Animal Disease Biosecurity
Coordinated Agricultural Project

2019 SYMPOSIUM SUMMARY

Innovation and Collaboration for Agricultural Biosecurity

TABLE OF CONTENTS

BACKGROUND

The Animal Disease Biosecurity Coordinated Agricultural Project (ADBCAP) is a USDA-funded, multidisciplinary, multi-institutional effort combining social science, human decision-making, economics and animal health perspectives. The goal of the project work is to enhance the prevention, control and recovery from new and emerging livestock diseases of economic importance.

On May 15 and 16, 2019, the ADBCAP team hosted a symposium and workshops in College Park, Maryland, attended by over 50 members of the project team and external guests. The goals of the symposium were to share outcomes of the project with livestock industry and government professionals, and generate ideas for future work. Videos of symposium presentations and panel discussions can be viewed on the ADBCAP project website at agbiosecurityproject.org.

Now in its fifth and final year, the ADBCAP has brought together experts from ten academic institutions and livestock industry stakeholders, with the common goal of understanding the human dimension of animal disease dynamics. The project has emphasized data collection using surveys and experimental games and has incorporated data into computer simulation models, educational products and communication strategies.

To date, project personnel have generated ten peer-reviewed publications, numerous conference and workshop presentations, youth learning modules and online resources for agricultural producers. An overarching goal has been to make the project outcomes useful to industry stakeholders throughout livestock production networks.

United States Department of Agriculture
National Institute of Food and Agriculture

This work is/was supported by the USDA National Institute of Food and Agriculture (NIFA), under award number 2015-69004-23273. The contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA or NIFA.

EXECUTIVE SUMMARY

The ADBCAP symposium and workshops held on May 15 and 16, 2019, in College Park, Maryland, featured presentations by members of the ADBCAP project team and discussions with industry, Extension and agency personnel. The symposium included ADBCAP team members from ten universities across the country.

Day One

On day one of the symposium, ADBCAP Director Julie Smith gave the initial remarks, followed by USDA National Program Leader for Animal Biosecurity Michelle Colby. Chris Koliba led off the presentations with an overview of the Social Ecological Gaming and Simulation (SEGS) laboratory at the University of Vermont, and the use of computationally complex tools to solve real world problems concerning animal biosecurity. These approaches revealed opportunities for improving both policy and practice at the strategic, tactical and operational levels.

The next presentation, given by Scott Merrill and Luke Trinity, focused on SEGS' creation of a simulation game on the operational level: farm workers' willingness to comply with biosecurity practices. Afterward, Scott Merrill, Eric Clark and Ollin Langle from the SEGS lab discussed their creation of a simulation game focused on studying swine industry owners' and operators' willingness to invest in biosecurity practices at the tactical level.

Glynn Tonsor of Kansas State University gave two presentations. The first was based in part on the research of Lee Schulz of Iowa State University. This presentation included results of a 2017 survey assessing swine industry indemnity expectations and how indemnification expectations affect adoption of biosecurity measures. Tonsor then presented results of a study of animal health information sharing within the beef industry.

Gabriela Bucini, Eric Clark and Ollin Langle of the University of Vermont discussed the use of agent-based models (ABMs) to track simulated epidemics through production systems. By applying data compiled from actual outbreaks and human behavioral data collected through simulation games, these ABMs can be used by policy makers for decision-making.

Exploring theoretical constructs of behavior, Asim Zia of the University of Vermont discussed the socio-psychological influences of risk-induced behaviors as opposed to economic incentives. He and his colleagues created a structural equation model based on data collected from two types of surveys. Then, Gabriela Bucini, Ollin Langle and Eric Clark gave a presentation on using ABMs to account for human behavior, specifically in the transmission of animal diseases through networks with various levels of biosecurity measures.

Deanna and Tim Sellnow from the University of Central Florida discussed the importance of communication and how the IDEA model

(internalization, distribution, explanation, action) can be effectively used in biosecurity risk communication.

