study groups had little to no knowledge or understanding of diseases and the prevention products associated with those diseases. In South Vietnam the highest net present value for foot and mouth vaccine was seen in large-scale dairy farms followed by small-scale dairy farms; however, among small-scale beef farms, the net present value after vaccinations could be zero or even negative as compared to no vaccinations (Truong et al., 2018).

Studies in other agriculture sectors have begun to search for answers concerning low vaccine adoption among livestock producers. During a study of willingness to pay for contagious bovine pleuropneumonia vaccination in Kenya, 27 percent of farmers were willing to pay for the current vaccine for the disease (Kairu-Wanyoike et al., 2017).

Benefits and Losses

Some research has looked at case-specific benefits and losses for different diseases for which vaccines are available. Generally, animal health-related losses to the livestock producer can encompass many types of loss from direct costs, to foregone income due to animal death, to lower returns due to decreased weight gain. Blakebrough-Hall, McMeniman, and Gonzalez (2020) evaluated the economic effect of BRD on 898 head of steers at a feedlot in New South Wales, Australia. Upon feedlot entry, the steers were provided with a respiratory vaccination, a modified live intranasal vaccine for Infectious Bovine Rhinotracheitis (IBR), a 5 in 1 vaccination for clostridial diseases, and an antiparasitic injection. By the end of the study, 870 steers (96.88 percent) made it to slaughter. Of the remaining calves, 23 steers (2.56 percent) died and 5 steers (0.56 percent) were not permitted to travel due to chronic lameness. There were 145 steers (18 percent) treated for BRD which did not include the mortalities and rejected steers. Of the steers that died, an animal autopsy pointed to BRD as the cause of death for 18 of the steers meaning the death loss associated with BRD was 2 percent of the initial herd. They treated 30 steers three times or more for BRD and of those steers, 11 died. These are some of the costs associated with treatments for BRD in the herd in Australian Dollars: $5.70 for initial BRD vaccination, $13.31 for BRD treatment costs, and $122.26 per animal treated three times or more for BRD. When looking at the overall net losses associated with each steer lost to BRD, the average cost per steer in Australian dollars was $1,647.53 (Blakebrough-Hall, 2020).

Preventive vaccination does incur costs for the producer. Mulenga, Raper, and Peel (2021) found from the 2017 Oklahoma Beef Management and Marketing Survey that vaccinations require more processing in a chute. This was found to be a reason for not vaccinating because the producers doubt there will be positive returns. However, the study found a lower conditional probability for

vaccination adoption (0.57) relative to feed bunk training (0.81) and 45-day weaning (0.71) when producers had already implemented the base practices of castration, horn management, and deworming. A feedlot study in Nebraska examined the costs associated with the decrease in daily average gain and treatments for each animal contracted BRD, without the added costs of labor being factored in for handling and care. The study found an economic loss of $13.90 per infected animal in a feedlot with 1,000 cattle that suffered from BRD (Snowder, et al., 2006). Nationally, the value of cattle death losses due to sickness and disease in 2015 was estimated to be $3.87 billion for the 3.9 million cattle and calves The same study found that non-predator death losses made up lost 98 percent of the death loss in cattle and 89 percent of the death loss in calves (USDA, 2015).

When looking at vaccinating for E. Coli, if cattle were processed twice in a feedlot production practice, then the added labor and vaccine cost would result in about $5 per head; however, if cattle were only processed once in this practice, then the added costs of labor, vaccine, and processing would result in a cost of $6.50 per head with no performance loss, and about $13 per head with a performance loss (Lueger et al., 2012). When looking at Mycobacterium Avium ssp. Paratuberculosis (MAP) vaccination in United States dairy cattle, there was a direct benefit of nearly $4 per vaccinated head when increasing the initial disease shedders prevalence from 5-25% (Groenendaal et al., 2015). A contagious respiratory cattle disease called Contagious Bovine Pleuropneumonia (CBPP) in Kenya has caused a 27.4 percent production loss due to decreased calving and abortion rates (Kairu-Wanyoike et al., 2017).

Vaccines have benefits to the producer beyond the prevention of severe symptoms of a disease/virus. One type of benefit producers can receive for vaccinating their cattle is certification. The certification has strict guidelines which must be followed to qualify for the certification, and the certification covers cattle attributes that cannot be determined by a person observing the cattle (Williams et al., 2012). The Oklahoma Quality Beef Network (OQBN)

certification adds a premium of $2.39 to $5.74 per hundred weights to cattle depending on their weight category in the program, and $1.44 of this total is attributed to the cattle being vaccinated (Williams et al., 2012). There was a rise of percent of cattle in certified health programs from 53 percent in 2001 to 88 percent in 2010 (Zimmerman et al., 2012). Vaccines are only a preventative to severe outcomes of diseases meaning vaccinated cattle are not immune to catching the disease, but Tonsor's (2015) study showed how vaccinating infected cattle can also be beneficial. In one United States study, there was a 50% reduction of E. Coli presence found in cattle and a 75% reduction of high E. Coli presence in cattle after two doses of the siderophore receptor and porin (SRP) vaccine (Tonsor and Schroeder, 2015).

There have also been other studies on the decrease of Q fever prevalence in French dairy cattle if they are vaccinated with one of three vaccine strategies: vaccinate the whole herd over the whole ten-year period, vaccinate for a limited period (3 years), and only vaccinating the heifers over the whole ten years (Courcoul et al., 2011). Q fever is a zoonotic disease-causing abortion, infertility, and mastitis in affected cattle. Courcoul et al, (2011) found the highest decrease in the disease with the first scenario of vaccinating the whole herd for the entire duration of the study, and the second highest was with the third scenario where only heifers were vaccinated for the entire duration of the study. The second scenario where the herd was only vaccinated for the first three years showed a decrease in the disease presence; however, once the vaccine was not administered to the herd, the disease presence increased over the remaining years (Courcoul et al., 2011).

Several studies showed how economic loss is associated with not vaccinating cattle which can result in losses to producers and consumers (Roberts et al., 2012; Groenendaal et al., 2015; Kairu-Wanyoike et al., 2017). However, there has been research showing some sort of gain or increased economic welfare from cattle vaccine adoption over non-vaccinated cattle. In dairy cattle, there was an economic benefit of $8.03 per dairy cow vaccinated for MAP (an infection causing Johne's disease) after having a shedding rate of 10% (Groenendaal et al., 2015). In another study,

net benefits (million KSh) increased by 6.4% when cattle were vaccinated twice a year (Kairu-Wanyoike et al., 2017). Tonsor and Schroeder (2015) found a $1 billion loss in welfare with no performance loss and a $1.8 billion loss in welfare with a performance impact in the beef economy if E. Coli vaccination was adopted with no benefits which result in a 50 percent decrease in food illnesses from beef products.

CHAPTER IV

PREVIOUS ANIMAL HEALTH MANAGEMENT INFORMATION FOR OKLAHOMA COW-CALF PRODUCERS

The 2017 Oklahoma Beef Management and Marketing survey (Raper and Peel, 2017) included questions on vaccination and other management practice adoption that provide useful background for this study. A summary of those questions is presented in this section and will be compared to more current numbers from the 2022 Oklahoma Cow-Calf Biosecurity Survey used in this analysis. In the 2017 study, when producers were asked how many doses of respiratory vaccinations they provided to their calves, 31 percent said zero, 31 percent said one, and 38 percent said more than once. Of those producers who vaccinated for respiratory illness, just over half vaccinated their calves twice for respiratory disease. Regionally, the Northwest region had the highest proportion of producer respondents who provide two rounds of respiratory vaccinations to their calves (78%). Only 8 percent of producers tested their cows for BVD-PI animals.

As shown in Table 1, producers providing two respiratory vaccines to their calves said it was due to the premium buyers were willing to pay, followed by the lessened occurrence of disease in

their calves, and then marketing opportunities based on their vaccination program. When it came to record-keeping, there was a close percentage of producers who kept vaccination (between 45 and 72 percent) and medical records (between 46 and 65 percent) in the state overall and regionally for both practices with varying reasons why they do these practices. The top reason, like implementing two rounds of respiratory vaccines, was the ability to market cattle due to that practice or because a premium was offered for record-keeping practices.

Producers were also asked why they did not adopt respiratory vaccinations for calves, as shown in Table 2. Many of the producers said their top reason for not doing two rounds of respiratory vaccinations on their calves was due to not using it even though they were familiar with the practice, or they had been okay with not doing it in the past. The reason for not using vaccination and medical records was all due to not using the practice despite being familiar with the practice. The percentages for the practices in the 2017 practice adoption tables were for the cattle operations rather than asking for the breeding herd or calves individually.

Table 1: Top Three Producer Incentives for Adoption of selected Health Management Practices 2017

Practice 1: 2X Respiratory Vaccines							
Region	Practice Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
State	54.93%	Buyers are willing to pay a premium	24.45%	Lessens incidences of illnesses or injury in my calves	16.79%	I market my calves to sellers based on this practice.	13.32%
NW	75.96%	Buyers are willing to pay a premium	36.54%	Lessens incidences of illnesses or injury in my calves	21.15%	I market my calves to sellers based on this practice.	16.35%
NE	56.29%	Buyers are willing to pay a premium	25.15%	Lessens incidences of illnesses or injury in my calves	18.56%	I market my calves to sellers based on this practice.	16.17%
SW	46.15%	Buyers are willing to pay a premium	19.66%	Lessens incidences of illnesses or injury in my calves	13.68%	Improves my reputation with buyers.	12.82%
SE	44.14%	Buyers are willing to pay a premium	18.62%	Lessens incidences of illnesses or injury in my calves	13.10%	I market my calves to sellers based on this practice.	10.34%
Practice 2: Maintaining Written Vaccination Records							
Region	Practice Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
State	60.51%	I market my calves to sellers based on this practice., Buyers are willing to pay a premium	13.89%	Improves my reputation with buyers.	9.69%	I use this practice, but don't know how to use it in marketing my cattle., Lessens incidences of illnesses or injury in my calves	8.23%
NW	72.12%	Buyers are willing to pay a premium	20.19%	I market my calves to sellers based on this practice.	13.46%	Improves my reputation with buyers.	12.50%
NE	66.46%	I market my calves to sellers based on this practice.	18.29%	Buyers are willing to pay a premium	14.02%	Lessens incidences of illnesses or injury in my calves	12.20%

Source: 2017 Oklahoma Beef Management and Marketing Survey, calculated by authors.

Table 1 continued: Top Three Producer Incentives for Adoption of selected Health Management Practices 2017

Practice 2 continued: Maintaining Written Vaccination Records							
Region	Practice Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
SW	59.02%	Buyers are willing to pay a premium	15.57%	I market my calves to sellers based on this practice.	13.11%	Improves my reputation with buyers.	8.20%
SE	45.45%	I market my calves to sellers based on this practice., I use this practice but don't know how to use it in marketing my cattle.	9.09%	Buyers are willing to pay a premium	7.69%	Lessens incidences of illnesses or injury in my calves	6.99%
Practice 3: Maintaining Written Medical Records							
Region	Practice Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
State	57.80%	I market my calves to sellers based on this practice.	11.56%	Buyers are willing to pay a premium	10.64%	I use this practice but don't know how to use it in marketing my cattle.	8.81%
NW	64.71%	Buyers are willing to pay a premium	18.63%	I market my calves to sellers based on this practice.	12.75%	Improves my reputation with buyers.	10.78%
NE	64.02%	I market my calves to sellers based on this practice.	13.41%	Buyers are willing to pay a premium	10.37%	Lessens incidences of illnesses or injury in my calves	9.76%
SW	54.92%	Buyers are willing to pay a premium	12.30%	I market my calves to sellers based on this practice.	11.48%	I use this practice but don't know how to use it in marketing my cattle.	9.02%
SE	46.85%	I use this practice but don't know how to use it in marketing my cattle.	11.19%	I market my calves to sellers based on this practice.	6.99%	Lessens incidences of illnesses or injury in my calves	6.29%

Source: 2017 Oklahoma Beef Management and Marketing Survey, calculated by authors.

Notes: Producers were asked to give a reason for why practices were adopted on their farms. The percentage adoption column provides the adoption rate of the specific practice in the location. State and regional percentages are provided along with the top three reasons for the adoption of each practice.

Table 2: Top Three Producer Constraints for Adoption of selected Health Management Practices 2017

Practice 1: 2X Respiratory Vaccines							
Region	Percentage No Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
State	49.79%	I am familiar with this practice but don't use it.	13.52%	Haven't done it in the past and have done okay.	11.59%	Don't really know what value it adds.	4.55%
NW	36.91%	I am familiar with this practice but don't use it.	10.74%	Don't really know what value it adds.	7.38%	Haven't done it in the past and have done okay.	4.70%
NE	54.70%	Haven't done it in the past and have done okay.	14.10%	I am familiar with this practice but don't use it.	13.68%	Don't really know what value it adds., Requires too much labor.	4.27%
SW	54.41%	I am familiar with this practice but don't use it., Haven't done it in the past and have done okay.	17.65%	Requires too much labor.	4.41%	Don't really know what value it adds.	3.68%
SE	52.17%	I am familiar with this practice but don't use it.	13.59%	Haven't done it in the past and have done okay.	9.78%	Don't really know what value it adds.	3.80%
Practice 2: Maintaining Written Vaccination Records							
Region	Percentage No Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
State	41.51%	I am familiar with this practice but don't use it.	11.08%	Haven't done it in the past and have done okay.	7.15%	Don't really know what value it adds.	3.93%
NW	36.55%	I am familiar with this practice but don't use it.	6.90%	Don't really know what value it adds.	5.52%	Haven't done it in the past and have done okay.	3.45%
NE	41.48%	I am familiar with this practice but don't use it.	10.04%	Haven't done it in the past and have done okay.	8.73%	Don't really know what value it adds.	3.06%

Source: 2017 Oklahoma Beef Management and Marketing Survey, calculated by authors.

Table 2 continued: Top Three Producer Constraints for Adoption of selected Health Management Practices 2017

Practice 2 continued: Maintaining Written Vaccination Records							
Region	Percentage No Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
SW	36.84%	I am familiar with this practice but don't use it.	13.53%	Haven't done it in the past and have done okay.	8.27%	Don't really know what value it adds.	3.76%
SE	50.00%	I am familiar with this practice but don't use it.	13.59%	Haven't done it in the past and have done okay.	8.15%	Don't really know what value it adds.	4.35%
Practice 3: Maintaining Written Medical Records							
Region	Percentage No Adoption	Top reason why	Percent of Producers	Second reason why	Percent of Producers	Third reason why	Percent of Producers
State	44.13%	I am familiar with this practice but don't use it.	12.99%	Haven't done it in the past and have done okay.	7.26%	Don't really know what value it adds.	4.89%
NW	41.78%	I am familiar with this practice but don't use it.	10.96%	Don't really know what value it adds.	6.85%	Haven't done it in the past and have done okay.	6.16%
NE	45.02%	I am familiar with this practice but don't use it.	13.85%	Haven't done it in the past and have done okay.	8.23%	Don't really know what value it adds.	3.46%
SW	39.10%	I am familiar with this practice but don't use it.	13.53%	Haven't done it in the past and have done okay.	7.52%	Don't really know what value it adds.	4.51%
SE	49.73%	I am familiar with this practice but don't use it.	13.66%	Haven't done it in the past and have done okay.	7.65%	Don't really know what value it adds.	6.01%

Source: 2017 Oklahoma Beef Management and Marketing Survey, calculated by authors.

Notes: Producers were asked to give a reason for why practices were not adopted on their farms. The percentage no adoption column provides the non-adoption rate of the specific practice in the location. State and regional percentages are provided along with the top three reasons for the adoption of each practice.

CHAPTER V

METHODS AND DATA

This study will use the results of the 2022 Oklahoma Cow-Calf Biosecurity Survey to explore herd health resources, perceived management and biosecurity activity effectiveness, disease knowledge, animal health and biosecurity practice administration, and other factors. Data on implementation costs collected from a variety of sources for factors such as respiratory vaccine cost and quantity and supplies required to implement biosecurity practices for high and low levels of biosecurity plan adoption will be used to develop a cost analysis for different respiratory vaccine management practices based on farm and herd assumptions from the USDA.

