

Rochester Institute of Technology

**RIT Digital Institutional Repository**

---

Theses

---

10-26-2016

## **Technological, Policy, and Organizational Issues in the Response to Biological Emergency Incidents in the US Food Supply**

Kristina J. Owens  
kjo4716@rit.edu

Follow this and additional works at: <https://repository.rit.edu/theses>

---

### **Recommended Citation**

Owens, Kristina J., "Technological, Policy, and Organizational Issues in the Response to Biological Emergency Incidents in the US Food Supply" (2016). Thesis. Rochester Institute of Technology. Accessed from

This Thesis is brought to you for free and open access by the RIT Libraries. For more information, please contact [repository@rit.edu](mailto:repository@rit.edu).

**R·I·T**

**Technological, Policy, and Organizational Issues in the Response to  
Biological Emergency Incidents in the US Food Supply**

**By**

**Kristina J. Owens**

A Thesis Submitted in partial fulfillment of the requirements for the degree  
of Master of Science in Science, Technology, and Public Policy

**Department of Public Policy**

**College of Liberal Arts**

**Rochester Institute of Technology**

**Rochester, NY**

**October 26, 2016**

# R·I·T

**Technological, Policy, and Organizational Issues in the Response to Biological  
Emergency Incidents in the US Food Supply**

**By**  
**Kristina J. Owens**

*Masters of Science, Science, Technology and Public Policy  
Thesis Submitted in Fulfillment of the Graduation Requirements for the*

*College of Liberal Arts/Public Policy Program at  
ROCHESTER INSTITUTE OF TECHNOLOGY  
Rochester, New York*

*October 2016*

*Submitted by:*

Kristina J. Owens

---

Signature

Date

*Accepted by:*

Dr. Sandra Rothenberg /Professor

---

Public Policy /Rochester Institute of Technology

Signature

Date

Dr. Franz Foltz/Associate Professor

---

Science, Technology, and Society/Rochester Institute of Technology

Signature

Date

Dr. Elizabeth Ruder/Assistant Professor

---

Wegmans School of Health and Nutrition /Rochester Institute of Technology

Signature

Date

Dr. Franz Foltz/Graduate Director

---

Science, Technology, and Society /Rochester Institute of Technology

Signature

Date

## **ABSTRACT**

Numerous emergency incidents in U.S. food supply occur each year. Incidents include invasive pests and diseases impacting agriculture crops and foodborne pathogens contaminating meat and poultry. An effective response is not just dependent on the technology that is being used, but also policy and organizational factors. This research is a cross-case analysis of two federal regulatory and emergency response agencies under the U.S. Department of Agriculture: Animal Plant Health Inspection Service (APHIS) and Food Safety and Inspection Service (FSIS). This research analyzes how each agency uses technology, policy and organizational factors to respond to their respective emergencies. This study also strives to identify factors that make a response effective and successful to protect U.S. agriculture and public health

To analyze each agency's response, two food supply emergencies were used for this study: the 2006 Pale Cyst Nematode infestation in Idaho potato fields and the 2012-2013 Multistate Outbreak of *Salmonella* Heidelberg in poultry products. This study gathered secondary source material such as government documents, congressional hearings, news articles, documentaries, and peer-reviewed scientific articles. Data also includes information from discussions with experts. Comparing the two cases studies provides insight on how public policy can be changed in order to improve responses by both agencies. This thesis will also contribute to the understanding of the role of technology within a government organization.

# Table of Contents

<b>ABSTRACT .....</b>	<b>3</b>
<b>LIST OF FIGURES AND TABLES .....</b>	<b>6</b>
<b>DEFINITIONS .....</b>	<b>7</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>8</b>
<b>CHAPTER ONE .....</b>	<b>9</b>
1.1 Background of food safety policy.....	10
1.2 United States Department of Agriculture.....	13
1.3 A case study approach.....	14
<b>CHAPTER TWO: LITERATURE REVIEW .....</b>	<b>15</b>
2.1 Technology diffusion and adoption .....	15
2.2 Technology diffusion in government.....	18
2.3 Preventative and reactive technology innovation .....	21
2.4 Technology in the response to public or agriculture food crisis .....	22
2.5 Available technology for rapid technology for <i>Salmonella</i> detection .....	24
2.6 Available technology for Pale (Potato) Cyst Nematode detection and prevention .....	28
<b>CHAPTER THREE: METHODS.....</b>	<b>31</b>
3.1 Organizational features, about the agency .....	33
3.2 Policies in place to respond to an emergency .....	33
3.3 Available technology used in the prevention and response.....	33
3.4 The response to the specific emergency case.....	34
<b>CHAPTER FOUR: CASE STUDY 1- APHIS &amp; Potato Cyst Nematode.....</b>	<b>36</b>
4.1 History and organization .....	36
4.1.1 APHIS stakeholders.....	40
4.2 Incident background and response .....	40
4.2.1 Technological response.....	42
4.2.2 Organizational response .....	47
4.2.3 Policy response.....	48
4.3 APHIS response 2010-present .....	50
<b>CHAPTER FIVE: CASE STUDY 2: FSIS &amp; Salmonella Outbreak Response .....</b>	<b>55</b>
5.1. History and organization.....	55
5.1.1 FSIS stakeholders.....	59
5.2 Identification of the outbreaks .....	60
<b>CHAPTER SIX: ANALYSIS.....</b>	<b>76</b>
6.1 Case study differences .....	79
6.1.1 Organization.....	81
6.1.2 Power and authority.....	83
6.1.2.2 Regulatory authority .....	87
6.1.2.3 Policies and regulations .....	88
6.1.3 Nature of technology .....	89

<b>CHAPTER SEVEN: DISCUSSION .....</b>	<b>91</b>
<b>7.2 Response factors .....</b>	<b>92</b>
7.2.1 Preventative and reactive policies .....	92
7.2.2 Role of stakeholders .....	93
<b>7.3 Role of technology .....</b>	<b>93</b>
<b>7.4 Implications for public policy .....</b>	<b>96</b>
<b>CHAPTER EIGHT: LIMITATIONS, RECOMMENDATIONS &amp; CONCLUSIONS .....</b>	<b>98</b>
<b>8.1 Limitations .....</b>	<b>98</b>
8.1.1 Previous knowledge.....	98
8.1.2 Budget.....	99
8.1.2 Access to informants .....	100
8.1.3 Organizational theory and behavior.....	100
<b>8.2 Conclusions and recommendations .....</b>	<b>101</b>
8.3.1 Recommendations .....	103
8.3.1.1 Create a methods development laboratory .....	103
8.3.1.2 Strengthen the network of food safety scientists.....	103
8.3.1.3 Integrate science and technology at all levels of policies and programs.....	104
<b>REFERENCES.....</b>	<b>105</b>

## LIST OF FIGURES AND TABLES

Table 2.1: Select news articles and peer-review articles on IT technology adoption.....	20
Table 2.2: Common themes of journal articles of the latest molecular technologies.....	26
Table 2.3: Example of advanced, sensitive and available technologies.....	29
Table 3.1: Key features and factors of each agency .....	34
Figure 4.1: APHIS organizational chart .....	38
Figure 4.2: Plant Protection and Quarantine programs.....	39
Figure 4.3: Map of quarantine area of Pale Cyst Nematode (APHIS, 2016c).....	41
Table 4.1: Summary of the timeline for the communication response by APHIS .....	42
Table 4.2: Alternative fumigation technologies for eradication of PCN .....	47
Table 4.3: Technologies in development for detection, eradication and fumigation of PCN .....	51
Chart 4.1: Regulated and infested fields from January 2010-Present.....	52
Chart 4.2: Regulated and deregulated infested or suspect fields .....	53
Table 5.1: FSIS unit roles .....	57
Table 5.2: Detailed comparison of Salmonella outbreaks (CDC, 2013, 2014) .....	61
Table 5.3: Timeline of Salmonella outbreak investigation.....	62
Figure 5.1: First Salmonella outbreak (CDC, 2013).....	63
Figure 5.2: Second Salmonella outbreak (CDC, 2014) .....	64
Table 5.4 FSIS policy response .....	66
Table 5.5 Ten priorities for FSIS Salmonella Action Plan (FSIS, 2013b).....	67
Table 5.6 Documents from external organizations .....	69
Table 6.1 Observation differences that influence the agencies responses.....	78
Table 6.2 Major differences between the case studies.....	80
Table 6.3 Agency stakeholders influence .....	84
Table 6.4 Type of response .....	89

## DEFINITIONS

Acronym	Definition
USDA	United States Department of Agriculture
FSIS	Food Safety and Inspection Service
APHIS	Animal Plant Health Inspection Service
CDC	Centers for Disease Control and Prevention
FDA	Food and Drug Administration
CPHST	Center for Plant Health Science Technology
PPQ	Plant Protection and Quarantine
PCN	Pale Cyst Nematode or Potato Cyst Nematode
PCR	Polymerase Chain Reaction, a technology used in molecular biology
GAO	Government Accountability Office
ARS	Agriculture Research Service

Scientific Name	Definition
<i>Globodera pallida</i>	Latin name for the common names: Pale Cyst Nematode or Potato Cyst Nematode
<i>Salmonella</i>	A group of bacteria that causes about 1 million illnesses each year. Symptoms are stomach cramps, diarrhea for 4-7 days within 12-24 hours of exposure. Most recover but some are hospitalized (CDC, 2016d)
<i>Escherichia coli</i>	A large group of bacteria that has several strains that cause foodborne pathogens (CDC, 2016a)



## ACKNOWLEDGEMENTS

Many in my life have inspired the journey of the last two years. I am incredibly grateful for the support and guidance of these individuals to help me make my graduate work and this thesis project a success.

First and foremost I am grateful for my parents' and twin sister's love and support throughout these last two years: Robert Owens, Luisa Rios-Owens and Wendy Owens. I cannot thank them enough for allowing me to take this break in my career, to reviewing my papers and thesis and supporting me not just in school but also in everything I do.

Second, I am thankful for the RIT professors in the Public Policy Department and beyond who made graduate work enlightening, interesting and helped me learn to think about science and technology in a policy framework. I am grateful for my Committee Chair: Dr. Sandra Rothenberg who guided me through the thesis research and defense, and my committee members Dr. Franz Foltz and Dr. Elizabeth Ruder for providing me with vital and constructive feedback. I am also so thankful for the Public Policy Department secretary Peggy Mack for patiently helping me understand the administrative side of graduate school. I am also thankful for the moral support and friendship of my fellow classmates at RIT.

Third, in last two years, I have had the honor to intern and volunteer for three amazing and committed Members of Congress: New York Senator Kirsten E. Gillibrand and Representative Louise Slaughter, and Massachusetts Representative Joe Kennedy, III. Senator Gillibrand's staff in the Rochester regional office and her agriculture Legislative Assistant helped me brainstorm the topic of my thesis, Congressman Kennedy's DC staff helped me identify resources necessary for this thesis, and finally both the Congresswoman Louise Slaughter and her staff provided me with key documents and insight necessary for the completion of this thesis.

Finally, I am incredibly grateful and humbled by everyone's love and support as I finish this journey and begin a new one.

## CHAPTER ONE

The role of government is to protect the citizens of the country against harm in terms of both public health and economic stability. The government must be the ultimate advocate for the people. This means government policy should protect citizens against foodborne pathogens and invasive pests and diseases. Foodborne pathogens can cause illness and invasive pests and diseases can destabilize our economy. Regardless of the efforts put in place over the years, each year 48 million are sickened by a foodborne pathogen (CDC, 2016b). The Centers for Disease Control and Prevention (CDC), estimates that 1 in 6 US residents are sickened with a foodborne illness each year. Of the 48 million individuals who are sickened, 128,000 are hospitalized each year (CDC, 2015). Many of these foodborne pathogens are preventable through the use of proper, effective and available detection technology. Despite the ability to prevent these diseases, foodborne illness outbreaks continue to occur, is a symptom of a broken and complex US food safety system. The impact on individuals, communities, businesses and the US economy is great. Recently it was estimated that these foodborne pathogen outbreaks cost the United States \$15.6 billion dollars, which is about half the cost of *Ebola* on the world economy (Flynn, 2014). This cost estimate could be low, since the analysis done by Flynn (2014) was based on actual reported foodborne pathogen outbreaks and sicknesses. CDC reports include the documented cases but also an estimate of unreported illnesses. The estimated cases of *Salmonella* is thought to be 30 times what is reported (Young, 2015). Many of the foodborne pathogens will cause temporary discomfort for the

individual, so it may not be identified as a foodborne illness. It is often hard to differentiate foodborne illnesses from the flu. Even so, the CDC estimates the implications can be detrimental to the US economy through missed work and lower productivity (CDC, 2016d).

The food safety system is highly complex. Many attempts have been made to improve and strengthen it to prevent, or at least minimize foodborne pathogen outbreaks. This study focuses on one of the 15 government agencies: United States Department of Agriculture (USDA). The Food Safety and Inspection Service (FSIS) is the primary agency within USDA working on protecting public health. To better understand FSIS responses to food emergencies, this study compares how FSIS and another USDA agency: Animal Plant Inspection Service (APHIS) respond to emergency outbreaks. As will be illustrated in the two cases analyzed in this thesis, APHIS is relatively successful to responding to plant and animal disease outbreaks, while FSIS has a weak response to foodborne pathogen outbreaks. This thesis explores the reasons behind these differences in effectiveness, and could identify recommendations to minimize the foodborne pathogen outbreaks occurring in meat and poultry. The findings could also provide an insight to further strengthen APHIS's responses to plant or animal disease outbreaks.

## **1.1 Background of food safety policy**

Over the last 100 years, food safety has increasingly become a greater concern for the both government organizations and the public. This concern is reemphasized with weekly reports of foodborne pathogen outbreaks by the CDC, FSIS, and from various news outlets that focus on food safety such as Food Safety News (CDC, 2016c; FSIS, 2016c; FSN, 2016). Technological advances in foodborne pathogen detection have also

grown significantly, providing more tools necessary to better protect the public from potential outbreaks. Even with technological advances and a greater number of programs focus on food safety, the US continues to experience multiple foodborne pathogen outbreaks (Flynn, 2014). Each year, approximately 48 million people get sick and up to 3000 deaths are attributed to foodborne illnesses (GAO, 2015b). These deaths are almost always preventable, but due to the breakdown of the food safety system, deaths continue to occur unnecessarily. The food safety system is very complex and reducing the number of incidents will require a complex solutions. A technology-based solution may be too simplistic. Solutions would also have to include effective and relevant policy.

The seminal publication in the area of food safety is Upton Sinclair's book *The Jungle* (Sinclair, 1906). This publication's first intention was to demonstrate the maltreatment of workers in meat packing factories. However, most of the public's outrage was directed at the food facilities unsanitary practices. With pressure from the public, the government began to take food safety seriously. President Theodore Roosevelt sent government officials to confirm Upton Sinclair's claims. The government's findings were even more devastating (Burkett, 2012). In the same year, two key laws were passed to begin addressing the food safety concerns: *Pure Food and Drug Act* and *the Federal Meat Inspection Act of 1906* (FSIS, 2015d). Prior to *The Jungle*, there had been a push for legislation by individuals within USDA for several years. *The Pure Food and Drug Act* was often referred to the Wiley Act in honor of Dr. Harvey Wiley; USDA's Chief Chemist, who advocated for food safety regulations and policies for nearly 20 years (FSIS, 2015d).

In the convening years up to 1937, additional legislation was added, (i.e. egg inspection), and new departments were created, such as the Food and Drug Administration (FDA) (FSIS, 2016b). Foodborne pathogen outbreaks were once limited to specific areas of the country. Technological advances in refrigeration and transportation allowed for greater distribution of food products. The downside of these technological was food borne pathogens outbreaks no longer remained close to the source. In 1938, comprehensive legislation was passed to update and modernize the past legislations. This act was called the Food, Drug and Cosmetic Act of 1938. From 1938-2010, multiple legislation was passed, and new government agencies were added over the years to address the complex challenges of food safety in the US (FSIS, 2015d). To this day, fifteen different federal agencies address different aspects of the US food safety system (GAO, 2015b).

On January 4, 2011, President Obama signed into law the FDA Food Safety Modernization Act (FSMA). It was the first comprehensive overhaul of the US food safety system in 70 years. The law's main focus was on the FDA, which has the bulk of the responsibility for U.S. food safety, followed by USDA's Food Safety and Inspection Service (FSIS). The legislation shifted the approach by the government from responding to crisis to actively preventing foodborne pathogen outbreaks. This law gave FDA more authority to demand compliance by food facilities in order to prevent outbreaks. The FDA provided a comprehensive explanation of the law on their website: *"For the first time, FDA will have a legislative mandate to require comprehensive, science based preventative controls across the food supply"* (FDA, 2011, p. 1). The law also mandated that FDA work with other federal agencies to ensure the safety of the US food system. In particular, the law required that FDA to work with Food Safety and Inspections Service (FSIS) and

other agencies to implement this major overhaul in the food system. The law did not necessarily direct FSIS to change their focus from reactive to preventative. Since the passage of the FSMA, however, it has become clearer that FSIS also needs major reforms (Hoelzer, 2016). The enactment of the Food Safety Modernization Act in 2011 has since highlighted weaknesses not just for FDA, but also for FSIS. Multiple congressional hearings, letters of concern from Members of Congress and the Government Accountability Office (GAO) have publically expressed concerns due to FSIS's response to various foodborne pathogen outbreaks (R. L. DeLauro, Slaughter, L.M., Moran, J.P., Rnagel, C.B., Blumenauer, E., Holmes Norton, E., Schakowsky, J.D., Grijalva, R.M., Clarke, Y.D., Pingree, C., Titus, D., McLane Kuster, A., Brownley, J., Cardenas, T., Connolly, G.E., 2014; GAO, 2016).

## **1.2 United States Department of Agriculture**

The US Department of Agriculture is one of the largest and oldest US government agencies. It was founded in 1862. Today USDA strives to provide *“leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management. We have a vision to provide economic opportunity through innovation, helping rural America to thrive; to promote agriculture production that better nourishes Americans”*(USDA, 2015). The department has over 100,000 employees in 29 agencies including both FSIS and APHIS. In USDA's Strategic Plan, 2014-2018 science and technology-based policy is a priority for the entire department.

### 1.3 A case study approach

To solve all the problems of the complex food safety system is impractical. This thesis uses a case study comparison analysis to compare FSIS response to food safety emergencies to APHIS' response to invasive pest emergencies. Both agencies are similar in their mission, which makes it ideal for this method. Any recommendations or changes that will arise from this analysis would be easier to implement since both agencies are under USDA. Comparing FSIS to other agencies such as the FDA could be more challenging since two different government departments dictate policies and regulations.

For this thesis three key research questions were used to elucidate relevant information and provide a basis for further analysis:

- *What factors influence how agencies differ in their responses to emergency situations that have health or an economic impact and how effective are these responses?*
- *What role does technology play in response effectiveness?*
- *What are implications for public policy?*

This thesis will be broken up in eight chapters. I will first provide an extensive literature review of the technologies used for both outbreak responses of the *Salmonella* outbreak in 2012 to present, the Pale Cyst Nematode outbreak in 2006 to the present, a review of how organizations adopt new technologies and organizational and policy factors. The proceeding chapters will discuss the methods used, a detailed background of each of the responses by FSIS and APHIS, a chapter on the analysis of each case and a comparison, a discussion of the findings then a final chapter on the limitations and recommendations.

## **CHAPTER TWO: LITERATURE REVIEW**

Tackling the problems of emergencies in the food supply require an analysis and review of several different topics. A successful response by a government organization requires an integrated approach that includes technological, organizational and policy factors. This chapter will include how technology is adopted in an organization, how organizations respond to a crisis, a review of the available technology for both case study pathogens, and a discussion of preventative versus reactive innovations.

### **2.1 Technology diffusion and adoption**

Central in this thesis is the importance of technologies used for preventing and responding to public health crisis of a foodborne pathogen outbreak. Understanding how and if food pathogen diagnostic technology is developed and adopted is an important aspect of understanding the effectiveness of government responses to food safety crises. One might assume that government agencies would be continuously adopting and adapting the latest technologies to reduce the number of food and agriculture emergencies such as foodborne pathogen outbreaks or invasive pest outbreaks. This assumption may not be correct. Theories regarding the diffusion of innovation can explain why even though the particular technology has clear advantages, it is not adopted.

The diffusion of innovation is studied in numerous academic fields, such as anthropology, communications, sociology and psychology (Rogers, 2003). There are several models of technology diffusion and adoption that are discussed in the literature. The two main models that are discussed to explain technology diffusion are epidemic model and probit model (Cetindamar, 2001; Geroski, 2000). The epidemic model theorizes that diffusion and adoption of technology is due to the amount of information



available to the potential adopters. The epidemic model is the most commonly used model when discussing technology diffusion and innovation. For example, in the case of food safety testing technologies, this model would suggest that decision makers within US Department of Agriculture, Food Safety and Inspection Service (FSIS), and Animal Plant Health Inspection Services (APHIS) are simply 100% aware of the newest technologies or unaware of the newest technology. In this model, by ensuring that there is enough knowledge and experience, the organizations would readily adopt the newest technologies. Also, the epidemic model would suggest that both agencies would be adopting and adapting at the same rate since they have similar missions of protecting public and economic health. The epidemic model, however, cannot explain all the variance in technology adoption and diffusion (Cetindamar, 2001; Geroski, 2000). Others have argued that the only barrier to technology diffusion is not just simple information. Instead, they argue that you need to consider the technology in itself (Geroski, 2000).

The probit model is the alternative model used in explaining technology diffusion. The probit model suggests diffusion and adoptions depends on the organization's goals, needs, and abilities (Cetindamar, 2001; Geroski, 2000). In contrast to the epidemic model, which focuses on the knowledge and understanding of new technology, the probit model focuses on the political, organizational, and technological challenges faced by government agencies that are being asked to adopt "state of the art" technologies.

