

Active Assessment of U.S. Livestock Biosecurity and Policies

**A Thesis Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville**

**Victoria Lynn Campbell
May 2019**

Copyright © 2019 by Victoria L. Campbell
All rights reserved.

ACKNOWLEDGEMENTS

I would first like to express my sincere gratitude to my advisor, Dr. Jada Thompson, for her unwavering support, profound guidance, reflective teaching, and continual encouragement over the last two years. I would also like to thank the members of my thesis committee, Dr. Burton English and Dean David White, as well as, my undergraduate advisor Jonathan Walton. Their participation and reassurance throughout this research process cultivated my passion for success along with the resources to do so.

I would like to acknowledge the Department of Agricultural and Resource Economics at the University of Tennessee. This department has been my home for the past six years throughout my undergraduate and graduate studies, and it has provided an extraordinary environment for growth and learning, both academically and socially. I will cherish the connections and friends I have made here, along with the many new opportunities I was able to experience.

Lastly, I would like to thank my parents, Tony and Rhonda; sisters, Jessica and Rylee; Granny Annie; Aunt Tracy; and Sheryl for their emotional and financial support. Without them, and many wonderful, loving friends, I would not be where I am today. I thank God for each of them and this incredible opportunity.

ABSTRACT

Effective livestock disease management is a fundamental necessity for producers to provide and the government to guarantee a safe and secure food supply for consumers. It is the responsibility of both parties to ensure that the industry is appropriately protected from Foreign Animal Diseases (FADs). Producers, consumers, communities, businesses, and the environment can all suffer when an FAD outbreak occurs. To what extent an outbreak can be damaging depends greatly on the level of biosecurity producers have in place and the livestock disease management procedures government officials have created. Currently in the United States, more work can be done on both sides. This study looks at what producers are currently doing in regard to disease prevention on their operations, what they prefer, and what they are willing to improve upon.

Livestock producers were surveyed, and their responses were analyzed in efforts to answer two separate questions: What are poultry producers' willingness to pay (WTP) to adopt on-farm carcass disposal capabilities, and what indemnity policy do feedlot operators prefer. Preventative biosecurity at the farm level is covered thoroughly throughout the literature, however, a minimal amount of research has been conducted on producers' preferences and decision-making processes post-FAD outbreak, which is the focus of this work. Individual operation characteristics provided additional factors for the econometric analysis of each study. A one and one-half bound dichotomous choice question allowed an interval regression model to be estimated for poultry producers WTP for on-farm carcass disposal showing poultry producers were willing to pay

\$15,651 on average (one-time payment). Producers ranked four different indemnity policies in order of preference, which allowed a ranked-order probit model to estimate what policies are preferred by feedlot operators and the factors contributing to that policy. In general, livestock insurance with government subsidized premiums was the second-best choice behind status quo policy potentially providing a next best option in terms of producer preferences. By analyzing this type of producer information, policy writers and industry leaders can create new policies that both encourage early disease reporting and incentivize greater biosecurity implementation, which will reduce the effects of FAD outbreaks when they occur.

TABLE OF CONTENTS

INTRODUCTION.....	1
CHAPTER I Producer's willingness-to-invest in on-farm carcass disposal: a study on U.S. poultry biosecurity during a disease outbreak	3
Abstract	4
Introduction.....	5
Background	8
Poultry Disease	8
A Biosecurity Culture.....	10
Disposal Methods.....	11
Disease Outbreak Zones	12
Routine Poultry Mortality	13
Government Incentive	14
Data	15
Methodology	16
Conceptual Framework	16
Modeling	17
Results.....	21
Interval Regression Results	22
Conclusions	24
CHAPTER II Producer Perception of Current U.S. Livestock indemnity policy	27
Abstract	28
Introduction.....	28
Background	31
Government Compensation	31
The Challenge.....	32
Possible Solutions.....	34
Data	36
Methodology	37
Conceptual Framework	37
Modeling	38
Results.....	41
Small Feedlots	42
Perception of Disease Likelihood	43
Conclusions	44
CONCLUSION	47
REFERENCES.....	50
APPENDICES	61
Appendix A	62
Appendix B	73
Poultry Biosecurity Survey	73
Feedlot Biosecurity Survey	77
VITA	81

LIST OF TABLES

Table 1.1 Summary Statistics of Select Poultry Producer Survey Responses	64
Table 1.2 Simplified Probit Model Results of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)	65
Table 1.3 Simplified Probit Model Marginal Effects of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)	65
Table 1.4 Probit Model Results of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$).....	66
Table 1.5 Probit Model Marginal Effects of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)	66
Table 1.6 Interval Regression Results of Producer Willingness to Adopt Additional Disposal Capacity	67
Table 2.1 Summary Statistics of Select Feedlot Operator Survey Responses.....	68
Table 2.2 Ranked-Ordered Probit Model Results for Feedlot Operator Indemnity Policy Preferences.....	70
Table 2.3 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Market Value	71
Table 2.4 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Farm Receipts	71
Table 2.5 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Biosecurity Efforts.....	72
Table 2.6 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Subsidized Insurance	72

LIST OF FIGURES

Figure 1.1 Example of Zones, Areas, and Premises in HPAI Outbreak Response (USDA-APHIS-VS 2015)	62
Figure 1.2 Map of States Represented in “Midwest” Variable	63
Figure 2.1 Initial Survey Tabulations for Feedlot Operator Indemnity Policy Preferences	69

INTRODUCTION

With value of agricultural production totaling nearly \$400 billion in 2016, the agriculture industry has and will continue to play a vital role in the U.S. economy (USDA-ERS 2016b). More specifically, animal agriculture represents a major portion of that value. The top agricultural commodity in the United States is cattle and calves and both dairy and broiler production are included in the top five U.S. commodities (USDA-ERS 2016a). It is imperative that these industries remain protected as livestock producers face countless coinciding risks that many other businesses may not. Weather, disease, the environment, public-health, as well as, animal welfare are just a few issues that livestock producers manage, and it is up to them to balance each risk, along with the specific regulations that accompany them. The U.S. government has many policies in place to assist farmers in handling these risks. In particular, if a livestock disease outbreak occurs, there is legislation in place to minimize damages and costs to the farm, the public, the environment, and the government itself.

The following two chapters will provide an in-depth analysis of farmer willingness to pay for increased biosecurity and livestock indemnity preference by examining results from a livestock producer survey. By evaluating producers' responses to current government policy pertaining specifically to animal agriculture in the event of a disease outbreak, government officials will have a more complete understanding of the producers' decision-making process in the presence of such risks. Estimating producers' willingness to invest in on-farm biosecurity methods will also help policy writers gauge future financial legislation pertaining to animal disease prevention and

eradication. After all, the government's aim in regulation is to ensure that animals are healthy, production systems are efficient, producers are not unfairly burdened, consumers have a safe and secure food supply, and governmental costs to taxpayers are minimized. The results and conclusions of these two analyses on farmer's willingness to pay and their indemnity preferences will provide valuable insight that has not previously been discussed in the literature.

CHAPTER I
PRODUCER'S WILLINGNESS-TO-INVEST IN ON-FARM CARCASS
DISPOSAL: A STUDY ON U.S. POULTRY BIOSECURITY DURING A
DISEASE OUTBREAK

Abstract

Biosecurity procedures play a vital role in livestock disease management both in prevention and in management after a Foreign Animal Disease (FAD) outbreak. As one of the more integrated livestock commodities, the U.S. poultry industry mandates certain biosecurity and disease safety standards, however, the decision to implement these practices are ultimately left up to the individual producer. These operational decisions occur as producers weigh the risks between short-term costs and long-run disease protection, which can be translated into changes in profit margins and potential moral hazard which occurs because biosecurity is non-excludable. Producers free-ride on other farms' biosecurity expecting that if an FAD outbreak does occur, their neighbors' disease protection efforts will stop it. However, despite producers weighing the risks of preventing a disease at the farm-level, they can neglect the levels of biosecurity procedures that are necessary when an outbreak happens, specifically for this study, on-farm carcass disposal for routine mortality. When an FAD is reported, zones are created around the premises that restrict the movement of animals and animal products across and outside of those zones in order to limit disease spread. If a poultry producer normally uses a disposal method such as a renderer or landfill for their routine mortality, they can no longer transport those carcasses offsite if their operation falls within a movement restricted zone forcing them find other means of on-farm disposal. This study estimates poultry producer willingness to pay (WTP) for on-farm carcass disposal methods for routine mortality during an FAD outbreak.

From an online producer survey, a group of poultry producers were asked questions about their operations' characteristics and disease perception, along with a one and one-half dichotomous choice question that provided actual costs of adoption. An interval regression model was created to estimate the average WTP and allowed for the analysis of various factors that influenced the WTP. The results provide industry and policy writers costs and information that can be used when creating new policy and plans to incentivize farm-level biosecurity, while continuing to encourage disease reporting, which together, improves overall livestock disease management in the United States.

Introduction

Poultry, specifically chicken, has always been a main protein source for humans, however, throughout history, it has been inferior to both beef and pork (red meat) consumption, until recently (Barclay, 2012; National Chicken Council, 2017). In 2015, United States per capita poultry consumption surpassed that of red meat consumption for the first time since before 1960 with total poultry consumption ending at 105.2 pounds per capita and total red meat consumption ending at 104.2 lbs. per capita (National Chicken Council, 2017). According to the literature, various factors such as medical research, changes in household dynamic, and even changes in prices and preferences in other areas of the economy explain the increase of poultry consumption in the United States (Barclay, 2012; O. B. Kennedy et al., 2004; Rimm, 2011; Tonsor, Mintert, and Schroeder, 2010).

Information about the healthfulness of meat is a vital contributing factor to the consumers' demand. Publicly-available and reader-friendly medical research like the Harvard Health Letter published by the Harvard School of Health has allowed the average consumer to be more informed about various aspects of their health (Rimm, 2011). In Dr. Eric Rimm's edition of the Harvard Health Letter (2011), he explains the percentages of fats in animal proteins and the potential repercussions of consuming them, along with illustrating that chicken and turkey both have significantly lower levels of saturated fat than beef and pork. He shows that according to the research, high levels of saturated fat consumption are associated with heart disease and the facets that accompany it (Rimm, 2011). The same conclusion was drawn by Dr. Michael Miller in a study published in the American Heart Association Journal where nurses, over a 26-year period, who consumed more than the recommended amount of red meat, increased their risk of chronic heart disease by thirty percent (Miller, 2010). Tonsor, Mintert, and Schroeder (2010) published research from a study concluding that increased information about such heart diseases and diet has a negative effect of demand for consuming beef. Environmentally-conscious consumers may have also impacted the poultry consumption shift because even with the drastic advances in technology to produce animals more efficiently, red meat animal production has a more negative impact on the environment (requires more land, food and water) than poultry (Barclay, 2012; O. B. Kennedy et al., 2004).

Aside from increased public information, the rise in poultry consumption can also be explained due to changes in household dynamics. In the same study by Tonsor,

Mintert, and Schroeder (2010), they also discovered that for every one percent increase in food purchased outside of the home, it increased poultry consumption demand by 1.9%. Increased food consumption outside of the home (e.g. eating at restaurants) results from more households having both parents in the workforce thus less time to prepare meals at home, and it is positively related to poultry consumption because more restaurants serve chicken on their menus because it is cheaper than beef (Speer, 2013; Spiegel, 2014). Even with the affordability of poultry, it still represents a significant portion of the U.S. agricultural economy. In 2016, according to the United States Department of Agriculture's National Agricultural Statistics Service (USDA-NASS), the value of sales for poultry in the United States was approximately \$38.7 billion with over half of those sales (67.04%) coming solely from broiler production (USDA-NASS, 2016).

Poultry is a major component of Americans' diet; therefore, producers need to be vigilant and take the necessary precautions to protect their livestock so that a healthy supply of poultry products is consistently available to consumers. The situation for a poultry farmer can change in an instant; one seemingly small disease outbreak can cause substantial disruptions for a poultry producer and the supply chain as a whole through disease and response efforts, such as depopulation and transportation restrictions. There are practices producers can adopt and implement to limit these types of risks and help facilitate business continuity during such an event. Estimating poultry producers' willingness to invest in on-farm carcass disposal capabilities will provide a better understanding as to what incentives and disincentives policy makers should

consider in preventing, controlling, and eradicating animal disease outbreaks in the future.

Background

Poultry Disease

There are numerous diseases that birds can acquire and cause devastating impacts to farms, consumers, public-health, and the economy as a whole (Hennessy and Wolf, 2018). Two of the most common types of fatal bird diseases are Exotic Newcastle Disease (END) and Avian Influenza (AI). END is a viral disease that can be contracted by all birds. With a death rate of nearly 100 percent, END is known to be “one of that most infectious poultry diseases in the world” (2014 USDA-APHIS). The last reported commercial outbreak of END in the United States was from 2002-2003 and cost the federal government around \$180 million to stop and eliminate the spread of the disease (USDA-ARS 2016).