Data: 2022 Oklahoma Cow-Calf Biosecurity Survey

This analysis is based on a unique set of survey data. The Oklahoma Cow-Calf Biosecurity Survey was developed by Oklahoma State University through funding from USDA Animal and Plant Health Inspection Service, Veterinary Services under National Animal Disease Preparedness and Response Program (NADPRP). The survey was administered through a

contract with the USDA National Agricultural Statistics Service (NASS). The survey population of 4700 cow-calf producers was identified through the USDA NASS beef cattle frame, and selected producers were alerted via postcard in January 2022 prior to receiving the survey. Two weeks after the postcard, a paper survey was mailed out with a postage-paid return envelope. Two weeks after the mailout, each producer was called to see if they had any questions or had already returned the survey. The producer had the option during the call to complete the survey over the phone rather than mail in the paper survey. A second call attempt was made if the first attempt was unsuccessful. The data collection process was completed in February 2022.

Surveys asked producers to share beef cattle management and biosecurity activities performed in the 2021 calendar year. Of the 4700 producers' contact, 1466 surveys were returned. The first question allowed the producer to indicate that they did not actively manage cattle in the 2021 calendar year, this question was used to filter responses down to a subsample of producers who owned and actively managed a cattle herd in 2021. A total of 981 active cow-calf producers completed the survey so they would be the initial sample which will get broken down further in the regression based on the whole completed survey. The survey sections were as follows: Cattle Operation Characteristics, Current Herd Management Practices, Biosecurity Practices and Animal Movement, Disease Knowledge, and Producer Characteristics. A full version of the survey can be found in Appendix H.

Summary Statistics and Descriptive Analysis of Survey Data

Summary statistics for variables of interest are in Table 3 and Table 4. A detailed description of each variable name is provided in Appendix F, as well as the survey question number it was derived from. Table 3 includes those variables that are binary (0/1) while Table 4 contains those

variables that are continuous. Both tables[3] include a full sample (*State*) summary statistics and regional (*NW, SW, NE, SE*) summary statistics. Most of the variables are binary, meaning the producer indicated "yes" (set equal to 1) or "no" (set equal to 0) in their answer. Table 3 and Table 4 also includes the number of subsample observations (N) for each variable since some producers left questions blank when filling out the survey, and not every N equal 981 observations. All the summary statistics are unweighted based on the sample and have not been adjusted to represent the entire population.

In Table 3, *Vac-Test* is the only non-binary variable. Producers were questioned on the frequency with which they either vaccinate or test for various diseases before bringing cattle onto the farm in the past three years. If the producer did not bring any cattle onto their farm in the last 3 years, zeros were placed in the blanks as the question would have been skipped. We included people who both brought cattle onto their operation and those who didn't so that may affect the size of this *Vac-Test* term. This variable is a count of the vaccinations and testing requirements the producer has for BVD and respiratory disease before new herd additions are allowed onto the property. For example, if a producer only purchases cattle that have had a respiratory vaccine administered, but not a BVD vaccine or any testing for either disease, the value would be 1. If that producer only bought cattle that had received both respiratory and BVD vaccinations but did not require any testing, the value would be a 2. If the producer only purchased cattle that had been tested for both diseases and only vaccinated for one of them, then that would be a 3. If the producer only purchased cattle that had both vaccines and required testing for both BVD and respiratory disease, the value would be a 4. This makes the Vac-Test variable a sum of the vaccination and testing practices for BVD and Respiratory disease before entry on the farm.

[3] All summary statistics and regression results were cleared by USDA NASS to assure data confidentiality was maintained in the process of this analysis.

Across the sample, herd sizes (*Herd 1-24, Herd 25-49, Herd 50-99, Herd 100-249*) seem to be relatively evenly distributed across the response number. The exception is the largest herd size category of more than 250 head of cows (*Herd GE 250*), which unsurprisingly represented the smallest proportion of producers. In 2017, there was a total of 2,129,403 beef cows in Oklahoma and there were 46,080 beef farms, making the average herd size about 46 head (USDA NASS, 2017). It can also be noted that the Southwest region had the most spread in respondent numbers in the herd size categories. The Southwest region contains the highest percentage of producers in the state, overall. In terms of herd size, the region also had the highest percentage of producers who indicated their herd size in categories *Herd 1-24* and *Herd 25-49*, and it contains the smallest percentage of producers with herd size categories *Herd 50-99*.

To further illustrate these points, Figure 1 shows survey respondents' percentage of herd sizes across the entire Oklahoma sample (*State mean)* and by regional samples. The smallest herd size groups were most common among respondents in every region except for the Northeast region. The Northeast region contains the highest percentage of 50-99 head herds and 100-249 head herds across all regions, indicating that cow herds tend to be larger in that region of the state. This may be related to regional differences in grazing rates and forage types. When looking at USDA NASS Census numbers for 2017, their category breakdown of herd sizes followed ours with the smallest categories (1-9 head of cattle, and 10-19 head of cattle) holding the most cattle. As the herd sizes increased, the number of producers with higher herd sizes decreased to less than 5 percent of the producer having more than 200 head of cattle in their herds (USDA, 2017).

Based on responses to the questions for the administration of respiratory (*RVX calves, RVX breeding*) and clostridial vaccinations (*CVX calves, CVX breeding*), more producers in the survey vaccinated their calves than their breeding herd for both vaccine types. More producers responded to the calf vaccination questions then the breeding herd questions. To further illustrate the use of different types of vaccines, the percentage of producers providing different types of vaccinations

to their herds is shown in Figure 2. Overall, a lower percentage of producers are vaccinating the breeding herd for respiratory and clostridial disease as compared to calves. The percentage of respiratory vaccines provided to both the breeding herd and calves are also noticeably lower than the clostridial vaccines provided to the herd. This break down provides some insight into the producer's utilization of the two vaccines specifically inquired about in the survey; however, there may be other vaccination practices the survey did not delve into. Figure 2 indicates that rates of clostridial vaccine adoption are higher than rates of respiratory vaccine adoption.

Table 3 indicates the practice of maintaining medical records for the breeding herd and calves by respondents is utilized at about the same rate throughout the state and regions. The maintenance of medical records for calves was slightly higher than the maintenance of medical records for the breeding herd.

Another factor that may influence respiratory vaccine adoption is the producer's perceived risk associated with the disease. The survey asks for a producer's perception of BVD threat to their personal operation (*BVDp threat, BVDp no threat, BVDp uk*) and BRD threat in their personal operations (*BRDp threat, BRDp no threat, BRDp uk*). Summary data indicate that there is a higher percentage of producers who do not perceive either BRD or BVD as a threat to their operation (47.59 percent *BRDp no threat* and 45.82 percent *BVDp no threat*). However, only a small percentage of producers are unsure of the threat to their operation or are unfamiliar with the diseases (18.73 percent *BRDp uk* and 21.49 percent *BVDp uk*).

The same levels are not found when looking at a producer's perception of BVD threat to the industry (*BVDi threat, BVDi no threat, BVDi uk)* and BRD threat to the industry (*BRDi threat, BRDi no threat, BRDi uk*). There is a higher percentage of producers perceiving BVD and BRD as a threat to the industry (58.01 percent *BRDi threat* and 49.62 percent *BVDi threat*) and a small

percentage perceiving no threat to the industry (19.38 percent *BRDi no threat* and 24.87 percent *BVDi no threat*).

Persistently Infected (PI) animals (*PI Cows, PI Bulls, PI nonbreeding*) in the herd can also be a problem for the producer because they are born to always carry BVD and can never be cured so they can infect other members of the herd. A higher percentage of producers tested their bulls (22.70 percent) than their cows (16.76 percent) or nonbreeding (8.23 percent) herd for PI status. Some further analysis could be done to determine if testing is due to bulls being replaced and new ones entering the herd.

In the survey, producers were provided with a definition of biosecurity and then asked how familiar they are with the definition of biosecurity. Most producers had either not heard of the definition (*Bio not heard*) or had heard of it but had not implemented biosecurity into their practice (*Bio not used*). Of the producers who answered the question, 13.29 percent of producers had implemented some level of biosecurity into their practice (*Bio implemented*). Producers were then asked about their familiarity with the recommendation of the Secure Beef Supply plan. As with the biosecurity definition question, most of the producers had never heard of the Secure Beef Supply plan or they had heard of it but didn't know what it was or how to implement it into their practice (*SBS NH UK)*. Only 15.43 percent of the producers had heard of the Secure Beef Supply and had some level of implementation of it in their practice (*SBS heard used*).

After examining response rates for different education levels, it was decided to split education as being a high school degree as compared to respondents with a secondary degree beyond high school (*ED higher HS*) which could include a vocational/technical/2 year degree, a bachelor degree, or a graduate degree. If a producer selected multiple education options, then the highest level of education was the only one recorded. The summary statistics show over half of the producers who answered the survey had a secondary degree beyond a high school degree.

When looking at the producer characteristics across the state and regions in Table 3 a typical producer in the state and in all the regions is between the age of 65-74, receives 1 to 20 percent of their household income from the cattle operation, and has a secondary degree beyond a high school degree. Common herd sizes were the smallest in the western half of the state (SW and NW), largest in the northeast region (NE), and the southeast region was somewhere between the west and northeast. The typical respondent was likely to have heard the definition of biosecurity but did not indicate that they had implemented biosecurity in their operation. However, when looking at the Bioplan elements variable in Table 4 the typical producer had adopted 20 percent of the elements of a biosecurity plan. This may indicate that some producers are adopting biosecurity practices even if they do not consider themselves as adopting biosecurity. Perhaps, then, some biosecurity elements are just considered good management practices.

Table 3: Select 2022 Oklahoma Cow-Calf Biosecurity Survey Summary Statistics

Abbreviated Name	Survey Question	State		Northwest		Southwest		Northeast		Southeast	
		Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
Herd 1-24	1.4	0.2682	977	0.2697	178	0.3344	299	0.1735	219	0.2609	276
Herd 25-49		0.2108	977	0.2191	178	0.2207	299	0.2009	219	0.2065	276
Herd 50-99		0.2344	977	0.2472	178	0.1672	299	0.2831	219	0.2609	276
Herd 100-249		0.2242	977	0.2135	178	0.2174	299	0.2694	219	0.2065	276
Herd GE 250		0.0624	977	0.0506	178	0.0602	299	0.0731	219	0.0652	276
Region NW	1.5	0.1824	976	1.0000	178	NA	---	NA	---	NA	---
Region SW		0.3064	976	NA	---	1.0000	299	NA	---	NA	---
Region NE		0.2275	976	NA	---	NA	---	1.0000	222	NA	---
Region SE		0.2838	976	NA	---	NA	---	NA	---	1.000	276
PI Cows	2.5	0.1676	907	0.1890	164	0.1599	269	0.1675	203	0.1579	266
PI Bulls		0.2270	890	0.3232	164	0.1839	261	0.2273	198	0.2061	262
PI nonbreed		0.0823	778	0.0621	145	0.0975	236	0.0819	171	0.0762	223
RVX calves	2.6d	0.7561	943	0.7941	170	0.7439	285	0.7962	211	0.7243	272
RVX breeding		0.5381	866	0.4938	160	0.5078	258	0.6513	195	0.5141	249
MT record calves	2.6m	0.4732	934	0.5202	173	0.4410	288	0.5095	210	0.4479	259
MT record breeding	2.6n	0.4900	900	0.5298	168	0.4613	271	0.5198	202	0.4706	255
CVX calves	2.6q	0.8911	937	0.9364	173	0.8472	288	0.8990	208	0.9053	264
CVX breeding	2.6r	0.6281	898	0.6564	163	0.6066	272	0.6318	201	0.6279	258
Bio not heard	3.1	0.3070	948	0.2890	173	0.3114	289	0.2394	213	0.3643	269
Bio implemented		0.1329	948	0.1156	173	0.1073	289	0.1925	213	0.1264	269
Bio not used		0.5601	948	0.5954	173	0.5813	289	0.5681	213	0.5093	269
SBS NK UK	3.2	0.8351	940	0.8353	170	0.8147	286	0.8411	214	0.8496	266
SBS heard used		0.1543	940	0.1529	170	0.1713	286	0.1542	214	0.1391	266
BVD not familiar	5.1	0.1879	841	0.2013	159	0.2372	253	0.1436	188	0.1555	238
BVD seen		0.0904	841	0.0692	159	0.1225	253	0.0638	188	0.0924	238
BVD some familiar		0.2259	841	0.2327	159	0.2411	253	0.2287	188	0.2059	238
BVD not in my herd		0.3508	841	0.3648	159	0.3202	253	0.3670	188	0.3613	238
BVD in my herd		0.1546	841	0.1447	159	0.0988	253	0.2074	188	0.1807	238
Vac-Test	5.4	0.4465	981	0.5337	178	0.4114	299	0.5135	222	0.3732	276

Source: 2022 Oklahoma Cow-Calf Biosecurity Survey

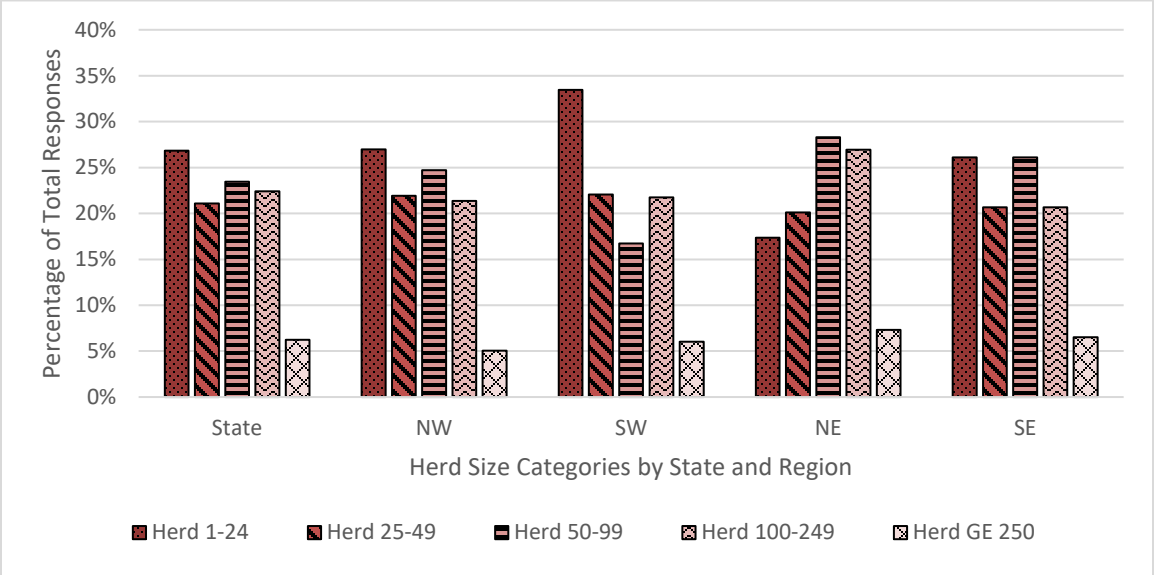
Table 3 continued: Select 2022 Oklahoma Cow-Calf Biosecurity Survey Summary Statistics

BRDp threat	5.5	0.3367	790	0.3537	147	0.2988	241	0.3908	174	0.3230	226
BRDp no threat		0.4759	790	0.4830	147	0.4481	241	0.4828	174	0.4956	226
BRDp uk		0.1873	790	0.1633	147	0.2531	241	0.1264	174	0.1814	226
BVDp threat		0.3256	777	0.3356	149	0.2778	234	0.3642	173	0.3379	219
BVDp no threat		0.4582	777	0.4631	149	0.4487	234	0.4798	173	0.4475	219
BVDp uk		0.2149	777	0.1946	149	0.2735	234	0.1561	173	0.2146	219
BRDi threat	5.5	0.5801	805	0.6118	152	0.5143	245	0.6541	185	0.5656	221
BRDi no threat		0.1938	805	0.1908	152	0.2122	245	0.1892	185	0.1810	221
BRDi uk		0.2261	805	0.1974	152	0.2735	245	0.1568	185	0.2534	221
BVDi threat		0.4962	788	0.4533	150	0.4398	241	0.5611	180	0.5349	215
BVDi no threat		0.2487	788	0.3200	150	0.2448	241	0.2333	180	0.2140	215
BVDi uk		0.2602	788	0.2333	150	0.3195	241	0.2056	180	0.2605	215
Age LE 44	6.1	0.0744	981	0.1067	178	0.0702	299	0.0541	222	0.0761	276
Age 45-54		0.1111	981	0.1517	178	0.0970	299	0.1216	222	0.0906	276
Age 55-64		0.2508	981	0.2022	178	0.2508	299	0.2838	222	0.2536	276
Age 65-74		0.3191	981	0.3258	178	0.2876	299	0.3018	222	0.3659	276
Age GE 75		0.1876	981	0.1629	178	0.2241	299	0.1892	222	0.1630	276
ED higher HS	6.2	0.5800	981	0.5787	178	0.5485	299	0.6441	222	0.5616	276
OP income 0 percent	6.9	0.1060	981	0.0787	178	0.1204	299	0.1081	222	0.1051	276
OP income 1-20 percent		0.4271	981	0.4382	178	0.4281	299	0.4099	222	0.4312	276
OP income 21-60 percent		0.2416	981	0.2697	178	0.2308	299	0.2432	222	0.2355	276
OP income 61-100 percent		0.0693	981	0.0899	178	0.0702	299	0.0811	222	0.0471	276

Source: 2022 Oklahoma Cow-Calf Biosecurity Survey

Notes: (a) Percentage of answered variables in the state of Oklahoma (b) Reported percentages are unweighted, sample means. (c) Regions are broken by interstate 40 (east/west) and interstate 35 (north/south) to create regions (d) N is the subsample observations for each variable. (e) a list of the location of each variable in the survey along with their answer interpretation can be found in Appendix F.