The applicability of the probit model to understanding diffusion can be seen in the area of environmental technology diffusion and adoption. This field is similar to the fields of food safety and agriculture health and may elucidate the challenges of technology diffusion and adoption in both fields. Lanjouw (1995), for example, looked at the extent of

environmental technology innovation and diffusion occurred in developed countries, such as the US, by looking at patent applications and economic investments. The authors found an increase in patent applications as technology was being adopted (Lanjouw, 1995). The increase in patent applications may be prerequisite to adoption. Cetindamar (2001) discusses the role of regulations in the diffusion of environment technologies in Turkey, and argues that diffusing technology through different organizations is incredibly complicated and often much slower than is preferred (Cetindamar, 2001). When looking at the diffusion of environmental technologies, Cetindamar (2001) looked at how regulations played a role in adopting pollution preventing technologies; she found that regulations are created to facilitate the adoption of a new technology.

Both Cetindamar (2001) and Lanjouw (1995) found there are aspects of the epidemic and the probit model that explain technology diffusion (Cetindamar, 2001; Lanjouw, 1995). Sanchez (1998) delves more deeply into the influence of regulations and organizational characteristics on the diffusion of a technology. The author notes that the success or failure of a regulation to encourage the diffusion of environmental technology depends on particular characteristics, such as the age of an organization. It was hypothesized that the older the organization, the more negative the impact on the adoption of new technologies. The authors found that was not necessarily the case; in fact, younger organizations were more risk adverse than the older organizations (Sanchez, 1998).

Durfee (1999) further discusses additional reasons why environmental technologies are not diffused rapidly and suggests intervening in a way that increases the risk of inaction. Durfee (1999) alludes to regulations also having influence on the lack of adoption. For example, an organization may not adopt a pollution preventing technology

as they are waiting to see what the regulation will be. The primary incentive for industry action is in increase in sales and profits, which is not the same as cost reduction. Many of the technologies could reduce costs, but industry does not view that as an incentive. Durfee (1999) concludes by recommending that the government should recognize the differences within each organization.

In summary, most of the literature concerning technology diffusion suggests that there is a need to understand the factors beyond technology itself that influence technology diffusion within an organization. As it can be seen in the articles that address environmental technology it is not about the technology but other factors such as regulations and organizational structure. It is easy to say the technology FSIS is currently using is not sufficiently advanced but one cannot ignore all these factors discussed by these authors (Cetindamar, 2001; Lanjouw, 1995; Sanchez, 1998). Additional these questions would also need to be addressed based on this review such as there enough legislation and regulations that allow the USDA FSIS to continue to adopt the latest technology? For this thesis, both the probit and the epidemic model will be referred to when analyzing both FSIS and APHIS response to outbreaks.

## **2.2 Technology diffusion in government**

Most of the literature available concerning technology diffusion does not look at technology diffusion within government. Understanding technology diffusion in this particular context is important, as government organizations have unique structural, cultural, and political issues. Currently, literature focusing on technology diffusion within government mostly focuses on information technology diffusing through different levels of government whether it is federal, state or local (Alic, 2008; Cetindamar, 2001; De Cian,

Bosetti, & Tavoni, 2011; Durfee, 1999; Greenhalgh, 2004). Several online news articles have cited a mix of views on how fast or slow state of the art information technology (IT) is being diffused within the government (Mergel, 2013; Welch & Feeney, 2014). Many of the issues addressed in the debate around the diffusion of IT in government may apply to food safety.

The clichéd perception that government is slow in adopting new ideas applies for technology adoption. Some of the authors listed in Table 2.1 write that slow adoption of technology by government is beneficial, while others fear that it is hindering progress. The authors feel a slower rate of adoption ensures sustainable progress (Cherkis, 2013; Konkel, 2014; Rein, 2015). The authors also focused on many of the challenges in technology adoption in government. One of the challenges the authors mention in IT adoption is individual resistance to new technologies. The general consensus of the authors is that government is in general risk-adverse to the technology adoption for various reasons.

<b>Technology Adoption in Government</b>		
<b>Technology</b>	<b>Article Title and Authors</b>	<b>Conclusions</b>
General Technology	What is the biggest obstacle to tech adoption in Government Konkel (2014)	The authors indicate the biggest obstacles are people.
General Technology	Industry perspective: Successful Technology adoption is never about the Technology. Dittmer (2013)	The author discusses that technology is not the main factor it's the people using or not using the technology.
Internet of Things and Bring your own tech	Federal Agencies Behind the Curve: IoT and BYOD. Fedorschak (2015)	The authors state there are clear economic and policy advantages to both these. Authors are surprised that these are hardly recognized in Federal Agencies.
General Technology	Technology Adoption Slower, But Certain in Government –And for good Reasons Cherkis (2013)	Author believes that the adoption of technology in government is slow for a good reason. Ensures more sustainability.
General Technology	Federal Managers Love Technology but fear government is to slow in adopting Rein (2015)	Federal employees feel the newest technology would be incredibly useful in their work. Most are frustrated by the slowness of government.

***Table 2.1: Select news articles and peer-review articles on IT technology adoption***

In addition to the above articles, there are a couple articles that start addressing the organizational factors that are involved in IT adoption. The authors Del Aguila-Obra and Padilla-Meléndez (2006) discuss three key components that are affecting IT adoptions: availability of technology resources, organizational structure and managerial capabilities. An assumption that is often made is the larger the organization the slower the adoption of new technology, but the authors did not find this to be the case (Del

Aguila-Obra & Padilla-Meléndez, 2006). Another article by Oguz (2016) focused on the case of digital libraries and discusses the influences of different organizational factors such as size of the organization and the culture, as well as economic factors that impact the final decisions of adopting new technology.

Another factor that may influence the adoption of technology is stakeholder influence. Kamal (2011) discusses how stakeholders may influence policy, organizational factors and ultimately technology adoption. The author defines levels of stakeholders, primary and strategic, and then further discuss the impact each of them may have on adopting and integrating technology in government (Kamal, 2011). This paper highlights possible reasons for different levels of integration of technology within one government department such as the US Department of Agriculture.

### **2.3 Preventative and reactive technology innovation**

One factor that is often brought up in Food Safety is the need for the government to shift from being reactive to becoming preventative. In other words putting out fires is not sustainable (FDA, 2011; FSWG, 2011). Preventative innovation is discussed by Rogers (2003) in his book Diffusion of Innovation, as well as a journal article discussing the prevention of addiction (Rogers, 2002). Preventative innovation is much more difficult to adopt because this technology or idea is difficult for individuals to conceptualize or visualize the potential. The benefits are only seen in the distant, rather than the immediate, future. The outcome, such as an outbreak, may still occur even with implementing preventive technologies (Overstreet, 2013; Rogers, 2002). Overstreet (2013) recently performed a meta-analysis of predicting which preventative innovations will be more successful. Overstreet (2013) found it challenging to prove a correlation.

What he did find was that subjective factors influence the adoption of preventative technology. For example, when the Human papillomavirus (HPV) vaccine came on market, children were already receiving vaccines to prevent other diseases; therefore, this new vaccine was easy to adopt. However, the more innovative the technology, the slower the adoption (Overstreet, 2013).

## **2.4 Technology in the response to public or agriculture food crisis**

There are a number of factors that have been identified as critical to a successful response to a disaster crisis (Welch & Feeney, 2014). The most critical factors seem to be an understanding of who has the authority in an emergency situation, and how efforts are communicated and coordinated (Quarantelli, 1988). Quarantelli (1988) concludes, “*Prior planning can limit these management difficulties but cannot completely eliminate all of them*”(pg 383). This quote can also be applied to ensure the proper technology is available to be used in responding to a crisis. A more recent article focuses on resource sufficiency, organizational effectiveness and cohesion (Huang, 2010). Huang (2010) writes that the most important aspects of effective response to an emergency are sufficient economic resources.

Recent articles published by scientists from APHIS Veterinary Services provide further insight into a successful emergency response. Levings (2012) reviews the response by government agencies to emerging and exotic zoonotic diseases. The purpose of the review was to outline ways to prepare for a serious animal disease outbreak, provide insight on the unique challenges of animal pathogens, and provide a framework for an integrative approach to “prevention, preparedness, response and recovery” (Levings, 2012). Levings (2012) evaluates what is essential for an effective response:

*“Preparedness includes situational awareness, research, tool acquisition, modeling, training and exercises”* (p. 81). Later in 2013, two other APHIS animal disease scientists further discussed the need for effective preparation for animal diseases (Diez, 2013). Unlike previous articles, their recommendations focus on the improving surveillance and diagnostic tools. Discussion of organizational factors are discussed less so. However, having adequate resources is mentioned in their conclusions (Diez, 2013).

When trying to identify sources that address USDA FSIS, most analyses focuses on the Food and Drug Administration since they deal with the bulk of the complex food safety system. The food safety system’s complex organization is a topic that is written about in sources as diverse as the Government Accountability Office and The New Yorker (GAO, 2015a; Hylton, 2015). Most analyses focuses on the Food and Drug Administration and how they interact with both the states and FSIS. In a recent analysis on the legal aspects of foodborne illness surveillance, recommendations and observations focused on how the different agencies could better collaborate and understand the legal authority of each state or government agency (David, 2013). It concludes that complexity of the food safety system is hindering efforts to reduce the number of foodborne illnesses according to recent news and magazine articles. Hylton (2015) supports this idea, and uses the example of mixed authority of both the FDA and FSIS in this online news article: *“Fish are the province of the F.D.A.-except catfish, which falls under the F.S.I.S, Frozen cheese pizza is regulated by the F.D.A, but frozen pizza with slices of pepperoni is monitored by the F.S.I.S.,”* (Hylton, 2015 para 16). The author further discusses internal organizational tensions and dysfunction. On occasion, articles will discuss technology, but mainly as it relates to staffing and the coordination.



One exception to the lack of attention to technology was Guzewich (2012), who discusses laboratory facilities and testing involved in outbreak surveillance and response. He argues that there is a need for: 1) laboratories doing diagnostics to be more involved in the process and 2) “Laboratorians” need to be in the field more and less in the laboratory.

In sum, research has focused primarily on the organization and resource issues that get in the way of effective food safety emergency response. Very little focus has been on the technology that is being used in the response to the emergency. While there is research on technology adoption in government, it mostly focuses on IT technologies.

## **2.5 Available technology for rapid technology for *Salmonella* detection**

Preventing *Salmonella* outbreaks in poultry and meat products requires the best technologies to detect and prevent *Salmonella* contamination. This requires policies, but also the right technology to effectively detect *Salmonella* and prevent contaminated poultry and meat products to reach the market. This section of the review provides a brief overview of the available technology for *Salmonella* detection and prevention. When researching the available technology I searched for peer-reviewed journal articles through the National Center for Biotechnology Information (NCBI), I found 100s of articles claiming to have developed rapid detection methods. Included in this search is an article by researchers from Cornell University. Wiedmann, Wang, Post, and Nightingale (2014) addressed how the food safety industry can evaluate all of the new technologies being developed. Wiedmann et al. (2014) says:

*“The number of commercially available kits and methods for rapid detection of foodborne pathogens continues to increase at a considerable pace, and the diversity of methods and assay formats is reaching a point where it is very difficult even for experts to weigh the advantages and disadvantages of different methods and to decide which methods to choose for a certain testing need”* (p. 670).

The impetus for many academic researchers to develop rapid and effective detection and prevention technologies is stated in all of the introductions of all of these articles (Cheung, 2012; S. Maurischat, Baumann, B., Martin, A., Malorny, B., 2015; S. H. Park, and Ricke, S.C., 2014; S. H. Park et al., 2014; Rohonczy, 2014; Xu, 2016; Zheng, 2014). These publications are just a select survey of hundreds of publications of new and improved technologies that have been developed to date.

Based on this quick review of technologies available for the detection of *Salmonella* in poultry and poultry food products four major themes listed in Table 2.2 were prevalent throughout each of the publications.

<b>Common themes</b>	<b>Example quote</b>
<i>Salmonella</i> is one of the major causes foodborne illnesses	<i>“Salmonella is the leading cause of foodborne illnesses in the United states and one of the main contributors to salmonellosis is the consumption of contaminated poultry and poultry products”</i> (S. H. Park, and Ricke, S.C., 2014).
Despite the past challenges, Rapid detection methods for <i>Salmonella</i> are not only essential but becoming easier to adopt	<i>“ Some of these rapid methods have been already validated and accepted by international authorities as a standard method”</i> (Cheung, 2012).
Current standard technology are reliable but are both time consuming and labor intensive	<i>“Various Salmonella detection methods are available, however the majority of these are time-consuming, including the standard method (ISO 6579:2002), which may provide the final results within 5 days”</i> (Rohonczy, 2014).
Rapid detection technology is as good if not better than the standard culture methods	<i>“ We validated this multiplex real-time PCR Methods on 48 commercial samples and results were comparable to standard culture methods”</i> (Zhang et al., 2015).

**Table 2.2: Common themes of journal articles of the latest molecular technologies**

All authors were in agreement that *Salmonella* is one of the major causes of foodborne illnesses in the US. The authors cited the CDC website, using these facts as the reasons they chose to focus on developing state of the art and rapid detection methods (CDC, 2015, 2016b, 2016c; Cheung, 2012; S. H. Park, and Ricke, S.C., 2014; S. H. Park et al., 2014; Xu, 2016; Zheng, 2014).

Each of these authors also acknowledged that rapid advanced technologies have had challenges and that the reliable culture based technologies are still the gold standard. Ahmed (2014) compares the advanced technology of polymerase chain reaction (PCR) with the classical techniques of culturing the bacteria on petri plates with nutrient media. This classical technology includes several steps to differentiate between different strains

of the bacteria. The techniques require highly skilled professional to perform procedures that require several days to perform. The on advantage the classical technique is that it is inexpensive (Ahmed, 2014). Other authors prove that their technology has overcome the past weaknesses of the culture-based technologies. For example, Abdallah (2013) recognizes the need to control and prevent multiple pathogens including *Salmonella*. The authors present an alternative technology for detection and differentiation of the bacteria such as *Salmonella* (Abdallah, 2013). Other authors such as Bird et al. (2014) have officially had their methods validated internationally. While Maurischat, Szabo, Baumann, and Malorny (2015) claim that their method “*proved to be reliable and fast alternatives to cultural vaccine strain identification tests helping decision makers with control measurements to take action within a shorter period of time*”(S. Maurischat et al., 2015, p.92).

In many of the publications, it is often repeated and acknowledged that the standard technology used in food safety is reliable, but labor intensive. Most methods require highly skilled and trained professionals. Another case these scientists make is that the older dependable technologies may not be able to detect low levels of the bacteria (S. H. Park et al., 2014). Some of the preventative technologies used in food facilities are supposed to eliminate *Salmonella*, but many fear that low levels of the bacteria may still persist despite these efforts (Kirsten E. Gillibrand, 2016; L. M. Slaughter, Delauro, Rosa L., Moran, J., Bordallo, M.Z., Cardenas, T., Grijalva R.M., Courtney, J., Waxmn, H.A., Brownley, J., Cartwright, M., Coehn, S., 2014). *Salmonella* is commonly found everywhere and some variants are more infectious than others (S. H. Park et al., 2014). The challenge of some of the preventative technologies can mask the presence of bacteria

or other pathogens. The current molecular technology effectiveness can be hindered when a plant or food sample is treated with some chemicals. Based on a recent publication in the Journal of Food Protection, a group of scientists at ARS found that due to the disinfectants used in the elimination of *Salmonella* there is the danger of false negatives. Thus resulting in the chance for FSIS to be unable to detect contaminated poultry (Gamble, 2016).

In sum, the technology is available and proven to be ready to be used to effectively reduce the amount of *Salmonella* outbreaks nationwide. If FSIS should choose to use these technologies, by no means are each ready to be used on day one, but would need to be adapted to the needs of the agency in order to best prevent the future outbreaks.

## **2.6 Available technology for Pale (Potato) Cyst Nematode detection and prevention**

Historically the identification of Pale Cyst Nematode (PCN), or *Globodera pallida*, infestation is either seen through the symptoms of a potato crop or through standard soil survey. Previously detection was confirmed by world nematology experts through morphological identification, which consists of microscopic identification by an expert diagnostician. As technology has advanced, detection is now confirmed by the latest advanced molecular technology. In the response to the outbreak there has also been new prevention agriculture technologies such as using bio-fumigants techniques. The purpose of all of the technologies is to ensure a rapid and sensitive detection of this pest, prevent and minimize the spread of the pest, and ultimately eradicate the pest from potato fields. Though the number of publications is fewer than *Salmonella*, the Pale Cyst

Nematode research is quite abundant due to the economic impact that this pest can have.

Table 2.3 provides an overview of peer-reviewed articles of select technologies.

Title & Author	Type of Technology
Multiplex real-time PCR assays for the identification of the potato cyst and tobacco cyst nematodes(Nakhla, 2010)	Detection technology
Adaptation to resistant hosts increases fitness on susceptible hosts in the plant parasitic nematode <i>Globodera pallida</i> (Fournet, 2016)	Prevention technology
Field Evaluation of the nematicide fluensulfone for control of the potato cyst nematode <i>Globodera pallida</i> (Norshie, 2016)	Eradication technology
Morphological and Molecular Identification of <i>Globodera pallida</i> Associated with Potato in Idaho (Skantar, 2007)	Detection technology
Biofumigation for Control of Pale Potato Cyst Nematodes: Activity of Brassica Leaf Extracts and Green Manures on <i>Globodera pallida</i> in Vitro and in Soil(Lord J.S., 2011)	Eradication technology

**Table 2.3: Example of advanced, sensitive and available technologies**

It is accepted by all of the authors in Table 2.3 that the discovery of the Pale Cyst Nematode in Idaho signifies a major threat to the US potato industry. This pest can have both an ecological and economic impact nationwide and beyond (Nakhla, 2010; Skantar, 2007). In terms of detection technology, there needs to be technology that can rapidly identify and differentiate the Pale Cyst Nematode from other potato cyst nematodes (Hafez, 2007; Nakhla, 2010; Skantar, 2007). Nakhla (2010) goes further and suggest that the standard molecular technology needs to be strengthened and simplified to minimize

the labor and time to detection. These authors adapted and developed new technology to address these challenges (Nakhla, 2010).

For PCN, it is not just about developing effective detection technology but also technology that could eliminate or prevent the infestation of a potato field in the US. Researchers have published new technologies such as resistant potato plants or both biofumigants and nematicides (Fournet, 2016; Lord J.S., 2011; Norshie, 2016)

In conclusion, many of the literature available discuss a range of issue from technology adoption, organizational factors, and policy factors in emergencies but rarely are each of these components integrated and analyzed together. In this thesis I will analyze all of them and how each of them factor in how APHIS and FSIS differ in their responses.

## **CHAPTER THREE: METHODS**

The US food safety system is incredibly complex in part due to the multiple agencies involved. FSIS is one of fifteen federal agencies involved in the food safety system. For this thesis, I have focused on technological, political and organization of two specific federal agencies. A cross-case analysis was conducted to identify factors that influence effective responses to national level emergencies in US Food supply. As referred to in the literature review section, most past analysis has been focused on staffing, resources and coordination (Del Aguila-Obra & Padilla-Meléndez, 2006; Quarantelli, 1988), while there has been limited analysis of the use of technology in emergency preparation. If an article discusses technology, political and organizational factors are rarely part of the discussion.

Food Safety and Inspection Service (FSIS) was selected because they have a major influence on the overall food safety system. APHIS, a ‘sister’ agency, was selected because they are also part of USDA. APHIS focuses on the animal and plant health while FSIS focuses on public health. Key organizational and political factors are the same for both APHIS and FSIS since they are under one government department. Additionally the size and budget of each agency are nearly identical, which allows for the analysis to identify other factors that are influencing each agency’s response. APHIS was also selected since I have ten years of experience working within APHIS and can provide an inside perspective of the organization.

The analysis of both cases were modeled after Robert Yin (2009). Yin (2009) discusses the importance of comparison case studies as providing a framework for analysis. This approach is applicable and relevant to answer the research questions. The



complexity of analyzing effective responses to food supply emergencies requires this approach discussed by Yin (2009) .

For the analysis, I obtained documents from each of the agencies websites, documents from different policy organizations such as the Pew Charitable trust, and news articles written about both agencies that related to their responses. I also reach out to possible informants for each case. I was able to talk to a representative of the Safe Food project at Pew Charitable Trusts and to Congresswoman Louise Slaughter and her staff about their concerns and with the hopes for possible connections to FSIS.

In reviewing these documents, I focused on two specific incident responses: 1) FSIS's response to the Salmonella Outbreaks in 2012-2013 and 2) APHIS's response to Potato (Pale) Cyst Nematode. The first case was chosen because it deals with food safety and its challenges. Comparing this to APHIS's response to agriculture plant health is appropriate because: 1) the technology used to detect animal and plant pathogens are similar to human foodborne pathogens, 2) APHIS, like FSIS, is a regulatory agency and has similar obligations, 3) both agencies are under the authority of USDA; this means if there is an emergency situation, USDA at the department level has the authority to direct both agencies (Levings, 2012), and 4) data on APHIS is not only from public documents, but also from my own personal experiences working for this agency.

For each of the agencies, I collected the following information: organizational features, the policies in place for the initial response, the policies created in response of the crisis; available technology for the response and as a result of the response; and specific information about each emergency.

### **3.1 Organizational features, about the agency**

Though the focus was how these agencies respond to emergency pathogen outbreaks, key facts had to be gathered to better understand why certain decisions were made. I delved more deeply into organizational features such as size, quantity of units, the mission and vision, strategic plans. This data provided me with organizational features that may allude to not just the stated mandate, but also the underlying efforts.

### **3.2 Policies in place to respond to an emergency**

To understand the agency response to the particular emergency, I collected government documents referring to the rules and regulations used as a guide for the agency's current response. Most of these can be seen in notices and other documents published in the official Federal Register. I also looked at any additional policies stated on the website for each agency. For FSIS, the amount of information available was much less than was available for APHIS. I also attained letters from and to Members of Congress. The topics of these public letters were of the policies that were put in place because of the emergencies.

### **3.3 Available technology used in the prevention and response**

In addition to gathering and identifying technology that is available from academia and industry, I looked at the technology that was being used by the agency to address the specific emergency. For both cases I compared the technology used and the technology that was potentially available for use.