The bird virus that has caused the most damage to the United States in recent history is AI, specifically, Highly Pathogenic Avian Influenza (HPAI). This viral disease is carried by waterfowl and other wild birds (Hawkins et al., 2017). There is also a virus known as Low Pathogenic Avian Influenza (LPAI). The difference between the two pathogenicities is if the poultry mortality rate is greater than 75 percent, then it is considered HPAI (OIE 2015). Due to the high mortality rates associated with the disease, HPAI is a great concern for both farmers and the government. The most recent case of HPAI was reported on March 5, 2017 as a strain H7 in Lincoln County, Tennessee (USDA-APHIS 2017). The poultry house consisted of 73,500 birds that,

once reported, were quarantined and depopulated (USDA-APHIS 2017). The disease was quickly controlled and no other cases around the area were reported. This was a major victory for the USDA's Animal and Plant Health Inspection Service (APHIS) along with all other participants who were involved in the process of controlling and surveying the infected area, as well as, taking the necessary precautions so the disease would not spread to other farms or other sectors of the supply chain. The previous outbreak in 2014-2015 did not prove to be as easily and quickly resolved. HPAI was first discovered in the United States in December of 2014 and lasted until June of 2015. Over the course of the outbreak, 42.1 million egg-layer and pullet chickens along with 7.5 million turkeys were depopulated, and the cost to the federal government exceeded \$950 million in taxpayer money (USDA-APHIS-VS 2016). Not only was this the largest outbreak and spread of HPAI in noted U.S. history, but overall, it was also the largest animal health event in U.S. history (Hagerman and Marsh, 2016). Action and planning committees were put in place after this outbreak to research and create policy and protocols on how to prevent such a catastrophe from happening again. It is evident that some progress was made from the 2015 outbreak to the most recent one in 2017, however, more can still be done on both the farmer-level and policy-level, such as increased farm-level biosecurity awareness, training and protocols, increased surveillance for diseased birds, and more effective indemnity payment policies that incentivize the implementation of biosecurity measures and disease reporting without financially disincentivizing these actions due to indemnity payments being too large.

A Biosecurity Culture

Farmers have the first chance to prevent animal health disasters from occurring with biosecurity measures they have or could have in place. Biosecurity is a set of methods, protocols and/or actions implemented to lessen the introduction of disease and minimize the negative effects of an outbreak (Muhammad and Jones, 2008). Biosecurity is recognized as a public good because it is non-rivalrous and non-excludable. The non-rivalry notion indicates that when a farmer implements biosecurity measures, it does not hinder or take away the opportunity for another farmer to implement biosecurity measures. Likewise, biosecurity is non-excludable because a farmer cannot prevent another person from reaping the benefits of biosecurity measures that they implement (Siekkinen et al., 2012). The entire supply chain from farm to consumer benefits from farm-level biosecurity. Consumers gain by having a safe, healthy food supply and having the peace of mind of positive animal welfare. However, biosecurity is also a “weaker link” public good (Burnett, 2006; Hennessy and Wolf, 2018; Siekkinen et al., 2012). The level of biosecurity in place is only as great as the weakest effort. The farmer that takes the least amount of effort to implement biosecurity measures is also the farmer that has the least to lose or to protect, meaning, the community of producers’ biosecurity efforts are only as strong as the smallest producer (Hennessy and Wolf, 2018). This is the reason why biosecurity is also an externality. Whether it is a positive or negative externality depends on whether biosecurity is implemented or not. When a farmer implements biosecurity on his or her own farm, it only positively affects the surrounding farms. However, the reverse is also true. Producers do not always have to

reap the consequences of not implementing good biosecurity on their own farms; they free-ride off of the biosecurity that producers around them implement in hopes that if a disease occurs, it will be stopped by another producer (Hennessy and Wang, 2010; Hennessy and Wolf, 2018; Sumner, Bervejillo, and Jarvis, 2005). The only way this process can correct itself is if a “biosecurity culture” is created among farmers. This would consist of farmers informing and encouraging their neighbor producers to adopt biosecurity measures even though the financial motivations are not immediately identifiable (Julien and Thomson, 2011). In terms of carcass disposal biosecurity, the externality is evident. Depending on where a farmer disposes of their dead livestock, it could have immensely positive or gravely negative implications for other farmers, people, and the environment.

Disposal Methods

While animal diseases are contracted through several faucets, biosecurity, which includes the type of disposal method used, influences both farming and supply chain outcomes. Livestock carcass disposal methods are vastly discussed throughout the literature. Historically, the most used methods for carcass disposal have been burial and burning (Gwyther et al., 2011). Today, the most widely known carcass disposal methods are burial, incineration, composting, rendering, and landfill disposal (Blake et al., 2008; Bonhotal, Jean and Schwarz, Mary, 2009; Gwyther et al., 2011; Hawkins et al., 2017). Other current disposal methods that may be infrequently used include anaerobic digestion and alkaline hydrolysis, along with several others (Blake et al., 2008; Gwyther et al., 2011). These latter methods were developed to address environmental concerns

regarding carcass disposal, but they can be very costly to implement. There are pros and cons to each type of disposal method, but a producer selects which method will be the best fit financially and geographically for their individual operation.

Disease Outbreak Zones

Despite the best efforts of biosecurity, there can still be a disease event if there is enough pathogenic pressure. When a disease occurs, the “Foreign Animal Disease Preparedness & Response Plan,” published by the USDA-APHIS-Veterinary Services (USDA-APHIS-VS), outlines four different zones that are established around the infected farm. **Figure 1.1** (all tables and figures are located in the **Appendix A**) displays a visual representation of each zone (USDA-APHIS-VS 2015). The location of where the outbreak is detected and reported is known as the “infected zone” and consists of the area around the infected premises. The perimeter of this zone must be no less than 1.86 miles (3 km) around the infected premises. The next zone is known as the “buffer zone” and is a perimeter no less than 4.35 miles (7 km) beyond the infected zone perimeter. Both of these zones together are known as the “control area,” which is ~6.21 miles (10 km) around the initial infected premises (Hawkins et al., 2017; USDA-APHIS-VS 2017). Movement and transportation restrictions are placed on farms that lie within the “control area” in efforts to stop a disease from spreading. On-farm carcass disposal capacity is vital if and when a highly infectious disease outbreak occurs. The obvious reason is for those farms that contract the disease and are mandated to depopulate entire houses of birds at a time. In order to estimate producers’ perception of proactive disease measures, this study will focus on disposal capabilities of poultry producers that

lie within the “control area,” instead of the catastrophic mortality that occurs on the initial infected premises.

Routine Poultry Mortality

In 2012, according to the USDA’s National Agricultural Statistics Service (NASS), there were 233,770 poultry farms in the United States, where there were 42,226 broiler operations, 198,272 layer farms, and 19,956 turkey farms (USDA-NASS 2015). Based on a layer hen study conducted in 2013 by the USDA-APHIS-VS National Animal Health Monitoring System (NAHMS) (2014), over 50% of farms experienced routine mortality at rates of 4% or higher. They also discovered that small farms had the highest percentage of higher mortality, which also reiterates the notion that biosecurity is indeed a weaker link good (USDA-APHIS-VS 2014).

Routine mortality is inevitable for poultry producers. All poultry producers have some way of disposing of their routine mortality. However, if a major disease outbreak occurs, the producer’s operation falls within the control area, and their disposal choice is transporting the carcasses to or having them picked up to be transported to either a rendering facility or landfill, that producer now has to dispose their mortality through a different outlet since the carcasses cannot be moved off the premises to prevent possible spread of the disease. Even though the producer is not the one with the infected poultry, they still lay within in the control area, and if this happens, they may or may not be prepared to implement an on-farm disposal measure. According to the University of Tennessee Extension’s *Commercial Poultry Producer’s Guide to Disposal Options for HPAI Mortalities in Tennessee*, “all commercial poultry producers should

have an HPAI response plan in place” (Hawkins et al., 2017). However, through reading the guide, there seems to be a large emphasis on the word “should.” Therefore, this unknown facet of whether or not a producer would be prepared to handle all of their routine mortality is dependent on several factors. One consists of the producer’s opinion of how soon and how often a disease outbreak could occur. If a producer does not already have a safe method to dispose of routine poultry mortality on their farm or the supplies and plan available to implement on-farm carcass disposal methods, then if the farm is caught within the control area, the producer may resort to measures that could negatively affect the surrounding community and environment. This could be as simple as burying carcasses too close to the ground water table and contaminating the water supply or throwing them in an open trench that can easily become a vector for disease spread (Blake et al., 2008; Gwyther et al., 2011; Henry and Bitney, 2010). These types of questions, along with others related to on-farm carcass disposal adoption (willingness to pay), will be discussed through the results and analysis of a poultry producer survey.

Government Incentive

When considering a producer’s WTP, other options that could incentivize biosecurity adoption will be analyzed. One question on the producer survey asks about a government cost-share program. It insinuates that if the government was willing to subsidize a percentage of the cost of adopting on-farm biosecurity, would the producer then be willing to pay the remaining percentage? Other questions consider if a poultry producer’s willingness to adopt could change if the decision to adopt was tied to indemnity payments from the government in the event of catastrophic mortality loss.

This latter question will be analyzed more in-depth in the next chapter of this study. Nonetheless, there is a challenge surrounding incentivizing producers with government assistance because the assistance must be great enough to persuade a farmer to adopt and report when disease is detected, but not so great that it discourages the farmer to adopt preventative and disposal biosecurity measures all together (Fraser, 2016; Hennessy and Wolf, 2018).

Data

In the fall of 2018, an online poultry producer survey was sent out by Watt Poultry USA and the U.S. Poultry and Egg Association to poultry producers across the United States. The eleven-question survey focuses on current, individual poultry operation management decisions, mainly, the producer's current carcass disposal methods/plans and his or her WTP to increase on-farm biosecurity efforts (**Appendix B**). To gather numerical data to estimate each producer's WTP, the survey consisted of a one and one-half bound (OOHB) dichotomous choice question (Bateman et al., 2004; Thompson et al., 2018; Tonsor, Schroeder, and Lusk, 2013). Producers were given a scenario of a possible impending disease and transportation restrictions and the question (**Appendix B, Question 4**) was stated "Given knowledge of this situation and the implications it may present to your operation, if it costs \$X in one-time, fixed expenses to establish this capacity on your operation to dispose on-site for at least 2 months would you make this investment within the next 3 years?" \$X represented a randomized cost that was calculated using the Mersenne Twister, Qualtrics native algorithm (Qualtrics, 2015). For those that indicated 'yes,' a follow-up question was asked to better refine their WTP

bound by doubling the amount they first saw, and for the ‘no’ answers, other additional questions were asked in efforts to flip their indicated ‘no’ to a ‘yes,’ regarding willingness-to-invest in biosecurity methods.

Methodology

Conceptual Framework

Producers face countless decisions that involve risk for their business. These production decisions are made in order for the producer to maximize profit subject to a given level of utility that particular producer requires (Nicholson and Snyder, 2012). For many producers, the utility is that farming is their livelihood, it is what they know, and it is the thing they enjoy doing most. Above that, they are profit maximizers. Producers are also price takers due to their heavy involvement in both the input and output market sectors (Levin and Milgrom, 2004). Because they cannot set their own prices, the decisions regarding farm costs are vital for the producer and crucial for the government to understand when trying to enhance current livestock disease management policies. To the producer in the short run, not implementing certain biosecurity methods saves them money through costs associated with implementation. However, in the long run, producers potentially end up losing more money than they saved by not implementing because their operation was left disease-susceptible. Thus, biosecurity poses a condition to producers: short run cost-savings versus long run disease-susceptibility. This decision is based on risk, and because producers are thought to be risk averse (Mulwa et al., 2017), the decision to protect their farm against risk in the long run would prevail, but the producer’s perception of disease occurrence must also be considered.

Producer's disease perception compared to other variables will be analyzed from *Question 6* on the survey (**Appendix B**). It is hypothesized that if producers think disease occurrence is less likely to impact their individual farm, then their willingness-to-invest in biosecurity will also be less likely. Moreover, due to cost constraints facing producers as a result of being price takers, it is also projected that they will not have an exceptionally high WTP.

Modeling

A probit model consisting of variables from the survey questions will be used to estimate poultry producers' average WTP to improve their current biosecurity methods (Hanmer and Kalkan, 2013; Meng et al., 2014; Mulwa et al., 2017; Okpukpara, 2016). The probit model was selected as a result of the latent variable approach (1) where the dependent variable of this model is binary, e.g. either 1 or 0, with 1 being "will adopt" and 0 being "will not adopt," and the idea that other underlying factors are influencing that decision in the model (Moore, 2013). This can be represented as:

$$y_i^* = \beta x_i + \varepsilon$$

$$y_i \begin{cases} 1 & \text{if } y_i^* > \tau \\ 0 & \text{if } y_i^* \leq \tau \end{cases} \quad (1)$$

where τ is some unknown threshold, y^* is unobserved, β represents a vector of coefficients, X are explanatory variables, and ε is the error term, and for the probit model, is normally distributed.

In looking for producer's WTP, marginal effects must be calculated to determine which variables in the model change in order for the dependent variable to become

more likely. The maximum likelihood estimation method will be utilized to determine which variables increase a producer's willingness-to-invest in on-farm carcass disposal due to the non-linearity of the data (Maddala, 1988; Samal et al., 2011). Equation 2 shows the probability function as,

$$P_i = \Phi \left[\beta_1 + \sum_{j=2}^k \beta_j x_{ij} \right] \quad (2)$$

where Φ is the cumulative normal distribution of the error term, j is the number of betas (β), k represents the number of variables that have coefficients, and i is the number of observations. Because the model will be estimated using the maximum likelihood method, the likelihood equation can be written as:

$$L = \prod_{y_i=1} P_i \prod_{y_i=0} (1-P_i) \quad (3)$$

In order to transform the nonlinear likelihood function (3) into a model that can be regressed linearly, the log must be taken, which is represented by equation 4. Finally, the derivative of the log-likelihood function will thus allow the variable coefficients, or betas, to be estimated.

$$LL = \sum_{j=2}^k \ln P_i + \ln(1-P_i) \quad (4)$$

From there, the surveyed producers mean WTP was estimated using equation 5 (ERD 2013):

$$\left(\beta_1 + \sum_{i=3}^n \frac{\beta_i * x_i}{\beta_2} \right) * (-1) \quad (5)$$

where β_i represents the estimated coefficients in the model, n is the number of observations, and x_i represents the variables included in the model.