Following the Sellnows, Jeannette McDonald, founder and CEO of TLCProjects LLC, discussed the development of an online animal biosecurity learning resource for grade 6-12 students. McDonald was followed by Kris Hiney from Oklahoma State University and Betsy Greene from the University of Arizona. They developed a hands-on set of activities complementing the online learning modules created by McDonald. The activity kits are called SCRUB (Science Creates Real Understanding of Biosecurity), and are designed to be used in a classroom setting with students interested in animal science. Finishing off the first day of presentations was the unveiling of the new Healthy Farms Healthy Agriculture biosecurity website by Joanna Cummings of the University of Vermont.

After the presentations, two panel discussions were held in the evening. The first introduced funding opportunities in biosecurity or behavioral sciences from several agencies and foundations; the second panel introduced tactical science networks active in biosecurity.

Day Two

Day two of the symposium was designed to be highly interactive and to foster new linkages among those engaged in biosecurity education and outreach. Participants in the interactive workshops represented plant and animal biosecurity interests from both a research and practice perspective. Julie Smith gave opening remarks followed by a panel of three storytelling presentations by Glynn Tonsor of Kansas State University, Matthew Myers of CBE Educational Services, and Tim Sellnow of the University of Central Florida.

The symposium keynote presenter was Matthew Seeger, Dean of the College of Fine, Performing and Communication Arts at Wayne State University. Seeger is an expert in the field of risk and crisis communications and has research interests including infectious disease outbreaks, natural disasters, terrorism, pandemic disease and industrial accidents. His presentation was called, "Agricultural Biosecurity: Pre-Crisis and Risk Communication." A background of risk and crisis communication was given, along with their applications to animal biosecurity topic areas of pre-crisis and post-crisis communication.

Joel Iverson from the University of Montana led participants through a series of presentations about the functionality of Communities of Practice (CoP) for biosecurity stakeholders including producers, educators, Extension professionals, researchers, consultants and veterinarians.

After discussing CoPs, participants reflected on their experiences: responses were collected and analyzed. Workshop attendees affirmed that CoPs can be fruitful sources of information and resources. This is particularly true when CoPs consist of individuals from differing backgrounds who contribute uniquely to a vision or common goal of the community.

Overall, participants stated that the day was energizing and helped provide a way to cultivate their existing CoPs. Specifically, their written comments were coded and analyzed according to the three facets of CoP theory.

CONFERENCE HIGHLIGHTS

Overview of USDA NIFA Biosecurity Funding

Michelle Colby, USDA NIFA Program Leader for Animal Biosecurity

The USDA National Institute of Food and Agriculture (NIFA) has over 20 projects in animal biosecurity, with funding exceeding $10 million. NIFA funds both capacity and competitively funded projects including conference grants, small business funding, workforce development, and large coordinated agricultural project (CAP) grants. Multidisciplinary projects will continue to be emphasized. While the Challenge Grant Program has been eliminated, there is a home for projects such as this one under the Sustainable Agriculture Systems program.

The emphasis on multidisciplinary animal biosecurity projects extends to the Agricultural and Food Research Initiative (AFRI) Foundational and Applied Sciences funding. As NIFA grows our portfolio in biosecurity, the broader emphasis on agricultural biosecurity integrating the entire farm-to-fork spectrum is our eventual goal among supported projects. Of key importance are projects integrating research with Extension and education, ensuring research funded with taxpayer dollars produces results extending into the classroom and the field.

Additional information can be found in the 2019-20 request for applications (RFA) for the AFRI Competitive Grants Program, which can be found at https://nifa.usda.gov/sites/default/files/rfa/20190507-fy2019-afri-foundational-and-applied-science-rfa.pdf. This document includes priority funding for Interdisciplinary Engagement in Animal Systems (IDEAS).

A Systems Approach to Improving Biosecurity Investments

Christopher Koliba, University of Vermont

At the University of Vermont, we have established the Social Ecological Gaming and Simulation (SEGS) lab, which has a mission of "harnessing complexity to solve problems." Located at a land-grant institution, the SEGS team is interested in application of systems science to complex problems, as well as real-world applications to solve social and ecological problems. We develop new, cutting-edge tools and methodologies integrating computer science, data science, and social and natural sciences.

The value of using a social ecological approach in the study of disease and biosecurity is looking at the problem at multiple scales. Understanding disease begins at the bottom at the cellular level and then percolates up to the societal level.

The team at SEGS also uses the idea of complex adaptive systems, which uses past experiences of crisis to understand how systems collapse and better understand the need for system innovation and change.