### 3.4 The response to the specific emergency case

In this section, I looked at how each agency responded to the emergencies such as press releases and reports. To supplement my findings, I looked for news articles, letters and requests written by Members of Congress. In FSIS's cases there was a PBS special and several Congressional Hearings. For APHIS, I also found a law suit that was recently filed against them by the farmers.

A cross-case study analysis was then conducted using the method described by Miles (1984). The author uses several examples of how the findings can be organized and analyzed. The approach for this study will be to look at how decisions were made in each case starting with mapping out a timeline of each incident. This timeline will show how rapidly each agency responded to the outbreaks and what they did after the initial identification of the incident. A timeline can provide clues on how effective the emergency response was for each incident.

<b>Key Features</b>	<b>APHIS</b>	<b>FSIS</b>
Organizational features	Strategic plan, roles of each unit, stakeholders	Strategic plan, roles of each unit, stakeholders
Policy factors	Relevant policy and regulations	Relevant policy and regulations
Technology factors	Available technology to respond	Available technology to respond

***Table 3.1: Key features and factors of each agency***

For everything collected, a qualitative analysis was done following insight from both Yin (2009) and Miles (1984). Main themes were identified; these themes informed the interviews that were conducted. As expected interviewing individual close to the outbreaks was challenging. I was able to informally interview individuals who later provided me with additional information. For APHIS, because of the pending lawsuits

they were unable to provide me much more than was available on the website. In the analysis, explanations, speculations and also alternative explanations were discussed.

## **CHAPTER FOUR: CASE STUDY 1- APHIS & Potato Cyst Nematode**

### **4.1 History and organization**

APHIS, Animal and Plant Health Inspection Service is an agency under the United States Department of Agriculture. APHIS's mission is *"To protect the health and value of American agriculture and natural resources"*. APHIS is essentially a regulatory agency. Previously APHIS understood that its role is to simply regulate agriculture as dictated by Congress and USDA leadership. However, over the last ten years there has been acknowledgement and greater understanding by APHIS leadership, evidence through the strategic plans written every five years, that they must think beyond rules and regulation. APHIS has recognized that agriculture continues to transform and evolve. Therefore, APHIS as an agency needs to adapt at the same pace as the evolving field of agriculture (APHIS, 2015).

In APHIS' current strategic plan for 2015-2019, six key facts were acknowledged. First, the traditional regulatory processes cannot stay the same and at times regulations may not always be appropriate in every situation. APHIS's acknowledges that while regulations may be one part in meeting the goal of safeguarding American agriculture, APHIS needs to be open to alternative approaches. APHIS intends to continue working more effectively with stakeholders to come up with solutions that may be of regulatory or non-regulatory nature. Using outreach and education, APHIS hopes to identify the best tools necessary to solve key problems (APHIS, 2015).

The second fact that APHIS acknowledged was "Rapid Advances in Science and Technology" (APHIS, 2015). APHIS acknowledged that technology is advancing at a phenomenal rate and has the potential to help APHIS serve the customers-stakeholders,

partners and the general public in much more effective manner. APHIS acknowledges both the changes from information technology to the plant and animal sciences:

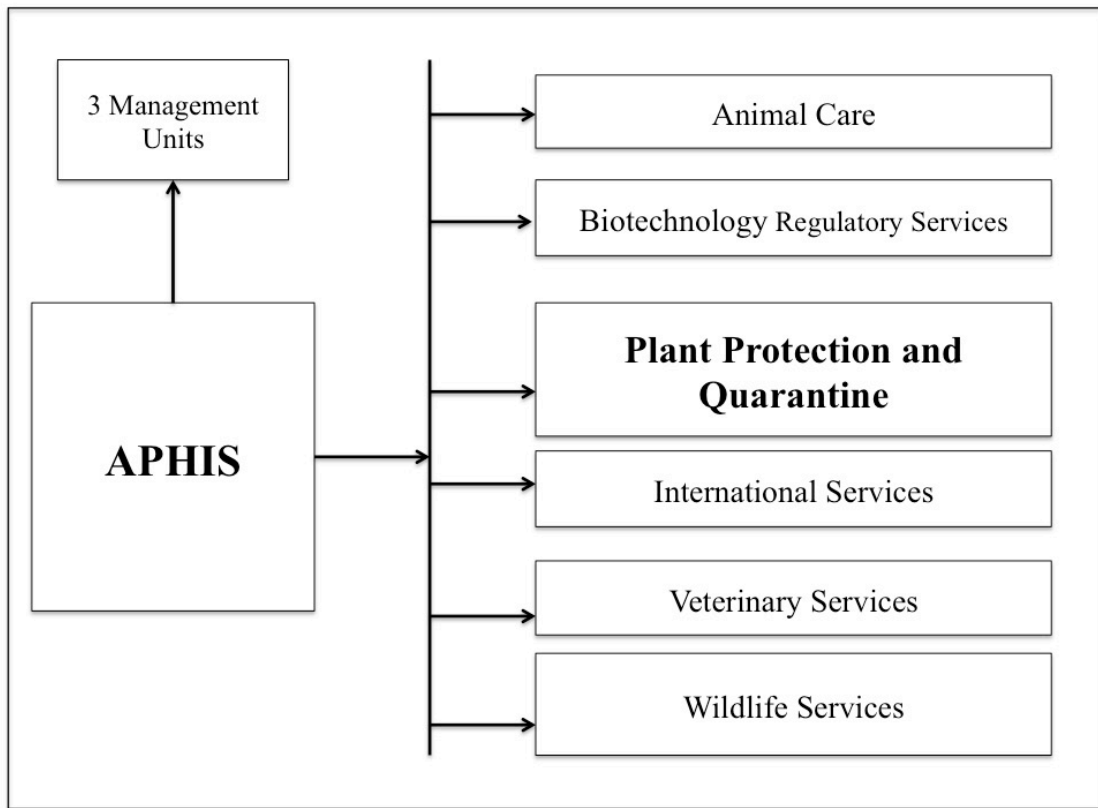
*“Plant and animal sciences are also changing quickly with developments in the areas of genetic engineering, disease detection and veterinary biologics, among others. These rapid advances can often result in government agencies being reactive rather than proactive, leaving customers feeling frustrated by a lack of leadership on the part of government” (APHIS, 2015, p.4).*

This statement reflects an effort by APHIS to be more preventative and less reactive. This idea is further emphasized in the following statement: *“Our science centers will lead the way in developing and delivering science-based knowledge and methods to identify and analyze risks and mitigate threats.”(APHIS, 2015, p. 5).*

APHIS states that it is necessary to *“provide leadership on diagnostic techniques, tests, and new technologies including greater use of genomics and bioinformatics”(APHIS, 2015, p. 5).* This statement directly refers to how APHIS approaches an emergency such as the PCN. Other tactics discussed in strategic plan include better strengthen the timeliness of the diagnostics. Early and rapid detection is important due to the devastating consequences of not identifying the pest or disease quickly and timely (APHIS, 2015).

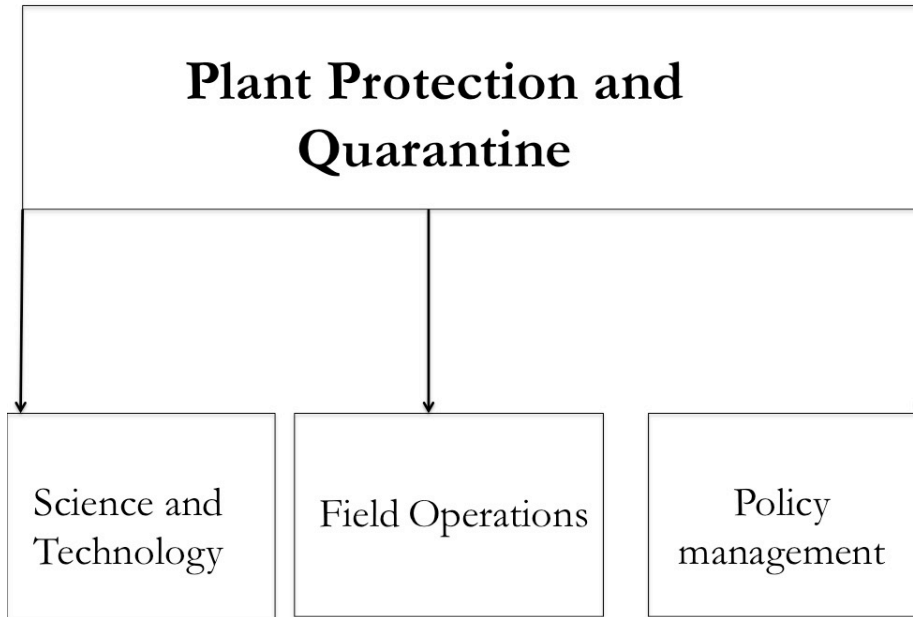
APHIS also acknowledges four additional facts 1) animal, plant and human health are connected on many levels including on a global level, 2) services are in demand at an increasing rate, thus APHIS intends to serve their stakeholders, mostly farmers, to the best of its ability, even with a stricter budget, 3) building and maintaining positive relationships is priority in the near and distant future, and 4) reducing trade barriers, both technical and political, is a must as the demand for US agriculture increases internationally (APHIS, 2015).

The organization of APHIS has three management units and six operational units and two programs that support federal government wide efforts. There are a total of 8,300 employees who work for this agency (APHIS, 2016a). In Figure 4.1 shows an abbreviated organization chart of APHIS.



**Figure 4.1: APHIS organizational chart**

The operational unit Plant Protection and Quarantine (PPQ) oversees the Pale Cyst Nematode Program. This program was designed to detect and eradicate this invasive pest. In Figure 4.2 there is a breakdown of PPQ’s organization.



**Figure 4.2: Plant Protection and Quarantine programs**

Under Plant Protection and Quarantine (PPQ), the Center for Plant Health Science and Technology (CPHST) is a unit that is APHIS’s in-house technology development organization. CPHST mission is to “develop, adapt, and support technology to detect, identify, and mitigate the impact of invasive organisms”(CPHST, 2008, p. 1). CPHST supports APHIS with “methods development, scientific investigation, analysis, and technology” as well as scientific support for policy decision made by leaders within APHIS and USDA (CPHST, 2008, 2016). CPHST has nine laboratories and three programs that cut across multiple labs. Each of the laboratories develops technologies that address challenges related to invasive pest and diseases within the entire plant health system. Molecular diagnostic technology is developed for plant pathogens, invasive pests and weeds. CPHST supports research in biological control methods, waste disposal and decontamination related to agriculture waste. CPHST ultimately aims to provide



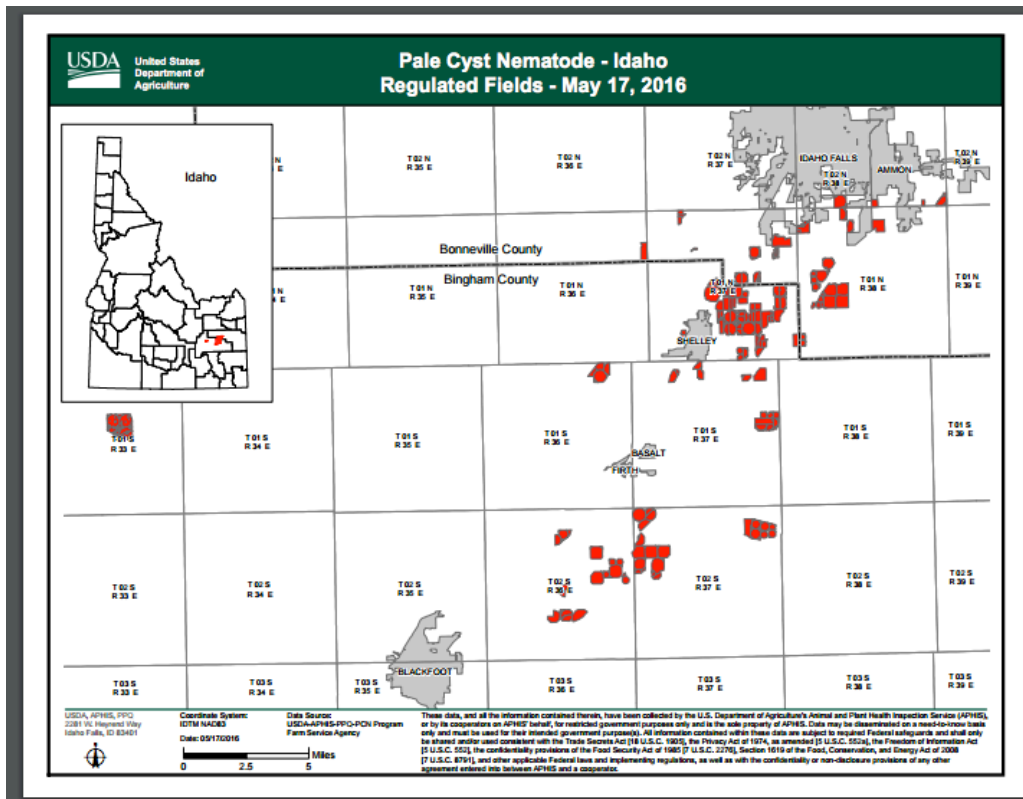
science-based knowledge so policy makers can make the most informed decisions (CPHST, 2016).

#### *4.1.1 APHIS stakeholders*

APHIS has several stakeholders but the primary stakeholder is the farmer. Regulations created and implemented first and foremost impact the farmer who grows a range of agriculture crops and/or involved in animal husbandry. APHIS works with range of secondary stakeholders both internally and externally. When regulating plants and animals, APHIS works with various state, local, and tribal organizations to ensure they meet their mission of protecting US agriculture and natural resources.

## **4.2 Incident background and response**

During a routine soil survey for invasive pests, APHIS and ISDA, the Idaho State Department of Agriculture, officials found and confirmed the detection of *Globodera pallida* on April 19<sup>th</sup>, 2006. This pest, with the common names of potato cyst nematode and pale cyst nematode (PCN), was found to originate from 911 acres in northern Bingham County in Idaho (Figure 4.3. PCN was found in the soil only, with no evidence of symptoms on the potato plants (APHIS, 2006g). APHIS and Idaho State Department of Agriculture (ISDA) authorities took action as soon as field based personnel suspected the presence of PCN. In Figure 4.3, one can see the current state of quarantined fields in Idaho.



**Figure 4.3: Map of quarantine area of Pale Cyst Nematode (APHIS, 2016c)**

The PCN outbreak can be broken up into two phases: 2006-2009 and 2010-Present. There was subtle but clear shift in the details, policies and stakeholder outreach in 2009, which may be reflective in the change of administration government-wide. During each phase, the response can be analyzed by dividing its three facets: technological, organizational and policy. The technological response involved detection, prevention and eradication. In the first few years, detection and eradication technology predominated the response. Later, the use of prevention technologies predominated APHIS's efforts.

Table 4.1 provides a brief timeline of the events over the last ten years.

<b>Year</b>	<b>Actions</b>
2006	Discovery of PCN before evidence of damage to Potato Crops from internal and external working groups. APHIS adapts detection technology. Nine Stakeholder updates Quarantines positive fields by August.
2007	Four Stakeholder updates. Two peer-reviewed articles written. Federal Interim rule went into effect to provide a guide. Found another PCN Infested field.
2008	Two stakeholder updates. Continued sampling and found two more PCN cysts.
2009	Three stakeholder updates. APHIS publishes National survey and Sample forwarding protocols (APHIS, 2009b). Officially switched from using the common name Potato Cyst Nematode to Pale Cyst Nematode.
2010	Monthly reports in addition to stakeholder updates, addressing research, eradication, regulatory and trade activities. Documentation of public outreach efforts.
2011	Quarterly program reports plus stakeholder updates. First acknowledgement of the impact of the sequestration. Officials concern the budget will impact the program. Confirmed another PCN finding.
2012	Quarterly program reports plus stakeholder updates. APHIS provided training for growers on proper sanitization. Published a five year review of the PCN program (APHIS, 2012b). Five additional fields with PCN were found.
2013	Quarterly reports and stakeholder updates continued. Four additional Fields were found with PCN.
2014	Quarterly reports and stakeholder updates continued. Found more PCN in already regulated fields. Six additional fields found with PCN.
2015	Quarterly reports and stakeholder updates continued. No additional PCN infestation.
2016	Pending lawsuit, resulting in no stakeholder reports so far in 2016. Scientific Research continues.

***Table 4.1: Summary of the timeline for the communication response by APHIS***

Table 4.1 focuses on the information obtained from stakeholder updates, and the technology development that occurred. This is discussed in later in this chapter.

#### *4.2.1 Technological response*

In the first three years, APHIS focused on accurately detecting the Pale Cyst Nematode (PCN), investigating the possible source of the PCN with traceback investigations, and developing advanced technology to eradicate and to eliminate the Pale Cyst Nematode from the Idaho potato fields.

USDA APHIS used detection technology within weeks and months of finding the Pale Cyst Nematode. USDA scientists and nematode experts confirmed the finding of the Pale Cyst Nematode. The available molecular technology was adapted by CPHST and used to confirm that the discovery was indeed the serious plant pest PCN. Not only did APHIS employ scientists to detect and identify the Pale Cyst Nematode, but they also brought together several scientists within USDA and ISDA to discuss a strategy of sampling and detection. It was agreed between USDA and ISDA that an independent party would be employed to impartially confirm the findings. Agency scientists acknowledged the difficulty of differentiating between three closely related nematodes: *Globodera pallida*, *Globodera rostochiensis* and *Globodera tabacum*. The later species is of the greatest concern while the former two species were already common in the US. The inclusive nature of APHIS's efforts was confirmed by several scientists in a 'First Report' from a peer-reviewed journal *Plant Disease* in March of 2007 (Hafez, 2007). In addition, an article was later published in the *Journal of Nematology* describing the importance of the discovery of the Pale Cyst Nematode and the need for advanced technology to detect, prevent and eradicate this economically devastating pest (Skantar, 2007).

In the first three years (2006-2009) of the discovery, advanced detection technology became a crucial part of APHIS's response to the Pale Cyst Nematode. To confirm the identification of two Pale Cyst Nematode cysts, USDA scientists used advanced molecular technology. The confirmation of these as being *Globodera pallida* was first identified by experts using a specialized microscope to identify the morphological features including the "cyst shape, characteristics of the cyst terminal

cone including the nature of fenestration, cyst wall pattern, anal-vulval distance, number of cuticular ridges between anus and vulva, and Granek's ratio" (Hafez, 2007, p. 1). The scientists also looked for identifying characteristics in the juveniles and eggs that were found in the cysts. To further confirm that it was indeed *Globodera pallida* (Pale Cyst Nematode), molecular diagnostics tests were also used: A polymerase chain reaction with a restriction fragment length polymorphism (PCR-RFLP) which differentiated Pale Cyst Nematode from the Golden Cyst Nematode, a closely related species and often hard to differentiate (Skantar, 2007). Another PCR was done using the Internal Transcriber spacer (ITS) genes, which are often used in detection technology. The fragments obtained from the PCR were then sequenced to further confirm the identity of the Pale Cyst Nematode (*G. pallida*) (Hafez, 2007).

The presence of Pale Cyst Nematode was confirmed within months. APHIS tasked the Center for Plant Health Science Technology (CPHST) to convene a Pale Cyst Nematode Technical working group (PCN-TWG). This working group discussed the status of this pest and made management recommendations based on the scientific knowledge and expertise. As a result of one of the recommendations, APHIS tasked CPHST's in-house molecular diagnostics and methods development laboratory in Beltsville, Maryland (CPHST, 2016). This laboratory adapted the available molecular biology technology to reduce the amount of time for a diagnosis. This effort began in the summer of 2006. First, the effort focused on ways to adapt the current molecular methods, while later efforts focused on how to improve and develop more sensitive detection technology. This laboratory's effort was documented in a peer-reviewed journal article that was finally published in 2010 (Nakhla, 2010). In this journal article,

Nakhla (2010) of CPHST Beltsville places significant emphasis on why CPHST Beltsville chose to adapt the original technology. The author writes that the disadvantage of the standard diagnostic method as being labor intensive and time consuming. This propelled the laboratory to further minimize the time and labor involved in the diagnosis by developing new technology to rapidly detect and differentiate between three closely related *Globodera* species (Nakhla, 2010). CPHST also worked with the original laboratory within USDA's Agriculture Research Service (ARS) that diagnosed the PCN cysts. The ARS scientists acknowledged the "urgent need for new molecular diagnostic capabilities" (Skantar, 2007. p. 1).

In addition to detection of the Pale Cyst Nematode, a comprehensive effort to survey and sample all of the regulated fields was enacted from the beginning of the incident. APHIS with their partners implemented three types of surveys: Detection, Delimiting and Eradication (APHIS, 2006g, 2010h). To assist in surveying, by May of 2006, within weeks of the discovery of the Pale Cyst Nematode, a mechanical wheel sampler arrived in Idaho to help ISDA and APHIS scientists with their sampling, reducing the labor required to survey the fields. This particular sampler design was based on the sampler used for the Golden Cyst Nematode (*Globodera rostochiensis*) survey in New York State (APHIS, 2006g).

Prevention and eradication technologies were also developed and tested between 2006 and 2009. It should be noted that the policy and the technology used in the discovery of the Pale Cyst Nematode was a 'preventative technology'. The Pale Cyst Nematode was present, but yet to cause damage in the Idaho potato fields. In these early years, APHIS sponsored various research efforts to directly address the infestation of

Pale Cyst Nematode in Idaho. APHIS also had one of its methods development laboratories in Gulfport Mississippi, which is run by CPHST; conduct research on the soil from infested fields. CPHST Gulfport tested new technologies to characterize soil and connect its profile to specific sites (APHIS, 2006d).

After three years of responding to the PCN crisis in April of 2009, APHIS's various programs including Plant Protection and Quarantine, Emergency and Domestic Programs (EDP), National Identification Service (NIS) and Center for Plant Health Science and Technology (CPHST) published the Pale Potato Cyst Nematode National Survey and Diagnostic Cyst Sample Forwarding Protocols (CPHST, 2009). The purpose of this document was to provide the proper procedure for a national survey for the Pale Cyst Nematode. The document addressed the technology that could be used, the time to survey a field, the disposal of soil and water used in the survey, the actual equipment and technology used for proper cyst extraction, and once cysts are extracted the proper packaging, transportation and chain of custody (CPHST, 2009).