The hypothetical latent variable model for this study is illustrated by equation 6. The illustration includes variables that may or may not be included in the final model but are included in the preliminary model because they are hypothesized to have a significant effect on a producer's willingness-to-invest.

$$\begin{aligned} \text{BioQ} = & \beta_1 + \beta_2 \text{BioCost} + \beta_3 \text{Onsite} + \beta_4 \text{DeathLoss} + \beta_5 \text{Small} + \\ & \beta_6 \text{Midwest} + \beta_7 \text{FullOwn} + \beta_8 \text{ProbOfDisease} + \varepsilon \end{aligned} \quad (6)$$

where *BioQ* is the binary dependent variable with 1 being “will adopt” and 0 being “will not adopt”; *BioCost* represents the randomized cost of adopting on-farm carcass disposal the producer was presented while participating in the survey; *Onsite* represents the percentage of current on-farm carcass disposal; *DeathLoss* represents the farm's routine mortality rate; *Small* is a binary variable that represents the number of birds on the operation with 1 being farm size less than or equal to 149,999 birds and 0 being farm size greater than or equal to 150,000 birds; *Midwest* is a binary variable that incorporates the location of the operation with 1 being located in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Wisconsin (See **Figure 1.2**) and 0 otherwise; *FullOwn* represents a series of binary variables describing the ownership of the operation with 1 representing the producer's share of ownership being greater than or equal to 81 percent and 0 being less than or equal to 80 percent; *ProbOfDisease* represents a series of binary variables describing

the producer's individual perception of disease risk; β represents the coefficients associated with the variables; and ε represents the error term for the model.

However, fairly large samples sizes are needed for this type of probit model to gain accurate estimations (Lopez-Feldman, 2012). Due to limited survey responses and small sample size (15 useable observations once all variables were included), an integral regression model was created to derive more precise WTP results. This type of model consists of upper and lower bounds, which enhances the results by creating a more accurate representation of the data. The bounds are the costs that the producers were presented while taking the survey for the OOHb question (Bateman et al., 2004). The log-likelihood equation that was used to calculate the interval regression model can be written as,

$$LLF = \sum_i \left\{ d_i^N \ln \Phi(\lambda Z_i + \beta X_i) + d_i^{YN} [\ln \Phi(\lambda Z_i + \beta 2X_i) - \ln \Phi(\lambda Z_i + \beta X_i)] + d_i^{YY} [1 - \ln \Phi(\lambda Z_i + \beta 2X_i)] \right\} \quad (7)$$

where for the i th feedlot operator: $d_i^N=1$ when the response was NO, $d_i^{YN}=1$ if the response was YES-NO, and $d_i^{YY}=1$ if the response was YES-YES, 0 otherwise; Z_i represents a series of explanatory factors, X_i are the prices presented, λ and β are vectors of conformable coefficients (Thompson et al., 2018; Tonsor et al., 2010). The surveyed producers' predicted mean WTP for the interval regression model was then estimated using equation 8:

$$\widehat{WTP} = \frac{1}{n} \sum_{i=1}^n x_i \hat{\beta} \quad (8)$$

The models were estimated with robust standard errors to adjust for any heteroskedasticity, and a correlation matrix, collinearity diagnostic index, and a variance

inflation factor (VIF) test were all estimated to test for this. All results were well below concerning thresholds.

Results

Before any models were estimated, summary statistics were calculated on the dataset (**Table 1.1**). The range of randomized costs that producers saw while taking the survey and that were generated by Qualtrics within preset limitations was between \$2,057 and \$47,428. Of producers who responded to the survey, 40.2% already utilized some sort of on-farm carcass disposal capabilities, and the average farm mortality rate was 4.15%. The majority of respondents considered themselves larger operations, as only 26.7% of producers had 149,999 birds or less, and only 11.3% of surveyed producers had an ownership share of 81% or more in their operation. A quarter of producers (24.6%) believed the probability of an FAD affecting their individual operation was 5% or less, meaning there would not be an FAD outbreak that would affect their farm within the next 25 years. Lastly, of the producers who completed the survey, 47.6% would be willing to adopt additional on-farm carcass disposal capabilities, showing initially that there is indeed some level of willingness to expand on-farm disposal capacity among poultry producers who participated in the survey.

To gain a base estimate for producers' WTP for on-farm carcass disposal, a probit model was estimated that only included the *BioCost* variable, which was the costs presented for the OOHB question (**Table 1.2 & 1.3**). A higher cost corresponded with a greater likelihood of a producer claiming they would adopt new or additional on-farm

carcass disposal methods; however, this result was not statistically significant. With only including the cost in the model, the average willingness to pay was \$29,609.

The probit model (**Table 1.4 & 1.5**) with the additional variables, *Onsite*, *DeathLoss*, *Small*, *Midwest*, *FullOwn*, and *ProbOfDisease* was estimated but was insignificant due to the limited sample size, which lead to omitted variable biases. However, because of the OOH question, upper and lower bounds were established for the respondents' WTP, thus allowing a shift from the probit model to an interval regression model (Bateman et al., 2004; Lopez-Feldman, 2012).

Interval Regression Results

Based on the interval regression model (**Table 1.6**), several variables that were collected from the survey pertaining to the adoption of on-farm disposal methods were significant and could serve as estimators of the larger population of poultry producers. Producers who already have on-farm carcass disposal capabilities in place are less likely to be willing to adopt, which is economical given prior investments. Specifically, these producer's WTP was \$490 less, on average. Although not statistically significant, the interval regression results also showed that producers who have high mortality rates on their farms are more willing to adopt on-farm carcass disposal methods. An explanation for this response can be that operations with higher mortality could be faced with a larger predicament if under a movement restriction due to a disease outbreak and if they do not have on-farm disposal capabilities. Size of farm seemed to also have a statistically significant impact on willingness to adopt. Smaller farms, farms with 149,999 birds or less, were less willing to adopt as well, which could be contributed to the

weaker link public good mindset that sometimes surrounds biosecurity, or it could be that smaller farms have less capital and disposable income to spend implementing such on-farm measures. These smaller producers' WTP was \$19,549 less, on average.

A surprising finding that did not coincide with prior expectations, was related to producers who were considered to have full ownership of their operation. The model showed that these owners were less likely to invest by an average of \$37,490. A theory as to why this result was substantial could be that, as full owners of the poultry operation, the financial burden of implementing new biosecurity procedures would fall solely on their shoulders, whereas, for a producer who may share ownership of a poultry operation, they could perceive the costs of new biosecurity adoption could be shared, thus reducing the financial burden. Lastly, producers who had a disease probability of 1 to 5% were also less likely to adopt. These producers believe that an FAD outbreak will not affect their individual operation within the next 25 years. Therefore, they have a lower WTP for additional biosecurity implementation like on-farm carcass disposal because the current costs of implementation are not recuperated by the discounted future benefits that this type of biosecurity would provide. On average, these producers had a WTP of \$36,460 less.

Overall, poultry producers who participated in the survey have a statistically significant mean WTP to implement on-farm carcass disposal methods of \$15,651. This indicates that there is a market for adopting biosecurity practices among poultry producers who participated in the survey, which could translate to a larger majority of poultry producers as a whole. If this did indicate some willingness to adopt by poultry

producers at large, it could signal the importance of disposal capacity and biosecurity practices in addressing potential financial risks associated with disease exposure.

Conclusions

In recent years, poultry consumption has surpassed red meat consumption for the first time in decades. Research on the healthfulness of poultry and lower prices have been identified as contributing factors to the rise in poultry popularity. With such high consumer demand, it is vital for producers to protect the poultry food supply, through ways such as biosecurity at the farm-level. Researchers have discussed the moral hazard associated with biosecurity and its weaker-link public good notability. A farming community's biosecurity is only as good as the smallest farm's or the lowest amount of biosecurity efforts in place. It is easy for a producer to piggyback off of other producers' biosecurity implementation in hopes that they stop a disease outbreak, however, the issue arises when their farm is not protected, they contract an FAD, and then the surrounding farms, community, and economy are damaged by no fault of their own. Biosecurity procedures before, during, and after a livestock disease outbreak are important, and their awareness and implementation cannot be understated.

Most people think of preventative measures when the topic of biosecurity arises, however, there is an immense amount of biosecurity practices and methods that are vital after or when an FAD outbreak occurs. This study looked at a group of poultry producers' WTP for on-farm carcass disposal methods by analyzing their responses to a survey. The survey consisted of questions relating to individual operation characteristics (size, location, mortality rate, ownership, etc.) and current biosecurity

procedures. The producers who participated in the survey were also provided with a one and one-half bound (OOHB) dichotomous choice question relating to their willingness to implement on-farm carcass disposal practices at randomized cost levels (Bateman et al., 2004; Thompson et al., 2018). Using select variables from the survey, along with the answers to the OOHB question, an interval regression model was formulated to estimate the mean WTP for the group of poultry producers that participated in the study.

Statistically significant results showed that small producers, who fully own their poultry operations, that already possess some sort of on-farm carcass disposal capabilities, and who believed no FAD would affect their operation within the next 25 years, had a lower WTP for on-farm carcass disposal methods. Taking into consideration those variables that significantly lowered a producer's willingness to adopt, the overall mean WTP for the poultry producers who participated in the survey was \$15,651. This study aimed to understand producers and create awareness pertaining to FADs and carcass disposal during a disease outbreak, while also identifying specific poultry farm characteristics and factors that impact their willingness to adopt such practices. Policy writers can use this information when creating or amending livestock disease management legislation in the future, and it will allow them to see what factors impact and contribute to these types of financial decisions for poultry producers.

To improve and extend this study in the future, a larger sample size would allow stronger predictions to be made for the larger majority of poultry producers. A study in

connection to this one, surveyed feedlot operators to estimate their WTP to adopt feedlot lot on-farm carcass disposal methods. However, expanding into other animal proteins, such as dairy or pork, would allow for a more rounded WTP estimation for the livestock industry as a whole.

CHAPTER II
PRODUCER PERCEPTION OF CURRENT U.S. LIVESTOCK INDEMNITY
POLICY

Abstract

Livestock disease management is crucial for producers. However, the government holds the responsibility to ensure that proper management is carried out because livestock diseases not only affect animals and producers, they also impact public welfare and the economy as a whole. The largest animal health event on record in the United States was an outbreak of Highly Pathogenic Avian Influenza in 2014, and it cost U.S. taxpayers approximately \$950 million to stop, control, and eradicate the disease. A main duty the U.S. government has in eradicating a disease is through the depopulation of infected or potentially infected animals. In order for this to happen legally however, producers must be paid fair market compensation for the animal. Livestock indemnity has been covered vastly throughout literature from the policy level, yet research is lacking at the producer level, particularly on producers' preferences regarding indemnity. Through a ranked-ordered probit model, producers' rankings of four different types of indemnity are analyzed. The results indicate heterogeneity in preference rankings and provide policymakers with insightful information on producers' opinions on compensation after a disease outbreak and allow legislators to consider producers' preferences when updating or creating new policies regarding livestock disease management in the future.

Introduction

Livestock disease management can be difficult to implement, regulate, and enforce, yet it is a highly essential task that the U.S. government must address. Its significance is

due to the fact that livestock diseases not only affect animals, but also impact producers, public welfare, and the economy as a whole (Sumner et al., 2005). The largest animal health event in U.S. history was the outbreak of Highly Pathogenic Avian Influenza (HPAI) in December of 2014. The outbreak lasted until June of 2015 and cost the U.S. government approximately \$950 million (USDA-APHIS-VS 2016). The most recent outbreak of Virulent Newcastle Disease (VND), which, like HPAI, affects poultry and other bird species, was confirmed on May 18, 2018 (Hayden and Cole, 2018). The largest case of VND in the United States, or what was then referred to as Exotic Newcastle Disease (END), started in 2002 and lasted until 2003, costing U.S. taxpayers roughly \$180 million in government funds (USDA-ARS 2016). Aside from costing the United States money and resources to detect, eradicate, and compensate producers, livestock diseases also influence other areas of the economy such as international trade and general overall commodity prices. For example, Bovine spongiform encephalopathy (BSE), commonly known as “mad cow disease,” was first confirmed in the United States in Washington State on December 23, 2003 and spurred multiple countries to ban U.S. beef imports, which in turn, forced domestic beef prices to plummet (Jin, Skripnitchenko, and Koo, 2004). Even though U.S. consumers reaped the benefit of cheaper domestic beef prices, it was reported that producers experienced approximately 20 percent losses in gross revenue due to the price decline (Sumner et al., 2005).

Livestock disease management cannot be solely left up to the producer because of the public good effect it symbolizes. The public benefits outweigh the private benefits in disease management because the producers themselves are responsible for

implementing prevention and biosecurity measures at their own private costs, while the public reaps the benefits of disease outbreaks not occurring. Due to this reason, producers tend to underinvest in preventative disease measures because they do not see the private incentive for them to do so (Sumner et al., 2005). As a result, government intervention is necessary for effective livestock disease management. It is their responsibility to ensure producers are implementing *ex-ante* and *ex-post* disease measures through the balancing of public benefits and private costs (Gramig, Horan, and Wolf, 2009; Hennessy and Wolf, 2018; Muhammad and Jones, 2008). One way the government is currently attempting to assist in livestock disease management is through compensation after an outbreak occurs, which typically includes the direct costs associated with eradicating the disease and the value of the livestock that is depopulated. This study focuses on producers' views of current indemnity policy and possible changes to the ways indemnity could be handled in the future. Variations in producers' viewpoints will also be analyzed based on factors such as individual perception of a disease outbreak occurring, size of operation, and type of livestock raised. This analysis and findings will be beneficial to policy makers as they are trying to conceptualize the best methods to approach livestock disease management in the future.