The **Operational level**, or first tier as illustrated in Figure 1, is at the core of our model; these are the "foot soldiers" or those "on the ground." If farm workers do not follow biosecurity protocols, the whole model will likely fail.

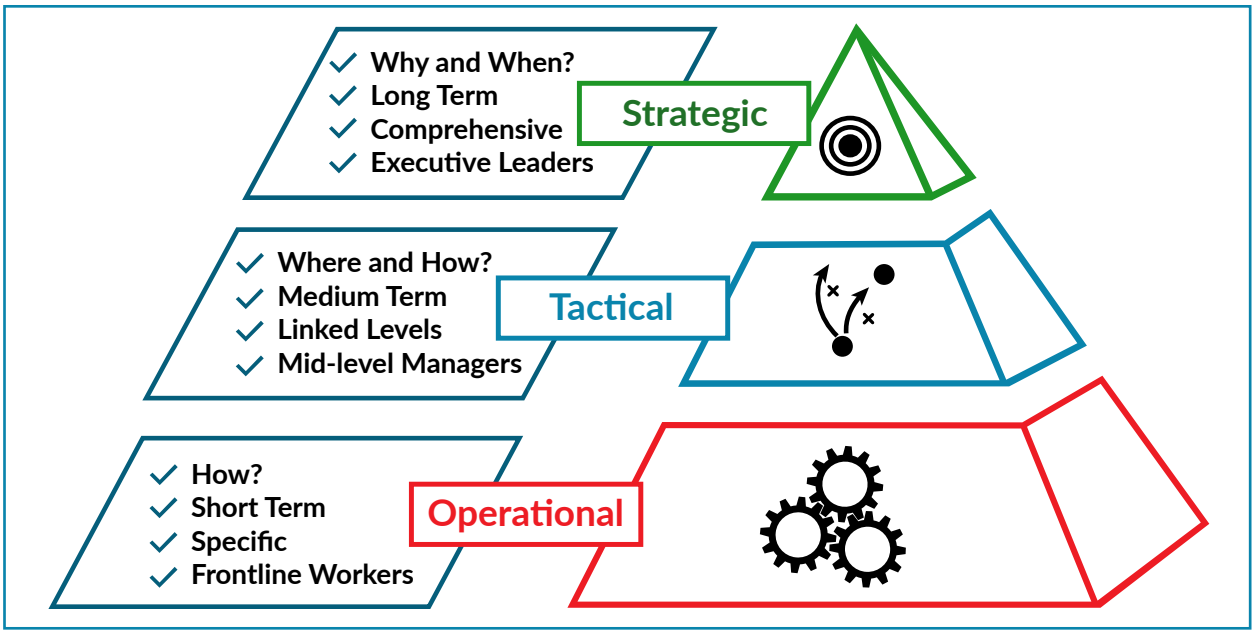


Figure 1. Illustration of levels of investigation of agricultural production systems targeted by social ecological approaches in the study of biosecurity decision-making.

The second tier is the **Tactical level**. This level represents production managers and farm owners. They are the decision makers for implementing biosecurity measures.

The top tier is the **Strategic level**. These are the production systems owners, who create and adapt biosecurity protocols across multiple facilities. This level also includes national policies, such as indemnification. The challenge is that workers introduce unpredictability into the system because they have free will.

In the next presentations, the idea of "serious gaming" will be introduced. This method of simulated activities helps researchers learn more about human behavior. By creating artificial environments, much can be learned about how people will respond to different messages, incentives and risks. Though the idea of simulated teaching tools has been used since the 1950s, technology and computational power have increased, giving us greater ability to make sense of patterns in large datasets.

These simulated activities focusing on animal biosecurity have been tested on a variety of people including farmers, veterinarians, students and professional gamers. The results have a similar human response, allowing us to further simplify the systems.

Serious Games and Decision-Making

Scott Merrill and Luke Trinity, University of Vermont

Traditionally, epidemiological factors have been studied to understand disease spread. More recent efforts have started to include the human behavioral component, which may be just as important. It is widely agreed that implementing biosecurity is critical to preventing disease incursion and spread. There are two major components of biosecurity: willingness to adopt or invest in biosecurity at a facility, and willingness to comply with biosecurity protocols. This presentation focuses on willingness to comply at the operational level.