Table 4.2 demonstrates alternative approaches to eradication and prevention that was used for fumigation.

<b>Eradication/Prevention Research (2006-2009)</b>	<b>Date of use</b>	<b>Notes</b>
Oil Radish-Biofumigant	Summer 2007	It is used to prevent soil erosion. The plants are tilled into the soil. It rejuvenates the soil and releases a compound that is toxic to Nematodes.(APHIS, 2008a)
Yellow Blossom Clover – Biofumigant	Summer 2008	It was used in response to complaints of the odor that Oil Radishes gave off. (APHIS, 2008a)
Arugula	Summer 2009	It was used as a cover crop (APHIS, 2010g)

***Table 4.2: Alternative fumigation technologies for eradication of PCN***

In addition to the alternative fumigation technologies seen in Table 4.2, APHIS used traditional methods of eradication since 2007. It included Methyl Bromide, Telone II during the winter months and Biofumigant plants during the summer (APHIS, 2010d). Methyl Bromide and Telone II are considered the strongest and the only known effective nematicides.

APHIS and ISDA also made use of the detection technology to determine if the eradication of the PCN from infested fields worked. Scientists performed viability assessments to show the effectiveness of the fumigation (APHIS, 2008b).

#### *4.2.2 Organizational response*

The organizational response by APHIS within the first three years included several key organizational changes. ISDA and APHIS created a new and fully functional laboratory in Idaho to alleviate the load on ISDA. This new state of the art laboratory processed more soil samples that increased due to the statewide survey that was implemented during these first years. This laboratory also led efforts on the viability



testing to ensure that the eradication was successful. This laboratory was fully functional by March of 2009 (APHIS, 2009a).

#### *4.2.3 Policy response*

As of spring of 2007, new policies were created and implemented. APHIS, in collaboration with ISDA created the Potato Cyst Nematode Response and Recovery Program (PCNRR). The program has clear goals which were documented as the following: 1) prevent the spread of PCN by surveying the potato fields in Idaho, 2) delimit the current infestation by immediately regulating the infested fields, 3) eradicate the infestation using traditional and non-traditional fumigation methods, 4) restore lost foreign markets which were lost in the initial finding of PCN, and 5) preserve current markets with transparent communication (APHIS, 2007a).

The restoration of lost foreign markets was a major factor in APHIS's response to this incident. Upon discovery of PCN, Canada, Japan, Korea, Mexico and several other countries immediately stopped accepting potatoes from the US regardless of what state the potatoes came from. International potato trade returned to relative normalcy by accepting potatoes from all areas of the country except the quarantined areas of Idaho or in some cases the entire state of Idaho. The potato farms from other states did not suffer from this incident (APHIS, 2006a, 2006b, 2006c, 2006d, 2006e, 2006f, 2006g, 2006h).

In order to preserve current markets, communication and outreach became a key priority for APHIS. Since May 1, 2006, APHIS has given frequent reports to both stakeholders and beyond. The public reports were aimed at stakeholders but were made publically available through the APHIS official website from 2006 to 2009. Each report gave a summary, an update on the survey progress, any changes in regulations, personnel

working on the detection and surveys, and an update on trade. During this period of time, (2006-2009) there was inconsistent, but frequent, communication.

These reports also addressed complaints and concerns of the stakeholders. For example, in 2008, stakeholders complained about the offensive smell of the oil radish as a cover crop. APHIS responded with an indication they were investigating alternative cover crops such as yellow blossom clover and arugula (APHIS, 2008a).

Regulations were also changed to reflect the new situation. APHIS issued an Emergency Action Notification (EANS). The Idaho State Department of Agriculture (ISDA) also issued restrictions. These restrictions aimed to prevent the movement of soil, plants, plant material, and farm equipment. The initial regulations only applied to seven sites, which included fields, cellars and potato handling facilities (APHIS, 2006g). In 2007, APHIS published an interim rule that instructed how fields would be regulated and deregulated (APHIS, 2007b).

In addition to the traditional responses, in the first months and years of APHIS's response to this incident included investigation by ISDA and APHIS scientists on how Idaho fields had become infested with the Pale Cyst Nematode. Part of this investigation included determining the origins of 'used' farm equipment. The scientists attempted to identify possible sources of contamination from farming practices, tillage equipment, irrigation sources and wildlife patterns (APHIS, 2006e). As the investigation continued they began looking at such sources as used farm equipment that was imported, nursery stock, foreign flower bulbs, and illicit potato seed importation (APHIS, 2006a).

### **4.3 APHIS response 2010-present**

With a new Presidential administration and new leaders within USDA, the response appeared to become more strategic, professional and standard. In 2010 communication to key stakeholders were held on a monthly basis, the proceeding reports were published on a quarterly basis. The stakeholder reports were published on a quarterly basis as well. Beginning in 2010, the results of the state survey were presented in the stakeholder and program reports. A national survey was also implemented throughout the US for the purpose of ensuring that the Pale Cyst Nematode was not present in any other state (APHIS, 2010h).

In addition to changes in administration, in August of 2010, APHIS, under the authority of the Farm Bill which is the Agriculture Act that is renewed every five years, was able to create interagency agreements with USDA ARS Prosser and New York (APHIS, 2010a, 2016b). Previous to these formal agreements, APHIS appeared to already be informally collaborating with both agencies. The Farm Bill continues to play a role in how APHIS responds (APHIS, 2010c).

APHIS technological response from 2010 continues to date. APHIS supports various organizations including ARS, as well as internally with CPHST. Table 4.3 presents a list of research and new technology that has been developed. These new technologies helped with rapidly surveying a field for PCN, alternative bio-control methods, identifying weeds that may be attracting the PCN and genetic research for identifying potatoes that are resistant to PCN.

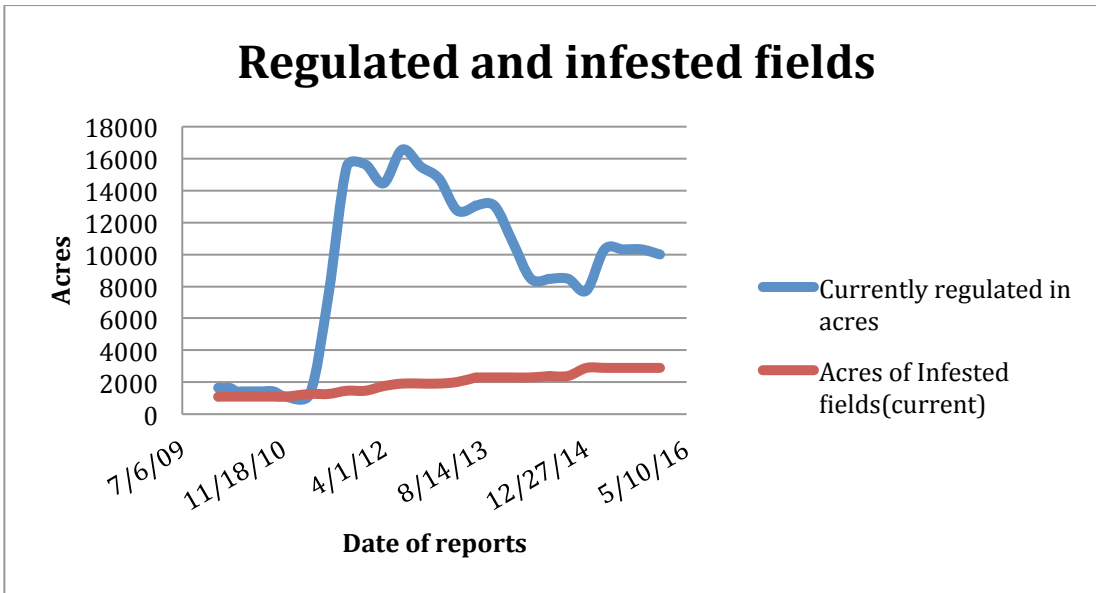
<b>Eradication/Prevention Research</b>	<b>Date of use</b>	<b>Notes</b>
Flow-Cam Technology	February 2010	This technology is used to identify PCN cysts in soil flotsam (APHIS, 2010g).
Bacteria/Fungal species being researched	March 2010(APHIS, 2010f)	For bio-control agents.
Green Manure/Brassica spp	March 2010(APHIS, 2010f), May 2010	For bio-control.
Alternative PCN Hosts	March 2010(APHIS, 2010f)	To determine if weeds are attracting PCN to the fields.
PCN Rearing	April 2010	To be used in PCN eradication research (APHIS, 2010d).
Electronic Scanning Device	April 2010	New Mexico State University visited the program to help in its development (APHIS, 2010d).
Sticky Night Shade	May 2010	This weed may be a host for PCN that can be used as a trap crop, this research is being done at University of Idaho (APHIS, 2010c).
Genetic Research: PCN and Golden Nematode resistant potatoes	May 2010	This research is being done at Cornell University (APHIS, 2010c).
Biology of the PCN	June 2010	University of Idaho (APHIS, 2010e).
<i>Solanum sisymbriifolium</i>	June 2010	ARS-Prosser (APHIS, 2010e).
<i>Brassica juncea</i> Seed meal	September 2010	Field studies of type of Bio-control being conducted. It produces a glucosinolates as a gas that is toxic to <i>Globodera pallida</i> (APHIS, 2010b).
Bio-control,	2 <sup>nd</sup> Quarter 2012	Testing Fungi that may prevent PCN complete its life cycle(APHIS, 2012a).

**Table 4.3: Technologies in development for detection, eradication and fumigation of PCN**

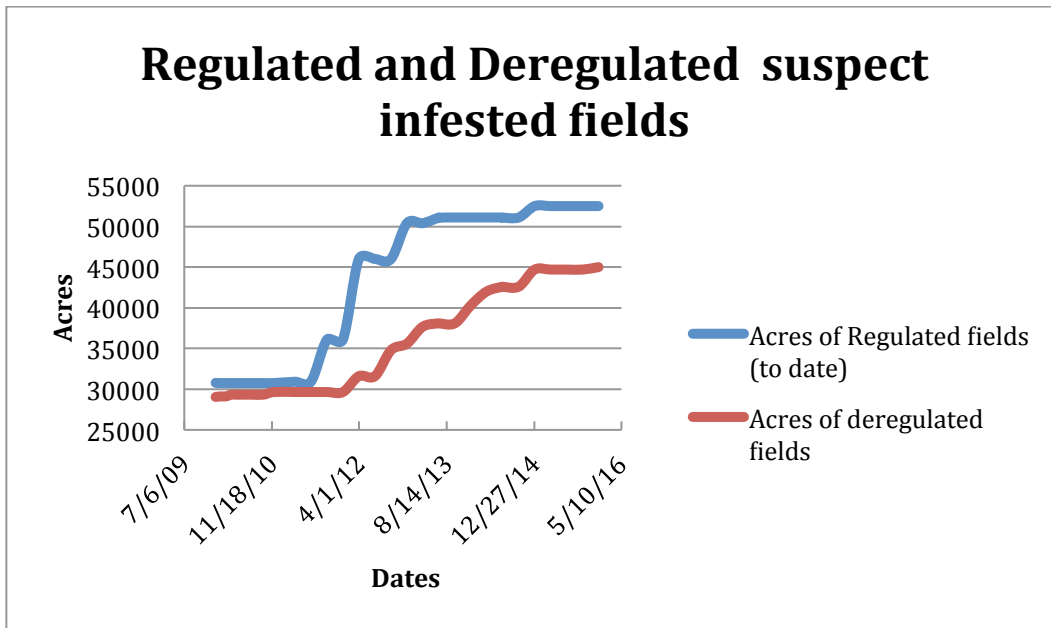
The technology responses that would help prevent or eradicate the PCN were broken up in several ways: fumigation, prevention and trapping. Fumigation included the traditional use of nematicides and pesticides such as Methyl Bromide and Telone II.

Simultaneously research in developing different biofumigants, which include using a plant that naturally gives off a gas that is toxic to nematodes (Lord J.S., 2011). APHIS and ISDA official also used other pest management techniques, such as using different types of green manure and plants that attracted and trapped the nematodes, as listed in Table 4.3.

APHIS and ISDA continued to regulate and deregulate potato fields based on the results of the surveys and detections. Additional regulations aimed to prevent the movement of soil, plants, plant material, and farm equipment. With additional information beginning in 2010, the number of regulated and deregulated fields was easy to graph and demonstrate APHIS’s progress in actively preventing the spread of PCN (Chart 4.1 and Chart 4.2).



**Chart 4.1: Regulated and infested fields from January 2010-Present**



**Chart 4.2: Regulated and deregulated infested or suspect fields**

Most of the documents reflecting the response to the outbreak have minimal discussion of funding challenges. However, by Fiscal-Year 2012 (FY12) there was a discussion of the uncertainty of how extensive the budget had been cut due to the Sequestration by the Congress. It was noted that the potato-breeding program was no longer receiving funding in FY12.

One of the challenges APHIS continues to confront is a lawsuit filed in April of 2015 by 13 Idaho farms. In a newspaper article, the farmers accused APHIS of unfairly “violating administrative law by imposing the regulations in an arbitrary and capricious manner and failing to follow public notice and comment requirements” (Perkowski, 2016). The farmers would like USDA APHIS to lift the band on interstate commerce. The farmers further claim that placing their farms in quarantine was illegal since it overrides state authority and impacts the farmers financially (Keller, 2016). In addition to the legal complaints, the farmers have demanded that USDA pay reparations due to cattle dying and becoming sick due to eating methyl bromide contaminated hay. The USDA

has refused to pay these farmers since they feel there is no connection to the sick cattle and methyl bromide (Nosowitz, 2016). In the lawsuit against APHIS, there were several allegations that reflected APHIS's response to the outbreak. The farmers claimed that APHIS has provided clear and transparent communication about how farms are regulated and deregulated, technical working group consisted of select individuals but no representatives of the Farmers or industry and they claimed that regulation decisions are ad hoc ("Idaho Farmers Vs USDA APHIS ", 2016).

APHIS continues to respond and manage the presence of the Pale Cyst Nematode. APHIS response has been preventative since no fields have shown signs of damage from the presence of the PCN. Research by APHIS and its partners continues to this date. APHIS justifies their continual preventative actions with the following statement: "*Early detection of pests minimizes agricultural production costs and enhances product quality and marketability*"(APHIS, 2016d, p.1). This idea is prevalent throughout all the documents collected for this research.

## **CHAPTER FIVE: CASE STUDY 2: FSIS & Salmonella Outbreak Response**

### **5.1. History and organization**

Food Safety and Inspection Service (FSIS) is the public health agency of the US Department of Agriculture. FSIS's main mission is to ensure that meat, poultry and processed eggs are "safe, wholesome and accurately labeled" (FSIS, 2016d, p. 1). FSIS's mission is dictated by four Congressional Acts: Federal Meat Inspection Act (FMIA) 1906, Agricultural Marketing Act (AMA) 1946, The Poultry Products Inspection Act (PPIA) 1957, and the Egg Products Inspection Act (EPIA) 1970. The FMIA was enacted at the same time as the Pure Food and Drug Act of 1906.

In addition to these Congressional Acts, in July of 1996, FSIS established a rule for the purpose of pathogen reduction. This new rule was called the Hazard Analysis and Critical Control Point (HACCP) System and since that time FSIS has used the HACCP system to reduce the number of pathogens present on poultry, meat and egg products. This final rule has to be followed by food facilities that process meat, poultry and egg products. The drive for establishing this rule was a response to several severe Foodborne Illness outbreaks in the early 90s (Young, 2015).

FSIS has expanded the HACCP system to include a focus on the microbiological hazards such as foodborne pathogens. Traditionally HACCP was used in the food industry to identify hazards such as chemicals, and pesticides. Foodborne pathogens especially bacteria, viruses and fungal pathogens are often present but not detectable without advanced technologies. The FSIS Pathogen Reduction: HACCP system specifically focused on reducing the occurrence and the amount of pathogenic microorganisms in meat, poultry, and egg products. First, FSIS used HACCP system to



require all food facilities to write and implement standard operating procedures for proper sanitation. Second, each facility would need to test for microbes on regular basis. Third, the facilities must meet the pathogen reduction performance standards for *Salmonella*. Finally, each facility would have to implement a performance plan to reduce the presence of these pathogens (FSIS, 1996). The HACCP system continues to be the standard used for inspections by FSIS to this day. FSIS sends over 8,000 personnel to the 6,000 food facilities to ensure they have established, met and followed the regulations and policies created under the HACCP system (FSIS, 2013a).

Over time, FSIS organization has evolved to become increasingly complex with over 9,600 employees. Most of FSIS employees are inspectors, but FSIS also employs highly skilled professionals such as scientists, veterinarians, data analysts, policy analyst and risk managers. The roles of these professionals are to ensure the safety of poultry, meat and egg products by focusing on the developing rules, regulations and policies that focus on the latest science knowledge (FSIS, 2013a).

FSIS consists of five offices with the Administration and nine different offices addressing different aspects of Food Safety including: The Office of Field Operations, Office of Public Health Science; Office of Policy and Program Development; Office of Investigation, Enforcement and Audit; Office of Data Integration and Food Protection; the Office of Public Affairs and Consumer Education; Office of Outreach Employee Education and Training; and Office of Management (FSIS, 2013a, 2016a). Table 5.1 lists of FSIS offices that play a role in food safety. Each office's role is categorized as a preventative, responsive or both.

<b>Unit</b>	<b>Main Role Played in Food Safety</b>
The Office of Field Operations	Prevention
Office of Public Health Science	Prevention and response
Office of Policy and Program Development	Response, some prevention
Office of Investigation, Enforcement and Audit	Response
Office of Data Integration and Food Protection	Response
Office of Public Affairs and Consumer Education	Response
Office of Outreach Employee Education and Training	Prevention

**Table 5.1: FSIS unit roles**

The Office of Field Operations is the primary unit that addresses food safety. This office oversees nearly 8,000 personnel involved in inspecting poultry, meat and egg products. There are 10 district offices throughout the nation that support inspectors who are based in each of the 6,000 facilities. These facilities include poultry, meat and egg processing plants, as well as inspectors at the US border stations. FSIS officials also look at products that have been imported from other countries. This office ensures that foreign products adhere to the same standards as US based food facilities.

Under The Office of Public Health Science (Table 5.1) there are three scientific units. First is the Science Staff, which focuses on evaluating current and future hazards. This unit also plays a role in outbreak investigations and advises agency leaders by providing a scientific perspective for improving and developing policies. The second unit is Risk Assessment and Analytics, which uses mathematical models to evaluate and predict current and future intervention strategies to minimize foodborne pathogen outbreaks. The third unit is Applied Epidemiology, which works with various stakeholders to investigate and monitor foodborne pathogen outbreaks related to the food

products FSIS inspects (FSIS, 2013a). Though these units are scientific, as they only focus on the available science rather researching about new science and technology. Most of the new fundamental research is delegated to Agriculture Research Service.

The Office of Public Health Science states that they use scientific knowledge and expertise to investigate any foodborne outbreaks, but also works to prevent outbreaks through research and risk analysis. FSIS does not have methods development research laboratories. FSIS can identify research priorities and possible risks, but actual methods develop work are outsourced to Agriculture Research Service (ARS) and academia. The Office of Public Health Science develops policies to assist in the response and prevention of foodborne pathogen outbreaks within poultry, meat and eggs. They use data from past outbreaks and inspections to advise leaders on how to improve the current system.

The key office in outbreak responses is the Office of Investigation, Enforcement and Audit. When there is an outbreak reported by the CDC, this office is tasked with the investigation. This office is also involved in surveillance and enforcement activities related to the current regulations and policies (FSIS, 2013a).

All of the other offices also play crucial roles in protecting public health. The Office of Policy and Program Development interprets the science and the data to develop the best policies and regulations for public health; The Office of Data Integration and Food Protection plays a role in the responding and analyzing outbreaks; the Office of Public Affairs and Consumer Education ensures the stakeholders and the public are aware and updated on outbreaks; and finally the Office of Outreach Employee Education and Training ensures that FSIS employees are given the necessary training to continue to improve their efforts to meet the mission of FSIS (FSIS, 2013a, 2016a).

As stated in FSIS's 2013 published mission book (FSIS, 2013a), FSIS works to reduce the number of foodborne pathogens that cause substantial illness in meat, poultry and egg products. FSIS states that policies are driven by science, from inspections to anticipating future threats. To strive to meet these policies, FSIS implements several programs and activities. First, FSIS inspects over 6,000 food facilities nationwide. Second, FSIS ensures that the inspection methods are constantly adapting to address emerging threats. Third, FSIS activities includes education and outreach to the consumers (FSIS, 2013a) . FSIS repeatedly emphasizes the importance of science in all their efforts in protecting public health (FSIS, 2013a).

FSIS also works collaboratively with a range of federal and state agencies and the public to help them reach their goals. FSIS strives to strengthen collaboration with these diverse organizations to further protect the US from foodborne pathogen outbreaks (FSIS, 2013a). More specifically, FSIS works with the CDC when an outbreak occurs and is connected to poultry, meat or egg products (FSIS, 2013a).

In addition to the activities that regularly occur within each unit in FSIS, since 2012, FSIS provided an Annual Performance Plan (APP) with a 'year in review' for each year including 2015. The purpose of publishing these yearly APPs, is to report on FSIS accomplishments but also continue to identify areas of improvement (FSIS, 2015a).

#### *5.1.1 FSIS stakeholders*

FSIS's primary stakeholders are stated as the US consumer of poultry and meat products, however FSIS focuses mainly on the poultry and meat processing facilities and companies. The influences of these food-processing corporations have incredible control in the regulations that are ultimately created and implemented. FSIS also work with state,

local and tribal organizations. Responding to an emergency, FSIS works with multiple federal agencies such as the CDC as well as with state public health organizations to investigate a source of an outbreak.