Background

Government Compensation

When a livestock disease is identified or reported in a herd or flock, by law, the U.S. government has the responsibility to step in and take action. Title 7 of the U.S. Code of Federal Regulations under the Animal Health Protection Chapter 109 § 8301 states, “Congress finds that the prevention, detection, control, and eradication of diseases and pests of animals are essential to protect animal health, the health and welfare of the people of the United States, the economic interest of the livestock and related industries of the United States, [and] the environment...” (U.S. Government, 2012, p. 7). Detection, control, and eradication of disease pests, 7 C.F.R. § 8303 (2012) goes on to state that “the Secretary [United States Secretary of Agriculture] may carry out operations and measures to detect, control, or eradicate any pest or disease of livestock.” However, livestock diseases are eradicated by depopulating the diseased animals and others that have the potential to become infected. The 5th Amendment of the U.S. Constitution states “...nor shall private property be taken for public use, without just compensation” (U.S. Government, 1992). Because these animals are privately owned by individual producers and are being seized by the government for the good of the public, the producers must be paid compensation, as it is written. This compensation is also known as indemnity (Hennessy and Wolf, 2018; Kuchler and Hamm, 2000; Muhammad and Jones, 2008; Ott, 2005).

The agency within the United States Department of Agriculture (USDA) that is responsible for carrying out the actions to detect, control, and eradicate livestock

diseases is the Animal and Plant Health Inspection Service (APHIS) (Grannis and Bruch, 2005; Kuchler and Hamm, 2000). The agency is in charge of calculating indemnity payment amounts for the diseased animals. Cooperative control and eradication of livestock or poultry diseases, 9 C.F.R. § 51.3 (2000) states that “each eligible animal will be appraised to determine its fair market value. The indemnity shall be the appraised value, minus the salvage value.” In other words, the indemnity payment the producer will receive is the APHIS appraised fair market value less any other compensation the producer receives for the deceased animals such as insurance payouts or other disaster assistance (Gramig et al., 2009; Grannis and Bruch, 2005; Ott, 2005). Compensating producers fair market value for diseased animals seems reasonable, however the government wants producers to see this compensation as an incentive to report disease early so it can be stopped with minimal damage, and as an incentive to implement biosecurity at the farm level to prevent the introduction of disease. Some worry that the current uniform methods of indemnity may be creating perverse incentives for producers to produce diseased animals and/or to not report disease altogether because indemnity only covers the direct cost of the depopulated animal leaving many indirect costs of a disease outbreak up to the producer (Gramig et al., 2005, 2009; Hennessy and Wolf, 2018; Kuchler and Hamm, 2000; OECD, 2017). This ordeal is thoroughly discussed in the literature.

The Challenge

As previously discussed, as policy makers consider changes to the current way indemnity is handled, they must recognize producers’ private costs and benefits. An

issue with current indemnity is that it does not cover indirect costs of a disease outbreak. These “consequential losses” can include, but are not limited to, the cost of feed for animals awaiting depopulation, loss in reproductive or genetically superior stock, and loss of income due to downtime and immobility as a result of quarantines (Gramig et al., 2009; Grannis and Bruch, 2005; Ott, 2005; USDA-APHIS 2017). From an outsider’s perspective, the largest risk to the producer seems to be the loss of the actual animal during a disease outbreak, however, that may not be the case in all situations. In some instances, these indirect costs have the potential to create substantial burdens for producers. As a result, producers who recognize the damaging effects the disease eradication process can have on their individual business, may rethink reporting the disease in the first place and either depopulating themselves or proceeding to take the livestock to slaughter, which can have grave implications due to the rapid transmission capabilities of diseases. Therefore, the current form of indemnity could be counterproductive as it could be doing the exact opposite of what indemnity is supposed to. It further exacerbates the outbreak of disease instead of identifying it early and controlling it (Gramig et al., 2005).

On the other hand, if policy makers make indemnity payouts too large, this can create perverse incentives for producers to produce more diseased animals and at the least, discourage producers from implementing preventative biosecurity measures at the farm level (Hennessy and Wolf, 2018; OECD, 2017). This idea is what many in the literature call the “moral hazard” of government indemnity for livestock disease (Gramig et al., 2009; Hennessy and Wolf, 2018; Muhammad and Jones, 2008). A study

published by Muhammad and Jones (2008), mathematically illustrated this indirect effect of higher indemnity. They showed that a rise in the number of diseased animals being reported to APHIS is due to higher compensation, which can lead to the reduction of biosecurity adoption, thus increasing the number of diseased animals overall. Some researchers go as far to say that based on their own research conclusions, even fair market value for diseased livestock is too high and by compensating producers at that rate is damaging producers' incentives to invest in biosecurity (Fraser, 2016; Hennessy and Wang, 2010). Kuchler and Hamm (2000) explain that in the short run, if reports of diseases are decreasing and relative indemnities are increasing or remaining constant, then diseased animals must be becoming harder to find, thus the indemnity program is working. However, this only works if there is an incentive to actually look for infected animals. Policy makers must understand producer's private incentives when planning livestock disease indemnity programs. The challenge has been covered greatly throughout the literature, and many of the researchers also offer recommendations or solutions to improve current policy.

Possible Solutions

One solution to the perverse incentives surrounding government indemnity is a policy that shifts more of the risk of livestock disease to the producer (Gramig et al., 2009; Hennessy and Wolf, 2018; OECD, 2017). Instead of the government being responsible for paying compensation for diseased and depopulated animals, a new policy could include discounted indemnity rates for already diseased animals and producers receiving no indemnity payment at all for dead animals. This shifts some of the risk to

the producer and greatly encourages early reporting of disease because producers will essentially be losing more money the longer they wait to report. In conjunction, the idea also creates the necessary incentive for producers to implement biosecurity because there is no longer a motivation to produce diseased animals (Gramig et al., 2009; Hennessy and Wolf, 2018; OECD, 2017). A policy that shifts the risks of disease to the producer while also encouraging both early reporting and biosecurity implementation simultaneously, is how an efficient livestock disease indemnity program should work. By preventing disease introduction and eradicating disease occurrences promptly, the repercussions of an outbreak will minimally impact producers, livestock, the public, the environment, and the overall economy, which is indeed the goal of livestock disease management.

A second consideration that could potentially alleviate some of the downside risk of current livestock indemnity policy in the United States is livestock insurance. If producers took out private insurance policies on their livestock, then the consequential losses of a disease outbreak that are not assured under government indemnity could then be covered by the insurance company (Grannis and Bruch, 2005). The producer would also still be encouraged to practice good biosecurity as it would more than likely be a requirement by the insurance agency because it signifies the producer is doing everything in his or her own power to keep the herd or flock healthy. The insurance company may even offer discounted premiums to producers for implementing such disease prevention measures (Ott, 2005). It has also been suggested that government livestock indemnity eligibility could be tied to insurance program participation as it

suggests producers who are insured are already adhering to good biosecurity practices (Grannis and Bruch, 2005). However, there is a reason why livestock insurance is not as prevalent or popular as other insurance programs such as crop insurance. Livestock disease insurance comes with high risk and large payouts if an outbreak were to occur, which companies may not want to undertake. Producers also may not want to make the business decision to pay the high premiums it would involve for the insurance company to offer that type of expensive coverage (Hennessy and Wolf, 2018; Ott, 2005). There are professional opinions analyzing the pros and cons of livestock disease insurance, however, the results of this study will help contribute to a more complete understanding of producer opinions on government indemnity, which will be valuable to U.S. policy makers who could be updating current livestock disease policy and writing new legislation in the future.

Data

A survey was sent out in May of 2017 to feedlot owners through a popular cattle producer magazine, *Feedlot Magazine*, (**Appendix B**), and two follow-up emails were sent out to producers after the initial survey dispersal. From the survey data, a total of 139 respondents were represented. The survey consisted of questions aimed toward producers' current on-farm carcass disposal methods and their views on current government indemnity policy. *Question 7* on the feedlot survey provided four different indemnity policies and asked producers to rank the choices in order of preference with '1' being most preferred and '4' being the least preferred. The four options were '*Indemnity equal to current market value of animal if sold on day of claim*,' '*Indemnity*

equal to current market value or cost to raise animal, whichever is the highest but requires feedlots sharing farm receipts,’ ‘Indemnity funds available based upon evidence of “best-effort” biosecurity practices being in place through feedlot inspection,’ and ‘Indemnity funds available through private insurance programs, where premiums are subsidized by the government.’ By analyzing how producers ranked these indemnity options, the results can prove valuable in creating or modifying current policy by understanding how indemnity is perceived at the farm-level and by knowing what producers prefer.

Methodology

Conceptual Framework

When considering policies that are intended to benefit producers such as government compensation after a livestock disease outbreak, it is vital to understand how producers make decisions in the presence of risk. Producers are said to be risk averse (Mulwa et al., 2017). However, they are also profit maximizers because a farm is a business, and if that business is not profitable, it cannot persist (Nicholson and Snyder, 2012).

Therefore, the producer must weigh the odds of risk and profit when making cost decisions. Other factors are also included in this decision-making process, and through this study, the specific demographics and variables that impact a producer’s perception on indemnity policy will be realized.

Modeling

A ranked-order probit model will be used to estimate the impacts specific independent variables collected from the survey data have on ranked-order dependent variables.

First, summary statistics and tabulations of the data will be computed and analyzed to understand the overall survey and test for the presence of perfect collinearity. Next, an ordered probit model will allow conclusions to be drawn about what factors determine the ranking order of the four indemnity options. Such a model is derived from an underlying latent variable model with thresholds, or cuts-offs, creating the bounds for the four rankings. These thresholds are necessary for the regression because the rankings 1, 2, 3, and 4 are ordinal, but the actual numbers themselves do not mean anything (Chiburis and Lokshin, 2007; Gutiérrez et al., 2016; Katchova, 2013a; P. Kennedy, 2003). The latent variable model for this probit can be illustrated as:

$$y_i^* = \beta x_i + \varepsilon$$
$$y_i = \begin{cases} 1, & \text{if } y_i^* \leq \tau_1 \\ 2, & \text{if } \tau_2 \geq y_i^* > \tau_1 \\ 3, & \text{if } \tau_3 \geq y_i^* > \tau_2 \\ 4, & \text{if } y_i^* > \tau_3 \end{cases} \quad (9)$$

where y^* is unobserved, β represents the coefficients on variables x , τ are the unknown thresholds or cut off points, and ε is the error term that is normally distributed for the probit model. The derivation process to get to the maximum likelihood distribution function (11) is shown in equation (10) (Wooldridge, 2001).

$$P(y=1) = P(y^* \leq \tau_1) = P(\beta x + \varepsilon \leq \tau_1) = \Phi(\tau_1 - \beta x) \quad (10)$$

$$P(y=2) = P(\tau_2 \geq y_i^* > \tau_1) = P(\tau_2 \geq \beta x + \varepsilon > \tau_1) = \Phi(\tau_2 - \beta x) - \Phi(\tau_1 - \beta x)$$

$$P(y=3) = P(\tau_3 \geq y_i^* > \tau_2) = P(\tau_3 \geq \beta x + \varepsilon > \tau_2) = \Phi(\tau_3 - \beta x) - \Phi(\tau_2 - \beta x)$$

$$P(y=4) = P(y^* > \tau_3) = P(\beta x + \varepsilon > \tau_3) = \Phi[1 - (\tau_3 - \beta x)]$$

where P is the probability and Φ is the standard normal cumulative distribution function.

$$L = \prod_{y=1} \Phi(\tau_1 - \beta x) \prod_{y=2} [\Phi(\tau_2 - \beta x) - \Phi(\tau_1 - \beta x)] \prod_{y=3} [\Phi(\tau_3 - \beta x) - \Phi(\tau_2 - \beta x)] \prod_{y=4} \Phi[1 - (\tau_3 - \beta x)] \quad (11)$$

Similar to **Chapter 1**, the log-likelihood function (12) will allow the factors that determine the order of the indemnity options to be estimated by linear regression.

$$LL = \sum_{y=1} \ln \Phi(\tau_1 - \beta x) + \sum_{y=2} \ln [\Phi(\tau_2 - \beta x) - \Phi(\tau_1 - \beta x)] + \sum_{y=3} \ln [\Phi(\tau_3 - \beta x) - \Phi(\tau_2 - \beta x)] + \sum_{y=4} \ln \Phi[1 - (\tau_3 - \beta x)] \quad (12)$$

The latent variable model that will be used for this analysis will look very similar to the model used in **Chapter 1** equation (6). However, instead of estimating the likelihood to adopt, in this model, the dependent variable (y) will be the likelihood of ranking the four indemnity options; see equation (13). A separate model for each indemnity option will be estimated. Thus, the factors or variables that contribute to producer's various rankings of the policies can be analyzed.

$$\text{Indemnity Policy Ranking} = \beta_1 + \beta_2 \text{Midwest} + \beta_3 \text{FullOwn} + \beta_4 \text{Small} + \beta_5 \text{Onsite} + \beta_6 \text{DeathLoss} + \beta_7 \text{ProbOfDisease} + \varepsilon \quad (13)$$

where *Indemnity Policy Ranking* is the ordinal dependent variable between 1 and 4 with 1 being “most preferred” indemnity choice and 4 being “least preferred”; *Midwest* represents a series of binary variables describing the region in which the operation is located in the U.S.; *FullOwn* represents a series of binary variables describing the ownership of the operation with 1 representing the producer’s share of ownership being greater than or equal to 81 percent and 0 being less than or equal to 80 percent. *Small* represents a series of binary variables describing the size of the operation with 1 being less than or equal to 1,999 head and 0 being greater than or equal to 2,000 head; *ProbOfDisease* represents a series of binary variables describing the producer’s individual perception of disease risk; *DeathLoss* represents the farm’s routine livestock mortality rate; and ε represents the error term for the model.