Members of the ADBCAP team attended a workshop in Minnesota and spoke with a participant about the protocol of workers coming in and out of facilities through shower areas. He said, "I would be happy if I could get my guys to use soap." It really struck us about the reality of compliance at the operational level, and how easy it is to become lax in the protocols.

The SEGS lab developed an experimental game (the Compliance Game) to study decision-making under various conditions at the operational level. In this game, the participant acts as a farm worker in a hog facility. Initially the worker moves around the facility accomplishing chores, which are represented by spinning coins. Outside chores appear periodically and pose the main decision in the game: whether to comply with the biosecurity protocol of showering and changing clothes before exiting—which takes time—or not comply and exit via the emergency door—which makes the player more money but risks infecting animals.

This game is incentive-based; participants are paid based on how well they prevent disease in the facility. It has been found that people are more willing to immerse themselves in this type of situation compared to more traditional forms of gathering data, such as surveys.

In the Compliance Game, the player is given the probability of infection based upon one of three methods:

- Linguistic, a word prompt of low, medium, or high risk.
- Numerical, a percentage number risk.
- Graphical, a green to red colored "threat gauge" from low to high, similar to what is used to represent the risk of forest fires or heat advisories.

As expected, compliance with biosecurity increases with increasing infection risk. However, without changing the risk of infection but changing information provided and the way it is provided, willingness to comply can be changed by as much as 50 percent. The most effective method for nudging players towards compliance is the graphical communication of risk.

In another version of this game, other simulated workers are introduced into the game to test if the simulated worker's compliance behavior affects the choices made by the participant. Looking at individual choices, some individuals

consistently followed the action of the co-worker, while others did the opposite of the co-worker.

The differences between individuals and/or groups is one consideration in the development of our simulation games. For instance, some people are considered anti-followers, and these participants are more likely not to comply in simulation games. This data could influence both future hiring practices and the development of customized messages based upon determined compliance type.

In addition to the operational level Compliance Game, the SEGS team also developed games at the tactical level and are using virtual reality as a tool to expand participant immersion in the scenario. Our pool of participants has been diverse and includes in-house audiences (students and local residents), Amazon Mechanical Turks (a diverse online source of gamers), and targeted audiences, such as those at agricultural conventions.

To summarize, the SEGS team used experimental computer-based games to collect data on human decision-making behavior and found, in terms of compliance with biosecurity protocols, people comply more when disease risk is high, when there is uncertainty about risk, and when those messages are conveyed graphically. However, variation does exist among people, and it is important to consider the distribution of individual differences when implementing changes or new policies.

Willingness to Invest in Livestock Biosecurity: Evidence from Digital Field Experiments

Scott Merrill, Eric Clark and Ollin Langle, University of Vermont

Another simulation game developed by the Social Ecological Gaming and Simulation (SEGS) lab to address the tactical level of agricultural systems was called the Protocol Adoption (or Investment) game. This game focused on farm managers and owners/operators, and studied their willingness to invest in biosecurity when given different kinds and amounts of information.

The game consists of a map with the participant's farm location as well as surrounding farms. Each farm on the map provides two kinds of information: the level of biosecurity protocols implemented, and if the farm is contaminated with disease. The amount and kind of information presented to participants was varied to examine changes in the decision-making behaviors of participants. Using the information provided, participants had to make choices about investing in additional biosecurity.

By changing the amount and kind of information provided to game participants and without changing risk levels, we found the difference in decision-making behaviors fluctuated by up to 20 percent.

We also recognized individual differences exist; what works for the majority doesn't work for everyone, and participants are not always consistent in their decision-making behaviors. In fact, some participants went in the opposite direction in their decision-making from the group.

One way to understand individual differences is by clustering decision makers into behavioral groups. We identified three main behavioral groups:

- Risk seeking/accepting
- Opportunistic
- Risk averse

Risk seeking/accepting participants are willing to invest in less biosecurity measures and hope for a higher payout. Opportunistic participants invest less in biosecurity measures when risk is low but invest more as risk increases. Risk averse participants maintain an increased level of biosecurity measures regardless of the risk of contagion. Understanding these clusters of behavioral groups can help us better develop indicators of what drives people to change. The majority of our participants (a group of 1000) came from Amazon Mechanical Turk (AMT), which is an online crowdsourcing tool offering performance-based incentives. In addition, 50 swine industry professionals were recruited at the World Pork Expo in Iowa to participate in the game. Comparing the AMT group to the group of industry professionals, the spectrum of behavior correlates quite well.