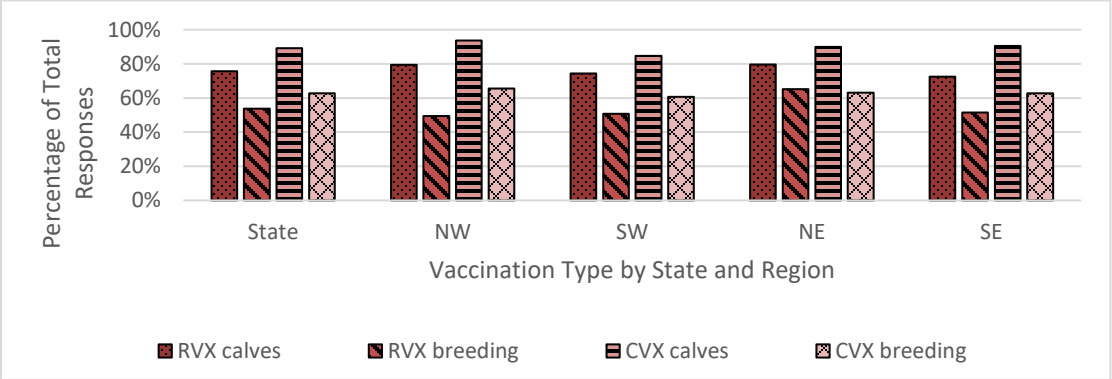
Figure 1: Respondent Herd Sizes, Statewide and by Region



Source: Calculated by the authors.

Notes: (a) Percentage of total respondents in the State of Oklahoma by Herd Size Categories. (b) Reported percentages are unweighted, sample means. (c) Regions are broken by interstate 40 (east/west) and interstate 35 (north/south) to create regions for the northwest (NW), southwest (SW), northeast (NE), and southeast (NE).

Figure 2: Vaccination Implementation for Calves and Breeding Herd Statewide and by Region



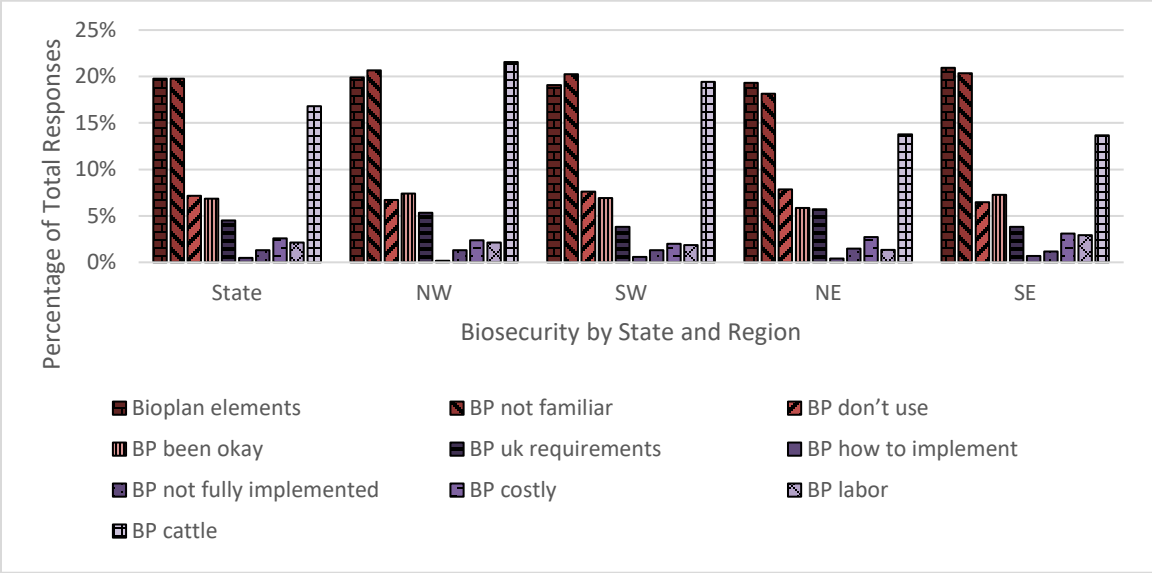
Source: Calculated by the authors.

Notes: (a) Percentage of total respondents in the state of Oklahoma that responded to the use of respiratory (RVX) and clostridial (CVX) vaccination for calves and/or for the breeding herd in the survey. (b) Reported percentages are unweighted, sample means. (c) Regions are broken by interstate 40 (east/west) and interstate 35 (north/south) to create regions for the northwest (NW), southwest (SW), northeast (NE), and southeast (NE).

The only continuous variable set is the calculated variables based on the percentage of biosecurity plan elements adopted by the producer which are shown in Table 4 below. In the survey, there is a table in which a producer indicated whether they had adopted an element of a biosecurity plan. It was decided a percentage could be obtained from this section for each producer over how many of the elements were adopted, then the reasons for why there is not a perfect adoption rate across all the biosecurity plan elements. In the question, producers were asked to indicate whether they had adopted each of the 20 biosecurity plan elements. The sum of adopted elements divided by the total number of elements was the percentage of biosecurity plan adoption (Bioplan Elements). Further, if a producer answered "no" for a particular element, they were asked to select one of 9 reasons why they did not adopt it. A similar process was used to calculate the percentage of non-adopted biosecurity plan elements that list a specific reason for not adopting. This was done for each of the 9 reasons. The most common reason an element was not adopted was due to lack of familiarity with the element (BP not familiar), followed by the producer feeling they didn't have enough cattle (BP cattle) to make it worthwhile. Returning to the herd size breakdowns in Table 3, it showed a majority of the producers had less than 250 head of cattle but about 48 percent of the producers have less than 50 head of cattle, so it makes sense to see producers not adopting the elements of a biosecurity plan due to a lack of cattle on their operation.

Figure 3 gives a better understanding of the percentage of reasons why biosecurity plan elements were not adopted by producers. Overall, the reason for the non-adoption of elements seems to be due to a lack of familiarity and a producer's perception of the element in relation to their herd size. The herd sizes statewide and by region displayed the herd size groups and the most concentration around the smaller herd size categories, so the response "I do not have enough cattle to mess with it" (BP cattle) lines up with the percentage of smaller herd sizes statewide and in the regions.

Figure 3: Reasons or Non-Adoption of Biosecurity Elements, Statewide and by Region



Source: Calculated by the authors.

Notes: (a) Percentage of total respondents in the state of Oklahoma: adopted elements of a biosecurity plan (Bioplan Elements) followed by reasons why elements were not adopted. (b) Reported percentages are unweighted, sample means. (c) Regions are broken by interstate 40 (east/west) and interstate 35 (north/south) to create regions for the northwest (NW), southwest (SW), northeast (NE), and southeast (NE). (d) Bioplan elements (Do you have the following biosecurity plan elements? If NO, please indicate why, BP not Familiar (I am not familiar with this practice), BP don't use (I am familiar with this practice but don't use it), BP been okay (I haven't done this I the pat and things have been okay), BP uk requirements (I don't really know what it requires), BP how to implement (I thought about it. I need help with the specifics of how to implement on my ranch), BP not fully implemented (I sometimes do this, but I haven't fully implemented it), BP costly (It is too costly), BP labor (It requires too much labor), BP cattle (I don't have enough cattle to mess with it).

Table 4:2022 Oklahoma Cow-Calf Biosecurity Survey Biosecurity Plan Element Summary

	State			Northwest			Southwest			Northeast			Southeast		
Abbreviated Name	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
Bioplan elements	0.1976	0.1753	981	0.1989	0.1649	178	0.1908	0.1703	299	0.1932	0.1642	222	0.2094	0.1941	276
BP not familiar	0.1976	0.3046	981	0.2065	0.3199	178	0.2025	0.3196	299	0.1815	0.2858	222	0.2036	0.2936	276
BP don't use	0.0717	0.1780	981	0.0671	0.1721	178	0.0759	0.1828	299	0.0784	0.1789	222	0.0649	0.1762	276
BP been okay	0.0687	0.1731	981	0.0739	0.1919	178	0.0692	0.1737	299	0.0586	0.1509	222	0.0726	0.1762	276
BP uk requirements	0.0451	0.1426	981	0.0534	0.1501	178	0.0383	0.1315	299	0.0572	0.1616	222	0.0382	0.1329	276
BP how to implement	0.0049	0.0404	981	0.0017	0.0090	178	0.0059	0.0367	299	0.0041	0.0286	222	0.0067	0.0602	276
BP not fully implemented	0.0129	0.0507	981	0.0132	0.0435	178	0.0129	0.0449	299	0.0146	0.0422	222	0.0116	0.0655	276
BP costly	0.0257	0.0999	981	0.0239	0.0898	178	0.0201	0.0777	299	0.0270	0.1002	222	0.0308	0.1221	276
BP labor	0.0214	0.0936	981	0.0213	0.0859	178	0.0187	0.0783	299	0.0133	0.0627	222	0.0293	0.1254	276
BP cattle	0.1681	0.2939	981	0.2154	0.3169	178	0.1943	0.3200	299	0.1376	0.2655	222	0.1368	0.2652	276

Source: 2022 Oklahoma Cow-Calf Biosecurity Survey

Notes: (a) Percentage of answered Biosecurity Element variables in the state of Oklahoma found from question 3.4 in the 2022 Oklahoma Cow-Calf Biosecurity Survey. (b) Reported percentages are unweighted, sample means. (c) Regions are broken by interstate 40 (east/west) and interstate 35 (north/south) to create regions. (d) N is the subsample observations for each variable. (e) SD is the Standard Deviation of the Variable. (e) a list of the location of each variable in the survey along with their answer interpretation can be found in Appendix F.

Probit Model

Probit models were chosen for the analysis because the dependent variables are both binary and many of the independent variables are also binary. Because different factors may influence the vaccination of breeding cattle in comparison to calves, two separate regressions were developed. There is a regression with the dependent variable "respiratory vaccinate calves"; then, there is a second regression with the dependent variable "respiratory vaccinate breeding herd". However, vaccination of the breeding cattle herd might influence the vaccination of calves, so the "respiratory vaccinate breeding herd" indicator variable was included in the calf vaccination regression.

(1) $$Calf_{RespVac} = \beta_0 + \beta_1 X_{NE} + \beta_2 X_{SE} + \beta_3 X_{SW} + \sum_{n=1}^{12} \beta_{ED} X_{ED} + \sum_{n=1}^{10} \beta_{Mgmt} X_{Mgmt} + \sum_{n=1}^{12} \beta_{Bio} X_{Bio} + \sum_{n=1}^{10} \beta_{Control} X_{Control} + \varepsilon$$

(2) $$Breeding_{RespVac} = \beta_0 + \beta_1 X_{NE} + \beta_2 X_{SE} + \beta_3 X_{SW} + \sum_{n=1}^{12} \beta_{ED} X_{ED} + \sum_{n=1}^{10} \beta_{Mgmt} X_{Mgmt} + \sum_{n=1}^{12} \beta_{Bio} X_{Bio} + \sum_{n=1}^{10} \beta_{Control} X_{Control} + \varepsilon$$

Table 5 shows which variables in the X matrices are in each of the categories for the regressions. In addition, indicator variables for the northeast (XNE), southeast (XSE), and southwest (XSW) regions were included. The knowledge matrix includes variables based on a producer's knowledge of the disease. The administration matrix includes variables in which a producer is asked about the administration of something such as vaccinations, testing, or records kept about administrations. The biosecurity matrix has variables based on biosecurity elements and familiarity with the definition of biosecurity and recommendations of the Secure Beef Supply

(SBS). Control is the final category, and it includes the demographic variables of a producer and herd sizes.

Table 5: Variables in the Matrices Shown in Equations 1 and 2 [(a,b)]

Knowledge (X_{ED})	**Administration (X_{Mgmt})**	**Biosecurity (X_{Bio})**	**Control ($X_{Control}$)**
BVD seen	*PI Cows*	*Bio not heard*	*Herd 25-49*
BVD some familiar	*PI Bulls*	*Bioplan_elements*	*Herd 50-99*
BVD not in my herd	*PI Nonbreeding*	*BP__uk_requirements*	*Herd 100-249*
BVD in my herd	*RVX breeding*	*BP_been_okay*	*Herd GE 250*
BRDp Threat	*RVX calves*	*BP_cattle*	*Age 55-64*
BRDp UK	*CVX calves*	*BP_costly*	*Age 65-74*
BVDp Threat	*CVX breeding*	*BP_dont_use*	*OP income 1-20 percent*
BVDp UK	*Vac-Test*	*BP_how_to_implement*	*OP income 21-60 percent*
BRDi Threat	*MT record calves*	*BP_labor*	*OP income 61-100 percent*
BRDi UK	*MT record breeding*	*BP_not_familiar*	*ED higher HS*
BVDi Threat		*BP__not_fully_implemented*	
BVDi UK		*SBS_heard_used*	

Notes: (a) Variables came from the 2022 Oklahoma Cow-Calf Biosecurity Survey. (b) For a full description of each variable and the survey question number it was derived from, please see Appendix F.

Probit analysis was completed in the R statistical software. The survey contained a robust set of possible variables that could have been selected. Too many variables would over-estimate the model causing estimate bias. An original set of over 100 possible variables was selected and then reduced based on correlations and information criterion tests.

To prevent under- or over-specification, the regression analysis was first defined using only a single independent variable and then one variable was added at a time to determine which variables are the most problematic to the regression output itself and needed to be dropped. After those variables were removed, the VIF (variable inflation factor) and AIC (Akaike information criterion) were used to identify any further specification errors. Any variable with a VIF of five or higher was removed one at a time from the regression, then the VIF and AIC were checked again.

Another consideration was the number of observations in which a particular question was left blank, and questions with too many incomplete answers were typically eliminated from consideration. The final regression included 638 observations and 41 variables for the calf regression.

The regression with the dependent variable "respiratory vaccinates breeding herd" used all the same variables as in the final regression for the calves except for the removal of the calf variables and the addition of the other breeding herd variables. The breeding herd regression included 526 observations and 45 variables. Likelihood Ratio Tests and the Wald test[4] were run. Both regressions failed to reject the null hypothesis that at least one variable was significant in the model.

Cost Estimation for Vaccinations and Biosecurity

As a complement to the survey data and regression analysis described above, the cost of biosecurity plan implementation was calculated for different sized cow-calf operations in the state. Cost variables were gathered from various sources to create a budget for the cost of different biosecurity and vaccination levels for various herd sizes. The OQBN-certified calf vaccine protocols (Vining 2022) and Oklahoma State Beef Cow-Calf Spring Calving Calendar (Lalman, Barnes, Peverley, Highfill, Wallace, Bidwell, Redmon, Smith, Kirkpatrick, Strasia, & Selk 2017) laid out the schedule and vaccinations necessary for the herd. Core herd assumptions will follow the USDA- National Animal Health Monitoring System (NAHMS) calculations from various years of reports on beef cow-calf operations. Different biosecurity practices from the Secure Beef Supply (SBS) will be used to develop the cost of practices producers may use in

[4] The Wald test was not available in the R package used for probit regression, however, when the model was validated in STATA the Wald tests were run.

place of vaccinations or even in combination with their vaccination program. Groups of biosecurity levels (none, high, and low) along with groups of vaccinations (no respiratory, whole herd, calves only, or breeding herd only) will be added to view the costs associated with each combination producers may choose from for their practices.