All computations and calculations for this ordered probit regression will be estimated in Stata (**Table 2.2**). As already stated, the magnitude of the regression coefficients will not mean anything due to different scale factors, however the sign of the coefficients can be interpreted as a positive or negative effect on the dependent variable. By calculating the marginal effects (**Table 2.3 - 2.6**), the coefficients then represent a numerical percentage of impact on the dependent variable and can be interpreted as a “one unit increase in variable x is either more likely or less likely to be a specific y (ranked dependent variable)” for continuous variables and “the likelihood of variable x being present (the 1) compared to the excluded variable (the 0)” for binary variables (Katchova, 2013b).

The ordered probit model was ran with robust standard errors to adjust for potential heteroskedasticity. With this type of ordered regression, it is also imperative to test and confirm that no perfect collinearity is present within the model. A correlation matrix, variance inflation factor (VIF) test, and condition index number were all computed and indicated that no perfect collinearity was occurring in the model.

Results

Analyzing the survey data allows essential foreknowledge to be gained before any regressions are calculated or models are estimated. According to the summary statistics (**Table 2.1**) of all 64 observations (number of respondents who answered the indemnity question) utilized in the study, indemnity equal to current market value was ranked lower more often concluding that overall, it was the most preferred method of indemnity among the producers who were surveyed. On average, 29.5% of those producers fully owned their operation (ownership greater than or equal to 81%); 30.2% were small farms (less than or equal to 1,999 head); 50.0% used on-farm carcass disposal methods; the average mortality rate, or death rate, was 1.9%; 45.5% of surveyed producers believed the probability of animal disease outbreak affecting their operation was between 1 and 5%; and 33.4% of producers believed an outbreak was essentially not going to happen in the near or medium future (probability less than or equal to 1%).

Figure 2.1 displays an illustration of the tabulations for each of the four indemnity policies. Coinciding with the summary statistics, the greatest number of producers (54.7%) selected market value as their most preferred indemnity policy. Focusing on that majority, 40% of those ranked subsidized insurance as their second choice, and

57.1% of those producers ranked the policy linked to cost raising of animal upon sharing farm receipts as their third choice, leaving indemnity linked to biosecurity efforts as the least preferred policy. Thus, before taking any other variables into consideration, on average, producer's rankings of the four indemnity policies are as follows starting with the most preferred to the least preferred:

- (1) Indemnity *equal to current market value* of animal if sold on day of claim
- (2) Indemnity funds available through *private insurance programs*, where premiums are *subsidized by the government*
- (3) Indemnity equal to current market value or *cost to raise animal*, whichever is the highest but requires feedlots *sharing farm receipts*
- (4) Indemnity funds available based upon evidence of "*best-effort*" *biosecurity practices* being in place through feedlot inspection

Small Feedlots

According to the ordered probit regression (**Table 2.2**), small feedlots, those with 1,999 head or less, are more likely to rank the indemnity policy pertaining to biosecurity efforts higher, meaning they prefer it less over other policies because a higher ranking corresponds with a less preferred choice in this model. The marginal effects for this indemnity policy (**Table 2.5**) estimated that small producers are 13.9% less likely to rank biosecurity efforts as their most preferred indemnity policy and 23.2% more likely to rank it as their least preferred choice. These results were expected as smaller farms have less disposable income to spend on additional or advanced biosecurity practices compared to larger farms who probably already have such biosecurity in place or have

the financial means to implement such measures. This result can help formulate new or changing indemnity policies in the future. For example, if indemnity legislation were to change and become linked to biosecurity efforts, it may be more economical to have various levels of biosecurity expectations for the varying farm sizes across the United States. A policy like this could benefit all farms in regard to animal disease prevention, and it would also take into consideration the smaller producers who do not have as much disposable income to spend on implementing as much biosecurity as larger farms could.

Perception of Disease Likelihood

Producers who believe that the probability of a disease impacting their individual operation is between 1% and 5%, or that a disease will happen but only once over the next 25 years, are 27.3% more likely to rank the indemnity policy pertaining to biosecurity efforts as their least preferred choice (**Table 2.5**). This result makes economic sense. Biosecurity is a set of actions and protocols put in place to stop the introduction of a disease and lessen the effects of an outbreak if one were to occur (Muhammad and Jones, 2008). If producers perceive that there is not an impending threat of disease to their individual farm, they are likely less concerned with implementing biosecurity. Those same producers were estimated to be 8.9% less likely to rank biosecurity efforts as their second policy choice, which coincides with the tabulations of the variable because 41.9% of producers whose probability of disease was between 1 and 5% ranked subsidized insurance as their second choice.

The same producers who believe that a disease outbreak will occur, but not anytime soon, were 10.4% more likely to rank subsidized insurance as their most preferred indemnity policy choice, 12.6% more likely to rank it as their second choice, and 19.9% less likely to rank it as their least preferred method of receiving indemnity **(Table 2.6)**. Based on these results, producers whose probability of impending disease is low, would rather have their indemnity payments tied to the government subsidizing premiums for insurance on their livestock rather than implementing biosecurity measures on their own.

Conclusions

Livestock indemnity is mandated by the government, but it is essential for producers during a livestock disease outbreak. Currently, indemnity compensation for a diseased or depopulated animal is paid based on the fair market value of the animal as estimated by AHPIS (Gramig et al., 2009; Grannis and Bruch, 2005; Ott, 2005). However, researchers have identified potential flaws with this current indemnity policy, such as possibly incentivizing the production of diseased animals and/or the disincentive to report an animal disease or implement preventative biosecurity measures altogether. Some possible solutions to these challenges that have been heavily discussed within the literature include livestock insurance and shifting more of the risk of a livestock disease to the producer by offering no compensation for dead animals and discounted compensation for already diseased animals. However, something that has not been researched as intently are producers' preferences regarding current livestock indemnity

policy in the United States, which is why this study is valuable. Through survey responses, producers' rankings of four different indemnity policies were analyzed.

A majority of producers' most preferred method of indemnity was the current policy of fair market value. However, if policy writers were to take into consideration the issues that have been realized regarding this current policy and amend current livestock indemnity legislation, the indemnity policy relating to livestock insurance with the government subsidizing the premiums was the next best option, according to the majority of producers who participated in the survey. 46% of all producers surveyed had a very low perception of disease outbreak, meaning they did not think that an animal disease would not impact their own operation within the next 25 years. Statistically significant results showed that these producers were especially fond of the subsidized insurance indemnity policy. Of those same producers, a majority chose indemnity linked to "best-effort" biosecurity practices as their least preferred choice. Significant results concluded that small producers, those with less than or equal to 1,999 head, also ranked the policy linked to biosecurity as their least favorite.

From this study, it was determined that producers prefer the current method of indemnity compensation after a livestock disease outbreak. However, if legislators were to amend the policy based on issues arising due to incentives or disincentives the current methods were creating, producers favor an indemnity policy tied to livestock insurance with government subsidized premiums, and they do not like the idea of indemnity compensation being linked to biosecurity practices although a policy with

various levels of biosecurity expectations based on varying farm sizes might change their preferences.

There was a main limitation in this study. The amount of observations limited the number of variables that could be included in the model and inhibited a greater amount of statistical significance within the results. This study could be strengthened by having broader survey response rates. This could be accomplished by collecting survey responses from other than just feedlot producers. Responses from producers of other animal proteins, such as poultry, swine, or dairy, would greatly strengthen the study and allow for more well-rounded conclusions to be drawn and recommended to legislators regarding livestock indemnity policy in the United States. However, limitations could also exist in such an all-encompassing model because livestock producers of varying proteins have different motives for ranking policies specific ways. These differences would have to be able to be accounted for in a future model.

CONCLUSION

The largest animal health event in U.S. history was an outbreak of Highly Pathogenic Avian Influenza in 2014, and it cost U.S. taxpayers over \$950 million for the government to stop and eradicate the disease (USDA-APHIS-VS 2016). When a foreign animal disease (FAD) outbreak occurs, it affects so many more facets of life than just the animals and producers. Consumers are impacted by the price changes at the grocery store when the food supply gets interrupted. If the excessive carcass production due to disease and depopulation is not handled properly, the environment suffers. Producers lose profits due to downtime in business operations and decreased prices. Government officials at organizations like the Animal and Plant Health Inspection Service (APHIS) have to use additional resources to stop, control, and eradicate the FAD, and those financial resources come from U.S. taxpayers. As a result of each of these, livestock disease management is extremely important, and the responsibility to ensure that it is carried out efficiently and effectively, falls on both the producer and the government.

These studies looked at two specific types of livestock disease management post-FAD outbreak: on-farm carcass disposal and indemnity. The ability to dispose of livestock carcasses onsite during an FAD outbreak is highly favored and sought after by the government because for farms who normally carry their routine mortality offsite to a renderer or landfill, that may no longer be an option due to movement restrictions. These restrictions are set forth by APHIS and impact the farms that may fall within a certain specified outbreak zone (Hawkins et al., 2017; USDA-APHIS-VS 2017). Indemnity, which is the compensation producers receive when the government has to

come in and depopulate animals due to an FAD, plays a vital role in livestock disease management. The current indemnity policy in the United States is an APHIS approved fair market value for the depopulated animal (Gramig et al., 2009; Grannis and Bruch, 2005; Ott, 2005). However, researchers have recently identified some potential issues with this current method such as incentivizing the production of diseased animals or disincentivizing producers from either reporting an FAD or implementing preventative biosecurity measures altogether. If these concerns became realized in a quantifiable way and legislators want to amend the current policy, it will be beneficial to know what policies producers themselves prefer, and what influences those preferences.

Results showed that of all the poultry producers who participated in the survey, the mean WTP to adopt on-farm carcass disposal capabilities was \$15,651. Characteristics such as size, ownership percentage, current biosecurity methods, and disease perception significantly contributed to estimating their WTP. For the second study, feedlot operators preferred the indemnity policy that is currently in place, which is fair market value for the animal. However, the second favored option was livestock insurance with premiums subsidized by the government, and the least preferred method was an indemnity policy tied to a farm's biosecurity efforts. Similar to the first study, characteristics such as size and disease perception had a significant impact on policy selection.

The information that both of these studies provide can be invaluable to government officials and policy writers in regard to livestock disease management. In order to efficiently control the repercussions of an FAD outbreak, legislators may want

to know how to incentivize producers to adopt on-farm carcass disposal methods to minimize community and environmental damage that could be caused due to transportation restrictions. By knowing the estimated WTP for the producers surveyed, it allows greater understanding of cost thresholds and can improve analyses to determine if something such as a subsidy program, could be implemented for producers to adopt these biosecurity measures. Likewise, with the current indemnity policy concerns that have been identified by researchers, policy writers and animal health officials may want to amend the form in which current indemnity is handled. By knowing what producers actually prefer and what factors contribute to those preferences, a more well-rounded, efficient policy can be created.

Limitations to these studies included sample size and limited classification of each group. By increasing the amount of survey responses, stronger, more significant predictions can be made for each group. Moreover, broadening both studies to include other animal protein classifications like dairy and pork, could allow for such estimations to be made for the overall livestock industry. Although, such an all-encompassing model may be difficult to produce, as different livestock groups have unique and varied motives for making certain risk decisions for their type of operation.

REFERENCES

Barclay, E. *A Nation of Meat Eaters: See How It All Adds Up*. NPR. 2012.

<https://www.npr.org/sections/thesalt/2012/06/27/155527365/visualizing-a-nation-of-meat-eaters> (Accessed 15 May 2018).

Bateman, I. J., B. H. Day, D. Dupont, and S. Georgiou. *Ooh La La: Testing The One-And-One-Half Bound Dichotomous Choice Elicitation Method For Robustness To Anomalies* (Working Paper No. EDM 04-06). Norwich, UK and Ontario, Canada: Centre for Social and Economic Research on the Global Environment (CSERGE), School of Environmental Sciences, University of East Anglia and Department of Economics, Brock University. 2004.

Blake, J. P., Carey, John B, Haque, Aminul K. M., Malone, George W., P. H. Patterson, N. L. Tablante, ... S. Clark. 'Poultry Carcass Disposal Options for Routine and Catastrophic Mortality'. *CAST Issue Paper* 40(October 2008):20.

Bonhot, Jean, and Schwarz, Mary. 'Environmental Effects of Mortality Disposal'. Presented at the *3rd International Symposium: Management of Animal Carcasses, Tissue and Related Byproducts*, University of California at Davis. 2009.

Burnett, K. M. 'Introductions of Invasive Species: Failure of the Weaker Link'. *Agricultural and Resource Economics Review* 35,1(April 2006).

Chiburis, R., and M. Lokshin. 'Maximum likelihood and two-step estimation of an ordered-probit selection model'. *The Stata Journal* 7,2(2007):167–182.

Economics and Research Department (ERD). *Estimation of Willingness to Pay*. Slide Show presented at the Session 2.2. 2013, April.