## **5.2 Identification of the outbreaks**

The CDC confirmed the public health outbreaks of *Salmonella* Heidelberg in June of 2012 and July of 2013. The CDC indicated that they informed FSIS, which then took action to investigate the connections between the poultry products and the suspected poultry processing facilities in July of 2013 (CDC, 2013, 2014). FSIS's official response to the *Salmonella* Heidelberg outbreak started on October 7, 2013 with a Public Health Alert and a Notice of Intended Enforcement to Foster Farms (McIntire, 2013; Sharma, 2013).

There were two identified multistate outbreaks of *Salmonella* Heidelberg infections linked to chicken beginning in June of 2012 ending July 31, 2014. The reason why these two outbreaks are being discussed in this case is that officials had strong evidence of a link between the illnesses to products from Foster Poultry Farms (CDC, 2013, 2014). In addition, government and non-government documents discuss both outbreaks (R. L. DeLauro, and Slaughter, L.M., 2013; Eskin, 2013). Foster Poultry Farms refused to accept this connection due to no direct connection of the particular *Salmonella* Heidelberg strain to their products (CDC, 2014). In Table 5.2 there is a summary of the two outbreaks.

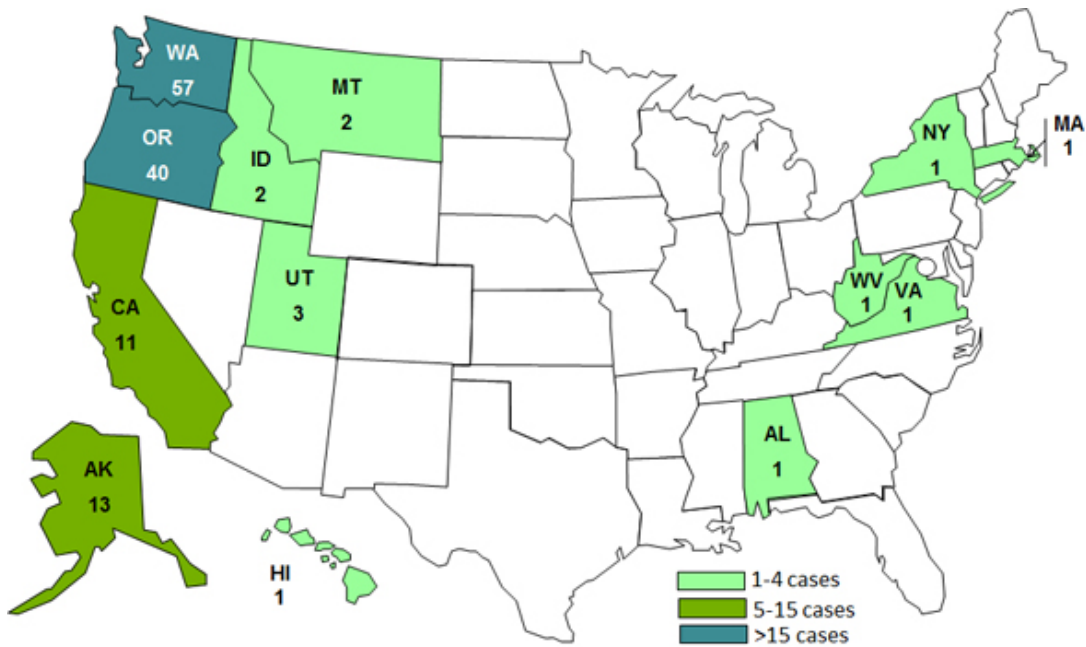
<b>Factors</b>	<b>Outbreak 1</b>	<b>Outbreak 2</b>
Pathogen	<i>Salmonella</i> Heidelberg	<i>Salmonella</i> Heidelberg
Number of infected	134	634
Percentage hospitalized	31%	38%
Percent identified Foster Farms products	71%	79%
States with reported illness	Most of the infected were in Oregon, and Washington	29 states/ 77% from California followed by Oregon, Washington, Arizona
Timeline of outbreak	June 4, -July 31 2013	March 1, 2013 to July 11, 2014

**Table 5.2: Detailed comparison of *Salmonella* outbreaks (CDC, 2013, 2014)**

As detailed in Tables 5.2 and 5.3, the first multistate outbreak was determined to be serious by March 5, 2013. The CDC reported that since June 4, 2012, 134 individuals were infected with a specific strain of *Salmonella* Heidelberg. Illnesses reported which were connected to this outbreak continued through July 10, 2013 and the CDC felt the outbreak was over at that point.

<b>Date</b>	<b>Event</b>	<b>Agency</b>
June 4, 2012	First case of <i>Salmonella Heidelberg</i> -1 <sup>st</sup> outbreak.	CDC
February 14, 2013	Official Announcement of 1 <sup>st</sup> Outbreak, FSIS starts investigation (CDC, 2013).	CDC
March 5, 2013	CDC reports the level a seriousness of the 1 <sup>st</sup> Outbreak.	CDC
March 1, 2013	First case of <i>Salmonella Heidelberg</i> -2 <sup>nd</sup> Outbreak	CDC
June 17, 2013	CDC Identifies a cluster of Illnesses (2 <sup>nd</sup> Outbreak).	CDC
June 28, 2013	FSIS reports to CDC of initiating investigation (2 <sup>nd</sup> Outbreak).	FSIS
July 1, 2013	FSIS notifies CDC that the chicken isolate is a farm Foster Farms Brand.	FSIS, CDC
July 5, 2013	FSIS calls Foster Farms to discuss their findings.	FSIS
July 10, 2013	End of 1 <sup>st</sup> Outbreak; CDC interviewed sick, nearly 80% consumed chicken at home, Traced back to 2 Foster Farm Slaughter facilities (CDC, 2013).	CDC, FSIS
July 22, 2013	FSIS begins to work with California public health officials to do a traceback investigation-2 <sup>nd</sup> Outbreak.	FSIS
August 9 <sup>th</sup> 2013	FSIS and CDC conference calls in with Foster Farms - 2 <sup>nd</sup> Outbreak.	FSIS, CDC
August 21, 2013	FSIS begins strategizing internally on sampling strategy of Foster Farm establishments.	FSIS
September 9-27 <sup>th</sup> , 2013	FSIS investigates four Foster Farm facilities that were suspected sources of the illnesses. FSIS reports results to the CDC at the end of the investigation.	FSIS, CDC
October 7, 2013	FSIS issues a Notice of Intended Enforcement to Foster Farms -2 <sup>nd</sup> Outbreak	FSIS
October 7, 2013	FSIS releases a Public Health Alert -2 <sup>nd</sup> Outbreak.	FSIS
October 12-17, 2013	Costco voluntarily recalls 23,000 units of cooked rotisserie chicken due to fear of <i>Salmonella</i> contamination-Chicken was from Foster Farms.	FSIS
July 3, 2014	Foster Farms recalled an unknown amount of chicken products. FSIS had finally able to connect a specific chicken product from Foster Farms to a sick individual(CDC, 2014).	FSIS

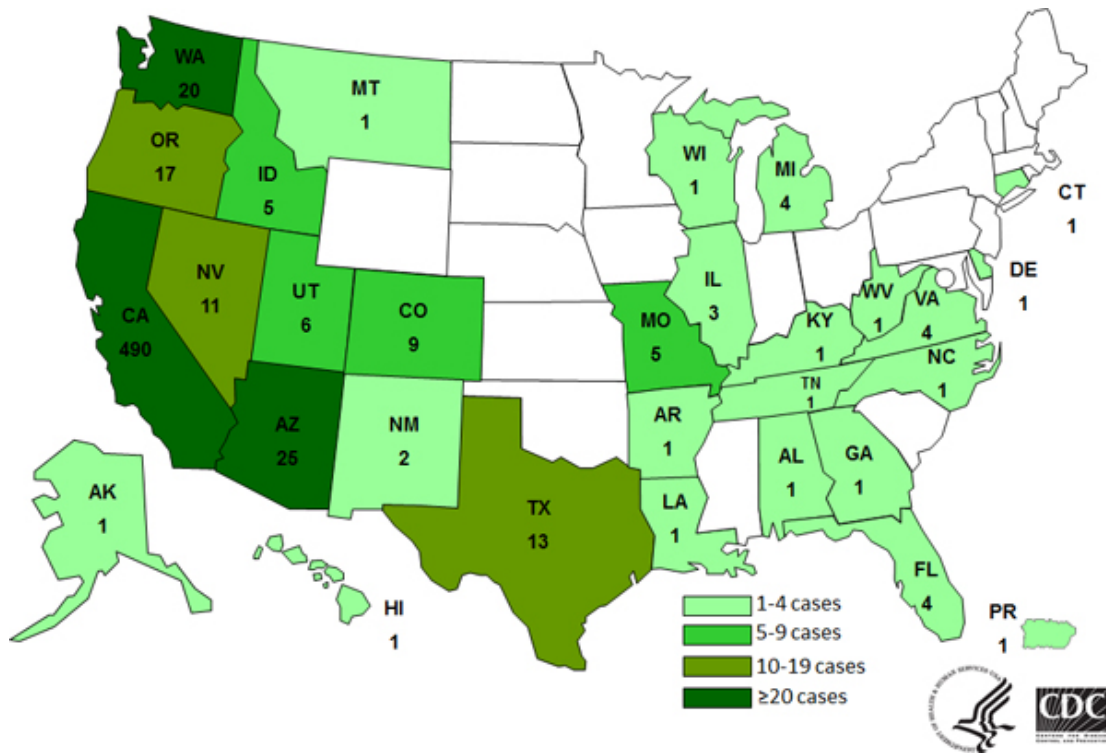
**Table 5.3: Timeline of *Salmonella* outbreak investigation**



**Figure 5.1: First Salmonella outbreak (CDC, 2013)**

In the first outbreak, as seen figure 5.1, the worst outbreaks were in the western part of the country. In Figure 5.2, one can see the extent of the second *Salmonella* Heidelberg outbreak. It should be noted that the second outbreak included cases in all of the states in the 1<sup>st</sup> outbreak with some exceptions, such as New York State.





**Figure 5.2: Second Salmonella outbreak (CDC, 2014)**

For the second outbreak, the CDC first determined that this was a multistate outbreak on March 1, 2013. According to the CDC, USDA-FSIS tested for *Salmonella* in a retail chicken isolate from Foster Farms on July 1, 2013. On July 5, 2013 FSIS summarized their investigation to Foster Farms. By July 22, 2013, FSIS began to collaborate with the California public health officials to begin a traceback investigation. On August 9, 2013, both FSIS and CDC had a conference call with Foster Farms to update them on their findings and the link they saw between the poultry products that had been processed through the specific Foster Farms poultry processing facilities. On August 21, 2013, FSIS began internal meetings to develop a plan to begin sampling four poultry facilities owned by Foster Farms more intensely. The plan was finalized on September 4<sup>th</sup> and implemented the rest of the month of September.

While the CDC continued to report on the outbreak, the media was reporting on each of the outbreaks and readily connecting them to Foster Farms (Robinson, 2013). For the both outbreaks, the CDC and FSIS felt there was a link or an association to Foster Poultry Farms. The recall for the first outbreak never happened and for the second outbreak the recall was finally enacted in July of 2014. This recall was able to happen because FSIS, after many sickness, was finally able to directly connect a strain of the *Salmonella* Heidelberg in a sick individual to a Foster Farms chicken product (CDC, 2014).

Various media channels were prolifically reporting on these two outbreaks. Many were critical of FSIS. For example, a NBC news reporter (Aleccia, 2014) explained why the FSIS cannot urge Foster Farms to recall their chicken products because there had not been a case that could be directly linked to one Foster Farm facility. The link was assumed based on structured interview results from sick individuals. CDC found that 71% of the sick in the first outbreak and 79% in the second had consumed chicken products from Foster Poultry Farms (Aleccia, 2014; CDC, 2013, 2014). Based on these reports, FSIS began investigating Foster Farms poultry facilities on September 9, 2013 to determine if the source of the illness was present (CDC, 2013).

After the reports of multi-state outbreak of *Salmonella* Heidelberg in late 2012 and early 2013 by the CDC, FSIS finally issued a health alert/press release on October 7, 2013. Simultaneously, FSIS issued a Notice of Intended Enforcement to Foster Poultry Farms. A letter from FSIS addressed to Mr. Ron Foster, CEO of Foster Farms stated:

*“This letter serves as an official notification by the Food Safety and Inspection Service (FSIS), Alameda District, of the intent to withhold the marks of inspection and suspend the assignment of inspectors for Slaughter, Raw Intact and Raw non Intact processes at your establishment, in accordance with FSIS Rules of Practice” (Sharma, 2013, p.1).*

By removing inspectors from the facilities, FSIS was essentially shutting down these facilities. It was not a recall of the products, but if FSIS went through with removing the inspectors, the result would be a loss for the company. In this letter, FSIS points out that multiple conversations took place in the summer, but FSIS felt Foster Farms continued to not meet the requirements of HACCP plan. At the end of the letter, FSIS insisted that Foster Poultry Farms respond to the letter with a demonstration of how they will resolve the *Salmonella* contamination issue (Sharma, 2013).

Below in Table 5.4, is a list of the various FSIS reports published to reduce the presence of Salmonella.

<b>Date</b>	<b>Title of Response</b>	<b>Summary</b>
December 2013	Strategic Performance Working Group: Salmonella Action Plan	Working group identifies key areas of improvement
January 2015	The FSIS Salmonella Action Plan: A One Year Action Plan	Reported on progress
December 2015	DRAFT FSIS Compliance Guideline for Controlling Salmonella and Campylobacter in Raw Poultry	As part of the SAP, drafted guidelines for large and small food processing facilities
February 2016	The FSIS Salmonella Action Plan: A Two year Update	Summary of everything FSIS has done in last two years

**Table 5.4 FSIS policy response**

As part of FSIS response to these outbreaks, in October of 2013, an internal working group, called the Strategic Performance Working Group, created an action plan. This action plan laid out steps to reduce the amount of *Salmonella* present in poultry and other meat products. This group was created by the FSIS Administrator to review the current food safety inspection programs. The reasons for focusing on this effort was that

despite various efforts by FSIS to minimize the presence of *Salmonella*, there continued to be high rate of Foodborne pathogen outbreaks associated with poultry and meat products that they inspect (FSIS, 2013b).

The committee settled on ten priorities that FSIS agreed to tackle as a response.

The ten priorities are listed below in Table 5.5.

Priority	Details
1	Modernize the poultry slaughter rule
2	Sampling and test evaluation
3	Improved in-plant strategy
4	Expand inspection and testing to pork products
5	Public posting of facilities performances results
6	Align <i>Salmonella</i> performance standards to ‘Healthy People 2020’
7	Establish new performance strategies
8	Explore lymph node contribution to <i>Salmonella</i> Contamination
9	Evaluate pre-harvest activities
10	Focus education and outreach on <i>Salmonella</i>

**Table 5.5 Ten priorities for FSIS Salmonella Action Plan (FSIS, 2013b).**

On December 4, 2013, FSIS presented The Salmonella Action Plan to the public. FSIS stated that this “presents a number of aggressive steps the agency will take to prevent Salmonella –related illnesses” (Tarr, 2013). This press release summarized the purpose of the plan and the steps FSIS would be taking to minimize the number of *Salmonella* outbreaks due to the consumption of poultry and meat products. The release also quoted then Under Secretary Elizabeth Hagen:

*“Far too many Americans are sickened by Salmonella every year. This aggressive and comprehensive steps detailed in the Salmonella Action Plan will protect consumers by making meat and poultry products safer”* (Tarr, 2013, p. 1).

Two annual updates of the Salmonella Action Plan were published in January of 2015 and February of 2016. In the January 2015 plan, FSIS reported that they met most of their goals and priorities. By February of 2016, FSIS declared that they accomplished

everything in the Salmonella Action Plan. FSIS also mentioned they will no longer continue this effort on an official capacity but will continue to monitor the activities. FSIS mentions that this action plan did not necessarily eliminate *Salmonella* completely, but these efforts will minimize the number of infections (FSIS, 2015c, 2016e).

As part of the action plan, FSIS released a guide for poultry processors to reduce *Salmonella* hazards (Stull, 2015). The plan also included guidance to reduce *Campylobacter* hazards. In the press release announcing this plan, the Deputy Under Secretary of Food Safety Al Almanza is quoted with explanation of the reason for developing this guide:

*“These guidelines take into account the latest science and practical considerations, including lessons learned from foodborne illness outbreaks in the last several years to assist establishments in producing safer food” (Stull, 2015, p.1 ).*

FSIS also points out that despite a reduction in other foodborne pathogens, *Salmonella* contamination continues at the same rate. This guide not only includes for whole chickens but also chicken parts which had previously had not been inspected (FSIS, 2015b; Register, 2015; Stull, 2015). Chicken parts make up about 80% of what is sold in the US; previously, inspectors were only inspecting whole chickens (Boghani, 2016).

FSIS’s response has essentially ended for these particular outbreaks. However, FSIS continues to address outbreaks as they arise. As of August of 2016, FSIS published a report on the presence of *Salmonella* from January 1998 through December 2014. In this report there was a table of the top strains of *Salmonella* that was most commonly found in their inspections in the calendar year of 2014. FSIS found that the more serious serotypes, *Salmonella* Enteritidis and Heidelberg, were the 2<sup>nd</sup> and 7<sup>th</sup> most common. Enteritidis was found in 9.5% of the samples and Heidelberg was found in 2.5% of the

samples (FSIS, 2016f). FSIS tests for as many as 32 different serotypes, however only about five cause serious human illness: Enteritidis, Typhimurium, Newport, Javiana and Heidelberg (Robinson, 2013).

Throughout this crisis, FSIS continued to receive substantial criticism from diverse organizations. Different government and policy organizations provided responses, critiques and insight on many of FSIS efforts. Some of the documents that provided these critiques are listed below in Table 5.5.

<b>Date</b>	<b>Report title</b>	<b>Organization</b>
October 2013	Letter to Under Secretary Hagen-USDA by Congresswomen Slaughter and DeLauro (R. L. DeLauro, and Slaughter, L.M., 2013).	US Congress
December 2013	Weakness in FSIS' Salmonella Regulation (Eskin, 2013).	Pew Charitable Trusts
March 2014	Letter to Acting Under Secretary for Food Safety: Mr. Brian Ronholm (L. M. Slaughter, Delauro, Rosa L., Moran, J., Bordallo, M.Z., Cardenas, T., Grijalva R.M., Courtney, J., Waxmn, H.A., Brownley, J., Cartwright, M., Coehn, S., 2014),	US Congress
October 2014	Letter to USDA Secretary Tom Vilsack (R. L. DeLauro, Slaughter, L.M., Moran, J.P., Rnagel, C.B., Blumenauer, E., Holmes Norton, E., Schakowsky, J.D., Grijalva, R.M., Clarke, Y.D., Pingree, C., Titus, D., McLane Kuster, A., Brownley, J., Cardenas, T., Connolly, G.E., 2014).	US Congress
September 2014	Food Safety: USDA needs to Strengthen Its Approach to Protecting Human Health From Pathogens in Poultry Products (GAO, 2014).	Government Accountability Office
May 2015	The Trouble with Chicken (Schwartz, 2015; Young, 2015).	PBS (Frontline and accompanying online articles)
July 2015	FSIS Ground Turkey Inspection and Safety Protocols (OIG, 2015) .	Office of Inspector General

***Table 5.6 Documents from external organizations***

Response from Congress was also highly critical and continues to be very critical. Letters to USDA on multiple occasions by Members of Congress were highly critical of

USDA FSIS' efforts. Each time FSIS published a report, a letter was written by several Members of Congress to express their concerns.

On October 16, 2013, ten days after FSIS issued a health alert, both Congresswoman Louise Slaughter and Congresswoman Rosa DeLauro wrote a very critical letter to the Under Secretary for Food Safety Dr. Elisabeth Hagen (R. L. DeLauro, and Slaughter, L.M., 2013). In this letter the Congresswomen outlined some key concerns: 1) *Salmonella* Heidelberg Outbreak one was linked to Foster Farms and declared over in July of 2013 with no indication of any action taken by FSIS. 2) In the same time frame a new *Salmonella* Heidelberg Outbreak occurred as the first one finished with even more sick. 3) Though the 2<sup>nd</sup> outbreak began in March, the investigation did not begin until July 1, 2013. 4) Though FSIS informed Foster Farms on July 25, 2013, contaminated products continue to be sold. 5) FSIS did not initiate intensive testing of the products from the facilities until September 9, two months later. 6) Foster Farm facilities had multiple non-compliance issues such as 'unsanitary conditions during both Outbreaks. 7) FSIS sent Notices of Intended Enforcement requiring a response in three days but Foster Farms appeared to not have complied. The Congresswomen had ten questions for which they requested a response. Most of their questions required FSIS to provide inspection reports, reasons for slow responses, and why there was no official action until October of 2013. They also asked FSIS about declaring certain Serotypes as adulterants (R. L. DeLauro, and Slaughter, L.M., 2013).

Members of Congress were not the only organizations analyzing the two *Salmonella* outbreaks and FSIS's response. The Pew Charitable Trust: Safe Food Project published a report in December 2013. Eskin (2013) states in this report that FSIS policies

do not ‘adequately protect Public Health’. The report found a few key weaknesses: 1) *Salmonella* is not considered an adulterant. Therefore, during inspection the minimal presence of *Salmonella* is tolerated, 2) the standards are not updated on a regular basis to address new variants of *Salmonella*, 3) there are no standards for chicken parts, and 4) FSIS only tests products once a year and if the facility is one of the best performing they are tested every other year (Eskin, 2013). During personal communication with one of Eskin’s team, Karen Hoelzer, many of these challenges were discussed and confirmed. Some of the concerns, such as performance standards for chicken parts, had been resolved by April of 2016. The Pew Charitable Trust team was more positive about FSIS current efforts (Hoelzer, 2016).