Courtesy of the National Pork Board, Des Moines, IA

One of our most interesting and surprising findings deals with the area of uncertainty. Consistently throughout the game, participants would invest the most when no information was provided on the biosecurity measures of surrounding farms. This was to be expected from all we know and understand about uncertainty.

The surprise came when we discovered participants were investing the least on biosecurity measures when they were provided no information on the contamination rates of surrounding farms. Even though participants faced the same type of uncertainty in the second scenario, they responded in the opposite way as expected.

Conducting research to better understand decision-making among different behavioral groups may lead to better customization to target interventions.

U.S. Swine Survey Insights-Tactical Plan: Gaining Empirical Insights on Producer Decision-Making

Glynn Tonsor, Kansas State University

In the world of swine agricultural economics, there is a need for better alignment of public and private efforts to prevent and control disease. In addition, there is a need for empirical data on economics because most of what we have to go by from the literature is currently conceptual. This study addressed these gaps in information—specifically empirical assessment of producer biosecurity decision-making—and how producers' expectations affect their biosecurity efforts.

In early 2017, a survey was administered to hog producers throughout the country. The survey focused on two issues: indemnity expectations, and how indemnification expectations affect the adoption of biosecurity measures. Indemnity is the government's policy of paying producers a portion of losses incurred from animal deaths due to disease. Based on the survey, roughly one third of producers expect no indemnity, roughly one third expect an indemnity payment regardless of their biosecurity status, and roughly one third think their indemnity payment will be conditional on their biosecurity status.

After the recent experience with highly pathogenic avian influenza, the U.S. government changed its indemnity policies; the variation in swine producers' expectations documented by the survey may reflect awareness of those changes.

An economic choice experiment was conducted in which producers were asked under what conditions they would or would not make an additional biosecurity investment. It was found that two-thirds of producers would invest in additional biosecurity measures if they believed that indemnity was conditioned on biosecurity.

A second finding was that, all else being equal, as the cost of biosecurity increases, willingness to invest decreases. The group who believed indemnity would be biosecurity-conditional were willing to invest more across the board than the other groups but were also conscious of cost. This suggests if the cost of biosecurity could be reduced by some method, those who expect the conditional indemnification policy could be first and greater adopters of biosecurity measures. This also allows us to build the argument of the benefit of adopting biosecurity-conditional indemnity policies.

Based on the survey, there was a wide range of perceptions within the swine industry about the risk and duration of future outbreaks of diseases of national concern that pose the most serious threat to U.S. animal agriculture. The survey also found producers are two to seven times more sensitive to the cost of biosecurity than to the risk reduction benefit it might provide. Implications include considering a cost-sharing policy as well as research and development that would reduce costs of biosecurity.

Also, we know private market signals increase producer effort among packers and processors, so further study should be conducted not just

about biosecurity protocol, but the impact of private market signals. We also need to increase our ability to monitor and incentivize after an investment has been made within the swine industry.

An academic comparison would be that it's easier to find funds to construct a new building than to find funding to maintain an existing building. In the same way, more funding needs to be dedicated to not only implementing biosecurity measures but also monitoring and incentivizing the maintenance of such measures.

Information Sharing in the Beef Industry-Tactical Plan: Where's the Beef?

Glynn Tonsor, Kansas State University

This study focused on animal health information sharing in the beef cattle industry. In the beef industry there is a seed stock sector and a cow-calf sector, with some intermediary sectors, and then ultimately the feedlot where cattle are sold to packing plants. Even though there are multiple levels of ownership, everything begins at the cow-calf level where animals are born.

The focus here is specifically on this level—the cow-calf sector—where owners sell their calves or yearlings.

In December 2003, there was an article in the Economist entitled, "The cow who stole Christmas." The article details the story of a calf born in Canada and then shipped, processed, and distributed in the United States. That cow unknowingly had the first U.S. case of bovine spongiform encephalopathy (BSE), a fatal neurodegenerative condition popularly known as "mad cow disease," and had a massive impact on the U.S. beef industry.