- Fraser, R. 'Compensation Payments and Animal Disease: Incentivizing Farmers Both to Undertake Costly On-farm Biosecurity and to Comply with Disease Reporting Requirements'. *Environmental and Resource Economics* (December 2016).
- Gramig, B. M., B. J. Barnett, J. R. Skees, and J. R. Black. 'Incentive compatibility in risk management of contagious livestock diseases.' In S. R. Koontz, D. L. Hoag, D. D. Thilmany, J. W. Green, & J. L. Grannis (Eds.), *The economics of livestock disease insurance: concepts, issues and international case studies* (pp. 39–52). Wallingford: CABI. 2005.
- Gramig, B. M., R. D. Horan, and C. A. Wolf. 'Livestock Disease Indemnity Design When Moral Hazard Is Followed by Adverse Selection'. *American Journal of Agricultural Economics* 91,3(August 2009):627–641.
- Grannis, J. L., and M. L. Bruch. 'The role of USDA-APHIS in livestock disease management within the USA.' In S. R. Koontz, D. L. Hoag, D. D. Thilmany, J. W. Green, & J. L. Grannis (Eds.), *The economics of livestock disease insurance: concepts, issues and international case studies* (pp. 19–28). Wallingford: CABI. 2005.
- Gutiérrez, P. A., M. Pérez-Ortiz, J. Sánchez-Monedero, F. Fernández-Navarro, and C. Hervás-Martínez. 'Ordinal Regression Methods: Survey and Experimental Study'. *IEEE Transactions on Knowledge and Data Engineering* 28,1(January 2016):127–146.

- Gwyther, C. L., A. P. Williams, P. N. Golyshin, G. Edwards-Jones, and D. L. Jones. 'The environmental and biosecurity characteristics of livestock carcass disposal methods: A review'. *Waste Management* 31,4(April 2011):767–778.
- Hanmer, M. J., and K. O. Kalkan. 'Behind the Curve: Clarifying the Best Approach to Calculating Predicted Probabilities and Marginal Effects from Limited Dependent Variable Models'. *American Journal of Political Science* 57,1(January 2013):263–277.
- Hawkins, S., F. Walker, L. Strickland, and D. Barnett. 'Commercial Poultry Producer's Guide to Disposal Options for HPAI Mortalities in Tennessee' (2017):5.
- Hayden, J., and L. Cole. 'USDA Confirms Virulent Newcastle Disease in Backyard Exhibition Birds in California, Not a Food Safety Concern'. 2018, May 18.
https://www.aphis.usda.gov/wcm/connect/APHIS_Content_Library/SA_Newsroom/SA_News/SA_By_Date/SA-2018/vrn?presentationtemplate=APHIS_Design_Library%2FPT_Print_Friendly_News_release (Accessed 13 June 2018).
- Hennessy, D. A., and T. Wang. 'Livestock Disease Indemnity Design When Biosecurity Externalities Exist'. Presented at the *AAEA, CAES, & WAEA Joint Annual Meeting*, Denver, Colorado: Agricultural & Applied Economics Association. 2010.
- Hennessy, D. A., and C. A. Wolf. 'Asymmetric Information, Externalities and Incentives in Animal Disease Prevention and Control'. *Journal of Agricultural Economics* 69,1(February 2018):226–242.

- Henry, C. G., and L. L. Bitney. 'Disposal Methods of Livestock and Poultry Mortality'. *University of Nebraska of Lincoln Extension* ,EC727(2010):8.
- Jin, H. J., A. Skripnitchenko, and W. W. Koo. *The Effects of the BSE Outbreak in the United States on the Beef and Cattle Industry* (Special No. 03–4) (p. 17). Fargo, ND: Center for Agricultural Policy and Trade Studies Department of Agribusiness and Applied Economics North Dakota State University. 2004.
<http://ageconsearch.umn.edu/bitstream/23072/1/sr030004.pdf> (Accessed 14 June 2018).
- Julien, D., and S. Thomson. 'Interactive methods to educate and engage poultry producers on the importance of practicing on-farm biosecurity'. *Journal of Agricultural Extension and Rural Development* 3,4(August 2011):137–140.
- Katchova, A. 'Ordered Probit and Logit Models'. Econometrics Academy.
- Katchova, A. 'Ordered Probit and Logit Models Example'. Econometrics Academy.
- Kennedy, O. B., B. J. Stewart-Knox, P. C. Mitchell, and D. I. Thurnham. 'Consumer perceptions of poultry meat: a qualitative analysis'. *Nutrition & Food Science* 34,3(June 2004):122–129.
- Kennedy, P. *A Guide to Econometrics* (5th ed.). Simon Fraser University: Blackwell Publishing. 2003.
- Kuchler, F., and S. Hamm. 'Animal disease incidence and indemnity eradication programs'. *Agricultural Economics* 22,2000(2000):10.
- Levin, J., and P. Milgrom. 'Producer Theory' (October 2004):23.

- Lopez-Feldman, A. *Introduction to Contingent Valuation using Stata* (No. 41018) (p. 17).
Munich Personal RePEc Archive. 2012. <http://mpa.ub.uni-muenchen.de/41018/>
(Accessed
- Maddala, G. S. *Introduction to Econometrics*. University of Florida: Macmillan Publishing Company. 1988.
- Meng, T., W. J. Florkowski, D. B. Sarpong, M. S. Chinnan, and A. V. A. Resurreccion. 'Modeling Food Retail Format Choice and Shopping Frequency Decision in Urban Ghana: A Multivariate Ordered Probit Regression Application' (p. 18). Presented at the *Agricultural & Applied Economics Association Annual Meeting*, Minneapolis, MN,. 2014.
- Miller, M. 'Hold the Patty, Not the Lettuce: Processing Foods for Over a Quarter Century in the Nurses' Health Study'. *Circulation* 122,9(August 2010):859–860.
- Moore, C. *An Introduction to Logistic and Probit Regression Models*. University of Texas. 2013, Fall.
- Muhammad, A., and K. Jones. 'The impact of federal indemnification on livestock biosecurity'. *Economics Bulletin* 17,10(April 2008):1–9.
- Mulwa, C., P. Marenja, D. B. Rahut, and M. Kassie. 'Response to climate risks among smallholder farmers in Malawi: A multivariate probit assessment of the role of information, household demographics, and farm characteristics'. *Climate Risk Management* 16(2017):208–221.
- National Chicken Council. *Per Capita Consumption of Poultry and Livestock, 1965 to Estimated 2018, in Pounds*. 2017. <https://www.nationalchickencouncil.org/about->

- the-industry/statistics/per-capita-consumption-of-poultry-and-livestock-1965-to-estimated-2012-in-pounds/ (Accessed
- Nicholson, W., and C. Snyder. *Microeconomic Theory: Basic Principles and Extensions* (11th ed.). Ohio: South-Western Cengage Learning. 2012.
- OECD. *Producer Incentives in Livestock Disease Management*. Paris: OECD Publishing. 2017.
- Okpukpara, B. 'Determinants of willingness to pay for biosecurity measures among poultry farmers: a mitigation response to bird flu incidence in Nigeria'. *The Journal of Animal & Plant Sciences* 26,5(2016):1418–1428.
- Ott, S. 'Issues associated with US livestock disease compensation in the 21st century.' In S. R. Koontz, D. L. Hoag, D. D. Thilmany, J. W. Green, & J. L. Grannis (Eds.), *The economics of livestock disease insurance: concepts, issues and international case studies* (pp. 68–81). Wallingford: CABI. 2005.
- Qualtrics. 'Piped Text'. 2015, April 23. <https://www.qualtrics.com/support/survey-platform/survey-module/editing-questions/piped-text/piped-text-overview/> (Accessed 8 January 2019).
- Rimm, E. 'Ask the doctor. I saw Harvard's Healthy Eating Plate and noticed that poultry was listed as a healthy protein. I am not surprised that you're recommending fish, nuts, or beans. But why poultry?' *Harvard Health Letter* 37,2(2011):2.
- Samal, P., S. Pandey, G. A. K. Kumar, and B. C. Barah. 'Rice Ecosystems and Factors Affecting Varietal Adoption in Rainfed Coastal Orissa: A Multivariate Probit Analysis'. *Agricultural Economics Research Review* 24(June 2011):7.

- Siekkinen, K.-M., J. Heikkilä, N. Tammiranta, and H. Rosengren. 'Measuring the costs of biosecurity on poultry farms: a case study in broiler production in Finland'. *Acta Veterinaria Scandinavica* 54,1(2012):12.
- Speer, N. 'Industry At A Glance: Retail Meat Prices'. *BEEF Magazine* (December 2013). 2013, December 11.
- Spiegel, A. 'Chicken More Popular Than Beef In U.S. For First Time In 100 Years'. *HuffPost*. 2014, January 2.
- Sumner, D. A., J. E. Bervejillo, and L. Jarvis. 'The role of public policy in controlling animal disease.' In S. R. Koontz, D. L. Hoag, D. D. Thilmany, J. W. Green, & J. L. Grannis (Eds.), *The economics of livestock disease insurance: concepts, issues and international case studies* (pp. 29–38). Wallingford: CABI. 2005.
- Thompson, J. M., G. T. Tonsor, D. L. Pendell, and W. Preston. 'United States feedlot operator willingness to pay for disposal capacity to address foreign animal disease risk'. *Transboundary and Emerging Diseases* 65,6(December 2018):1951–1958.
- Tonsor, G. T., J. R. Mintert, and T. C. Schroeder. 'U.S. Meat Demand: Household Dynamics and Media Information Impacts'. *Journal of Agricultural and Resource Economics* 35,1(2010):1–17.
- Tonsor, G. T., T. C. Schroeder, and J. L. Lusk. 'Consumer Valuation of Alternative Meat Origin Labels'. *Journal of Agricultural Economics* 64,3(September 2013):676–692.

- U.S. Department of Agriculture, Agricultural Research Service. 'Newcastle Disease: USDA ARS'. 2016, August 13. <https://www.ars.usda.gov/southeast-area/athens-ga/us-national-poultry-research-center/exotic-emerging-avian-viral-diseases-research/docs/newcastle-disease/> (Accessed 22 April 2018).
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service. *The HPAI Indemnity and Compensation Process* (No. 91-85–013). 2017. https://www.aphis.usda.gov/publications/animal_health/2016/hpai-indemnity.pdf (Accessed 15 June 2018).
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services. 'Highly Pathogenic Avian Influenza Response Plan— the Red Book' (2015):212.
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services. *2016 HPAI Preparedness and Response Plan*. 2016. https://www.aphis.usda.gov/animal_health/downloads/animal_diseases/ai/hpai-preparedness-and-response-plan-2015.pdf (Accessed 20 April 2018).
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services. 'Highly Pathogenic Avian Influenza (HPAI) Response: Ready Reference Guide--Overview of Zones'. National Preparedness and Incident Coordination (NPIC).
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, and National Animal Health Monitoring System. *Part 1: Reference of*

- Health and Management Practices on Table-Egg Farms in the United States, 2013* (Layers 2013 No. 685.0614) (pp. 1–108). Fort Collins, CO. 2014.
- U.S. Department of Agriculture Economic Research Service. 'Cash receipts by State'. 2016a.
- https://data.ers.usda.gov/reports.aspx?ID=17843#Pc3d37317341b45c6bf19592e1fa69b0c_2_17iT0R0x0 (Accessed 28 June 2018).
- U.S. Department of Agriculture Economic Research Service. 'Farm finance indicators State ranking'. 2016b.
- https://data.ers.usda.gov/reports.aspx?ID=17839#P3898b53ab9a34343988f894b64d1e295_2_185iT0R0x3 (Accessed 28 June 2018).
- U.S. Department of Agriculture, National Agricultural Statistics Service. 'Fact Sheet: USDA Poultry Production Data'.
- U.S. Government. 'U.S. Constitution', Pub. L. No. 5th Amendment (1992).
- U.S. Government. 'U.S. Code of Federal Regulations, Title 9 - Animals and Animal Products, Chapter I - Animal and Plant Health Inspection Service, Department of Agriculture, Subchapter B - Cooperative Control and Eradication of Livestock and Poultry Diseases' (2000).
- U.S. Government. 'United States Code, 2006 Edition, Supplement 5, Title 7 - Agriculture', Chapter 109-Animal Health Protection 7 C.F.R. §8301, 8303 § 8301-8308 (2012).
- USDA-NASS. *Poultry - Production and Value 2016 Summary 04/28/2017* (p. 14). 2016.

Wooldridge, J. M. *Econometric Analysis of Cross Section and Panel Data* (1st ed.).
Cambridge, Massachusetts: The MIT Press. 2001.