In 2014, Members of Congress continued voicing their concerns with multiple letters to FSIS. In March of 2014, Congresswomen Louise Slaughter and Rosa DeLauro along with nine other members of Congress sent a letter to Acting Under Secretary for Food Safety Mr. Brian Ronholm with their concerns of the Salmonella Action Plan. The Members of Congress’ main concerns were that the Salmonella Action Plan did not include a mandate for microbial testing for *Salmonella* and *Campylobacter*, address the reduction in inspectors on site, and did not discuss the Antibiotic Resistance microorganism, such as *Salmonella* Heidelberg, or the increase in poultry line speeds. This letter concludes by encouraging FSIS to slow down the implementation until four key issues are addressed 1) have an independent group assess the proposal, 2) make public the number of tests done per bird, 3) require system wide testing for *Salmonella* and *Campylobacter* within each plant, and 4) implement performance standards on chicken parts (L. M. Slaughter, Delauro, Rosa L., Moran, J., Bordallo, M.Z., Cardenas, T.,



Grijalva R.M., Courtney, J., Waxmn, H.A., Brownley, J., Cartwright, M., Coehn, S., 2014).

In May of 2014, acting Under Secretary for Food Safety Brian Ronholm responded to the above letter. The Under Secretary emphasized that FSIS uses a strict peer-review process and will do so for future efforts as well. FSIS will be requiring system wide testing and FSIS is indeed developing their own performance standards despite rumors of FSIS waiting for data from industry (Ronholm, 2014).

In September 2014, another government organization the Government Accountability Office (GAO) published its own evaluation of whether FSIS was protecting human health. GAO conducts strict evaluations of government programs, often at the request of Members of Congress but GAO also identifies important issues such as Food Safety. This report was done at the request of US Senator of New York State, Senator Kirsten E. Gillibrand. GAO's objectives were:

*“1) Describe actions USDA has taken since 2006 to reduce Salmonella and Campylobacter contamination in poultry products 2) evaluate USDA's Efforts to Assess the effects of these actions on the incidence of human illnesses from Salmonella and Campylobacter contamination in poultry products 3) determine challenges USDA faces in reducing these pathogens in poultry products” (GAO, 2014, p. 1).*

For this report, the GAO not only gathered various documents, but they also interviewed 11 individuals who represented various stakeholders in industry, consumer and government groups who had knowledge of poultry inspections. GAO acknowledged FSIS's efforts to modernize the poultry inspections based on the Salmonella Action Plan. GAO criticized USDA-FSIS for not also including standards for turkey products. GAO's final recommendation was to develop additional performance measures for *Salmonella*

and *Campylobacter* in all poultry products and provide guidance to control these pathogens at the farm level in addition in the poultry facilities (GAO, 2014).

In October 2014, Congresswomen Louise Slaughter and Rosa DeLauro, along with their colleagues, sent another letter in response to FSIS's final rule for the Modernization of Poultry Slaughter Inspection. They felt that the new rule will "*create a system that is detrimental to food and worker safety, as well as animal welfare*"(R. L. DeLauro, Slaughter, L.M., Moran, J.P., Rnagel, C.B., Blumenauer, E., Holmes Norton, E., Schakowsky, J.D., Grijalva, R.M., Clarke, Y.D., Pingree, C., Titus, D., McLane Kuster, A., Brownley, J., Cardenas, T., Connolly, G.E., 2014). This letter included 15 Members of Congress and provided very detailed list of their concerns. Few highlights of their concerns included the following: 1) concern whether 219 poultry plants will convert to the new inspection system and how will FSIS ensure buy-in, 2) concern whether FSIS will increase sampling of poultry products, do additional research on the effectiveness of their sampling and what kind of penalties will be for plants who are linked to foodborne illness outbreaks, 3) concern about workers being displaced and the overall safety of the workers with the new changes, 4) how will FSIS ensure the birds are not being mistreated, and 5) concern that with the new system suspect diseased birds will be removed before FSIS officials have a chance to see them. The letter concluded with asking the Secretary of Agriculture to respond within 30 days (R. L. DeLauro, Slaughter, L.M., Moran, J.P., Rnagel, C.B., Blumenauer, E., Holmes Norton, E., Schakowsky, J.D., Grijalva, R.M., Clarke, Y.D., Pingree, C., Titus, D., McLane Kuster, A., Brownley, J., Cardenas, T., Connolly, G.E., 2014). The response to this letter was not until January 26, 2015, months later. USDA Secretary Tom Vilsack justified the New Poultry Inspection

System (NPIS) by indicating that it was created by using science to guide their final system. This system now requires the poultry companies to do their own testing. FSIS, however, will do testing as well. FSIS feels that this new system allows inspectors to focus on removing suspect birds, taking more samples, checking for proper sanitation in the plants, ensuring and verifying that the plants are complying to safety plans, and meeting the establish regulation and being able to observe the live birds for signs of diseases. Finally, the Secretary of Agriculture acknowledge their concern for worker safety and demonstrated steps they have taken based on the concerns by Members of Congress and other stakeholders (Vilsack, 2015).

Like the Government Accountability Office, the Office of Inspector General of the USDA also did an in-depth evaluation in July of 2015: “*OIG reviewed how FSIS oversees the safety of ground turkey and other turkey products*” (OIG, 2015). OIG’s objective was to review the inspection of turkey in the plant and how they sampled and tested the turkey. They did this with interviews and observations of FSIS employees at all levels of the system from the local to the national level. In addition, OIG interviewed turkey facility management, industry trade groups, and a consumer advocacy group. They also looked at records and available data. The OIG made five recommendations. The first three recommendations were about improving their processes and data collection. The last two recommendations was to evaluate how FSIS are sampling and to improve their guidance FSIS provided to industry (OIG, 2015).

In 2015, FSIS was the subject of a major PBS documentary: “*The Trouble with Chicken*”. This documentary aired on PBS Frontline in May of 2015 and was accompanied with online articles analyzing the challenges FSIS has had. The hour long

documentary interviewed Congresswoman Rosa DeLauro and Senator Kirsten Gillibrand (Schwartz, 2015; Young, 2015).

In 2016, Congresswoman Louise Slaughter and Senator Kirsten E. Gillibrand continue to be concern on how effective FSIS is about reducing and eliminating the presence of the strains of *Salmonella* that causes illness. Conversations with Congresswoman Louise Slaughter, her staff and the staff of Senator Gillibrand only reinforced their concerns for the potential of *Salmonella* Heidelberg and other strains of *Salmonella*. Both offices are worried about the outdated technology, the recent protocol being used to sanitize the poultry because it has the potential to give false negatives, the fact that *Salmonella* Heidelberg is antibiotic resistant and finally FSIS's lack of transparency. Both offices actively express their concerns by writing these letters to USDA and introducing legislation that may address USDA FSIS's challenges (Slaughter, Gillibrand).

## CHAPTER SIX: ANALYSIS

Animal Plant Health Inspection Service (APHIS) and Food Safety and Inspection Service (FSIS) are two very similar agencies with slightly different missions. They are both involved in the protection of the national food supply. While they both use science and technology in the work they do, the rate of technology adoption for each agency is different due to technological, organizational, and policy issues involved in the effective response to food emergency incidents. As discussed in the literature review, if I used the epidemic model in the theory of diffusion, I would assume that these two agencies are adopting technology and responding to food supply crisis at the same rate. Technology adoption is one part of an agency's overall response to a crisis. The effective use of technology often results in an effective response. As we can see from the two cases, this is not happening. Using a modification of the probit model, we can begin explaining why these two agencies are different in their response (Rogers, 2003).

APHIS's response to the Pale Cyst Nematode infestation in the Idaho Potato fields revolved around the use of technology in prevention, surveillance, and response. APHIS was able to identify the Pale Cyst Nematode (PCN) before it began causing damage to the Idaho potato crops because policies were already put in place to survey for possible invasive pests in the agriculture soil. Discovering the PCN prompted APHIS to immediately take action. Stakeholder reports were published within weeks of the discovery, diagnostic technology was used immediately, preventative and fumigation technologies followed soon after. Research in the newest technologies by both internal and external scientists continued throughout the ten years since the discovery of the PCN. During these ten years, APHIS regulated and deregulated potato fields as they surveyed,

and eradicated the PCN. APHIS, in collaboration with the Idaho State Department of Agriculture, continues to monitor and survey the fields for any new PCN cysts.

FSIS responded by using technology to respond and investigate two outbreaks that were already harming the public. FSIS had been using technology to inspect for *Salmonella* contamination previous to the outbreaks, but it was not caught. Low levels of *Salmonella* contamination are allowed by FSIS. This is different to APHIS, which has zero tolerance for presence of PCN. In the first outbreak, it was unclear how FSIS responded. In the second outbreak, which started in March of 2013, FSIS responded by beginning an investigation in July of 2013, four months later. These two *Salmonella* outbreaks were in the public domain with countless news media articles, a PBS special, Government Accountability Office reports, and countless letters from Members of Congress. FSIS responded by developing a Salmonella Action Plan based on the recommendations of an internal working group, revised the inspection of poultry, developed guidance for poultry facilities to reduce *Salmonella*, and created a policy to inspect not just the whole chicken but chicken parts. All these responses occurred 15 months after the first outbreak that started in June of 2012. FSIS now mandates that each poultry facility perform molecular tests, but not eliminating the option for FSIS to also do their own microbiological testing. In Table 6.1 is a brief overview of some of the observational differences between the agencies.

<b>Differences</b>	<b>APHIS</b>	<b>FSIS</b>
Transparency	Very transparent	Not transparent
Stakeholder interest	Farmers	Industry, secondary public
External scrutiny	Very little	Nationwide scrutiny
Diseases	Pest-observable with microscope	Pathogen-detectable with advanced molecular technology

***Table 6.1 Observation differences that influence the agencies responses***

Researching the responses of the two agencies highlight some major differences. The level of transparency of was a substantial difference. APHIS appeared to make every effort to document their actions and report to the stakeholders as often as possible. The level of transparency greatly improved over the years. Since 2010, APHIS has had regular quarterly updates aimed at the primary stakeholders but also additional stakeholders both internal and external to USDA. FSIS, was not transparent and identifying sources of information for this analysis was challenging. Information was obtained from outside sources such as the CDC and Congress. Another major difference between the two agencies incidents was the level of scrutiny.

For APHIS, there was little media coverage. Media coverage was limited to local news outlets. For FSIS, the scrutiny was substantially greater. The largest level of media scrutiny came from a documentary by PBS in 2015: *The Trouble with Chicken* (Young, 2015). Scrutiny also came from Members of Congress. Every response from FSIS was followed up with a letter from numerous members of congress including our local Representative Louise Slaughter (R. L. DeLauro, and Slaughter, L.M., 2013). Finally, a difference that may have an impact on the agencies response is the type of unwanted biological pest or disease. APHIS’s incident was with an invasive pest that is not detectable by the naked eye but can be easily identified with microscopes. For FSIS the

*Salmonella* pathogen cannot be easily detected without advanced technology. In addition, it should be noted that the tolerance for the presence of PCN is zero while there is some allowance for the presence of *Salmonella*. This difference in developing and adopting preventative technology between the two agencies may be the nature of the type of pathogens. The impact of a pest or diseases is more visible for APHIS, while for FSIS adopting technology that will reduce foodborne illnesses may not be tangible since other factors such as the complexity of the food safety system obscures the cause of an outbreak (Rogers, 2002, 2003)

### **6.1 Case study differences**

In Table 6.2 is list of some of the major differences between the two incident case studies that may also explain why the two agencies respond differently.



<b>Area of Comparison</b>	<b>Differences</b>	<b>APHIS</b>	<b>FSIS</b>
Organization	Technical Capabilities and Networks	In-house and beyond	Dependent on Agriculture Research Service
	Number of Employees	8300	9600
	Mission	<i>“To protect the health and value of American agriculture and natural resources”</i>	<i>“The Food Safety and Inspection Service (FSIS) is the public health agency in the U.S. Department of Agriculture responsible for ensuring that the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled and packaged.”(FSIS, 2016a)</i>
	Annual Budget	\$1,140,000,000 (USDA, 2015)	\$1,014,000,000 (USDA, 2015)
	Organizational Culture	Actively has policies in place to inspect and catch pests before they cause harm	Reactive responses to outbreaks with changes of policy
Power and Authority	Regulatory Authority	Direct with little interference by stakeholders	Limited, encourages recalls, needs to work with states and CDC before response
	Stakeholders	Farmers, Potato Industry, States	Poultry Companies, States, CDC
Nature of Technology	Technology Competencies	Has in-house methods development laboratories. Also works with ARS to tackle long-term research problems	Has no in-house methods development laboratories. Depends on other Agriculture Research Service
	Testing Technologies	Multiple: prevention, detection and eradication	Limited inspections are mostly visible, microbiological testing is done occasionally, now requiring companies to do the testing

**Table 6.2 Major differences between the case studies**

There are four major differences between the two agencies: 1) Stakeholders are different: APHIS primary stakeholder are the farmers, FSIS stakeholders are poultry facilities, 2) regulatory authority: APHIS has more authority when PCN is found, while FSIS has limited authority, 3) prevention versus reactive: APHIS policies are designed to be preventative, FSIS's policies are heavy on their reaction and response, and 4) technology adoption is different: APHIS is constantly either researching or supporting research by their partners, while FSIS is tasking other organizations to do the technology research and adoption. The difference between these approaches is that APHIS is directing the research externally and internally. External technology is eventually adapted internally for APHIS's use. FSIS has less control on what research is being done externally. FSIS can advise these external laboratories on their needs but can do little to adapt the technology for their own use. The most recent evidence is FSIS mandating that poultry facilities do their own microbiological testing. In the rest of the chapter I will break down each of these major differences.

### *6.1.1 Organization*

There are several organizational similarities between APHIS and FSIS. First, the budget for both agencies is very similar based on a quick survey of the overall USDA Budget for Fiscal Year (FY) 2015: October 2014-September 2015. Knowing that the budget and size of both agencies are similar eliminates the idea that one agency is adopting and responding more effectively because of a larger budget. In 2013, however, both agencies were impacted by the Sequestration (*Food Safety Appropriations with Food Safety and Inspection Service 3/13/13, 2013*). Second, both agencies include

inspection as a major part of their role in protecting human health (FSIS) and US Agriculture (APHIS) (USDA, 2015). APHIS focuses on plant and animal health, while FSIS focuses on human health as related to pathogens found in meat and poultry products.

One of the key differences between APHIS and FSIS is that APHIS has several in-house methods laboratories that addresses plant pathogens, pests and invasive species. Each of these APHIS laboratories focuses on identifying the best technologies to prevent, detect and eradicate the pest, disease or other invasive species. The laboratories identify and adapt the latest technologies for high risk or high consequence pathogens. The laboratories also are used in emergency situations. In the case of the Pale Cyst Nematode, CPHST Beltsville quickly adapted the available technology to help with the response (CPHST, 2009). Also, in the proceeding years CPHST continued to adapt and develop faster and more accurate technology. CPHST Beltsville also trained field personnel in the diagnostics of PCN (CPHST, 2009). Other APHIS laboratories took on additional methods development tasks such as identifying preventative measures such as using bio-control technologies. Other laboratories looked to identify alternative fumigation methods both traditional nematicides and alternative solutions such as using bio-fumigants. To implement this response, APHIS collaborated internally and well as with external partners to tackle the problem of PCN in a multi-faceted manner. APHIS successfully collaborated with various universities and with Agriculture Research Service (ARS).

FSIS does not have an in-house methods development unit and heavily depends on ARS to develop and adapt the latest foodborne pathogen detection methods. On the other hand, APHIS rapidly develops and adapts relevant technologies to respond and

prevent the outbreaks. ARS works on a five-year project plan, often taking several years before the technology is ready to be used by FSIS (Fratamico et al., 2014). ARS also does similar work for APHIS but it is often on research for unknown pathogens that may in ten years be a threat but is not imminent (CPHST, 2008). Under USDA, ARS will often insist that they must do all the research, including research on the most urgent pathogens. APHIS realized early in their responses that this relationship was not workable in an emergency situation. APHIS worked hard to negotiate that APHIS is allowed to work on the most urgent technologies. APHIS and ARS took years to establish a meaningful and positive working relationship. FSIS appears not to have insisted on a similar arrangement. (*Food Safety Appropriations with Food Safety and Inspection Service 3/13/13*, 2013; NACMCF, 2010). In 2010, FSIS created a committee to evaluate the technology to be used in identifying foodborne pathogens (NACMCF, 2010). Not only did this committee evaluate the technologies they also evaluated other Agencies such as APHIS. This committee noted that APHIS regularly and successfully interacted with various partners and stakeholders. It was recommended that FSIS follow a similar manner of interacting with various partners.

#### *6.1.2 Power and authority*

The power and the authority of each of the agencies differ for various reasons. Understanding this requires an analysis of the stakeholders involved for each of the agencies. Below, in Table 6.3, is a list of the stakeholders involved in influencing each of the agencies and whether they are primary or secondary stakeholders.

<b>Stakeholders</b>	<b>APHIS</b>	<b>FSIS</b>
Farmers	Primary	Secondary
Potato Industry	Primary	NA
Poultry Industry	NA	Primary
US Congress	Secondary	Primary
Consumers	Secondary	Primary
Trade partners	Primary	Secondary
State and local Governments	Primary	Secondary

***Table 6.3 Agency stakeholders influence***

As it was discussed in the literature review, stakeholders for agencies are ranked based on their influence. The primary stakeholders have the greatest influence. Primary stakeholders are not necessarily the stated primary stakeholders, but who has the greater influence in policy decisions (Kamal, 2011).

*Farmers*

For each of the agencies farmers play a role in their responses and policies created and implemented. For APHIS, farmers are primary stakeholders since the regulations directly impact them. Farmers for FSIS are secondary to industry. Farmers are part of the system but do not have the same level of influence as industry. Policies are set in place for farmers to reduce *Salmonella*, but most of FSIS's their focus is on the meat and poultry industry's role.

*Industry*

For APHIS, the potato industry has participated in their response to the PCN. APHIS includes them in resolving and eradicating the PCN. The poultry industry interest is to ensure that the potatoes are marketable and can be sold domestically and internationally. This commitment is aligned with APHIS's interest to ensure that US agriculture is protected economically. For FSIS, the poultry industry plays a major role in

all the policies created. The poultry industry's interest is to ensure they can rapidly process the poultry with little interference from FSIS. The poultry industry has substantial economic interest while FSIS stated interest is protect public health. These interests are not necessarily aligned possibly making harder to resolve issues to reduce *Salmonella* and other foodborne pathogens.

### *Congress*

For APHIS, Congress seems to take little interest in how they handle the PCN response. Other issues are looked at, but usually at the department level. For FSIS, Members of Congress are greatly concerned. New York State Members of Congress Senator Kirsten Gillibrand and Congresswoman Louise Slaughter are some of the primary critics of FSIS. Both the Senator and the Congresswoman are concerned for the safety of their constituents. Both of these Members of Congress also value science in policy. Congresswoman Louise Slaughter academic background is in microbiology and public health. Both the Congresswoman and the Senator hire staff that has scientific credentials to ensure they can continual to address the food safety challenges using the best understanding of the science involved (K.E. Gillibrand, 2016; L. M. Slaughter, 2016). According to each member's staff, there are several Members of Congress that will defend the poultry farmers and industry. This is most apparent in the recent introduction of legislation by Congressman Jason Smith of Missouri (Smith, 2016). In terms of power and authority, the Members of Congress that currently represent farmer groups or industry group have more power than the members who are advocating for their constituents.

### *Consumers*

Consumers for FSIS play a larger role than for APHIS. Due to the public nature of the foodborne pathogen outbreaks, consumers have more influence in the policies that may be created, enforced and manner in which FSIS responds to emergencies. For APHIS, consumers are secondary since PCN does not cause human disease in the same way *Salmonella* does. Because consumers play a greater role with FSIS, it creates contrasting influence with the poultry industry. For APHIS, consumers only play a minor role and have little or no influence on the potato industry in this particular case. For FSIS, the influence of the consumer and influence of the poultry industry create an uneven tug of war perhaps providing an understanding why FSIS responds differently.

### *Trade partners*

International trade partners are much greater stakeholders for APHIS. When PCN was discovered, several countries: Canada, Japan, Korea and others shut down the exportation of potatoes. It was APHIS's duty to work diplomatically to reopen trade negotiations.

### *State and local governments*

Both APHIS and FSIS has to work with state and local governments in their responses to the respective crisis. APHIS worked with Idaho from start of the emergency, FSIS began working with California to investigate the source of the *Salmonella*.

#### 6.1.2.2 Regulatory authority

APHIS has the authority to regulate and deregulate the fields suspected of having the Pale Cyst Nematode (PCN). As was mentioned above in stakeholder differences, FSIS's stakeholder Foster Poultry Farms never voluntarily did the recall until July 2014. FSIS was forced to be 100% sure that *Salmonella* Heidelberg indeed originated from the Foster Farm facilities. FSIS's investigations did find that the sicknesses were possibly associated with Foster Farms poultry products but was never definite. FSIS could not confirm it until 2014 when FSIS was able to find an unopened poultry product from a sick individual who had purchased two packages of the product. The strain of *Salmonella* Heidelberg found on the Foster Poultry Farms product was the same strain that was found in the affected individual. At this point Foster Farms finally recalled an undetermined amount of poultry product (CDC, 2014; Hylton, 2015).

The primary stakeholders for APHIS when responding to PCN are potato farmers from Idaho. The finding of the PCN in Idaho meant changes in how these stakeholders the farms, farmed the potatoes, how they treated their soil and how they sanitized their farm equipment. Regulation and deregulation of the fields directly impacted these growers. APHIS also had the support of the Idaho State Department of Agriculture. Implementing regulations was relatively easy with this partnership. Though APHIS did make a point of working collaboratively with a diversity of stakeholders including the farmers. Usually decisions could be easily made without too much pushback from the farmers. The priorities of APHIS and the farmers are more aligned. Farmers do want to make sure they can sell their potatoes internationally. APHIS's mission is to make sure this opportunity is protected. APHIS also had secondary stakeholders, which were the



national potato industry and the state of Idaho. When the potato farmers began complaining about the methyl bromide use, APHIS investigated but found no correlation. APHIS knew the farmers would be filing a lawsuit. APHIS did not have a fear of a lawsuit since this is more of a burden to the farmers rather than APHIS. FSIS mission states they are meant to protect public health, but in this particular outbreak the primary stakeholder was the poultry processing plants and industry. FSIS does not necessarily interact with the public, but rather the CDC does. The public may be a stakeholder, but a secondary stakeholder since the impact is not necessarily direct. This interaction with stakeholders was discussed in the literature review and clarified by Kamal (2011). In this case, it appears Members of Congress advocate for their constituents to ensure they are not getting sick. For FSIS, the poultry industry seems to be a major influence of their policies. The poultry industry is influential economically and politically. Therefore, FSIS is drawn to balance the needs of the industry with public health. FSIS did warn Foster Poultry Farms of non-compliance multiple times preceding the outbreaks. FSIS gave Foster Poultry Farms multiple chances to respond appropriately. FSIS did not feel they could demand a recall until 2014. The hesitation of FSIS is apparent in their responses to Congress (R. L. DeLauro, and Slaughter, L.M., 2013).