Since 2003, there has been an effort to increase information sharing and identification among owners at different levels in the beef industry. This evolved into federal policy known as the National Animal Identification System, which no longer exists. However, there is still a drive to increase animal identification and traceability for various reasons.

In November 2018, surveys were sent to cow-calf producers and feedlot owners asking about their willingness to participate in traceability systems. Another survey was sent to only cow-calf producers asking about their willingness to report suspected foot-and-mouth disease (FMD) on their operations.

There are two general types of traceability systems:

- Visual, which is a written system.
- Electronic, which is entered into computers and can be used to trace animals back to their source.

The first result to note is that both kinds of producers were willing to participate in a traceability system as opposed to having none. However, significantly more cow-calf producers preferred no system than did feedlot operators. The difference shows a gap between buyers and sellers. More feedlot operators preferred a visual system, whereas more cow-calf producers preferred an electronic system. In addition, the cost of participating differs for producers of

different sizes, with the actual cost being greater for smaller producers.

Knowledge gaps exist in understanding how producers decide to participate in traceability systems, and what drives producers' willingness to promptly report suspected diseases. Moreover, are there alternative government policies that could help increase participation and reporting? Economics plays a role here: animals are worth more than before, and trade is more important to our market than it was before. These two factors increase the potential benefit and value of gathering information to fill these knowledge gaps.

> **"After 20 years of talking, there is still just partial adoption of animal identification and traceability. We have to recognize the economic reality of these producers."**

A potential policy that could increase participation in a traceability system could be to pay producers a premium to enroll their animals. The cow-calf sector is generally willing to participate in a traceability system if offered a premium, but feedlots are less likely to participate because the costs of implementing such a system very well would be passed off to them in the cost of calves. Projecting out on this, a premium of $2.50 per head would result in 41 percent participation in an electronic system.

The opposite scenario is to develop a discount or penalty for those who do not participate. Not surprisingly, as the discount for not participating increases, so does participation; at a $20 discount, participation is around 16 percent. The point is incentives and penalties do not have the same effect; this could have implications for policy if the political will to invest in traceability systems increases.

Private market incentives to share animal health information exist, but not in a way to get most of the industry to participate. Most discussion about broader industry-wide buy-in for the betterment of the world ignores the fact that decisions are made based on the individual economics of today. That distinction is important to keep in mind and is the reason, after 20 years of talking, there is still just partial adoption of animal identification and traceability. We have to recognize the economic reality of these producers.

The next stage of this study is to investigate how the government's response (full herd depopulation, partial/conditional depopulation, or vaccination) to a report of a suspected disease such as FMD affects willingness to report. Results will be forthcoming.

Socio-Psychological Determinants of Cattle Producers' Intent to Comply with Animal Disease Control Practices: A Structural Equation Modeling Approach

Asim Zia, University of Vermont

Often when considering animal biosecurity, we are discussing economic factors and incentives. This presentation, in large part based off the work and data of Amy Delgado, looks instead at the socio-psychological influences of risk-induced behaviors. The data collected were used to build a structural equation model in which both voluntary (producers will consult a veterinarian when signs of potential disease are observed) and government regulated (stop movement orders) scenarios are addressed.

Our research question was: What are the key determinants of compliance behavior of cattle producers regarding application of voluntary and regulatory risk management behaviors in livestock production, to control and/or contain a disease outbreak? To address this question, we chose the standard Theory of Planned Behavior (TPB) model, which examines individual, social, and informational factors controlling our beliefs, attitudes, and ultimately, behaviors.

We created two hypotheses in our study. Firstly, TPB variables would provide a significant positive effect in explaining intent to comply with animal disease control practices.

Secondly, risk behaviors about biosecurity risk, perceptions about the behaviors of other producers, trust in regulatory agencies, and moral/social norms about the behavior would have significant effects in explaining the intent to comply with animal disease control practices, mediated through standard TPB variables.

The methodology began with two focus groups leading to a stakeholder-informed structure of the socio-psychological pathways to be addressed. Consequently, two surveys were constructed and distributed to Texas cow-calf producers by Delgado and others. The first presented a scenario in which an outbreak had not been identified, but cattle were showing clinical signs of FMD.