APPENDICES

Appendix A

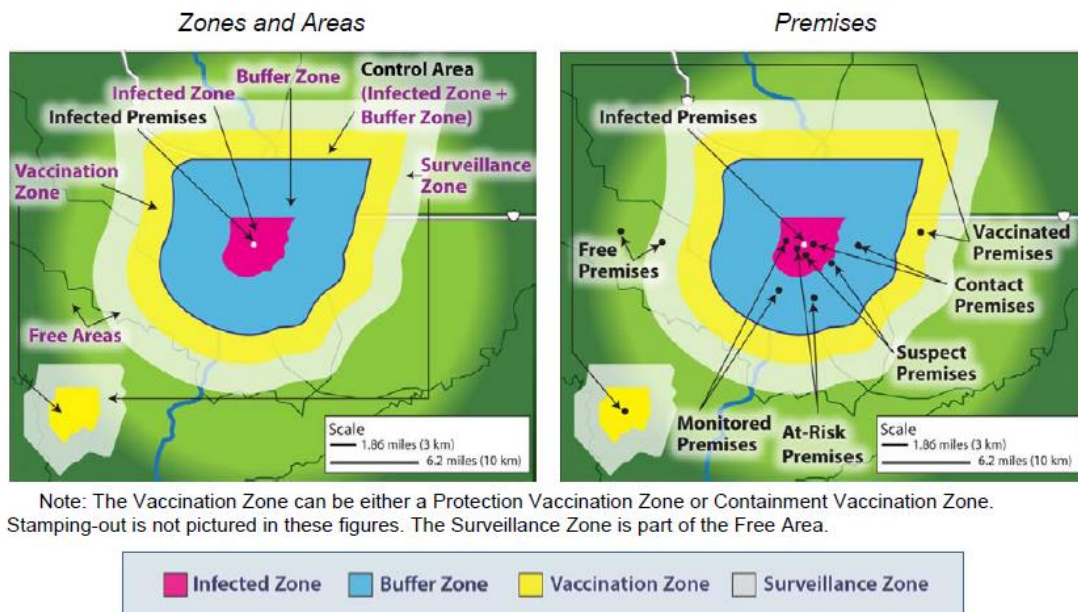
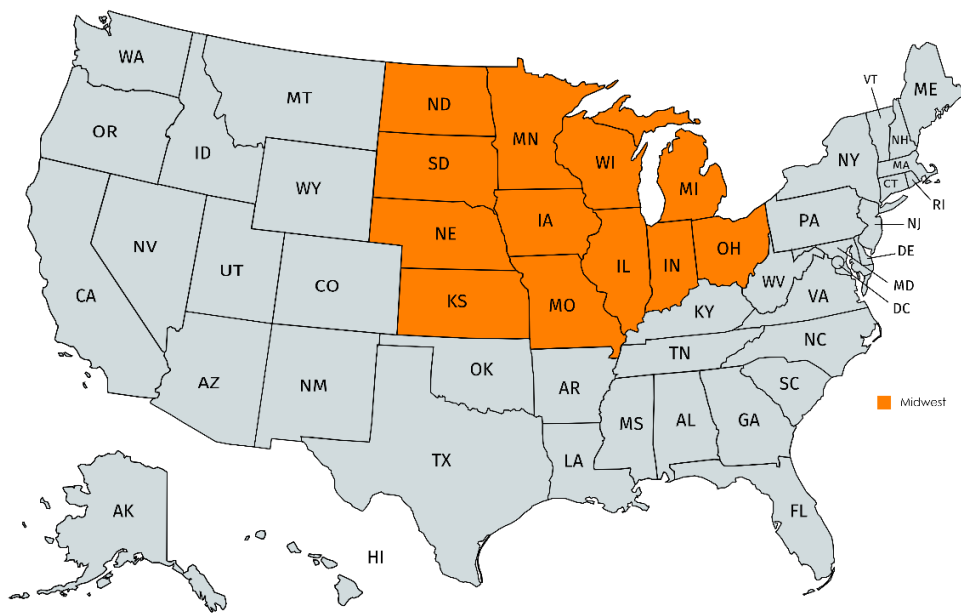


Figure 1.1 Example of Zones, Areas, and Premises in HPAI Outbreak Response (USDA-APHIS-VS 2015)



Credited with mapchart.net ®

Figure 1.2 Map of States Represented in “Midwest” Variable

Table 1.1 Summary Statistics of Select Poultry Producer Survey Responses

Variable	Description	N	Mean	Std. Dev.	Min	Max
Bio Q	1 if will adopt; 0 otherwise	21	0.476	0.512	0	1
Bio Cost ¹	Cost of adoption that producer was presented	53	24.703	13.903	2.057	47.428
Onsite	Current onsite carcass disposal %	53	40.189	49.009	0	100
Death Loss	Operation's livestock mortality rate	23	4.150	2.775	0	10
Small	1 if $\leq 149,999$ birds; 0 otherwise	15	0.267	0.458	0	1
Midwest	1 if operation located in Midwest ³ ; 0 otherwise	53	0.057	0.233	0	1
Full Own	1 if ownership of operation is $\geq 81\%$; 0 otherwise	53	0.113	0.320	0	1
Prob 1 or Less	Producer perception of FAD ² outbreak affecting individual operation once in next 100 years	53	0.057	0.233	0	1
Prob 1 to 5	Producer perception of FAD ² outbreak affecting individual operation once in next 25 years	53	0.189	0.395	0	1

¹ In thousandths of dollars

² Foreign Animal Disease

³ See Figure 1.2

Table 1.2 Simplified Probit Model Results of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)

Variable	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
BioCost	0.009	0.019	0.49	0.624	-0.028	0.047
Constant	-0.281	0.526	-0.53	0.594	-1.312	0.750
Willingness to Pay	29.609	31.81	0.93	0.352	-32.737	91.956

Table 1.3 Simplified Probit Model Marginal Effects of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)

Variable	Delta-method					
	dy/dx	Std. Err.	z	P>z	[95% Conf.	Interval]
BioCost	0.004	0.008	0.50	0.618	-0.011	0.018

Table 1.4 Probit Model Results of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)

Variable	Coef.	Robust Std. Err.	z	P>z	[95% Conf.	Interval]
Bio Cost	0.001	0.024	0.04	0.971	-0.047	0.049
Onsite	-0.010	0.008	-1.26	0.209	-0.027	0.006
Death Loss	0.107	0.159	0.67	0.502	-0.205	0.418
Small	-1.316	0.887	-1.48	0.138	-3.054	0.422
Midwest	-0.252	0.990	-0.25	0.799	-2.193	1.689
Full Own	-1.654	0.814	-2.03	0.042	-3.250	-0.059
Prob 1 or Less		(omitted)				
Prob 1 to 5	-0.277	0.836	-0.33	0.741	-1.915	1.362
Constant	1.090	1.514	0.72	0.471	-1.877	4.058
Willingness to Pay	-579.886	17092.87	-0.03	0.973	-34081.3	32921.53

Table 1.5 Probit Model Marginal Effects of Producer Willingness to Adopt Additional Disposal Capacity (in thousandths of \$)

Variable	dy/dx	Delta-method Std. Err.	z	P>z	[95% Conf.	Interval]
Bio Cost	0.000	0.008	0.04	0.971	-0.015	0.015
Onsite	-0.003	0.003	-1.18	0.240	-0.009	0.002
Death Loss	0.033	0.049	0.68	0.495	-0.063	0.129
Small	-0.411	0.236	-1.74	0.081	-0.874	0.051
Midwest	-0.079	0.308	-0.26	0.798	-0.682	0.525
Full Own	-0.517	0.179	-2.89	0.004	-0.868	-0.166
Prob 1 to 5	-0.086	0.265	-0.33	0.745	-0.607	0.434

Table 1.6 Interval Regression Results of Producer Willingness to Adopt Additional Disposal Capacity

Variable	Coef.	Robust Std. Err.	z	P>z	[95% Conf. Interval]
Onsite	-489	147.631	-3.32	0.001	-779 -200
Death Loss	1,145	2,195.073	0.52	0.602	-3,157 5,447
Small	-19,549	11,767.170	-1.66	0.097	-42,612 3,514
Midwest	-21,215	15,141.870	-1.40	0.161	-50,892 8,463
Full Own	-37,490	14,738.380	-2.54	0.011	-66,377 -8,603
Prob 1 or less	20,428	18,270.090	1.12	0.264	-15,381 56,236
Prob 1 to 5	-36,460	6,907.455	-5.28	0.000	-49,999 -22,922
Constant	83,304	.	.	.	.
/lnsigma	10	0.546	17.41	0.000	8 11
sigma	13,489	7,369.740	4,622.92	39,358.230	721 1,203
Willingness to Pay	15,651	8,061.346	1.94	0.052	-149 31,451

Table 2.1 Summary Statistics of Select Feedlot Operator Survey Responses

Variables	Description	N	Mean	Std. Dev.	Min	Max
Market Value	Indemnity as fair market value	64	1.766	1.004	1	4
Farm Receipts	Indemnity as cost of raising animal using farm receipts	64	2.703	1.079	1	4
Biosecurity	Indemnity based on “best-effort” biosecurity practices	64	2.875	1.062	1	4
Subsidy	Indemnity tied to livestock insurance with government paid subsidies	64	2.656	1.011	1	4
Midwest	1 if operation located in Midwest ² ; 0 otherwise	139	0.331	0.472	0	1
Full Own	1 if ownership of operation is $\geq 81\%$; 0 otherwise	139	0.295	0.458	0	1
Small	1 if $\leq 1,999$ head; 0 otherwise	139	0.302	0.461	0	1
Onsite	Current onsite carcass disposal %	100	49.96	47.924	0	100
Death Loss	Operation’s livestock mortality rate	82	1.926	1.461	0.03	10
Prob 1 or Less	Producer perception of FAD ¹ outbreak affecting individual operation once in next 100 years	77	0.338	0.476	0	1
Prob1 to 5%	Producer perception of FAD ¹ outbreak affecting individual operation once in next 25 years	77	0.455	0.501	0	1

¹ Foreign Animal Disease

² See Figure 1.2

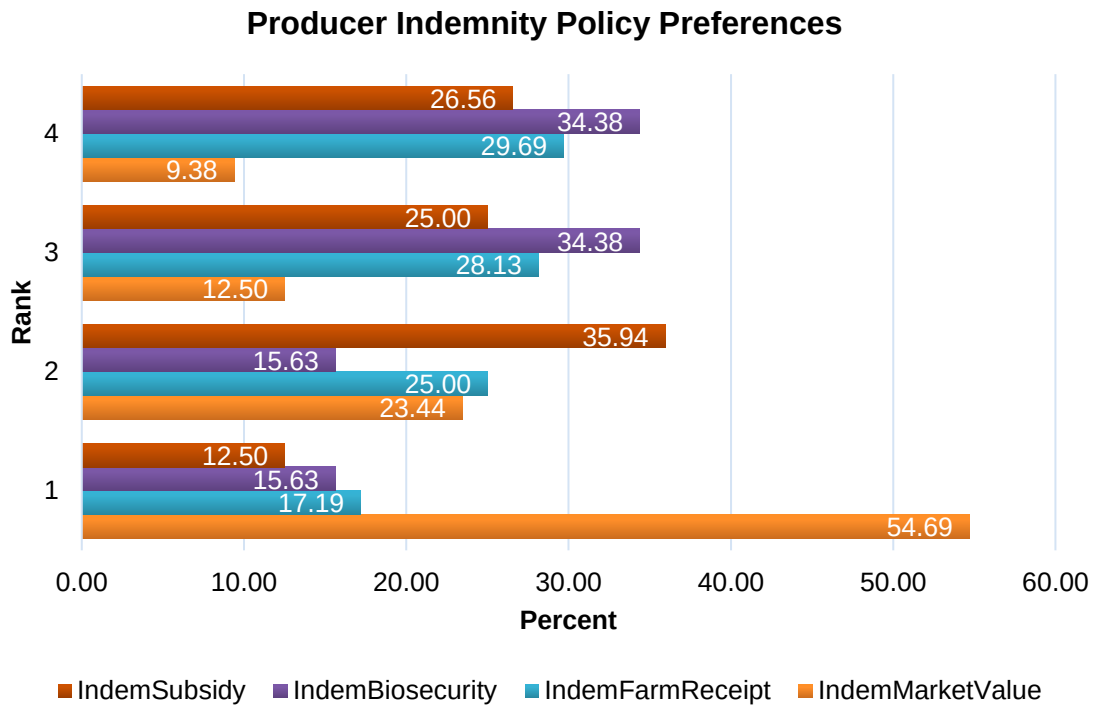


Figure 2.1 Initial Survey Tabulations for Feedlot Operator Indemnity Policy Preferences

Table 2.2 Ranked-Ordered Probit Model Results for Feedlot Operator Indemnity Policy Preferences

Variables	Indemnity Policy Choice			
	Market Value	Farm Receipts	Biosecurity Efforts	Subsidized Insurance
Midwest	0.102 (0.351)	-0.152 (0.320)	-0.003 (0.376)	0.043 (0.248)
Full Own	-0.304 (0.317)	0.251 (0.338)	-0.282 (0.332)	0.289 (0.309)
Small	-0.183 (0.334)	0.0146 (0.381)	0.637** (0.313)	-0.414 (0.340)
Onsite	0.001 (0.003)	-0.004 (0.004)	0.002 (0.003)	0 (0.003)
Death Loss	0.0597 (0.120)	0.093 (0.152)	-0.074 (0.0694)	-0.076 (0.0625)
Prob 1 or less	-0.031 (0.470)	0.029 (0.406)	0.218 (0.433)	-0.298 (0.359)
Prob 1 to 5%	-0.382 (0.408)	0.148 (0.334)	0.783* (0.410)	-0.592* (0.326)
Constant cut1	-0.170 (0.600)	-0.842** (0.418)	-0.466 (0.634)	-1.766*** (0.430)
Constant cut2	0.500 (0.611)	-0.072 (0.420)	0.081 (0.629)	-0.623 (0.422)
Constant cut3	1.092* (0.615)	0.690 (0.440)	1.057* (0.634)	0.087 (0.423)
Observations	64	64	64	64

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2.3 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Market Value

Variables	Choice 1	Choice 2	Choice 3	Choice 4
Midwest	-0.040	0.010	0.014	0.016
Full Own	0.120	-0.031	-0.042	-0.047
Small	0.073	-0.019	-0.025	-0.029
Onsite	0.000	0.000	0.000	0.000
Death Loss	-0.024	0.006	0.008	0.009
Prob 1 or less	0.012	-0.002	-0.004	-0.006
Prob 1 to 5%	0.151	-0.038	-0.052	-0.060

Table 2.4 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Farm Receipts

Variables	Choice 1	Choice 2	Choice 3	Choice 4
Midwest	0.037	0.022	-0.007	-0.052
Full Own	-0.062	-0.036	0.012	0.086
Small	-0.004	-0.002	0.001	0.005
Onsite	0.001	0.001	0.000	-0.001
Death Loss	-0.023	-0.013	0.004	0.032
Prob 1 or less	-0.008	-0.004	0.002	0.010
Prob 1 to 5%	-0.037	-0.021	0.007	0.051

Table 2.5 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Biosecurity Efforts

Variables	Choice 1	Choice 2	Choice 3	Choice 4
Midwest	0.001	0.000	0.000	-0.001
Full Own	0.062	0.035	0.006	-0.103
Small	-0.139**	-0.079	-0.013	0.232**
Onsite	0.000	0.000	0.000	0.001
Death Loss	0.016	0.009	0.002	-0.027
Prob 1 or less	-0.065	-0.020	0.020	0.065
Prob 1 to 5%	-0.182	-0.089*	-0.001	0.273**

** p<0.05, * p<0.1

Table 2.6 Ranked-Ordered Probit Model Marginal Effects for Feedlot Operator Indemnity Policy Preferences: Indemnity as Subsidized Insurance

Variables	Choice 1	Choice 2	Choice 3	Choice 4
Midwest	-0.008	-0.009	0.003	0.014
FullOwn	-0.056	-0.059	0.022	0.093
Small	0.080	0.085	-0.031	-0.134
Onsite	0.000	0.000	0.000	0.000
DeathLoss	0.015	0.015	-0.006	-0.024
Prob 1 or Less	0.043	0.071	-0.005	-0.108
Prob 1 to 5%	0.104*	0.126*	-0.032	-0.199*

* p<0.1

Appendix B

Poultry Biosecurity Survey

Biosecurity is a collection of management practices designed to minimize the risk of disease introduction and spread. One objective of this study is to assess current and possible future carcass disposal methods of U.S. poultry farms. The following questions will refer to "your operation." If your operation includes multiple farms or houses, please answer for them collectively.