#### *6.1.2.3 Policies and regulations*

APHIS's mission and vision describes an agency that is beyond inspection and regulation. FSIS's mission and vision states the commitment to protect human health against contamination of poultry, meat and egg products by chemicals, or pathogens. For FSIS, the need to balance the differing priorities of their stakeholders: consumers and poultry industry makes it appear they are giving priority to industry over public health.

This is evident in the lack of immediate response to the first outbreak and delaying the response in the second outbreak (R. L. DeLauro, and Slaughter, L.M., 2013).

An initial survey of the each of the agencies policies indicated that APHIS focused substantially on preventive measures (APHIS, 2015). Even though to some degree the response to Pale Cyst Nematode infestation was reactive it was also preventative. The Pale Cyst Nematode was present but had not caused any damage to the potato crops when it was discovered. The discovery was from a routine survey of soil samples. The policy of surveying soils was something APHIS did on a regular basis. APHIS did not prevent the infestation of PCN and to this day it is unclear the origin of the PCN whether it was always present or had been brought in from other potato regions. APHIS responded with prevention technology efforts to prevent the spread of the PCN before it even began affecting the crops. Table 6.4 shows the different types of response of the two agencies.

<b>Task</b>	<b>APHIS</b>	<b>FSIS</b>
Pathogen discovery	Preventive	Reactive
Technology use	Preventative and reactive	Reactive some preventative

**Table 6.4 Type of response**

### 6.1.3 Nature of technology

The rate of technology adoption is different regardless of the fact that the available technology for both PCN and *Salmonella* are accessible. The difference is that APHIS leads in developing the state of the art technology while FSIS depends on industry to choose technology to use in self-inspection, as long as it meets the minimum standard. For APHIS, the use and the development of technology were constant throughout all the documentation that I obtained. For FSIS, technology was not discussed

and it was hard to determine what technology they do use specifically in the inspections. There is information about the technology that is used by FSIS for detecting Salmonella by researching the website. Also, an interesting difference between the two agencies is how they use the molecular technology. FSIS uses the advanced molecular technology as a screening tool and the more labor-intensive culture method to confirm a positive. On the other hand, APHIS uses various basic screening technologies to detect for PCN and use the advanced molecular technology for confirmation of the presence of PCN.

In summary, there are four key differences between the two agencies: 1) Stakeholders, 2) Regulatory authority, 3) Prevention versus reactive, and 4) Technology adoption rates. Each of these factors contributes to APHIS being more effecting in preventing and responding to a food supply crisis.

## **CHAPTER SEVEN: DISCUSSION**

This thesis was able to compare similar agencies with similar directives of protecting the public on its health and its economic security. I looked at two agencies that were similar in size and mission but take two different paths. APHIS focused on the science and technology. FSIS focused on the policy with some emphasis on science. APHIS included science in all aspects of its response. FSIS delegated science to other agencies and organizations.

Overall, this thesis contributes to the understanding of the complexity of how government organizations respond to emergencies within the food supply. Technology adoption is most often addressed in the context of a community adopting a new vaccine or a new method to purify water. In addition, the review of how government organizations adopt technology, the focus was primarily on IT technology. Studies on the technology adoption within government focused on individuals within an organization rather than the organization as a whole. For example, the articles listed in Table 2.1 listed 'people' as the biggest obstacle to technology adoption (Konkel, 2014). Discussions of technology adoption in the literature review rarely discussed the necessary organizational factors (Kamal, 2011). Literature on disaster response also lacked attention to technology. Most of the literature discussed technology separately without the discussion of organizational or policy factors. Most studies on disaster response only focused on policy and organizational structure. The exception would be APHIS veterinary scientists who publish a few articles that discussed the need for the latest technologies to be prepared for a disaster.

Given these limitations in prior research, this thesis provides an insight that has not been discussed in previous analysis. In my analysis of each case, my personal experience in the Pale Cyst Nematode technology response, and my role in one APHIS's in-house methods development laboratories, I was able to address the three questions presented in my proposal: *What factors influence how agencies differ in their responses to emergency situations that have health or an economic impact and the effectiveness of these responses? What role does technology play in response effectiveness? What are implications for public policy?* In the next sections I will break down each of the questions to answer them.

## **7.2 Response factors**

The first research question looks to answer the factors that influence how each agency responds. Based on each of the cases, we are able determine a few key aspects that definitely influence how the agencies respond. Below are more details and discussion of these key factors.

### *7.2.1 Preventative and reactive policies*

Differentiation between preventative and reactive policies is hard. Both agencies had policies and regulations that appeared to be more preventative, but when placed into effect, APHIS was more preventative than FSIS. APHIS has more preventative policies with regular inspections for invasive pests. Inspection for invasive pests and diseases are a priority for APHIS and is followed at all organizational levels. FSIS inspections and the use of necessary technology were less frequent and often irregular. Available documents on the inspection regimen of FSIS indicated that inspections were on annual, biannual or triennial basis, regardless that poultry was being processed at a constant rate

every day. More often, FSIS reacted to the outbreaks rather than implement efforts to prevent possible outbreaks. Inspections in response outbreaks were more frequent than the regular inspections for *Salmonella*.

### 7.2.2 Role of stakeholders

Stakeholders for each agency had significant influence. For APHIS, the farmers were the primary stakeholders, while for FSIS the primary stakeholders are the poultry industry that they work with each day. With the majority of APHIS employees working onsite, they regularly interacted with them. The difference between the two primary stakeholders is the power and authority. Farmers did not have as much power over APHIS, while it appeared that the poultry industry had more power over FSIS. FSIS also appeared to be pulled in different directions with Congress overseeing their activities. Some members of Congress wanted FSIS to be more effective with more regulations and others preferred that they did not have so many regulations.

## 7.3 Role of technology

Based on this cross-case analysis we can see there is a lack of understanding of technology adoption in government and the organizational capabilities to develop technologies quickly in response to emergencies. APHIS discusses technology at all levels of internal and external policies, from the reports by their in-house development laboratories to the administrative level. While FSIS only responded with policies changes, rather integrate technology changes at all levels. Technology was delegated to other organizations and the poultry plants. Regardless of FSIS efforts, little improvement has been seen to minimize the *Salmonella* contamination in poultry products throughout the entire system.

APHIS approaches technology adoption in a different way. Technology is integrated within their policies and programs. This is different from FSIS's policies that refer to other agencies when addressing technology. APHIS has both an in-house group of scientists, as well as a strong network of external scientists that APHIS can depend on in an emergency. In the case for the Pale Cyst Nematode, the first scientist they reach out to was the world expert on nematodes at USDA Agriculture Research Service. The next step was to develop and adapt the available technology to be rapid and effective in detecting the Pale Cyst Nematode (Nakhla, 2010). APHIS also reached out to academia to research alternative pest management solutions. APHIS additionally trains internal and external scientists to take on the bulk of the diagnostics while their in-house methods development laboratory scientists can focus on improving the available methods and troubleshooting problem diagnostics. The combination of a group of in-house scientists provides an advantage not just having the flexibility of scientists who intimately understand what is needed in an emergency, but also these scientists have a strong network of external colleagues that they can reach out to.

In 2011, I did a project for APHIS's international office. This office wanted to know the extent of the informal and formal capacity building of international scientists and stakeholders that were being directed by CPHST scientists. At the time, there were eight laboratories that did a range of tasks that aligned with CPHST's mission of ensuring the best technology was available to respond to different pest and disease outbreaks. The result of this study showed a complex network of scientists exchanging information through various methods of capacity building. Over time, the network of scientists has strengthened, which provided APHIS with the capacity to respond to future emergencies.

CPHST also enhanced their network by providing free trainings and mini-workshops for scientists and policy makers both domestically and internationally. APHIS's international office was beginning to understand that APHIS and USDA leadership rarely understand the complexity of this network of scientists. The APHIS International office felt it was their duty to communicate this strength to APHIS and USDA leadership.

The idea that in-house scientists have a strong network of external colleagues that they regularly interact with plays an important role in being ready for an emergency. This is discussed in Rothenberg (2012) paper on the role of corporate environmental scientists, which found that for corporate climate scientists the external network of colleagues play a role in how much the companies were aware of their impact on the environment. For APHIS, the presence of the in-house scientists allowed for the eventual and continual understanding of the need for the latest technologies to detect for high consequence pests and diseases.

Furthermore, in my last year working for APHIS, I was tasked to identify high consequence pathogens that may impact US agriculture in the future. I gathered peer-reviewed articles, identified the technology being used, ordered the necessary reagents and reached out to scientific experts on each of the pathogens for reference samples. This ensured that the laboratory could quickly adapt the technology if there was an emergency. In addition to my preparation, a few of my colleagues continued my work by adapting the technology for APHIS's use. This effort to reach out to external experts strengthens the network that could help in emergencies. In the ten years since the discovery of the PCN, the in-house methods development laboratory grew and its network also expanded.



For FSIS, the lack of preparation was apparent in their response to the *Salmonella* outbreak in 2012-2013. In 2010, the National Advisory committee on Microbiological Criteria for Foods (NACMCF) was formed to respond to questions asked by FSIS on what is the most appropriate technology to adopt for routine inspections (NACMCF, 2010). In addition to providing insight on the best technologies, this committee found that FSIS felt they could not do methods development since it is considered research and this was under the purview of ARS. APHIS at one point did not do methods development, but after tough negotiations they worked out a system where APHIS could focus on methods development and allow for the more fundamental research to be done by ARS. After ten years the collaboration between the two agencies seem to be very effective. This the NACMCF committee further demonstrated that APHIS was doing methods development and collaborating very effectively with their research partners. Based on the response of FSIS to the outbreaks, it appears that this idea of not being able to do methods development is still present.

#### **7.4 Implications for public policy**

There are a number of implications of this study for policy makers. The differences of FSIS and APHIS demonstrated that policy approaches that nearly exclude technology hinder FSIS from being more effective. It is clear that having in-house scientists working on developing the best and most appropriate technologies facilitates the effectiveness of policies. Another advantage is that policies are better designed if in-house scientists are actively involved in the process because they bring external perspective from their colleagues that they interact with on a regular basis. APHIS in

response to the PCN outbreak included CPHST their in-house development laboratories in the PCN working group to identify effectively respond using science and technology.

Collaboration is something that is addressed in the Food Safety Modernization Act. However, GAO mentions that FSIS and FDA are still not effective at working together. If FSIS had in-house scientists it could allow for future and better collaboration. This effort could also make FSIS stated effort to be more preventative in their policies more successful. Finally, having these in-house scientists better prepares FSIS to implement preventative polices and move away from reactive policies that they are dependent on.

## **CHAPTER EIGHT: LIMITATIONS, RECOMMENDATIONS & CONCLUSIONS**

This case study analysis found many differences between the way APHIS and FSIS responded to food supply emergencies. Four key differences were found with multiple possible alternatives to the reasons why APHIS and FSIS adopts technology and responded to emergencies at different rates and with different strategies. APHIS had relative success, while FSIS received endless criticism of their response. This chapter will be the discussion of the limitations to this study, recommendations and final conclusions.

### **8.1 Limitations**

When doing the analysis, pulling together the vast amount of documents and identifying possible informants a few limitations were encountered. Limitation include: 1) previous knowledge, 2) budget, 3) access to additional informants, and 4) organizational culture

#### *8.1.1 Previous knowledge*

Previous to this study, I spent ten years working at APHIS Center for Plant Health Science Technology Laboratory in Beltsville, Maryland. I was a support scientist assisting the senior scientist to adapt and develop new and more advanced methods for the detection of the Pale Cyst Nematode. In June of 2006, I assisted the senior scientist in the adaption of the available methods to be used more rapidly. Later, we developed more advanced molecular methods for detection and differentiation of the Pale Cyst Nematode. After several years of testing and using the method for regular diagnostics, the method was published in a peer-reviewed journal (Nakhla, 2010). During this time, I was able to

gain understanding of the Pale Cyst Nematode program that cannot be replicated in the research I had done on the *Salmonella* outbreak. What my previous knowledge and credentials does give me is the skill necessary to evaluate the program at FSIS. Food borne pathogens are similar to the pathogens that infect our agriculture. The work not only gave me knowledge but perhaps a bias towards the need for an agency such as FSIS to be just as advanced if not more advanced than APHIS.

### *8.1.2 Budget*

It was rare to find discussion about the role the budget plays in each agency's response. This is regardless whether the documentation was from the agencies or from outside sources. Criticism of either organization rarely discussed the need for more funding. Documents from spring of 2013 do on occasion discuss the Sequestration. However, the sequestration was discussed during one of the congressional hearings on food safety. The Under Secretary Dr. Elisabeth Hagen discussed her concerns and explained the impact on food safety (*Food Safety Appropriations with Food Safety and Inspection Service 3/13/13, 2013*). It should be noted that the Sequestration occurred in the middle of the *Salmonella* Heidelberg outbreaks. APHIS also discussed the sequestration in some of the stakeholder reports with concerns of the impact that the sequestration would have on the response to PCN. An in-depth study of the budget for both agencies may provide more insight on how and why they responded differently to their food supply incidences. The analysis may provide an understanding of how funds are distributed within the agencies and perhaps identify a funding strategy that works. Funding is something that each agency has little control but budget distribution is something that could make a difference.

### *8.1.2 Access to informants*

One of the major challenges and limitations to this research is finding individuals within each agency who would discuss each of these outbreaks and how they saw each of the situations. APHIS is currently in the middle of a lawsuit that was filed by the Idaho farmers. Information from APHIS was slightly easier since I was involved in part of the technology response since 2006. However, when I approached the agency's PCN contact, I was told politely that he could not discuss much with me due to this lawsuit. For FSIS, finding informants was much more of a challenge. I attempted to reach out in multiple ways through my own contacts. The closest I could get was a congressional office staff who worked closely on food safety issues. I was able to obtain additional information through this office but not from FSIS directly. FSIS in general is not nearly as transparent as APHIS. The Office of Congresswoman Louise Slaughter was able to provide even more information about FSIS. The Congresswoman's staff main critique was the lack of transparency of FSIS. When I asked if they could connect me with anyone within FSIS they said that even for them it was difficult to get answers from FSIS. This is one limitation that may not be resolved, regardless of the amount of time. As an employee of APHIS for ten years I was often instructed not to answer any inquiries from stakeholders or the press. If I was approached I must direct them to the Legislative and Public Affairs offices, and if it was specific as in a result of a test, I was told to direct them to the appropriate agency leader.

### *8.1.3 Organizational theory and behavior*

In this research, and my understanding of some aspects of organizational theory, I noted factors learned from my Managing for Organizational Change class that may result

in the success or failure of an organization. APHIS is implementing many of the positive attributes of a successful organizational culture. FSIS seems to continue to have challenges in creating a positive environment. With more time and research this may be an aspect that provides additional information for more thorough understanding of success and failure in these types of government organizations. If given more time, more research could be done to identify elements that is allowing for APHIS to succeed, and FSIS to continue to struggle to reduce *Salmonella* contamination. It should also be noted that researchers in organizational behavior often spend time in the inside of an organization.

## **8.2 Conclusions and recommendations**

In the beginning of this research I started off with three questions: 1) what factors influence how agencies differ in their responses to emergency situations that have health or an economic impact and the effectiveness of these responses, 2) what role does technology play in response effectiveness, and 3) what are implications for public policy.

Based on the findings, four factors influence how APHIS and FSIS respond to their respective emergencies 1) stakeholders, 2) regulatory authority, 3) prevention, and 4) technology adoption. The first two factors, stakeholders and regulatory authority, may be out of the hands of FSIS or APHIS leadership. Stakeholders are set for both agencies but managing the stakeholders can be approached in different manners to better meet their stated goals of protecting public health and US agriculture. FSIS seems to balance the needs of their stakeholders, the poultry industry, the consumer and ultimately the protection of public health. APHIS, on the other hand, responds to their stakeholders, the farmers, with minimal complications because the priorities of both APHIS and its

primary stakeholders align. Regulatory authority is dictated by USDA leadership and Congress, however both agencies can work on adjusting the culture to positively deal with the framework they are provided.

The second two factors that influence effective responses is prevention and advanced technology adoption. APHIS is more successful in their responses because the rules and policies focus substantially on prevention. The PCN discovery was due to a policy that was in place to survey for invasive pests in soils. APHIS worked collaboratively with ISDA to regularly inspect for these pests. FSIS, on the other hand, inspects for *Salmonella* on an irregular basis. To this date, they do have a policy in place that requires the poultry plants to regularly inspect for *Salmonella*. However, it is unclear how they will enforce this new rule or if these poultry facilities are following and effectively using the best technologies.

These two cases definitely show that technology has a major role to play in the effectiveness of response to an emergency. APHIS was ready with some basic technologies but they were also ready to research and adopt alternative technologies while simultaneously preventing, detecting and eradicating with the technologies they had available. For FSIS it was apparent that the technologies they used were not used on a regular basis and were not necessarily the latest technologies. FSIS could only investigate possible new technologies, but not adapt or develop their own technologies that may have been more effective.

The fact that there continues to be foodborne pathogen outbreaks every week in the US means that effective public policies must be implemented. FSIS, in its current state, is

not being effective. To date, FSIS is unable to determine if their new policy strategies are truly making a difference.

It can be concluded that technology plays a substantial role in effective public policy. This may be what is preventing FSIS to be successful. Technology development and adoption within an agency must be integrated in all policy changes and improvements.

### *8.3.1 Recommendations*

Below are recommendations to improve the effectiveness of the current public policy of responding to food supply emergencies.

#### *8.3.1.1 Create a methods development laboratory*

FSIS should create a methods development laboratory in the same way APHIS has developed these laboratories in the last 20 years. These laboratories are not for fundamental research of foodborne pathogens but laboratories that design, and adapt current technology that is constantly being developed in academia and industry. The research that is done by APHIS is applied research designed to create tools that can be used within a year of development. Other Agencies, such as Agriculture Research Service, can continue to do research on more complex and less imminent pathogens for both FSIS and APHIS. FSIS should continue to improve the relationship with ARS and other research organizations to identify priority pathogens.

#### *8.3.1.2 Strengthen the network of food safety scientists*

FSIS can not only have their internal scientists but also include external food safety scientists in working groups that influence the policy development. This also



includes ensuring that the network is strengthened overtime through training, conferences and capacity building internally and externally.

#### *8.3.1.3 Integrate science and technology at all levels of policies and programs*

For FSIS, science and technology is only small part of the policies and often delegated to other agencies. FSIS could be more effective if an effort to integrate technology into the development of new technologies. Delegating the development of new preventative technologies makes it harder for FSIS to respond rapidly to emergencies. In the same way APHIS integrates technology, FSIS could also make an effort to include technology in their policies.

Finally, implementing these recommendations could begin to address weaknesses in the food safety system. It may be able to reduce the frequency of salmonella contaminated poultry products. These recommendations could also apply to other policy efforts to reduce other foodborne pathogen diseases. Regardless of the disease, the effectiveness of preventing the contamination is not just the scientific effort, but the organizational and policy efforts as well.