Biosecurity Cost Development

Using the Secure Beef Supply (SBS) as guidance for biosecurity practices that can be implemented on a farm, a detailed cost of biosecurity elements was created. The elements included cleaning and disinfectant supplies, equipment, and boot protectants. Each of the biosecurity costs was gathered from various websites found in Appendix C.

Herd size characteristics as shown in Table 6 were based on a NAHMS 2017 Beef Part I (USDA 2020a). The characteristics gathered were calving rate (91.7%), bull ratio (1 bull to 18.6 females), and heifer replacement rate (16.3%). Replacement heifers were further separated into two equal groups of purchased heifers (8.15%) and retained heifers (8.15%). It was assumed that the purchased heifers received the same vaccines as raised replacement heifers.

Table 6: Herd Population Numbers

Cows	***Bulls***	***Calves***	***Calves Sold***	***Kept Heifers***	***Purchased Heifers***	***Heifer total***	***Herd Total***
10	1	10	9	1	1	2	32
25	2	23	21	2	3	5	76
50	3	46	42	4	5	9	150
100	6	92	84	8	9	17	299
250	14	230	211	19	21	40	745

Source: NAHMS 2017 Beef Part 1 (USDA 2020a)

Notes: These numbers were calculated based on USDA herd population percentages

Using the gathered information, a more detailed cost of two different levels of biosecurity was created: baseline and high biosecurity costs. Individual cleaning items were added along with

large bulk protectants (exam gloves and boot covers) and varied syringe sizes (cost includes needles) to implement vaccination under each biosecurity level. Supplies required varied by herd size, and the total cost was calculated under each of the four cow herd inventory levels. This variable cost was added to a fixed cost per operation made up of bulk purchase items, which together provide an overall cost of biosecurity activities. The fixed cost may be a high up-front cost and this analysis may be overestimating the annual fixed cost for producers that have already implemented biosecurity practices on their farm. Information about the items found in the different biosecurity levels along with their prices can be found in Appendix C.

Vaccination Cost Development

The vaccines used are approved by the Oklahoma Quality Beef Network (OQBN) for their VAC-45 certification process for calves. The vaccines can be bought in different quantities based on the herd size being vaccinated but are broken into a per dose cost for this analysis. Most of the vaccine costs were found from PBS Animal Health. This website provided detailed information about each vaccine such as costs, dosage, frequency, restrictions, and antidotes. Some vaccines were not listed on this site, so their information was gathered from Valley Vet. There were a few vaccines on the list in which either no information could be found, or information was provided but no prices could be found, and they were listed as discontinued. Those vaccines are not included in the list of potential vaccines a ranch could use. A table can be found in Appendix D with the vaccines listed in categories with their properties, prices, and website locations.

The cattle vaccine schedule was obtained by following Oklahoma State's Beef Cow Herd Calendar for Spring Calving (Lalman et al., 2017). This provided the necessary vaccines for heifers, calves, cows, and bulls on an annual basis. The average of all vaccines in each category from the OQBN list was used as the cost of vaccination for the cattle herd. Then the vaccine cost

was calculated from the best bundle available for purchase. Table 7 shows the yearly vaccine cost for various types of vaccines at different herd sizes for modified live vaccines (*MLV*) or *Killed* vaccines in their practice.

Respiratory vaccines are the only vaccines in these scenarios to change in which groups they are administered to in the herd in Table 7. The herd is assumed to follow the other OQBN vaccines and vaccines suggested by the Oklahoma State University Beef Cow-Calf Calendar. The two types of respiratory vaccines a producer can choose from are Modified Live Vaccines (MLV) and Killed Vaccines. The next part of the vaccination breakdown is the segments of their herd to which they administer respiratory vaccinations, whether it be the whole herd (All), only the calves (Calves), or only the breeding herd (Breeding). There is also a scenario where the producer may provide no respiratory vaccines.

Table 7: Yearly Herd Vaccination Scenario Costs

Cows	Vaccines MLV (All)	Vaccines MLV (Calves)	Vaccines MLV (Breeding)	Vaccines Killed (All)	Vaccines Killed (Calves)	Vaccines Killed (Breeding)	No Respiratory (All)
10	$119.24	$87.73	$65.53	$123.75	$89.77	$67.99	$34.01
25	$285.15	$207.78	$159.82	$295.52	$212.55	$165.42	$82.44
50	$531.69	$386.79	$297.08	$489.81	$357.83	$284.15	$152.17
100	$1,058.20	$770.78	$588.96	$974.33	$712.87	$563.01	$301.55
250	$2,640.46	$1,937.04	$1,455.73	$2,435.02	$1,791.57	$1,395.76	$752.31

Source: sourced various price sources, see appendix for full details

Notes: the best vaccination combination was used from the overall average prices for the vaccinations gathered found in Appendix E. All means the whole herd was given a respiratory vaccine, Calves means only the calves received a respiratory vaccination, and Breeding means only the breeding herd was provided with respiratory vaccines. All herd numbers were based on NAHMS 2017 Beef Part 1 with respect to the Cows in the herd.

There are two different biosecurity level costs for different herd sizes (shown in Table 8) used in addition to the vaccination scenarios. The Secure Beef Supply (SBS) Biosecurity Check list was used to develop a biosecurity outline for high and low levels for this study. This allows for an idea of understanding the yearly costs per head a producer incurs for different levels of

biosecurity. Low Biosecurity included items such as antibacterial soap, paper towels, syringes with needles, shoulder gloves, and bleach. High biosecurity included all the low biosecurity items along with exam gloves and boot disinfectant. Many of the items in high biosecurity would be assumed to be used in double the quantity to maintain a higher level of cleanliness for biosecurity purposes.

Table 8: Yearly Herd Biosecurity Level Costs

Cows	**Low Biosecurity**	**High Biosecurity**
10	$2.79	$33.55
25	$4.45	$35.21
50	$7.12	$37.88
100	$14.14	$46.59
250	$31.75	$65.89

Source: various price sources, see appendix C for details

Notes: (a) Low Biosecurity included items such as antibacterial soap, paper towels, syringes with needles, shoulder gloves, and bleach. (b) High biosecurity included all the low biosecurity items along with exam gloves and boot disinfectant. (c) yearly costs for each herd size based on the cow population.

CHAPTER VI

RESULTS

When a probit model is used, the regression gives coefficients in the form of z-scores which can be hard to interpret into something meaningful. Regression coefficients were converted into marginal values using the margins function in R so that coefficients are easier to interpret. Marginal values are partial derivatives of the regression with regard to the other variables. The coefficients are now interpreted as predicted probabilities rather than z-scores (An Introduction to 'margins', 2021*)*. Regression results presented as marginal values are shown in Table 9 for the calf vaccination model and in Table 10 for the breeding herd vaccination model.

There were only five variables of significance in Table 9, all with a positive effect on a producer's decision to vaccinate their calves. Clostridial vaccinating the calves, respiratory vaccinating the breeding herd, and larger herd sizes were all significant influencers on a producer's decision to vaccinate their calves for respiratory disease. The use of clostridial vaccinations in the calves increases the predicted probability of a producer's decision to vaccinate their calves for respiratory disease by 0.2421. The use of respiratory vaccination on the breeding herd increases the predicted probability of a producer's decision to vaccinate their calves for

respiratory disease by 0.2131. Further, a herd size of 50 to 99 head increases the predicted probability of a producer's decision to vaccinate their calves for respiratory disease by 0.1244 as compared to those with very small (1 to 25 head) herds. A herd size of 100 to 249 head increases the predicted probability of a producer's decision to vaccinate their calves for respiratory disease by 0.1367 as compared to those with a very small (1 to 25 head) herd. Herd sizes of 250 head or more increase the predicted probability of a producer's decision to vaccinate their calves for respiratory disease by 0.1789 as compared to those with a very small (1 to 25 head) herd.

This tells us that, as the herd size category increased above 50 head there was a positive and increasing impact on the likelihood of using vaccination as compared to the smallest herd size. Further, a producer that administers one type of vaccine may also administer others, pointing to a well-managed vaccination plan for the herd. If the producer provides clostridial vaccines to their calves and or respiratory vaccines to their breeding herd, then they are also more likely to vaccinate their calves for respiratory disease. No other variables were of major significance to a producer's decision to vaccinate their calves.

Table 9: Marginal Values for Probit Regression of Calf Respiratory Vaccination Administration

Variable	AME	SE	Z	P	Lower	Upper
age55to64	0.0463	0.0337	1.3753	0.1690	-0.0197	0.1124
age65to74	-0.0070	0.0298	-0.2359	0.8135	-0.0654	0.0513
bio_not_heard	0.0141	0.0315	0.4472	0.6548	-0.0476	0.0758
Bioplan_elements	0.0223	0.0860	0.2591	0.7956	-0.1464	0.1909
BP__uk_requirements	-0.0877	0.0812	-1.0794	0.2804	-0.2469	0.0715
BP_been_okay	-0.0460	0.0676	-0.6812	0.4957	-0.1784	0.0864
BP_cattle	0.0045	0.0467	0.0960	0.9235	-0.0871	0.0961
BP_costly	0.1884	0.1671	1.1275	0.2595	-0.1391	0.5158
BP_dont_use	-0.0363	0.0789	-0.4598	0.6456	-0.1909	0.1183
BP_how_to_implement	2.1344	1.3268	1.6087	0.1077	-0.4660	4.7349
BP_labor	-0.1711	0.1633	-1.0476	0.2948	-0.4911	0.1490
BP_not_familiar	-0.0615	0.0447	-1.3759	0.1689	-0.1491	0.0261
BP_not_fully_implemented	0.1277	0.2920	0.4371	0.6620	-0.4447	0.7000

Source: Probit regression results based on the 2022 Oklahoma Cow-Calf Biosecurity Survey

Table 9 continued: Marginal Values for Probit Regression of Calf Respiratory Vaccination Administration

BRDi_threat	0.0014	0.0430	0.0331	0.9736	-0.0828	0.0857
BRDi_uk	0.0184	0.0518	0.3553	0.7224	-0.0832	0.1200
BRDp_threat	0.0243	0.0441	0.5502	0.5822	-0.0621	0.1106
BRDp_uk	0.0320	0.0480	0.6665	0.5051	-0.0621	0.1262
BVD_in_my_herd	0.0160	0.0548	0.2922	0.7702	-0.0913	0.1234
BVD_not_in_my_herd	0.0061	0.0406	0.1498	0.8809	-0.0735	0.0857
BVD_seen	0.0531	0.0486	1.0922	0.2747	-0.0422	0.1484
BVD_some_familiar	0.0373	0.0423	0.8827	0.3774	-0.0455	0.1202
BVDi_threat	-0.0111	0.0421	-0.2624	0.7930	-0.0936	0.0715
BVDi_uk	-0.0570	0.0503	-1.1329	0.2573	-0.1556	0.0416
BVDp_threat	0.0622	0.0440	1.4143	0.1573	-0.0240	0.1483
BVDp_uk	-0.0454	0.0468	-0.9711	0.3315	-0.1371	0.0463
cvx_calves	**0.2421**	**0.0383**	**6.3128**	**0.0000**	**0.1669**	**0.3172**
ed_higher_hs	0.0242	0.0275	0.8806	0.3785	-0.0297	0.0781
herd100to249	**0.1367**	**0.0446**	**3.0650**	**0.0022**	**0.0493**	**0.2241**
herd25to49	0.0476	0.0365	1.3048	0.1920	-0.0239	0.1192
herd50to99	**0.1244**	**0.0375**	**3.3166**	**0.0009**	**0.0509**	**0.1980**
herdGE250	**0.1789**	**0.0775**	**2.3075**	**0.0210**	**0.0270**	**0.3309**
mt_record_calves	0.0199	0.0277	0.7186	0.4724	-0.0344	0.0743
op_income_1to20percent	0.0245	0.0342	0.7146	0.4749	-0.0426	0.0916
op_income_21to60percent	-0.0588	0.0414	-1.4199	0.1556	-0.1400	0.0224
op_income_61to100percent	-0.0594	0.0611	-0.9720	0.3310	-0.1792	0.0604
region_ne	-0.0583	0.0415	-1.4050	0.1600	-0.1396	0.0230
region_se	-0.0576	0.0376	-1.5305	0.1259	-0.1313	0.0162
region_sw	0.0026	0.0386	0.0674	0.9463	-0.0731	0.0783
rvx_breeding	**0.2131**	**0.0256**	**8.3268**	**0.0000**	**0.1630**	**0.2633**
sbs_heard_used	0.0075	0.0401	0.1882	0.8508	-0.0710	0.0861
vac_test	0.0276	0.0178	1.5532	0.1204	-0.0072	0.0625

Source: Probit regression results based on the 2022 Oklahoma Cow-Calf Biosecurity Survey

Notes: (a) Probit regression results for respiratory vaccination of the calves in the form of marginal values. (b) a list of the location of each variable in the survey along with a variable description can be found in Appendix F.

Table 10 reports the marginal values for respiratory vaccination probit regression of the dependent breeding herd vaccination variable. Respiratory vaccinating of the calves, clostridial vaccinating the breeding herd, keeping medical records on the breeding herd, education, the producer's perception of BRD in the industry, and a producer's decision to not adopt the elements

of a biosecurity plan due to cost were all significant influencers on a producer's decision to vaccinate their breeding herd for respiratory disease. The use of respiratory vaccinations in calves increases the predicted probability of a producer's decision to vaccinate their breeding herd for respiratory disease by 0.3783. The use of clostridial vaccinations in the breeding herd increases the predicted probability of vaccinating the breeding herd for respiratory disease by 0.1714. A producer who also keeps written medical records on the breeding herd has an increased predicted probability of vaccinating their breeding herd for respiratory disease by 0.0919. A secondary degree also increases the predicted probability that a producer vaccinates their breeding herd for respiratory disease by 0.0899.

One of the disease awareness variables was also significant and had a negative sign. A response of "unknown" when asked to what extent BRD is a threat to the industry resulted in a decrease in the predicted probability to vaccinate their breeding herd for respiratory disease by 0.1895. One of the biosecurity elements was also significant, as the portion of biosecurity elements not adopted due to cost increased a producer's predicted probability to vaccinate their breeding herd for respiratory disease decreased by 0.6463.

Overall, this suggests that a producer who participates in some good herd health management practices—vaccinating calves for respiratory disease, providing their breeding herd with clostridial vaccinations, and keeping medical records for the herd— is likely to vaccinate their breeding herd for respiratory disease. This included a higher level of formal education increasing the likelihood of implementing respiratory vaccination in the breeding herd. It also included a lack of self-education on the risks of BRD (as indicated by selecting "I don't know what the risk of BRD is to the industry) having a negative impact on the likelihood of using respiratory vaccinations in their breeding herd. Finally, those producers who chose not to adopt biosecurity practices due to cost also had a reduced likelihood of implementing respiratory vaccines in the breeding herd.