Q0 Of the birds that were raised on your operation in the past 12 months, how would you classify your operation?

- ☐ Broiler (1)
- ☐ Table Egg-layer (2)
- ☐ Turkey (3)
- ☐ Primary Breeder – Broiler (4)
- ☐ Primary Breeder – Turkey (5)
- ☐ Other (6)

Q1 Of the birds that died on your operation in the past 12 months, what percentage were disposed of by the following methods?

- _____ Renderer (offsite) (1)
- _____ Landfill (offsite) (2)
- _____ Buried (on operation property) (3)
- _____ Composted (on operation property) (4)
- _____ Other (please specify) (5)

Q2 What is your best estimate of the \$/bird costs associated for your operation if you were to use the following alternative disposal methods given volumes presented by typical death loss on your operation?

- _____ Renderer (offsite) (1)
- _____ Landfill (offsite) (2)
- _____ Buried (on operation property) (3)
- _____ Composted (on operation property) (4)

Q3 What is your best estimate of typical death loss rates (%) (mortality rates) on your operation?

- _____ Death loss rate (%) (15)

Q4 Suppose in the next 10 years operations in your region experience a severe disease (e.g. highly pathogenic avian influenza) leading to governmental and industry-wide calls for quick changes in numerous farming practices to reduce spread and duration of the disease. One possible adjustment could be to entirely cease use of off-site disposal methods (e.g. renderer or landfill) and require sole use of on-site methods (e.g. burying or composting) for a period of 2 months.

In advance of this situation, your operation could elect to proactively establish the ability to solely use on-site disposal for carcasses and be capable to handle volumes equivalent to 2 months of your operation's normal death rates.

Given knowledge of this situation and the implications it may present to your operation, if it costs $\$ \{e://Field/BioCost\}$ in one-time, fixed expenses to establish this capacity on your operation to dispose on-site for at least 2 months would you make this investment within the next 3 years?

- ☐ Yes (1)
- ☐ No (2)

Condition: No Is Selected. Skip To: Q5.a Gov cost share option. Condition: Yes Is Selected. Skip To: Q4.YES. Doubling value.

Q4.yes Suppose alternatively it costs $\$(2 * \$ \{e://Field/BioCost\})$ in one-time, fixed expenses to establish this capacity on your operation to dispose on-site for at least 2 months would you make this investment within the next 3 years?

- ☐ Yes (23)
- ☐ No (24)

Condition: Yes Is Selected. Skip To: Q6 Perceived likelihood of disease. Condition: No Is Selected. Skip To: Q6 Perceived likelihood of disease.

Q5.a You indicated you would not make this $\$ \{e://Field/BioCost\}$ one-time investment. Suppose there was a governmental cost-share program available that would cover $\{e://Field/GovCoverPercent\} \%$ of the costs leaving the remaining 100% for you to cover. In this case would you proceed to make this investment within the next 3 years?

- ☐ Yes (1)
- ☐ No (2)

Q5.b You indicated you would not make this $\$ \{e://Field/BioCost\}$ one-time investment. Suppose the government established a rule that would make indemnity payments to those experiencing financial hardship in times of severe animal disease, would be

prioritized first for operations who could provide documented evidence of “best-effort” biosecurity practices being in place. If this policy was in place, would you proceed to make this investment within the next 3 years?

- ☐ Yes (1)
- ☐ No (2)

Q6 How likely do you think it is for the U.S. poultry industry to experience a severe disease event resulting in your operation having to solely use on-site disposal for at least two months?

- ☐ This will not occur in the next 200 years (nearly a 0% chance) (1)
- ☐ This may occur 1 time in the next 200 years (0.5% chance) (2)
- ☐ This may occur 1 time in the next 100 years (1% chance) (3)
- ☐ This may occur 1 times in the next 50 years (2% chance) (4)
- ☐ This may occur 1 time in the next 25 years (4% chance) (5)
- ☐ This may occur 1 time in the next 10 years (10% chance) (6)
- ☐ This may occur 1 time in the next 5 years (20% chance) (7)
- ☐ This may occur 2 or more times in the next 5 years (greater than 20% chance) (8)

Q7 Further, suppose in the severe disease situation mentioned earlier governmental indemnity funds were available to help offset financial hardship of operations who depopulated birds. How would you rank the following options for establishing indemnity payments (1= highly preferred, 4 = not preferred)?

- _____ Indemnity equal to current market value of bird if sold on day of claim (1)
- _____ Indemnity equal to current market value or cost to raise bird, whichever is the highest but requires producers sharing farm receipts (2)
- _____ Indemnity funds available based upon evidence of “best-effort” biosecurity practices being in place through farm inspections (3)
- _____ Indemnity funds available through private insurance programs, where premiums are subsidized by the government (4)

Q8 In what state does your operation primarily raise birds?

- ☐ Drop down list of every state

Q9 How many birds were raised on your total operation in the last 12 months?

- ☐ Less than 5,000 birds (1)
- ☐ 5,000 to 24,999 birds (2)
- ☐ 25,000 to 49,999 birds (3)
- ☐ 50,000 to 74,999 birds (4)
- ☐ 75,000 to 99,999 birds (5)
- ☐ 100,000 to 124,999 birds (6)
- ☐ 125,000 to 149,999 birds (7)
- ☐ 150,000 to 199,999 birds (8)
- ☐ More than 200,000 birds (9)

Q10 Of the birds placed on your operation in the last 12 months, what percentage did your operation own (as opposed to someone outside the operation retaining ownership such as an integrator)?

- ☐ 0% (1)
- ☐ 1 to 20% (2)
- ☐ 21 to 40% (3)
- ☐ 41 to 60% (4)
- ☐ 61 to 80% (5)
- ☐ 81 to 100% (6)

Q11 Thank you for your participation! Please leave any comments here:

Feedlot Biosecurity Survey

Biosecurity is a collection of management practices designed to minimize the risk of disease introduction and spread. One objective of this study is to assess current and possible future carcass disposal methods of U.S. feedlots. The following questions will refer to "your operation." Please answer the questions when considering the finishing feedlot(s) in your operation. If your operation includes multiple feedlots, please answer for them collectively.

Q1 Of the cattle that died on your operation in the past 12 months, what percentage were disposed of by the following methods?

- _____ Renderer (offsite)
- _____ Landfill (offsite)
- _____ Buried (on this feedlot property)
- _____ Composted (on this feedlot property)
- _____ Other (please specify)

Q2 What is your best estimate of the \$/head costs associated for your operation if you were to use the following alternative disposal methods given volumes presented by typical death loss on your operation?

- _____ Renderer (offsite)
- _____ Landfill (offsite)
- _____ Buried (on this feedlot property)
- _____ Composted (on this feedlot property)

Q3 What is your best estimate of typical death loss rates (%) on your operation?

- _____ Death loss rate (%)

Q4 Suppose in the next 10 years operations in your region experience a severe disease (e.g. Foot and Mouth Disease) leading to governmental and industry-wide calls for quick changes in numerous feedlot practices to reduce spread and duration of the disease. One possible adjustment could be to entirely cease use of off-site disposal methods (e.g. renderer or landfill) and require sole use of on-site methods (e.g. burying or composting) for a period of 2 months.

In advance of this situation, your operation could elect to proactively establish the ability to solely use on-site disposal for carcasses and be capable to handle volumes equivalent to 2 months of your operation's normal death rates. Given knowledge of this situation and the implications it may present to your operation, if it costs $\$ \{e://Field/BioCost\}$ in one-time, fixed expenses to establish this capacity on your operation to dispose on-site for at least 2 months would you make this investment within the next 3 years?

- ☐ Yes
- ☐ No

Condition: No Is Selected. Skip To: Q5.a Gov cost share option. Condition: Yes Is Selected. Skip To: Q4.YES. Doubling value.

Q4.YES Suppose alternatively it costs \$0 in one-time, fixed expenses to establish this capacity on your operation to dispose on-site for at least 2 months would you make this investment within the next 3 years?

- ☐ Yes
- ☐ No

Condition: Yes Is Selected. Skip To: Q6 Perceived likelihood of disease. Condition: No Is Selected. Skip To: Q6 Perceived likelihood of disease.

Q5.a You indicated you would not make this \$\$e://Field/BioCost} one-time investment. Suppose there was a governmental cost-share program available that would cover \$e://Field/GovCoverPercent}% of the costs leaving the remaining 100% for you to cover. In this case would you proceed to make this investment within the next 3 years?

- ☐ Yes
- ☐ No

Q5.b You indicated you would not make this \$\$e://Field/BioCost} one-time investment. Suppose the government established a rule that would make indemnity payments to those experiencing financial hardship in times of severe animal disease, would be prioritized first for operations who could provide documented evidence of “best-effort” biosecurity practices being in place. If this policy was in place, would you proceed to make this investment within the next 3 years?

- ☐ Yes
- ☐ No

Q6 How likely do you think it is for the U.S. feedlot industry to experience a severe disease event resulting in your operation having to solely use on-site disposal for at least two months?

- ☐ This will not occur in the next 200 years (nearly a 0% chance)
- ☐ This may occur 1 time in the next 200 years (0.5% chance)
- ☐ This may occur 1 time in the next 100 years (1% chance)
- ☐ This may occur 1 times in the next 50 years (2% chance)
- ☐ This may occur 1 time in the next 25 years (4% chance)
- ☐ This may occur 1 time in the next 10 years (10% chance)
- ☐ This may occur 1 time in the next 5 years (20% chance)
- ☐ This may occur 2 or more times in the next 5 years (greater than 20% chance)

Q7 Further, suppose in the severe disease situation mentioned earlier governmental indemnity funds were available to help offset financial hardship of operations who depopulated livestock. How would you rank the following options for establishing indemnity payments (1= highly preferred, 4 = not preferred)?

- _____ Indemnity equal to current market value of animal if sold on day of claim
- _____ Indemnity equal to current market value or cost to raise animal, whichever is the highest but requires feedlots sharing farm receipts
- _____ Indemnity funds available based upon evidence of “best-effort” biosecurity practices being in place through feedlot inspection
- _____ Indemnity funds available through private insurance programs, where premiums are subsidized by the government

Q8 In what state does your operation primarily feed cattle?

- ☐ Drop down list of every state

Q9 How many fed cattle were sold on your operation in the last 12 months?

- ☐ Less than 1,000 head
- ☐ 1,000 to 1,999 head
- ☐ 2,000 to 3,999 head
- ☐ 4,000 to 7,999 head
- ☐ 8,000 to 15,999 head
- ☐ 16,000 to 23,999 head
- ☐ 24,000 to 31,999 head
- ☐ 32,000 to 49,999 head
- ☐ More than 50,000 head

Q10 Of the animals placed on feed in the last 12 months, what percentage did your operation own (as opposed to someone outside the operation retaining ownership)?

- ☐ 0% (1)
- ☐ 1 to 20%
- ☐ 21 to 40%
- ☐ 41 to 60%
- ☐ 61 to 80%
- ☐ 81 to 100%

Q11 Thank you for your participation! Please leave any comments here:

VITA

Victoria Lynn Campbell is from Flintville, TN, and graduated 15th in her class from Lincoln County High School in 2013. She graduated *magna cum laude* from the University of Tennessee at Knoxville in 2017 with her Bachelor of Science in Agricultural and Resource Economics degree, majoring in Food and Agricultural Business. The summer between graduation and beginning her master's program, she interned with University of Tennessee Extension specializing in financial management. Upon completion of her master's degree, she plans to obtain a job in the U.S. agriculture industry, helping to ensure people have access to a dependable, safe food supply by utilizing the knowledge and skills she has mastered throughout her time at the University of Tennessee.