## REFERENCES

- Abdallah, S. A., Al-Shatti, L.A., Alhajraf, A.F., Al-Hammad, N., and Al-Awadi, B. (2013). The Detection of Foodborne bacteria on beef: the application of the electronic nose. *SpringerPlus*.
- Ahmed, O. B., Asghar, A.H., Abd El-Rahim, I.HA., Al, H. (2014). Detection of Salmonella in Food Samples by Culture and Polymerase Chain Reaction Methods *J Bacteriol Parasitol*, 5(3). doi:10.4172/2155-9597.1000187
- Aleccia, J. (2014, May 27, 2014). Salmonella Surprise 574 Sick In Foster Farms Outbreak; May 27, 2014. *NBC News: Health*
- Alic, J. A. (2008). A weakness in diffusion: US technology and science policy after World War II. *Technology in Society*, 30(1), 17-29. doi:10.1016/j.techsoc.2007.10.005
- APHIS. (2006a). *Potato Cyst Nematode (PCN) 7/31/2006*.
- APHIS. (2006b). *Potato Cyst Nematode (PCN) Stakeholder Update*
- APHIS. (2006c). *Potato Cyst Nematode (PCN) Stakeholder Update 5/31/06*.
- APHIS. (2006d). *Potato Cyst Nematode (PCN) Stakeholder Update 6/23/06*.
- APHIS. (2006e). *Potato Cyst Nematode (PCN) Stakeholder Update 7/18/2006*.
- APHIS. (2006f). *Potato Cyst Nematode (PCN) Stakeholder update 10/2/2006*.
- APHIS. (2006g). *Potato Cyst Nematode(PCN) Stakeholder Update 5/1/2006*.
- APHIS. (2006h). *Potato Cyst Nematode(PCN) Stakeholder Update 5/15/2006*.
- APHIS. (2007a). *Potato Cyst Nematode (PCN) Stakeholder Update 5/30/07*.
- APHIS. (2007b). *Potato Cyst Nematode (PCN) Stakeholder Update 11/30/07*.
- APHIS. (2008a). *Potato Cyst Nematode (PCN) Stakeholder Update 12/19/2008*.
- APHIS. (2008b). *Potato Cyst Nematode (PCN) Stakeholder Updates 8/1/2008*.
- APHIS. (2009a). *Pale Cyst Nematode (PCN) Stakeholder Updates 5/18/2009*.
- APHIS. (2009b). *Pale Potato Cyst Nematode National Survey and Diagnostic Cyst Sample Forwarding Protocols: Established April 29, 2009*.
- APHIS. (2010a). *Pale Cyst Nematode (Globodera pallida) Eradication Program -Idaho Falls, Idaho July 2010 Report*.
- APHIS. (2010b). *Pale Cyst Nematode (Globodera pallida) Eradication Program -Idaho Falls, Idaho September 2010 Report*
- APHIS. (2010c). *Pale Cyst Nematode (Globodera pallida) Eradication Program- Idaho Falls, Idaho May 2010 Report*
- APHIS. (2010d). *Pale Cyst Nematode (Globodera pallida) Eradication Program-Idaho Falls, Idaho April 2010 Report*.
- APHIS. (2010e). *Pale Cyst Nematode (Globodera pallida) Eradication Program-Idaho Falls, Idaho June 2010 Report*
- APHIS. (2010f). *Pale Cyst Nematode (Globodera pallida) Eradication Program-Idaho Falls, Idaho March 2010 Report*.
- APHIS. (2010g). *Pale Cyst Nematode (Globodera pallida) Eradication Program-Idaho Falls, Idaho; February 2010 Report*.
- APHIS. (2010h). *Pale Cyst Nematode (PCN) Stakeholder Update 2/3/10*.
- APHIS. (2012a). *Pale Cyst Nematode (Globodera pallida) Eradication Program-Idaho Falls, Idaho 2012 2nd Quarter Report*

- APHIS. (2012b). *Pale Cyst Nematode Five Year Review Report, Idaho Falls, Idaho-March 2012*.
- APHIS. (2015). *Safeguarding the Health and Value of American Agriculture Since 1972: Strategic Plan 2015-2019*.  
[https://www.aphis.usda.gov/about\\_aphis/downloads/APHIS\\_Strategic\\_Plan\\_2015.pdf](https://www.aphis.usda.gov/about_aphis/downloads/APHIS_Strategic_Plan_2015.pdf).
- APHIS (2016a, July 26, 2016). [Animal Plant Health Inspection twitter account @USDA\_APHIS ].
- APHIS. (2016b, August 22, 2016). APHIS-Farm Bill.
- APHIS. (2016c). Map of Quarantine areas in Idaho
- APHIS. (2016d, April 14, 2016). Pale Cyst Nematode.
- Bird, P., Fisher, K., Boyle, M., Huffman, T., Benzinger, M. J., Jr., Bedinghaus, P., . . . David, J. (2014). Evaluation of Modification of the 3M() Molecular Detection Assay (MDA) Salmonella Method (2013.09) for the Detection of Salmonella in Selected Foods: Collaborative Study. *J AOAC Int*, 97(5), 1329-1342.  
doi:10.5740/jaoacint.14-101
- Burkett, A. B. (2012). Food Safety In the United States: Is the Food Safety Modernization Act Enough to Lead us out of the Jungle. *Alabama Law Review*, 63(4).
- CDC. (2013). Multistate Outbreak of Salmonella Heidelberg Infections Linked to Chicken (Final Update).
- CDC. (2014). Multistate Outbreak of Multidrug-Resistant Salmonella Heidelberg Infections Linked to Foster Farms Brand Chicken (Final Update).
- CDC. (2015, January 8, 2014). Estimates of Foodborne Illness in the United States.
- CDC. (2016a, September 24, 2016). E.coli (Escherichia coli).
- CDC. (2016b). Estimates of Foodborne Illness in the United States.
- CDC. (2016c). National Outbreak Reporting System(NORS).
- CDC. (2016d, August 5, 2016). Salmonella.
- Cetindamar, D. (2001). The role of regulations in the diffusion of environment technologies: micro and macro issues. *European Journal of Innovation Management*, 4(4), 186-193.
- Cherkis, J. (2013, January 28, 2013). Technology Adoption Slower, But Certain In Government-- And for Good Reason. *Forbes*.
- Cheung, P.-Y., Kam, Kai Man. (2012). Salmonella in food surveillance: PCR, Immunoassays and other rapid detection and quantification methods. *Food research International*, 45, 802-808.
- CPHST. (2008). *Center for Plant Health Science and Technology Accomplishments, 2007*. (1601).
- CPHST. (2009). *Pale Potato Cyst Nematode National Survey and Diagnostic Cyst Forwarding Protocols April 29, 2009*.
- CPHST. (2016). About the Center for Plant Health Science and Technology
- David, S. D. a. K., Rebecca L. (2013). Navigating the Legal Framework for State FoodBorne Illness Surveillance and Outbreak Response: Observations and Challenges. *Journal of Law, Medicine & Ethics*, 6.

- De Cian, E., Bosetti, V., & Tavoni, M. (2011). Technology innovation and diffusion in “less than ideal” climate policies: An assessment with the WITCH model. *Climatic Change*, 114(1), 121-143. doi:10.1007/s10584-011-0320-5
- Del Aguila-Obra, A. R., & Padilla-Meléndez, A. (2006). Organizational factors affecting Internet technology adoption. *Internet Research*, 16(1), 94-110. doi:10.1108/10662240610642569
- DeLauro, R. L., and Slaughter, L.M. (2013). *Letter to Dr. Elisabeth Hagen, Undersecretary for Food Safety at USDA, October 16, 2013.*
- DeLauro, R. L., Slaughter, L.M., Moran, J.P., Rnagel, C.B., Blumenauer, E., Holmes Norton, E., Schakowsky, J.D., Grijalva, R.M., Clarke, Y.D., Pingree, C., Titus, D., McLane Kuster, A., Brownley, J., Cardenas, T., Connolly, G.E. (2014). *Letter to Secretary of Agriculture Tom Vilsack expressing disappointment in addressing Food Safety, October 17, 2014.*
- Diez, J. R. a. S., D.K. (2013). The Perspective of USDA APHIS Veterinary Services Emergency Management and Diagnostics in Preparing and Responding to Foreign Animal Diseases-Plans, Strategies, and countermeasures. *Developments in Biologicals*, 135, 15-22.
- Dittmer, J. (2013). Industry Perspective: Successful Technology Adoption is Never about the Technology [Written by the Vice President and General Manager of Defense sector at ARRAY].
- Durfee, M. (1999). Diffusion of Pollution Prevention Policy. *American Academy of Political and Social Science*(November), 108-119.
- Eskin, S., Ruzzante, J., Finan, C., Kessler, B., Branzelle, S. . (2013). *Weakness in FSIS's Salmonella Regulation: How two recent outbreaks illustrate a failure to protect public health.* Retrieved from
- FDA. (2011). FSMA Facts: Background on the FDA Food Safety Modernization Act (FSMA).
- Federschak, K., Desouza, K.C. and Dawson, G. . (2015). Federal Agencies behind the curve: IoT and BYOD.
- Flynn, D. (2014, October 9, 2014). USDA: U.S. Foodborne Illnesses cost more than 15.6 Billion Annually. *Food Safety News.*
- Food Safety Appropriations with Food Safety and Inspection Service 3/13/13*, (2013).
- Fournet, S., Eoche-Bosy, D., Renault, L., Hamelin, F.M. and Montarry, J. (2016). Adaptation to resistant hosts increases fitness on susceptible hosts in the plant parasitic nematode *Globodera pallida*. *Ecology and Evolution*, 6(8), 2559-2568.
- Fratamico, P. M., Wasilenko, J. L., Garman, B., Demarco, D. R., Varkey, S., Jensen, M., and Tice, G. (2014). Evaluation of a multiplex real-time PCR method for detecting shiga toxin-producing *Escherichia coli* in beef and comparison to the U.S. Department of Agriculture Food Safety and Inspection Service Microbiology laboratory guidebook method. *J Food Prot*, 77(2), 180-188. doi:10.4315/0362-028X.JFP-13-248
- FSIS. (1996). *Pathogen Reduction: Hazard Analysis and Critical Control Point (HACCP) Systems.* (9 CFR Parts 304, 308, 310, 327, 381, 416, and 417). Federal Register.
- FSIS. (2013a). *Mission Book: One Team One Purpose: Food Safety and Inspection Service: Protecting Public Health and Preventing Foodborne Illness.*

- FSIS. (2013b). *Strategic Performance Working Group: Salmonella Action Plan December 4, 2013.*
- FSIS. (2015a). *Annual Performance Plan FY 2015: One Team, One Purpose* <http://www.fsis.usda.gov/wps/wcm/connect/90c8c3a0-8b34-46f8-b8c7-d1e24fa8d7e2/APP-2015.pdf?MOD=AJPERES>.
- FSIS. (2015b). *DRAFT FSIS Compliance Guideline for Controlling Salmonella and Campylobacter in Raw Poultry, December 2015.*
- FSIS. (2015c). *The FSIS Salmonella Action Plan: A Year One Update: January 2015.*
- FSIS. (2015d). History of Food Safety Inspection Service.
- FSIS. (2016a). About Food Safety and Inspection Service. Retrieved from <http://www.fsis.usda.gov/wps/portal/informational/aboutfsis>
- FSIS. (2016b). Agency History.
- FSIS. (2016c, July 29, 2016). Current Recalls and Alerts 2016.
- FSIS. (2016d). *FSIS Onboarding Manual for New Employees* <http://www.fsis.usda.gov/wps/wcm/connect/68fb48cc-8a93-4aa0-8db4-f8e85b215c81/FSIS-Onboarding-Manual-Web.pdf?MOD=AJPERES>.
- FSIS. (2016e). *The FSIS Salmonella Action Plan: A Two year Update*
- FSIS. (2016f). *Serotypes Profile of Salmonella Isolates from Meat and Poultry Products, January 1998 through Decemebr 2014.* <http://www.fsis.usda.gov/wps/portal/fsis/topics/data-collection-and-reports/microbiology/annual-serotyping-reports>.
- FSN. (2016). Food Safety online news outlet
- FSWG. (2011). *The Federal Food Safety Group Progress Report December 2011.* <http://www.whitehouse.gov>.
- Gamble, G., Berrang, ME., Buhr, RJ., Hinton, Ajr., Bourassa, DV., Johnston, JJ., INgram, KD., Adams, ES., and Feldner, PW. (2016). Effect of Simulated Sanitizer Carryover on Recovery of Salmonella from Broiler Carcass Rinsates. *Journal of Food Protection*, 79(5), 710-714.
- GAO. (2014). *Federal Food Safety Oversight: Additional Actions Needed to Improve Planning and collaboration*
- GAO. (2015a). *Food Safety: Additional Actions Needed to Help FDA's Foreign Offices Ensure Safety of Imported Food.*
- GAO. (2015b). *GAO High Risk List 2015: Improving Federal Oversight of Food Safety.* <http://gao.gov/assets/670/668415.pdf>.
- GAO. (2016). Government Accountability Office : Food Safety
- Geroski, P. A. (2000). Models of technology diffusion. *Research Policy*, 29, 603-625.
- Gillibrand, K. E. (2016). [Conversations with the Staff of Senator Kirsten E. Gillibrand ].
- Gillibrand, K. E. (2016). *Letter to Secretary of Agriculture: Tom Vilsack June 24, 2016.*
- Greenhalgh, T. R., Glenn; MacFarlane, Fraser; Bate, Paul and Kyriakidou. (2004). Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations. *Millbank Quarterly*, 82(82), 581-629.
- Guzewich, J. J. (2012, March 22, 2012). No Quick Fixes for Outbreak Surveillance and Response. *Food Safety News*.
- Hafez, S. L. S., P., Handoo, Z.A., Skantar, A.M., Carta, L.K., and Chitwood, D.J. (2007). First report of the Pale Cyst Nematode *Globodera pallida*, in the United States. *Plant Disease*, 91(3).

- Hoelzer, K. (2016) *Food Safety Inspection Service/Interviewer: K. J. Owens*. Pew Charitable Trust n/a.
- Huang, C.-F., Wang, Jieh-Jiuh, Lin, Tai-Jun. (2010). Resource sufficiency, organizational cohesion, and organizational effectiveness of emergency response *Nat Hazards*, 58, 221-234.
- Hylton, W. S. (2015). Annals of Food: A Bug in the System: Why last night's chicken made you sick. *The New Yorker*, 11.
- Idaho Farmers Vs USDA APHIS No. 15-cv-143 (United States District Court for the District of Idaho 2016).
- Kamal, M., Weerakkody, V., Irani, Z. (2011). Analyzing the role of stakeholders in the adoption of technology integration solutions in UK Local Government: An Exploratory Study. *Government Information Quarterly*, 28, 200-210.
- Keller, R. (2016, March 28, 2016). Idaho potato growers can continue fighting quarantine News. *Ag Professional*
- Konkel, F. (2014). What is the Biggest Obstacle to Tech Adoption in Government?
- Lanjouw, J. O. a. M., Ashoka. (1995). Innovation and the International diffusion of environmentally responsive technology. *Research Policy*, 25, 549-571.
- Levings, R. L. (2012). Emerging and Exotic Zoonotic Disease Preparedness and Response in the United States-Coordination of the Animal Health Component. *Zoonose Public Health*, 59(Suppl 2), 80-94.
- Lord J.S., L., L., Atkinson, H.J., and Urwin, P.E. (2011). Biofumigation for Control of Pale Potato Cyst Nematodes: Activity of Brassica Leaf Extracts and Green Manures on *Globodera Pallida* in Vitro and in Soil. *Journal of Agricultural and Food Chemistry*, 59, 7882-7890.
- Maurischat, S., Baumann, B., Martin, A., Malorny, B. (2015). Rapid detection and specific differentiation of *Salmonella enterica* subsp. *enterica* Enteritidis, Typhimurium and its monophasic variant 4, [5],12:i:-by real-time multiplex PCR. *International Journal of Food Microbiology*, 193, 8-14.
- Maurischat, S., Szabo, I., Baumann, B., & Malorny, B. (2015). Rapid real-time PCR methods to distinguish *Salmonella* Enteritidis wildtype field isolates from vaccine strains Salmovac SE/Gallivac SE and AviPro SALMONELLA VAC E. *J Microbiol Methods*, 112, 92-98. doi:10.1016/j.mimet.2015.03.015
- McIntire, R. J. (2013). FSIS Issues Public Health Alert for Chicken Products Produced at Three Foster Farms -October 7, 2013 [Press release]
- Mergel, I. (2013). Social media adoption and resulting tactics in the U.S. federal government. *Government Information Quarterly*, 30(2), 123-130. doi:10.1016/j.giq.2012.12.004
- Miles, M. B. a. H., A. Michael. (1984). *Qualitative Data Analysis: A sourcebook of New Methods* (1st ed.).
- NACMCF. (2010). National Advisory Committee on Microbiological Criteria for Foods: Response to Questions posed by the Food Safety and Inspection Service Regarding Determination of the most Appropriate Technologies for the Food Safety and Inspection Service to Adopt in Performing Routine and baseline Microbiological Analysis. *Journal of Food Protection*, 73(6), 1160-1200.

- Nakhla, M. K., Owens, K.J., Li, W., Wei, G., Skantar, A.M., and Levy, L. (2010). Multiplex real-time PCR assays for the identification of the potato cyst and tobacco cyst nematodes. *Plant Disease*, 94, 959-965.
- Norshie, P. M., Grove, I.G., and Back, M.A. (2016). Field Evaluation of the nematicide fluensulfone for control of the potato cyst nematode *Globodera pallida*. *Pest Management Science*. doi:10.1002/ps.4329
- Nosowitz, D. (2016, April 26, 2016). USDA Won't pay Claims after Poisoning Idaho Cattle. *Modern Farmer*.
- Oguz, F. (2016). Organizational Influences in Technology Adoption Decisions: A Case Study of Digital Libraries. *College & Research Libraries*, 77(3), 314-334. doi:10.5860/crl.77.3.314
- OIG. (2015). *FSIS Ground Turkey Inspection and Safety Protocols*. (24601-0004-31).
- Overstreet, R. E., Cegielski, C., Hall, D. (2013). Predictors of the intent to Adopt preventive innovations: a meta-analysis. *Journal of Applied Social Psychology*, 23, 936-946.
- Park, S. H., and Ricke, S.C. (2014). Development of multiplex PCR Assay for simultaneous detection of Salmonella genus, Salmonella Subspecies I, Salm. Enteritidis, Salm. Heidelberg and Salm. Typhimurium. *Journal of Applied Microbiology*, 118, 152-160.
- Park, S. H., Aydin, M., Khatiwara, A., Dolan, M. C., Gilmore, D. F., Bouldin, J. L., . . . Ricke, S. C. (2014). Current and emerging technologies for rapid detection and characterization of Salmonella in poultry and poultry products. *Food Microbiol*, 38, 250-262. doi:10.1016/j.fm.2013.10.002
- Perkowski, M. (2016, March 21, 2016). Judge refuse to dismiss pale cyst nematode lawsuit. *Capital Press*.
- Quarantelli, E. L. (1988). Disaster Crisis Management: A Summary of Research Findings. *Journal of Management Studies*, 25(4), 14.
- Register, F. (2015). *Changes to the Salmonella and Campylobacter Verification Testing Program: Proposed Performance Standards for Salmonella and Campylobacter in not ready to eat comminuted Chicken and Turkey Products and Raw Chickent Parts and related Agency Verification Procedures and Other Changes to Agency Sampling*.
- Rein, L. (2015, January 13, 2015). Federal managers love Technology but fear Government is slow at Adopting it. *The Washington Post*.
- Robinson, S. (2013, August 19, 2013). The Big Five: Most Common Salmonella Strains in Foodborne Illness Outbreaks. *Food Safety News*
- Rogers, E. M. (2002). Diffusion Preventive Innovations. *Addictive Behaviours*, 27, 989-993.
- Rogers, E. M. (2003). *Diffusion of Innovation* (5th ed.): The Free Press.
- Rohonczy, K., Zoller, Linda., Hermann, Zsolt., Fodor, Andrea., Mraz, Balazs., and Tabajdi-Pinter, Veronika. (2014). Comparison of an automated ELFA and Tow Different Real-time PCR Techniques for Salmonella Detection poultry samples. *Acta Microbiologica et Immunologica Hungarica*, 61(3), 261=272.
- Ronholm, B. (2014). *Response letter from Under Secratary for Food Safety May 14, 2014*.

- Rothenberg, S. a. L., D.L. (2012). Coporate Perceptions of Climate Science: The Role of Coporate Environmental Scientists. *Business & Society*, 51(1), 31-61.
- Sanchez, C. M., and Mckinley, William. (1998). Environmental regulatory influence and product innovation: The contignecy Effets of Organizational Characteristics *J. Eng. Technol. Manage.*, 15, 257-278.
- Schwartz, E., Amico, C., Donald, D. (2015, May 14, 2015). Five Salmonella Outbreaks FOOd Inspectors Didnet See Coming. *PBS*.
- Sharma, Y. (2013). *Notice of Intended Enforcement : Foster Poultry Farms*.
- Sinclair, U. (1906). *The Jungle*: CreateSpace Independent Publishing Platform (November 29, 2014).
- Skantar, A. M., Handoo, Z.A., Carta, L.K., Chitwood, D.J. (2007). Morphological and Molecular Identification of Globodera pallida Associated with Potato in Idaho. *Journal of Nematology*, 39(2), 133-144.
- Slaughter, L. M. (2016). [Conversations with Congresswoman Louise Slaughter and various staff members].
- Slaughter, L. M., Delauro, Rosa L., Moran, J., Bordallo, M.Z., Cardenas, T., Grijalva R.M., Courtney, J., Waxmn, H.A., Brownley, J., Cartwright, M., Coehn, S. (2014). *Letter to Acting Under Secretary for Food Safety March 13, 2014*.
- Smith, J. (2016). Congressman Jason Smith Introduces Bill to Repeal Latest Assault on Rural America [Press release]
- Stull, J. (2015). FSIS Releases Updated Guide to help Poultry Processors Reduce Salmonella, Campylobacter Hazards [Press release]
- Tarr, A. (2013). FSIS Releases Comprehensive Strategy to Reduce Salmonella [Press release]
- USDA. (2015). *FY 2015 Budget Summary and Annual Performance Plan*.
- Vilsack, T. J. (2015). *Letter to Congressman Louise Slaughter from Secretary of Agriculture in response to the October 17, 2014; Dated January 26, 2015*.
- Welch, E. W., & Feeney, M. K. (2014). Technology in government: How organizational culture mediates information and communication technology outcomes. *Government Information Quarterly*, 31(4), 506-512. doi:10.1016/j.giq.2014.07.006
- Wiedmann, M., Wang, S., Post, L., & Nightingale, K. (2014). Assessment criteria and approaches for rapid detection methods to be used in the food industry. *J Food Prot*, 77(4), 670-690. doi:10.4315/0362-028X.JFP-13-138
- Xu, M., Wang R., Li, Y. (2016). Rapid detection of Escherichia coli O157:H7 and Salmonella Typhimurium in foods using an electrochemical immunosensor based on screen-printed interdigitated microelectrode and immunomagnetic separation. *Talanta*, 148, 200-208.
- Yin, R. K. (2009). *Case Study Research Design and Methods* (Fourth ed.).
- Young, R. (Writer). (2015). The Trouble with Chicken. In R. a. S. Young, Anthony (Producer), *Frontline* <http://www.pbs.org/wgbh/frontline/trouble-with-chicken>.
- Zhang, Z., Xiao, L., Lou, Y., Jin, M., Liao, C., Malakar, P. K., . . . Zhao, Y. (2015). Development of a multiplex real-time PCR method for simultaneous detection of Vibrio parahaemolyticus, Listeria monocytogenes and Salmonella spp. in raw shrimp. *Food Control*, 51, 31-36. doi:10.1016/j.foodcont.2014.11.007



Zheng, Q., Miks-Krajnik, Marta., Yang, Yishan., Xu, Wang., Yuk, Hyun-Gyun. (2014).  
Real-time PCR Method Combined with immunomagnetic separation for detecting  
healthy and heat-injured Salmonella Typhinurium on raw duck wings.  
*International Journal of Food Microbiology*, 186, 6-13.