Table 10: Marginal Values for Probit Regression of Breeding Herd Respiratory Vaccination Administration

Variable	AME	SE	Z	P	Lower	Upper
age55to64	-0.0358	0.0427	-0.8398	0.4010	-0.1194	0.0478
age65to74	-0.0234	0.0407	-0.5751	0.5652	-0.1033	0.0564
bio_not_heard	-0.0122	0.0455	-0.2686	0.7882	-0.1014	0.0770
Bioplan_elements	0.1139	0.1146	0.9944	0.3200	-0.1106	0.3385
BP__uk_requirements	-0.0529	0.1120	-0.4724	0.6366	-0.2723	0.1666
BP_been_okay	0.0121	0.0891	0.1358	0.8920	-0.1624	0.1866
BP_cattle	-0.0343	0.0691	-0.4967	0.6194	-0.1698	0.1011
BP_costly	**-0.6463**	**0.2051**	**-3.1509**	**0.0016**	**-1.0483**	**-0.2443**
BP_dont_use	0.1808	0.0979	1.8471	0.0647	-0.0111	0.3727
BP_how_to_implement	0.0092	0.4494	0.0204	0.9837	-0.8716	0.8900
BP_labor	0.3752	0.2614	1.4355	0.1511	-0.1371	0.8875
BP_not_familiar	0.0124	0.0636	0.1949	0.8455	-0.1122	0.1370
BP_not_fully_implemented	-0.4496	0.3415	-1.3168	0.1879	-1.1189	0.2196
BRDi_threat	-0.0369	0.0572	-0.6448	0.5190	-0.1491	0.0753
BRDi_uk	**-0.1895**	**0.0773**	**-2.4516**	**0.0142**	**-0.3411**	**-0.0380**
BRDp_threat	0.0090	0.0549	0.1644	0.8694	-0.0985	0.1166
BRDp_uk	0.0329	0.0765	0.4292	0.6678	-0.1172	0.1829
BVD_in_my_herd	0.0953	0.0712	1.3391	0.1805	-0.0442	0.2348
BVD_not_in_my_herd	0.0488	0.0592	0.8247	0.4095	-0.0672	0.1648
BVD_seen	-0.0911	0.0736	-1.2377	0.2158	-0.2352	0.0531
BVD_some_familiar	-0.0255	0.0615	-0.4146	0.6784	-0.1460	0.0950
BVDi_threat	0.1035	0.0547	1.8928	0.0584	-0.0037	0.2106
BVDi_uk	0.1316	0.0745	1.7672	0.0772	-0.0144	0.2776
BVDp_threat	-0.1052	0.0560	-1.8783	0.0603	-0.2151	0.0046
BVDp_uk	-0.0528	0.0768	-0.6878	0.4916	-0.2034	0.0977
cvx_breeding	**0.1714**	**0.0343**	**4.9933**	**0.0000**	**0.1042**	**0.2387**
ed_higher_hs	**0.0899**	**0.0365**	**2.4671**	**0.0136**	**0.0185**	**0.1614**
herd100to249	0.0933	0.0592	1.5758	0.1151	-0.0228	0.2094
herd25to49	0.0786	0.0535	1.4701	0.1415	-0.0262	0.1835
herd50to99	0.0649	0.0543	1.1954	0.2319	-0.0415	0.1714
herdGE250	0.0666	0.0798	0.8349	0.4038	-0.0898	0.2230
mt_record_breeding	**0.0919**	**0.0355**	**2.5899**	**0.0096**	**0.0223**	**0.1614**
op_income_1to20percent	-0.0727	0.0480	-1.5132	0.1302	-0.1669	0.0215
op_income_21to60percent	-0.0458	0.0547	-0.8378	0.4022	-0.1530	0.0614
op_income_61to100percent	0.0019	0.0756	0.0248	0.9802	-0.1464	0.1501
PI_bulls	-0.0060	0.0645	-0.0931	0.9258	-0.1324	0.1204
PI_cows	0.1068	0.0866	1.2340	0.2172	-0.0628	0.2765
PI_nonbreed	0.0919	0.0868	1.0585	0.2898	-0.0783	0.2621

Source: Probit regression results based on the 2022 Oklahoma Cow-Calf Biosecurity Survey

Table 10 continued: Marginal Values for Probit Regression of Breeding Herd Respiratory Vaccination Administration

region_ne	0.0947	0.0543	1.7444	0.0811	-0.0117	0.2011
region_se	0.0644	0.0516	1.2478	0.2121	-0.0368	0.1656
region_sw	0.0724	0.0502	1.4407	0.1497	-0.0261	0.1708
rvx_calves	**0.3783**	**0.0437**	**8.6610**	**0.0000**	**0.2927**	**0.4639**
sbs_heard_used	0.0024	0.0471	0.0504	0.9598	-0.0899	0.0947
vac_test	0.0071	0.0197	0.3589	0.7197	-0.0316	0.0457

Source: Probit regression results based on the 2022 Oklahoma Cow-Calf Biosecurity Survey

Notes: (a) Probit regression results for respiratory vaccinating the breeding herd in the form of marginal values. (b) a list of the location of each variable in the survey along with a variable description can be found in Appendix F

This last point can be expounded on through the biosecurity budget analysis. From Table 10, the cost of biosecurity elements was seen to affect a producer's decision to vaccinate their breeding herd for respiratory disease. In Table 4, the cost of biosecurity elements was the second highest reason for not adopting the elements of a biosecurity plan. Based on the cost budget calculated, low biosecurity adds a yearly cost of $2.79 to $31.75 as herd sizes increase and high biosecurity adds a yearly cost of $33.55 to $65.89 as herd sizes increase. In Appendix E, the average price of the vaccines bases on their bulk size was broken down into a single dose cost. It shows that as the bulk dosage amount increases, the individual dose cost typically decreases. The only exemptions to this finding were between the killed respiratory vaccine at bulk doses of 10 to 25, and between Clostridial Bacterin vaccines at bulk doses of 50 to 125.

CHAPTER VII

DISCUSSION AND CONCLUSION

Beef cattle herd health management is a complicated system, involving several different levels of production. Studies indicate that the stocker/backgrounding and feedlot industries benefit from vaccination at the cow-calf level, yet prior surveys have not found a high level of vaccination for common diseases. This causes a concern for cattle disease outbreaks originating from the producer's decision to not vaccinate their herd. If non-vaccinating beef producers started using the resources already available, then their new cost would contribute to healthier cattle herds in the United States which would benefit the entire beef cattle sector. This study explored the factors that motivated higher rates of respiratory vaccination adoption among cow-calf producers, for both calf vaccination and breeding herd vaccination.

Based on the results, calf vaccination seems primarily driven by herd size and the use of other calf vaccines. However, breeding herd vaccination was driven by a more complicated series of factors including education and cost. Vaccinations are a cost to the herd, increasing yearly by $87.73 for small herds providing MLV respiratory vaccines only to the calves with up to $2,640.46 for large herds vaccinating the whole herd with MLV respiratory vaccines under no

levels of biosecurity and following all other suggested yearly vaccinations. Market premiums such as the $1.44 per hundred weights from selling vaccinated cattle at the OQBN sale (Williams et al., 2012) could benefit a producer when they sell their calves. Low levels of biosecurity increase the yearly herd costs from $2.79 to $31.75 as herd sizes increase. Higher levels of biosecurity further increase those vaccination costs by $33.55 to $65.89 as herd sizes increase. The results of this study can be used by cooperative extension specialists to target vaccine programming in the cow-calf sector and to perform further research on the benefits of vaccination to potentially offset the costs. Further, vaccination likelihood increased with herd sizes for the calf regression, but not for the breeding herd. This finding aligns with research from other livestock industries. Campbell et al. (2019) found larger flocks of chickens were more likely to be vaccinated. Further analysis could be done to see if the marginal cost of vaccination in these largest herd sizes is fully offset by the benefits associated with reduced labor and reduced delays in getting sick calves well so they can be marketed.

Education was found to be an important variable, as well as the lack of education on disease risks. This aligns with prior research that found education to have a positive impact on the use of vaccinations as in Campbell et al. (2019) and Chen et al. (2021).

Comparing the 2017 Oklahoma Beef Management and Marketing survey results and the 2022 Oklahoma Beef Cattle Biosecurity survey results for respiratory vaccination of the calves showed an increase of nearly 7 percent in respiratory vaccination rates. This increase is encouraging given the Extension efforts that have happened to promote vaccination over the last 5 years. There is also double the number of producers in 2022 testing their cows for BVD-PI than the producers in 2017 according to the surveys.

This study shines new light on the reasons for vaccination adoption in Oklahoma. The unique survey data and robust response allowed several new variables to be explored, as compared to the

previous literature. This information can be used to develop educational materials and further work to improve the health of the Oklahoma beef cattle herd.

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APPENDICES

APPENDIX A: Edits in Excel for Survey Data

The first step in the process of analysis is to gather the section of interest along with the regions to be able to analyze the state and regional differences by the producers. Each question was copied into another excel document to make sure the original document was not disturbed and so reference to it could be made in case of errors. Some corrections and changes were made to the data to make it more statistical software friendly, and all these changes were made note of on a Word document. These changes range from correcting a number to the appropriate category for the question, adding a dummy variable into blanks to make it more statistical software friendly, making more columns to separate multiple answers in a single column, and changing characters to numbers. It was easier to make changes in the excel document because there is the find and replace feature and an if statement to find and make changes. Some of the changes made to the excel document were also question marks and commas combining multiple answer choices, and others were worded characters needing to be changed to their respective category number.

APPENDIX B: Complete Survey

To obtain the most complete data set for this section of the survey, some producers were filtered out by survey. If the producer was not supposed to complete the survey because they did not manage beef cattle during the 2021 year or they do not currently manage beef cattle, they were filtered out of the total responses because they would have incomplete surveys due to not having cattle. On some questions, zeros were allowed to be put into the whole column as only one option was applicable to each producer such as age range, education level, income percentage from the operation, herd size, region, etc. Unless it was understood a zero could be in place due to only one option, many blanks are left within the data as placing an answer would be an assumption of their choice and practice.

APPENDIX C: Biosecurity Elements' Costs Sources from August 2021

Table 11: Biosecurity Elements' Costs Sources from August 2021

Sources Summer	*Source Year*	*Biosecurity level*	*Item Name*	*Units*	*Single Item Unit*	*Price Per Unit*	*Price Per Single Unit*
Clean it Supply	2021	Both	antibacterial soap 1 gallon	each	gallon	$15.75	$15.75
Clean it Supply	2021	Both	paper towels 30 per case	30 per case	roll	$30.89	$1.03
Clean it Supply	2021	Both	germicidal bleach 1 gal	6 per case	gallon	$44.47	$7.41
Vitality Medical	2021	Both	5ml syringe with 20G needle	100 per box	syringe with needle	$36.10	$0.36
Vitality Medical	2021	High Only	exam gloves 100 count	10 per case	glove	$110.00	$1.10
Glove Nation	2021	Both	35" shoulder gloves 1000 per case	each	glove	$92.00	$0.09
Valley Vet	2022	High Only	Virkon S Disinfectant and Virucide	each	ounces	$68.95	$0.43

APPENDIX D: Vaccine Properties and Prices in Dollars

Table 12: Vaccine properties and Prices in Dollars

SOURCE JANUARY 2022	VAC TYPE	VACCINE NAME	ADMINISTRATION	BOOSTER	<6M REDOSE	ANNUALLY	5 DOSE COST	10 DOSE COST	25 DOSE COST	50 DOSE COST	100 DOSE COST	125 DOSE COST	200 DOSE COST	250 DOSE COST
PBS ANIMAL HEALTH	Respiratory MLV	Express 5	2ml SQ	Y	N	Y		12.97		58.30				
PBS ANIMAL HEALTH	Respiratory MLV	Express FP5	2ml SQ / IM	Y	N	Y		23.61		111.50				
PBS ANIMAL HEALTH	Respiratory MLV	Express FP10	2ml SQ / IM	Y	N	Y	9.83	18.16		84.30				
PBS ANIMAL HEALTH	Respiratory MLV	Pyramid 5 + Presponse	2ml SQ	N	Y	Y		35.66		171.78				
PBS ANIMAL HEALTH	Respiratory MLV	Pyramid 5	2ml SQ	N	Y	Y		12.97		58.30				
PBS ANIMAL HEALTH	Respiratory MLV	Pyramid 10	2ml SQ	N	Y	Y		18.16						

PBS ANIMAL HEALTH	RESPIRATORY MLV	TITANIUM 5	2ML SQ	Y	Y	Y		12.99		59.25
PBS ANIMAL HEALTH	Respiratory MLV	Vista 5 SQ	2ml SQ	N	N	Y	13.87	21.22		91.03
PBS ANIMAL HEALTH	Respiratory MLV	Vista Once SQ	2ml SQ	N	N	Y		42.75		210.17
PBS ANIMAL HEALTH	Respiratory MLV	Bovi-Shield Gold 5	2ml SQ	N	N	Y	8.87	16.70		72.54
PBS ANIMAL HEALTH	Respiratory MLV	Bovi-Shield Gold One Shot	2ml SQ	N	Y	Y	24.24	47.69		231.56
PBS ANIMAL HEALTH	Respiratory Kill	Trianlge 5	2ml SQ / IM	Y	Y	Y		20.66		95.26
PBS ANIMAL HEALTH	Respiratory Kill	Triangle 10	5ml SQ / IM	Y	Y	Y		23.37		108.87
PBS ANIMAL HEALTH	Respiratory Kill	Master Guard 10HB	3ml SQ / IM	Y	N	Y		24.66	51.92	
PBS ANIMAL HEALTH	Respiratory Kill	Vira Shield 6	5ml SQ	Y	N	Y		20.49		88.78
VALLEY VET	Respiratory Kill	Cattle Master Gold FP5	5ml SQ	Y	Y	Y	19.69	35.99	79.99	
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Pulmo-Guard PH-M	2ml SQ	Y	N	N		21.25		79.69
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Pulmo-Guard PH-M-1	2ml SQ	Y	N	N		17.60		86.77
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Bar Somnus 2P	2ml IM	Y	Y	Y		13.69		62.25
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Presponse HM	2ml IM	N	N	N		29.77		142.52
DRUGS.COM	Mann. Hae./Past. Mul.	DurVac Past HM	2ml SQ	Y	Y	N				
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Once PMH IN	1ml per nostril	N	N	Y		34.37		164.77

PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Once PMH IN	2ml one nostril	N	N	Y		34.37	164.77	
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Once PMH SQ	2ml SQ	N	N	Y		34.37	163.77	
DRUGS.COM	Mann. Hae./Past. Mul.	Respavir PMH SQ	2ml SQ	N	N	N				
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	RespiShield HM	2ml SQ	N	Y	N				
DRUGS.COM	Mann. Hae./Past. Mul.	Poly-Bac-B-3	2ml SQ	Y	N	N				
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Super Poly-Bac-B+IBRK&BVDK	2ml SQ	Y	N	N				240.62
ANIMAL HEALTH	Mann. Hae./Past. Mul.	Super Polu-Bac-B Somnus	2ml SQ	Y	N	N			106.50	
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	Nuplura PH	2ml SQ	N	N	N		28.09	131.23	
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	One Shot BVD	2ml SQ	N	Y	N		34.23	171.78	
VALLEY VET	Mann. Hae./Past. Mul.	One Shot	2ml SQ	Y	N	Y	20.99	34.29	158.49	
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	One Shot Ultra 7	2ml SQ	Y	N	Y		41.48	196.74	
PBS ANIMAL HEALTH	Mann. Hae./Past. Mul.	One Shot Ultra 8	2ml SQ	Y	N	Y		41.86	199.00	
PBS ANIMAL HEALTH	Clostridial Bacterins	Alpha 7	2ml SQ	N	Y	Y		9.58	44.72	
PBS ANIMAL HEALTH	Clostridial Bacterins	Alpha 7-MB-1	2ml SQ	N	Y	Y		18.68	87.16	

PBS ANIMAL HEALTH	Clostridial Bacterins	Bar Vac 7	5ml SQ	Y	N	Y		33.38			
PBS ANIMAL HEALTH	Clostridial Bacterins	Bar Vac 7 Somnus	5ml SQ	Y	N	Y	10.70	50.29			
ANIMAL HEALTH	Clostridial Bacterins	Bar Vac 8	5ml SQ	Y	N	Y	8.50	30.45			
PBS ANIMAL HEALTH	Clostridial Bacterins	Caliber 7	2ml SQ	Y	N	Y	8.56	38.87			
ANIMAL HEALTH	Clostridial Bacterins	Clostri Shield 7	2ml SQ	Y	Y	Y	6.34	26.13			118.73
PBS ANIMAL HEALTH	Clostridial Bacterins	20/20 Vision 7 w/ Spur	2ml SQ	Y	N	N	22.22	84.44			
PBS ANIMAL HEALTH	Clostridial Bacterins	Calvary 9	2ml SQ	Y	Y	Y	16.01	53.14	127.49		
PBS ANIMAL HEALTH	Clostridial Bacterins	Covexin 8	5ml SQ	Y	N	Y	12.47	53.96			
PBS ANIMAL HEALTH	Clostridial Bacterins	Piliguard Pinkeye-1 Trivalent	2ml SQ / IM	N	N	Y	15.61	67.04			
PBS ANIMAL HEALTH	Clostridial Bacterins	Vision 7 Somnus w/ Spur	2ml SQ	Y	Y	Y	15.58	62.15			
PBS ANIMAL HEALTH	Clostridial Bacterins	Vision 7 w/ Spur	2ml SQ	Y	Y	Y	10.69	39.18			
VALLEY VET	Clostridial Bacterins	Vision 8 Somnus w/ Spur	2ml SQ	Y	Y	Y	16.99	68.99			
PBS ANIMAL HEALTH	Clostridial Bacterins	Ultra Bac 7	5ml SQ	Y	N	Y	5.77	26.84		99.83	
PBS ANIMAL HEALTH	Clostridial Bacterins	Ultra Bac 7 w/ Somnus	5ml SQ	Y	N	Y	12.37	59.28			
PBS ANIMAL HEALTH	Clostridial Bacterins	Ultra Bac 8	5ml SQ	Y	N	Y	5.81	27.17			
PBS ANIMAL HEALTH	Clostridial Bacterins	Ultra Choice 7	2ml SQ	Y	N	Y	8.89	43.15			
PBS ANIMAL HEALTH	Clostridial Bacterins	Ultra Choice 8	2ml SQ	Y	N	Y	9.20	45.30			
PBS ANIMAL HEALTH	Cow Vaccines	VL5 SQ Cattle	2ml SQ	N	N	Y		80.52			

Notes: All vaccines are from the OQBN recommended list except the Cow vaccine which is from the recommendation of the Oklahoma State Beef Cow Herd Calendar

APPENDIX E: Average Vaccination Costs by Type and Bulk Doses

Table 13: Average Vaccination Costs by Type and Bulk Doses

Vaccine Type	Bulk Dosage	Bulk Price	Single Dose	Single Price
Respiratory MLV	5 doses	$ 14.20	1 dose	$ 2.84
Respiratory MLV	10 doses	$ 23.90	1 dose	$ 2.39
Respiratory MLV	50 doses	$ 114.87	1 dose	$ 2.30
Respiratory Kill	5 doses	$ 19.69	1 dose	$ 3.94
Respiratory Kill	10 doses	$ 25.03	1 dose	$ 2.50
Respiratory Kill	25 doses	$ 65.96	1 dose	$ 2.64
Respiratory Kill	50 doses	$ 97.64	1 dose	$ 1.95
Mann. Hae./Past. Mul.	5 doses	$ 20.99	1 dose	$ 4.20
Mann. Hae./Past. Mul.	10 doses	$ 30.45	1 dose	$ 3.04
Mann. Hae./Past. Mul.	50 doses	$ 140.64	1 dose	$ 2.81
Mann. Hae./Past. Mul.	100 doses	$ 240.62	1 dose	$ 2.41
Clostridial Bacterins	10 doses	$ 11.89	1 dose	$ 1.19
Clostridial Bacterins	50 doses	$ 49.56	1 dose	$ 0.99
Clostridial Bacterins	125 doses	$ 127.49	1 dose	$ 1.02
Clostridial Bacterins	200 doses	$ 99.83	1 dose	$ 0.50
Clostridial Bacterins	250 doses	$ 118.73	1 dose	$ 0.47
Cow vaccine	50 doses	$ 80.52	1 dose	$ 1.61

Notes: varies from Appendix 4 as these are the vaccine price averages from each vaccine approved by the OQBN

APPENDIX F: 2022 Oklahoma Cow-Calf Biosecurity Survey Variables with Survey Location and Detailed Description

Table 14: 2022 Oklahoma Cow-Calf Biosecurity Survey Variables with Survey Location and Detailed Description

Abbreviated Name	Variable Type	Variable Description
Herd 1-24	(0/1)	Q1.4 Value of 1 if the respondent has between 1-24 head of cattle
Herd 25-49	(0/1)	Q1.4 Value of 1 if the respondent has between 25-49 head of cattle
Herd 50-99	(0/1)	Q1.4 Value of 1 if the respondent has between 50-99 head of cattle
Herd 100-249	(0/1)	Q1.4 Value of 1 if the respondent has between 100-249 head of cattle
Herd GE 250	(0/1)	Q1.4 Value of 1 if the respondent has 250 plus cattle
Region NW	(0/1)	Q1.5 Value of 1 if the respondent is in the NW region of Oklahoma
Region SW	(0/1)	Q1.5 Value of 1 if the respondent is in the SW region of Oklahoma
Region NE	(0/1)	Q1.5 Value of 1 if the respondent is in the NE region of Oklahoma
Region SE	(0/1)	Q1.5 Value of 1 if the respondent is in the SE region of Oklahoma
PI Cows	(0/1)	Q2.5a Value of 1 if the respondent tests their cow herd for persistently infected disease BVD
PI Bulls	(0/1)	Q2.5b Value of 1 if the respondent tests their bull herd for persistently infected disease BVD
PI nonbreed	(0/1)	Q2.5c Value of 1 if the respondent tests their non-breeding herd for persistently infected disease BVD
RVX calves	(0/1)	Q2.6d Value of 1 if the respondent vaccinates their calves for respiratory disease
RVX breeding	(0/1)	Q2.6d Value of 1 if the respondent gives their breeding herd a respiratory vaccine
MT record calves	(0/1)	Q2.6m Value of 1 if the respondent keeps medical treatment records of their calves
MT record breeding	(0/1)	Q2.6n Value of 1 if the respondent keeps medical treatment records of their breeding herd
CVX calves	(0/1)	Q2.6q Value of 1 if the respondent gives their calves a clostridial (blackleg) vaccine

Table 14 continued: 2022 Oklahoma Cow-Calf Biosecurity Survey Variables with Survey Location and Detailed Description

CVX breeding	(0/1)	Q2.6r Value of 1 if the respondent gives their breeding herd a clostridial (blackleg) vaccine
Bio not heard	(0/1)	Q3.1 Value of 1 if the respondent has not heard of the biosecurity definition
Bio implemented	(0/1)	Q3.1 Value of 1 if the respondent has heard of the biosecurity definition and has implemented it on their farm/ranch
Bio not used	(0/1)	Q3.1 Value of 1 if the respondent has not implemented the definition of biosecurity on their farm/ranch
SBS NK UK	(0/1)	Q3.2 Value of 1 if the respondent knows what the recommendations of the Secure Beef Supply are and has started implementing or has already fully implemented it on their farm/ranch
SBS heard used	(0/1)	Q3.2 Value of 1 if the respondent does not know what the recommendations of the Secure Beef Supply are and has not started implementing on their farm/ranch
Bioplan elements	(0,1)	Q3.4 Percentage of biosecurity elements that the producer has adopted to their farm/ranch
BP not familiar	(0,1)	Q3.4 Percentage of biosecurity elements that the producer is not familiar with
BP don't use	(0,1)	Q3.4 Percentage of biosecurity elements that the producer is familiar with but does not use
BP been okay	(0,1)	Q3.4 Percentage of biosecurity elements that the producer hasn't done in the past and things have been okay on their farm/ranch
BP uk requirements	(0,1)	Q3.4 Percentage of biosecurity elements that the producer doesn't know what it requires
BP how to implement	(0,1)	Q3.4 Percentage of biosecurity elements that the producer has thought of but needs specifics on how to implement it on their ranch
BP not fully implemented	(0,1)	Q3.4 Percentage of biosecurity elements that the producer does sometimes but has not fully implemented
BP costly	(0,1)	Q3.4 Percentage of biosecurity elements that the producer says is too costly
BP labor	(0,1)	Q3.4 Percentage of biosecurity elements that the producer says requires too much labor
BP cattle	(0,1)	Q3.4 Percentage of biosecurity elements that the producer says they do not have enough cattle to mess with
BVD not familiar	(0/1)	Q5.1 Value of 1 if the respondent has seen the name BVD in the United States
BVD seen	(0/1)	Q5.1 Value of 1 if the respondent is not familiar with the name BVD in the United States
BVD some familiar	(0/1)	Q5.1 Value of 1 if the respondent has some familiarity with BVD in the United States
BVD not in my herd	(0/1)	Q5.1 Value of 1 if the respondent is familiar with BVD in the United States but has not experienced it in their herd

BVD in my herd	(0/1)	Q5.1 Value of 1 if the respondent is familiar with BVD in the United States and has experienced it in their herd
Vac test	(0,4)	Q5.4 Sum of prior vaccination and testing requirements for BRD and BVD prior to entry on the farm
BRDp threat	(0/1)	Q5.5 Value of 1 if the respondent says there is a threat of introducing BRD to their operation due to the arrival of cattle from outside sources
BRDp no threat	(0/1)	Q5.5 Value of 1 if the respondent says there is not a threat of introducing BRD to their operation due to the arrival of cattle from outside sources
BRDp uk	(0/1)	Q5.5 Value of 1 if the respondent says there is an unknown threat of introducing BRD to their operation due to the arrival of cattle from outside sources
BVDp threat	(0/1)	Q5.5 Value of 1 if the respondent says there is a threat of introducing BVD to their operation due to the arrival of cattle from outside sources
BVDp no threat	(0/1)	Q5.5 Value of 1 if the respondent says there is not a threat of introducing BVD to their operation due to the arrival of cattle from outside sources
BVDp uk	(0/1)	Q5.5 Value of 1 if the respondent says there is an unknown threat of introducing BVD to their operation due to the arrival of cattle from outside sources
BRDi threat	(0/1)	Q5.6 Value of 1 if the respondent says BRD is a threat to the beef industry
BRDi no threat	(0/1)	Q5.6 Value of 1 if the respondent says BRD is not a threat to the beef industry
BRDi uk	(0/1)	Q5.6 Value of 1 if the respondent says BRD is an unknown threat to the beef industry
BVDi threat	(0/1)	Q5.6 Value of 1 if the respondent says BVD is a threat to the beef industry
BVDi no threat	(0/1)	Q5.6 Value of 1 if the respondent says BVD is not a threat to the beef industry
BVDi uk	(0/1)	Q5.6 Value of 1 if the respondent says BVD is an unknown threat to the beef industry
Age LE 44	(0/1)	Q6.1 Value of 1 if the respondent is 44 or less
Age 45-54	(0/1)	Q6.1 Value of 1 if the respondent is between the age of 45-54
Age 55-64	(0/1)	Q6.1 Value of 1 if the respondent is between the age of 55-64
Age 65-74	(0/1)	Q6.1 Value of 1 if the respondent is age 75 or older
Age GE 75	(0/1)	Q6.1 Value of 1 if the respondent is between the age of 65-75
ED higher HS	(0/1)	Q6.2 Value of 1 if the respondent has a graduate degree
OP income 0 percent	(0/1)	Q6.9 Value of 1 if the respondent has 1-20 percent of their income come from the farm/ranch
OP income 1-20 percent	(0/1)	Q6.9 Value of 1 if the respondent has 0 percent of their income come from the farm/ranch
OP income 21-60 percent	(0/1)	Q6.9 Value of 1 if the respondent has 21-60 percent of their income come from the farm/ranch

OP income 61-100 percent	(0/1)	Q6.9 Value of 1 if the respondent has 61-100 percent of their income come from the farm/ranch

APPENDIX G: 2022 Institutional Review Board Approval Letter

Oklahoma State University Institutional Review Board

Date:	12/09/2021
Application Number:	IRB-21-520
Proposal Title:	2022 OSU Beef Biosecurity Survey
Principal Investigator:	Amy Hagerman
Co-Investigator(s):	Barry Whitworth, Kellie Raper, Rosslyn Biggs, Tori Marshall
Faculty Adviser:	
Project Coordinator:	
Research Assistant(s):	
Processed as:	Not Human Subjects Research

Status Recommended by Reviewer(s): Closed

Based on the information provided in this application, the OSU-Stillwater IRB has determined that your project does not qualify as human subject research as defined in 45 CFR 46.102 (d) and (f) and is not subject to oversight by the OSU IRB. Should you have any questions or concerns, please do not hesitate to contact the IRB office at 405-744-3377 or irb@okstate.edu.

Sincerely,
Oklahoma State University IRB

APPENDIX H: 2022 Oklahoma Beef Cow-Calf Biosecurity Survey

2022 Oklahoma Cow-Calf Biosecurity Survey

OMB No. 0535-0264
Approval Expires: 09/30/2022

USDA United States Department of Agriculture

NATIONAL AGRICULTURAL STATISTICS SERVICE

OSU AGRICULTURE

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Please make corrections to name, address and ZIP Code, if necessary.

The information you provide will be used for statistical purposes only. Your responses will be kept confidential and any person who willfully discloses ANY identifiable information about you or your operation is subject to a jail term, a fine, or both. This survey is conducted in accordance with the Confidential Information Protection provisions of Title V, Subtitle A, Public Law 107–347, and other applicable Federal laws. For more information on how we protect your information please visit: https://www.nass.usda.gov/confidentiality. Response to this survey is voluntary.

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB number is 0535-0266. The time required to complete this information collection is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Section 1. Cattle Operation Characteristics

Q1. Do you currently manage (e.g. own, lease, professionally manage) beef cattle?

☐ Yes (Continue to Section 1, Q1.1 below.) ☐ No

Have you managed (e.g. own, lease, professionally manage) beef cattle within the past year?

☐ Yes (Continue to Section 1, Q1.1 below.) ☐ No (If no, please stop and return survey in the envelope provided.)

Q1.1. Which of the following production activities have occurred in your operation: (Please check ALL that apply.)	Never	At least once in the past 5 years	Routinely
A. Cow/Calf and retain calves through feedlot	☐	☐	☐
B. Cow/Calf and stocker/backgrounding calves	☐	☐	☐
C. Cow/Calf and sell calves after period of at least 30 days	☐	☐	☐
D. Cow/Calf and sell calves at weaning	☐	☐	☐
E. Stocker/backgrounder and retain calves through feedlot	☐	☐	☐
F. Stocker/backgrounder	☐	☐	☐
G. Custom feeder	☐	☐	☐
H. Purebred seedstock	☐	☐	☐
I. Youth show animals	☐	☐	☐
J. Freezer beef	☐	☐	☐
K. Other_____	☐	☐	☐

Q1.2. Which ONE production activity in Question Q1.1 would you say BEST DESCRIBES your operation? Please write ONLY ONE letter (A through K) in the box below.

☐

Q1.3. Do you manage (e.g. own, lease, professionally manage) beef cows and produce calves?

☐ Yes (continue) ☐ No (Skip to back page, Section 7)

Q1.4. How many beef cows do you currently manage?

☐ 1-24 ☐ 25-49 ☐ 50-99 ☐ 100-249 ☐ 250-499 ☐ 500-749 ☐ 750-999 ☐ 1000 +

Q1.5. In which region of the state is your cattle operation? (As defined by Interstate 40 and Interstate 35)

☐ Northwest ☐ Southwest ☐ Northeast ☐ Southeast

Q1.6. Does your operation maintain cattle on land in multiple Oklahoma counties? ☐ YES ☐ NO

Q1.7. Does your operation maintain cattle on land in states that border Oklahoma? ☐ YES ☐ NO

If Yes, check all states that apply: ☐ Colorado ☐ New Mexico ☐ Texas ☐ Arkansas ☐ Missouri ☐ Kansas

Q1.8. On January 1, 2022, how many of each of the following beef animals were in your operation?

_____ Beef Cows + _____ Calves + _____ Replacement Heifers + _____ Other Cattle + _____ Bulls = _____ Total Cattle

Q1.9. Regarding frequency of retention and marketing, what has been typical of your cattle operation for the past 5 years. (Jan. 1, 2017- Dec. 31, 2021.)	*Please check only one per row.*				
	Always	Frequently	Sometimes	Rarely	Never
Sell steers/bulls at weaning or immediately after preconditioning					
Sell heifers at weaning or immediately after preconditioning					
Retain calves for grazing beyond a preconditioning period for later sale as feeder cattle					
Retain calves through the feedlot					
Retain heifers for replacements ***primarily*** for own use (selling only culled heifers)					
Retain heifers as replacements for own use with the intent to sell ***some*** replacement heifers					
Retain heifers as replacements with the intent to sell as open/bred replacements					

Q1.10. From January 1 to December 31, 2021, which of the animals listed below were: (Check all that apply)	A planned part of my farming/ranching operation	Not part of my operation, but seen within my operation	Fenceline proximity of my operation
Other beef cattle (Not your own)	☐Yes	☐Yes	☐Yes
Other owned cattle maintained separately (e.g. Purebred or show cattle, dairy)	☐Yes	☐Yes	☐Yes
Farmed bison/deer/elk	☐Yes	☐Yes	☐Yes
Sheep/goats	☐Yes	☐Yes	☐Yes
Domestic swine	☐Yes	☐Yes	☐Yes
Poultry	☐Yes	☐Yes	☐Yes
Horses, donkeys, mules, etc.	☐Yes	☐Yes	☐Yes
Feral swine		☐Yes	☐Yes
Wild deer/elk/antelope/bison		☐Yes	☐Yes

Please continue to Section 2.

Section 2: Current Herd Management Practices

Herd and Breeding Management

Q2.1. Are cows/heifers exposed to bulls in your cattle operation? ☐ Yes ☐ No

Q2.2. Do bulls reside on your operation full-time? ☐ Yes ☐ No

Q2.3. Bulls used for breeding my cowherd are: ☐ Owned ☐ Leased ☐ Shared

Q2.4. My bulls are used for breeding in herds outside of my operation: ☐ Yes ☐ No

Q2.5. In your existing herd, do you test the following groups for BVD-PI (persistently infected) animals?

Q2.5a. Cows: ☐ Yes ☐ No **Q2.5b. Bulls:** ☐ Yes ☐ No **Q2.5c. Non-Breeding Stock:** ☐ Yes ☐ No

Calf Health Management Practices

Q2.6. For each practice listed, please indicate whether you do this in your cow-calf operation.

a. Castrate bull calves to sell as steers	☐ YES ☐ NO	If Yes, when? _____ days of age ☐ Branding ☐ Weaning	
b. Calf horn management	☐ YES ☐ NO	If yes, indicate method: ☐ Polled genetics ☐ Dehorning	
c. Minimum 45 day weaning period before marketing	☐ YES ☐ NO		
d. Respiratory vaccines for calves (IBR, BVD, boosters, etc.) prior to marketing	☐ YES ☐ NO	If yes, how many rounds: ☐ Once ☐ More than once	
	If yes, when?	☐ At branding or 1-3 months old	_____ % calf crop
		☐ 2-4 weeks pre-weaning	_____ % calf crop
		☐ At weaning	_____ % calf crop
		☐ Post-weaning	_____ % calf crop
Respiratory vaccines for breeding herd	☐ YES ☐ NO	If yes, what type? ☐ Killed ☐ Modified Live	
e. Deworm calves	☐ YES ☐ NO	f. Deworm breeding herd	☐ YES ☐ NO
g. Get calves accustomed to feed bunks	☐ YES ☐ NO		
h. Implant calves **(any)**	☐ YES ☐ NO		
1. Steer Calves?	☐ YES ☐ NO	If Yes, When? At _____ days of age ☐ At branding ☐ At weaning	
2. Heifer calves intended for market?	☐ YES ☐ NO	If Yes, When? At _____ days of age ☐ At branding ☐ At weaning	
3. Heifer calves intended for replacements?	☐ YES ☐ NO	If Yes, When? At _____ days of age ☐ At branding ☐ At weaning	
i. Target the natural market (no antibiotics, etc.)	☐ YES ☐ NO	If yes, are you enrolled in any of the following types of verification programs: ☐ NHTC ☐ Never Ever ☐ Verified Natural	
j. Age and source verification	☐ YES ☐ NO		

Q2.6. (continued) For each practice listed, please indicate whether you do this in your cow-calf operation.					
k. Keep records of vaccinations - calves	☐YES	☐ NO	l. Keep records of vaccinations – breeding herd	☐YES	☐ NO
m. Keep records of medical treatments - calves	☐YES	☐ NO	n. Keep records of medical treatments - breeding herd	☐YES	☐ NO
o. Individually ID calves	☐YES	☐ NO	p. Individually ID breeding herd animals	☐YES	☐ NO
q. Clostridial (Blackleg) vaccine - calves	☐YES	☐ NO	r. Clostridial (Blackleg) vaccine – breeding herd	☐YES	☐ NO
s. External parasite control - calves	☐YES	☐ NO	t. External parasite control – breeding herd	☐YES	☐ NO
u. Internal parasite control - calves	☐YES	☐ NO	v. Internal parasite control – breeding herd	☐YES	☐ NO
w. Fly tags - calves	☐YES	☐ NO	x. Fly tags – breeding herd	☐YES	☐ NO

Q2.7. Do you have access to the facilities listed below?		If yes, nature of facility is:	If yes, please indicate nature of facility access: (Circle one)	If owned facilities, do any cattle NOT owned by you use these facilities?
Cattle squeeze chute/headgate	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO
Working/ processing pens	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO
Preconditioning pens	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO
Loading chute/ ramp	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO
Scales	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO
Palpation cage	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO
Calf tilt table	☐YES ☐NO	☐Permanent ☐Portable/Temporary	Own Co-Own/Share Rent/Lease Borrow	☐YES ☐NO

Please continue to Section 3.

Section 3: Biosecurity Practices and Animal Movement

Biosecurity **refers to everything that is done to keep diseases and the pathogens that carry them (including viruses, bacteria, funguses, parasites and other microorganisms) away from livestock, property, and people.**

Q3.1. How familiar are you with this definition of biosecurity? Please use only one ✓ or X that most closely applies to you.

	I have never heard of it
	I have heard people talk about biosecurity, but I don't really know what it means for me
	I have at least a basic understanding of what biosecurity means
	I understand biosecurity, but it only applies to farms/ranches bigger than mine
	I understand biosecurity and have implemented principles of biosecurity on my farm/ranch

Q3.2. How familiar are you with the recommendations for the Secure Beef Supply plan? Please use only one ✓ or X that most closely applies to you.

	I have not heard of the Secure Beef Supply plan.
	I have heard about the Secure Beef Supply plan, but I don't know what it is.
	I know what the Secure Beef Supply plan is, but I am not sure how to implement it on my beef operation.
	I know what the Secure Beef Supply plan is and have begun training to implement it on my beef operation.
	I have already implemented the SBS recommendations and my beef operation has a SBS plan in place.

Q3.3. How important are the following biosecurity practices for your farm/ranch? Please use only one ✓ or X per row.	Not important	Somewhat important	Important	Very important	Essential	I'm not sure what this is
Designating a biosecurity manager						
Developing and maintaining a written farm/ranch specific biosecurity plan						
Training all personnel on biosecurity practices						
Having a veterinarian (proven relationship or employee) on the farm/ranch team						
Individual and unique animal identification						
Daily evaluation of cattle health						
Requiring incoming animals be acquired from known source-not a livestock market						
Requiring disease testing of all incoming animals						
Requiring vaccinations for common preventable diseases of all incoming animals						
Isolating all incoming animals from the rest of the herd to monitor for disease						
Records (i.e. movements and health) on all incoming and outgoing animals						
Requiring health records or certifications of all semen and embryos						
Prohibiting the entry of all unpasteurized colostrum or other milk products						
Proper disposal of carcasses to prevent disease transmission or access by wildlife						
Restricting access to hay and feed by wildlife and outside personnel						
Limiting access to your farm/ranch to only authorized persons						
Requiring all persons entering the premises to have clean attire and footwear						
Maintenance of a logbook of all persons entering and leaving the farm/ranch						
Maintaining lines of separation between my farm/ranch and other farms/ranches						
Maintaining cleaning and disinfecting products for vehicles and equipment						
Cleaning and disinfecting vehicles and equipment after use						
Designating parking areas and limiting access for vehicles						

Q3.4. For each biosecurity plan element listed in the table below, please indicate whether this practice is used in your cattle farm/ranch. For practices where you choose NO, please indicate why you do not use this practice with a checkmark in the box(es) across the row for any and all constraints that apply to you. You may have multiple ✓ or X per row.

Do you have the following biosecurity plan elements?	Please indicate YES or NO	I am not familiar with this practice.	I am familiar with this practice, but don't use it.	I haven't done this in the past, and things have been okay.	I don't really know what it requires.	I thought about it. I need help with specifics of how to implement on my ranch.	I sometimes do this, but I haven't fully implemented it.	It is too costly.	It requires too much labor.	I don't have enough cattle to mess with it.
Do you have a designated biosecurity manager?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Is one individual at your farm/ranch responsible development of a biosecurity plan, training and education of visitors?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Do you have a biosecurity plan?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Is your biosecurity plan in writing?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Do you have a Premise Identification Number with Oklahoma Department of Agriculture, Food and Forestry (ODAFF)?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Is biosecurity training taken by all employees of your farm/ranch at least annually?	☐ YES - if Yes, skip row ☐ NO – complete row →									
When biosecurity training is taken by employees of your farm/ranch, is the training documented?	☐ YES - if Yes, skip row ☐ NO – complete row →									
When biosecurity training is taken by employees of your farm/ranch, is training provided in languages other than English?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Do you maintain an entry/exit log of visitors to the farm/ranch?	☐ YES - if Yes, skip row ☐ NO – complete row →									

Q 3.4. (continued) Do you have the following biosecurity plan elements?	Please indicate YES or NO	I am not familiar with this practice.	I am familiar with this practice, but don't use it.	I haven't done this in the past, and things have been okay.	I don't really know what it requires.	I thought about it. I need help with specifics of how to implement on my ranch.	I sometimes do this, but I haven't fully implemented it.	It is too costly.	It requires too much labor.	I don't have enough cattle to mess with it.
Is health testing required of semen and embryos prior to allowing entry?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are there control measures in place to limit wildlife (deer and feral hogs), rodents and other animals from interacting with your cattle herd?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are feed/hay maintained in a manner to prevent contamination from wildlife, dogs, rodents and other animals?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are wildlife, dogs, rodents and other scavengers prevented from having access to carcasses following disposal?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are individual and unique identifiers used for cattle?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are incoming animals required to be from a known source (not a livestock market)?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are all incoming animals required to be tested for common diseases?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are all incoming animals required to be vaccinated for common, preventable diseases?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are records kept of all incoming and outgoing animals to the farm/ranch including movement dates and health records?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Are all visitors entering the farm/ranch showering in and wearing clean clothing and footwear onto the farm/ranch?	☐ YES - if Yes, skip row ☐ NO – complete row →									
Do only authorized individuals have access to the farm/ranch?	☐ YES - if Yes, skip row ☐ NO – complete row →									

In disease outbreaks, the government may pay for cattle that are euthanized as a result of disease control efforts. This is referred to as an indemnity.

Q3.5. Would you be more likely to implement a biosecurity plan if it was a requirement to being paid any indemnity for your infected or exposed cattle?

☐ YES ☐ NO (If NO, please skip to Q3.8)

Q3.6. Would you be more likely to implement a biosecurity plan if it was a requirement to avoid a discount on indemnity payments for euthanized livestock? For example, a disaster payment program might dictate that a farm/ranch with a biosecurity plan in place would receive 100% of market value for euthanized livestock, while a farm without a biosecurity plan in place would receive only 25% of market value when a 75% indemnity payment discount is applied.

☐ NO	☐ YES, I would implement a biosecurity plan to avoid a discount on indemnity payments. Please put a ✓ or a X for all of the discounts below that you would want to avoid. _____5% _____10% _____25% _____50% _____75%

Q3.7.A line of separation is a barrier to prevent or reduce the spread of disease, such as a fence. For the following practices to create a line of separation, please indicate whether you have them in place (YES), do not have them in place (NO), or that they are in place, but not completely or consistently, on your farm/ranch (PARTIAL).

	Yes	No	Partial
a. Does your farm/ranch have a distinct physical boundary, such as fencing, around the entire property?			
b. Do cattle have the ability, or the potential ability, to have nose to nose contact with neighboring cattle on an adjacent premise?			
c. Are all access points to your farm/ranch restricted by a barrier (gates, cable, etc.)?			
	Yes	No	Sometimes
d. Does your farm or ranch have a designated parking area for all vehicles such that they will not enter beyond the line of separation?			
e. Does your farm/ranch work with your neighbors to maximize distance between groups of animals and maintain conditions of boundaries such as fences?			

Cleaning and disinfection is an important part of biosecurity. This includes washing vehicles and equipment in a designated location, or washing down facilities before or after use. It may also include using a disinfecting agent, or allowing equipment to sit in the sun for a period of time.

Q3.8. Does your farm/ranch have cleaning and disinfecting supplies on hand for vehicles and equipment?	☐ YES	☐ NO	☐ Only Sometimes	
Q3.9. Does your farm/ranch maintain a location to clean and disinfect vehicles?	☐ YES	☐ NO	☐ We have a location but no supplies on hand	☐ We keep supplies but do not have a designated location
Q3.10. Do all vehicles and equipment (other than trucks/trailers with live animals) get cleaned and disinfected before entering the farm/ranch?	☐ YES	☐ NO	☐ Only Sometimes	
Q3.11. Do all empty animal transport vehicles (trucks/trailers) get cleaned and disinfected prior to arrival for loading or after use between groups of animals?	☐ YES	☐ NO	☐ Only on arrival	☐ Only after use

Q3.12. For each of the following facilities, please indicate with a ✓ or X for the frequency with which they are cleaned and disinfected after use.							
	NA	Before every use	After every use	As needed	Annually	Monthly	Never
Cattle processing facilities							
Pens							
Barns							
Parking Area							
Office Area							
Vehicles							
Trailers							
Equipment							

Q3.13. Personnel and Visitors - Please indicate with a ✓ a X on each row when the following types of people visit your farm/ranch in the last 2 years and whether they had physical contact with your cattle?			
Type of Visitor	YES, we received this type of visitors	YES, those visits included physical contact with cattle	NO, we did not receive these types of visitors
Veterinarian or other animal health professional			
Nutritionist or animal feed company representative			
Animal pharmaceutical company representative			
Livestock hauler			
Feed hauler			
Market representatives (videotaping or sale arrangements)			
Extension/academic specialists (not including tours)			
Customer (private individual viewing cattle for sale)			
Tours (school, industry or other)			
Other customers (agro-tourism, hunters, etc.)			
Other non-business visitors (producers, neighbors, etc.)			

Records- Please indicate with a ✓ a X on each row whether you keep records and how those records are kept.			
Q3.14. Does your farm/ranch keep records for each individual animal including identification, age, location on the premise, health?	☐ YES	☐ NO (skip to Question 3.18)	☐ MOSTLY
Q 3.15. Are those records maintained at the farm/ranch or by another individual such as veterinarian?	☐ On-site	☐ Off-site	☐ Online
Q3.16 Do you keep records that are:	☐ Paper	☐ Electronic	☐ Both
Q3.17. Does your farm maintain the following kinds of records?			
a. A record of all cattle entering the premises, including date, source, health, etc.	☐ Always	☐ Sometimes	☐ Never
b. Health records for all semen and embryos entering the farm/ranch	☐ Always	☐ Sometimes	☐ Never

Q3.18. From January 1, 2021 to December 31, 2021, indicate for each type of cattle shipment, the *percent* of animals moved by livestock hauling equipment (e.g. trucks, trailers, etc.) of different ownership.				
	Owned Equipment	Borrowed Equipment	Hired Equipment	
Incoming Shipments (Purchaser) Check here if no purchases:				= 100%
Shipments during production (Pasture Movement)				= 100%
Outgoing Shipments (Marketing)				= 100%

Q3.19. If you have used any Borrowed/Shared Equipment in Q3.21, please answer the following questions about borrowed/sharing of equipment from January 1, 2021 to December 31, 2021. If you have not, please skip to Q3.20.			
	Incoming Shipments (Purchases)	During Production (Movements between pastures, etc.)	Outgoing Shipments (Marketing)
a. How many times did you haul cattle using borrowed livestock hauling equipment (trucks, trailers, etc.) from other producers?			
b. How many times was borrowed hauling equipment disinfected prior to use?			
c. How many times did you lend your livestock hauling equipment to other producers?			
d. How many times was shared hauling equipment disinfected when returned?			
e. How many times did you borrow or lend other equipment (tractors, chutes, feed wagons, manure spreaders, etc.) to other producers?			
f. How many times was borrowed or lent equipment disinfected when returned (tractors, chutes, feed wagons, manure spreaders, etc.)?			

Animal Movement			
Q3.20. Did you purchase breeding stock or other cattle for your operation in 2021? ☐ YES (CONTINUE) ☐ NO (Skip to Q3.29)			
Q3.21. If yes, where did you purchase the cattle? Please check all that apply. ☐ Auction Facility ☐ Order buyer ☐ Satellite/Video ☐ Direct from another producer			
Q3.22 Did you purchase cattle from out of state in 2021?	☐ YES	☐ NO	
Q3.23. Were out-of-state cattle shipped to you with a Certificate of Veterinary Inspection (CVI, sometimes called health papers)?	☐ YES	☐ NO	
Q3.24. Does your farm/ranch isolate incoming animals?	☐ YES	☐ NO	☐ Only Sometimes
Q3.25. If your farm/ranch isolates incoming animals, how long are they commonly isolated?	☐ 0-7 days	☐ 8-14 days	☐ 15 days or longer
Q3.26. Have cattle on your farm/ranch traveled and returned from shows, exhibitions, breeding, collection, etc. in the last 2 years?	☐ YES	☐ NO	
Q3.27. Are cattle that travel and return from shows, exhibitions, breeding, collection etc. isolated upon return?	☐ YES	☐ NO	
Q3.28 If owned cattle travel out of state, do you obtain a CVI?	☐ YES	☐ NO	

Q3.29. Please indicate with ONLY one ✓ or X on each row the frequency with which the following statements apply to your operation:	Always	Frequently	Sometimes	Rarely	Never
a. My owned cattle cross state lines moving between properties.					
b. Purchased cattle are processed in the same facilities as owned cattle					
c. Purchased cattle graze the same pastures as owned cattle but are not commingled (i.e. at different times)					
d. Do you maintain a (quarantine) rest period between uses for pastures used both by purchased and raised animals?					

Movement restrictions, i.e. quarantine rules, are commonly put in place while clinical symptoms are being investigated. These restrictions would prevent the movements of livestock on or off of the farm/ranch, and the movement of supplies on or off of the farm/ranch without a permit.		
Q3.30. Do you have a plan to maintain animals on your farm/ranch if animal movement were restricted for several weeks?	☐ YES	☐ NO
Q3.31. Would you need to build temporary pens or facilities for quarantines if animal movement restrictions were put in place?	☐ YES	☐ NO

Q3.32. In the event of an animal movement restriction, please indicate how many days you can continue operations until the following activities would be necessary:

Possible number of days of operation until:	Dec – Feb	Mar – May	Jun – Aug	Sep – Nov
Feed purchase				
Hay purchase				
Moving cattle to different grazing				
Moving cattle to market				

Q3.33. What is the limiting factor to the days you can continue operations as indicated above? (Please rank the top 3 with 1 being most important and 3 being least important)

	Dec – Feb	Mar – May	Jun – Aug	Sep – Nov
Drought				
Grass quality				
Feed and hay availability				
Feed and hay prices				
Cattle prices				
Other 1 (please specify)				
Other 2 (please specify)				

Product Movement			
Q3.34. Does your farm/ranch bring semen and/or embryos onto the farm/ranch?	☐ YES	☐ NO (Skip to Q3.35)	☐ Only Sometimes
Q3.35. Are cattle on your farm/ranch fed dairy products such as colostrum or milk replacer from other farms/ranches?	☐ YES	☐ NO	☐ Only Sometimes
Q3.36. If cattle are fed colostrum or milk replacer from other farms/ranches, what type of product?	☐ Only pasteurized product	☐ Only unpasteurized product	☐ Both pasteurized and unpasteurized
Q3.37. Does your farm/ranch remove manure from your farm/ranch to a different location?	☐ YES	☐ NO	

Carcass Disposal		
Q3.38. How are dead animals on your farm/ranch disposed of? Please indicate with a ✓ or X the disposal method most commonly used.	☐ Burial ☐ Rendering ☐ Burning	☐ Compost ☐ Other _____

Animal Identification

Q3.39. Which of the following are used to identify cattle on your farm/ranch? Please check all that apply with a ✓ or X.

- ☐ Management or Farm Eartag
- ☐ Official ear tag with printed US shield (e.g. silver tags, 840 electronic radiofrequency tags (RFID), orange metal or RFID Bangs vaccination tags)
- ☐ Breed registration tattoo
- ☐ Breed registration brand
- ☐ State registered brand
- ☐ Unregistered brand
- ☐ Ear notch
- ☐ Other

Animal Health Inspection		
Q3.40. How often are cattle inspected for health or illness, including lameness? Please indicate with a ✓ or X the most common frequency of inspection.	☐ Daily ☐ Every 2 days ☐ Once per week	☐ Once per month ☐ Other
Q3.41. Who evaluates the health of animals in Q3.40? Please indicate with a ✓ or X for ALL that apply. If "Other" in Q3.41, please describe here: _____	☐ Owner ☐ Manager ☐ Hired Personnel	☐ Veterinarian ☐ Other

Q3.42. What percentage of your herd has to be affected by disease to consult someone outside of your farm/ranch?

_____5% _____10% _____25% _____50% or more

Recovery

Recovery is the ability of a person, business or industry to return to a pre-disease state or reach a new stable state.

For each of the following foreign animal disease outbreak types, please indicate with only one ✓ or X the likelihood of the following statements for your operation.

Q 3.43 If a foreign animal disease outbreak occurred on *my operation or neighboring operation*,	Very unlikely	Unlikely	Unsure	Likely	Very likely	Will Never recover
a. My operation inventory would return to pre-outbreak levels within 5 years.						
b. My operation's profitability would recover within 5 years.						
c. My operation's reputation would recover within 5 years.						
d. My disease management strategies would change.						
Q 3.44 If a foreign animal disease outbreak occurred in *Oklahoma*,	Very unlikely	Unlikely	Unsure	Likely	Very likely	Will Never recover
a. The state's cattle inventory would return to pre-outbreak levels within 5 years.						
b. The profitability of the state's cattle industry would recover within 5 years.						
c. The state's reputation for cattle would recover within 5 years.						
d. My disease management strategies would change.						
Q 3.45 If a foreign animal disease outbreak occurred in the *United States*,	Very unlikely	Unlikely	Unsure	Likely	Very likely	Will Never recover
a. Trade levels for U.S. beef would recover to pre-outbreak levels within 5 years.						
b. Domestic consumption for beef would recover to pre-outbreak levels within 5 years.						
c. U.S. cattle inventory would return to pre-outbreak levels within 5 years.						
d. Beef prices would recover within 5 years.						

Please continue to Section 4

Section 4: Information Sources and Veterinary Consulting

Q4.1. How often have you sought information on production and/or marketing opportunities for your cattle from the following resources in the last 12 months? Please select the most common frequency for each information source with a ✓ or X in each row.

	Never	Once or twice	More than twice
OSU Area/County Extension Educator			
OSU State Extension Specialist			
OSU Fact Sheets			
OSU Newsletters			
OSU Websites			
OSU Webinars			
SunUp			
OSU Social Media			
OSU Facebook pages			
OSU Twitter accounts			
OSU Instagram			
OSU Other social media (please specify) _____			
Other (please specify) _____			

	Never	Once or twice	More than twice
Veterinarian			
Livestock market manager/staff			
Trade magazine			
Professional marketing service			
Ag Lender			
Other Individuals (please specify) _____			
Beef Industry Social Media (Please Specify)			
Facebook pages			
Twitter accounts			
Instagram accounts			
Other Industry social media (please specify) _____			
Other (please specify) _____			

Q4.2. Which of the following would be most helpful to you as a source of information on *Biosecurity Practices* in cattle operations? Please rank your top 3 picks.

Information Source	Rank Top 3
County Meetings	
Newsletters	
E-mails	
OSU Fact Sheets	
Ranch demonstrations	
Webinars (free online seminars)	
Podcasts	
SunUp	
Facebook	
Twitter	
Instagram	
Other Social Media *(Please specify)* _____	

Q4.3. If you consult with someone outside of your operation *after being affected by disease*, who would be most helpful to you as a source of information? Please rank your top 3 picks.

Information Source	Rank Top 3
Veterinarian	
Livestock market manager/staff	
Ag Lender	
Other Cattlemen	
County Extension Educator	
Online resources	
Social media network	
Industry group representative	
Other *(Please specify)* _____	

Q4.4. Did you use any of the following for your primary veterinarian during 2021? If you used more than one, please indicate with a ✓ or X for the one you used most often.	
	Private veterinarian that you called as needed
	Private veterinarian who made regular or routine visits
	Full time veterinarian on staff
	I did not use a veterinarian in 2021

The FDA definition of a "valid veterinarian-client-patient relationship" (VCPR) is described below. States can have their own definition of a VCPR as well.

1. A veterinarian has assumed the responsibility for making medical judgements regarding the health of (an) animal(s) and the need for medical treatment, and the client (the owner of the animal or animals or other caretaker) has agreed to follow the instructions of the veterinarian;

2. There is sufficient knowledge of the animal(s) by the veterinarian to initiate at least a general or preliminary diagnosis of the medical condition of the animal(s), and;

3. The practicing veterinarian is readily available for follow-up in case of adverse reactions or failure of the regimen of therapy. Such a relationship can exist only when the veterinarian has recently seen and is personally acquainted with the keeping and care of the animal(s) by virtue of examination of the animal(s), and/or by medically appropriate and timely visits to the premises where the animal(s) are kept.

Q 4.5 Do you have a VCPR with your veterinarian for cattle on this operation?

❑ YES ❑ NO ❑ I don't know

Q 4.6 How would you describe your VCPR with your veterinarian? Please indicate with a ✓ or X for ALL that apply.	
	A written document signed by my veterinarian and me
	A verbal agreement between my veterinarian and me
	My veterinarian has not formally mentioned a VCPR but I consider that I have one based on his relationship with my operation

Please continue to Section 5

Section 5: Disease Knowledge

Q5.1 What is your familiarity with the following diseases present in the United States?

	I am not familiar with it	I have seen the name	I have some familiarity with it	I am familiar with it, but have not experienced it in my herd	I am familiar with it and I have experienced it in my herd
Bovine Viral Diarrhea Virus (BVD)					
Johne's Disease					
Trichomoniasis (*Tritrichomonas fetus*)					
Bovine Leukemia Virus					
Infectious Bovine Rhinotracheitis (Rednose/IBR)					
Bovine Respiratory Syncytial Virus					
Bovine Parainfluenza 3 Virus					
Pasteurella multocida					
Mannheimia haemolytica					
Leptospirosis					
Anaplasmosis					
Vibriosis					
Campylobacteriosis					
Brucellosis					
Tuberculosis					
Theileria/Babesiosis (Texas Cattle Fever)					
Vesicular Stomatitis					
Bluetongue					
Malignant Catharrhal Fever					

Q5.2 What is your familiarity with the following foreign animal diseases?

	I am not familiar with it	I have seen the name	I have some familiarity with it	I am familiar with it, but would not recognize the symptoms	I am familiar with it and I would recognize the symptoms
Foot and Mouth Disease					
Bovine Spongiform Encephalopathy					
Rinderpest					
Heartwater					
Rift Valley Fever					
New World Screwworm					
Lumpy Skin Disease					
Contagious Bovine Pleuropneumonia					

Q5.3. Did you bring any new cattle) onto this operation in the last 3 years? This includes permanent additions as well as temporary additions such as leases and breeding agreements.

☐ YES ☐ NO (Skip to Q5.5)

Q5.4. Before bringing any cattle onto this operation in the last 3 years, did you normally require any vaccination and/or testing for the animals:

	Vaccination	Testing	Both	Neither	NA
Johne's disease (M. paratuberculosis)	[redacted]		[redacted]		
TB (bovine tuberculosis)					
Brucellosis (males and adult females)					
Brucellosis (heifers)					
BVD (bovine viral diarrhea)					
Respiratory disease (IBR, PI3, BRSV)					
Trichomoniasis (trich)					
Leptospirosis					
Other _____					

Q 5.5. Please rate the threat of introducing the following diseases into your operation due to the arrival of cattle from outside sources (check one per row):

	Large Threat	Medium Threat	Low Threat	Not a Threat	Don't know	Unfamiliar with the Disease
BRD (Bovine Respiratory Disease aka shipping fever or pneumonia)						
Clostridial (Blackleg, Tetanus)						
Coccidiosis						
Pinkeye						
Persistently infected Bovine viral Diarrhea (BVD) Cattle						
BLV (bovine leukosis virus) infection						
Tuberculosis (M. bovis)						
Brucellosis/bangs (B. abortus)						
Trichomonas infection (trich)						
Johne's Disease (M. avium)						
Foreign animal disease (e.g. Foot and Mouth Disease)						
Anaplasma infection						
Neospora infection						
Bluetongue						
Internal parasites (worms)						
Resistance to anthelmintics (dewormers)						

Q5.6. Do you believe the following health issues are a significant problem for the beef industry?

	Large Threat	Medium Threat	Low Threat	Not a Threat	Don't Know	Unfamiliar with the Disease
BRD (Bovine Respiratory Disease aka shipping fever or pneumonia)						
Clostridial (Blackleg, Tetanus)						
Coccidiosis						
Pinkeye						
Persistently infected Bovine viral Diarrhea (BVD) Cattle						
BLV (bovine leukosis virus) infection						
Tuberculosis (M. bovis)						
Brucellosis/bangs (B. abortus)						
Trichomonas infection (trich)						
Johne's Disease (M. avium)						
Foreign animal disease (e.g. Foot and Mouth Disease)						
Anaplasma infection						
Neospora infection						
Bluetongue						
Internal parasites (worms)						
Resistance to anthelmintics (dewormers)						

Q5.7. Would you AGREE, DISAGREE, or have NO OPINION with the following statement? Please select only one.

"The United States is well prepared to handle outbreaks of livestock disease currently not found in this country, such as foot-and-mouth disease."

☐ AGREE ☐ DISAGREE ☐ NO OPINION

Please continue to Section 6

Section 6. Producer Characteristics

Q6.1. Please circle your age group: ☐ <25 ☐ 25-29 ☐ 30-34 ☐ 35-39 ☐ 40-44 ☐ 45-49 ☐ 50-54 ☐ 55-64 ☐ 65-74 ☐ >75

Q6.2. Please circle the category that best describes the highest level of education that you have attained:

☐ High school graduate ☐ Vocational, technical, or 2-year degree ☐ Bachelor's degree ☐ Graduate or professional degree ☐ None of these

Q6.3. How many years have you been a primary decision maker in the cattle business? (Please circle one.)

☐ <5 ☐ 5-10 ☐ 11-15 ☐ 16-20 ☐ 21-25 ☐ >25

Q6.4. Please rank (1, 2, and 3) your top motivations for raising or owning cattle?

☐ Primary source of income
☐ Supplemental income
☐ Lifestyle/enjoyment
☐ Control excess forage/land management
☐ Tax advantages
☐ Family tradition/obligation
☐ Other 1 – Please specify: _____
☐ Other 2 – Please specify: _____

Q6.6. Do you live on the primary land base for your cattle operation?

☐ YES ☐ NO

Q.6.7. Of the total acreage of land used for cow/calf production, what percent is: _____Owned (%) + _____ Leased (%) = 100% Total

Q6.8. Which of the following best describes the past year's household NET INCOME from all sources?

☐ Less than $30,000
☐ $30,000 - $59,999
☐ $ 60,000 - $89,999
☐ $90,000 -$119,999
☐ $120,000 and above

Q6.9. Approximately what percentage of the past year's household net income came from your beef cattle operation?

☐ Zero percent
☐ 1 to 20 percent
☐ 21 to 40 percent
☐ 41 to 60 percent
☐ 61 to 80 percent
☐ 81 to 100 percent

Q6.10. Have you completed Beef Quality Assurance (BQA) training? ☐ YES ☐ NO

If yes, what year did you complete the training? _____

Q 6.11. Are you aware of the BQA Daily Biosecurity Plan for Disease Prevention? ☐ YES ☐ NO

Q6.12. Have you completed (or currently enrolled in) OSU's Master Cattleman program? ☐ YES ☐ NO

Q6.13. Have you completed (or currently enrolled in) OSU's Cow-Calf Boot Camp? ☐ YES ☐ NO

Q6.14. Are you a member of any of the following? (Please check all that apply.)

- ☐ Local/County Cattlemen's Association
- ☐ National Cattlemen's Beef Association
- ☐ American Farmers & Ranchers
- ☐ Veterinary Professional Association
- ☐ Breed Association (please state which below)

_____

- ☐ Oklahoma Cattlemen's Association
- ☐ Texas & Southwest Cattle Raisers
- ☐ RCALF
- ☐ Farm Bureau
- ☐ Other: _____

We know your time is valuable. Thank you for completing the survey and helping us better serve you!

VITA

Kristina Marie Harwell

Candidate for the Degree of

Master of Science

Thesis: FACTORS AFFECTING RESPIRATORY VACCINATION OF BEEF CATTLE IN OKLAHOMA

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