Producers were then asked to answer questions about compliance with voluntary actions, such as requesting a veterinarian, and regulatory compliance, such as stopping cattle movement. The second group of surveys had the same basic questions, but included a scenario in which an outbreak of FMD had already been identified in Texas.

In the area of voluntary compliance, survey findings were as expected. The producers' attitude had the biggest impact on their behavior, followed by social norms and their perceived behavioral control. Four additional latent variables also had a significant and positive effect, but only through TPB variables.

The survey findings around regulatory compliance were more surprising. We found expected results in the areas of producers' attitude and perceived behavioral control, but found social norms were not significant in

affecting compliance with regulatory mandates. More surprising was that risk perception decreased in the scenario in which an outbreak was known.

This was a complicated effect with both positive and negative factors but which resulted in a net loss in our model. More study needs to be done to understand the latent variables, such as risk perception, trust in regulatory agencies, social/moral norms, and perceptions about the behaviors of other producers.

The key finding in this study was there is value in clear communication about animal diseases by regulatory agencies, professionals in the industry and veterinarians. The messages provided to producers shape their risk perceptions and subsequent effects on their attitudes and perceived behavioral control toward compliance with regulations and practices. We also found efforts to increase trust in regulatory agencies could greatly increase compliance with animal disease control regulations.

Also, creating policy interventions increasing positive attitudes and perceived behavioral control will likely increase both regulatory and voluntary compliance when faced with risk scenarios.

A Simulated Production System for Strategic Decisions on Disease Control

Gabriela Bucini, Eric Clark and Ollin Langle, University of Vermont

The strategic level of our system approach pyramid (Figure 1, page 7) helps us understand links between social and epidemiological dynamics at the larger scale. At the strategic level, we recognize production farms are not isolated entities but rather the decisions, actions, and risk culture adopted by a farm have repercussions on the larger production system.

Every decision at the farm level can impact the well-being of the entire system, due to the connectivity and frequent interactions between producers. Decisions made at the operational and tactical levels influence the type of strategic planning needed to manage the system. The strategic decisions (i.e., policies and regulations) influence the tactical actions of both farm owners (biosecurity investments) and farm workers (compliance with biosecurity measures).

How do we study the effect of an outbreak, adoption of biosecurity, or movement of pigs and feed? In the modeling world, our team chose to use an approach called Agent-based Modeling (ABM). Agents are the acting entities of a complex system. The agents acting within our agent-based model are hog producers, feed mills and slaughter plants. They have individual and population characteristics such as a risk attitude towards biosecurity investment.

Agents can move animals and feed and can make decisions to manage their investment in biosecurity and comply with biosecurity protocols.

One of the most important insights from our modeling work is that a production system in which there is a high tolerance for infection risk is left with little capacity to control the consequences of a disease outbreak, resulting in outbreaks that are unpredictable in size and impact. This unpredictability could only be seen by adding the human behavioral component into the disease spread simulation model in the form of agents' risk attitude.

Our objective as we developed the ABM was to answer the following question with increasing depth: How does human behavior affect the disease and market dynamics of a production system? We worked alongside epidemiologists to couple their knowledge of disease transmission mechanisms with the effects added by human risk attitude and decision-making.

Our experimental games are the primary source of the data used to model human behavior in the ABM. By using the data collected in our simulated games and actual human behavioral data during past outbreaks, we were able to create a more realistic ABM of disease spread through various networks and with varied risk-taking behaviors. We tuned our ABM to reflect the epidemiological mechanisms of porcine epidemic diarrhea virus (PEDv) and ran it under several scenarios where we varied the proportions of (agent) producers in each risk attitude group. In other words, we varied the risk culture in the simulated system, and we collected output variables such as disease incidence, hog market prices, and farm budgets. The average values and variability of these variables in outputs from Monte Carlo

"How does human behavior affect the disease and market dynamics of a production system?"

experiments showed that a system dominated by a risk-tolerant culture is left vulnerable to disease with little control over the consequences of an outbreak. In such a system, we cannot quantify incidence risk because there is almost no ability to foresee how, where, or how long the disease is going to be present.

This unpredictable nature of an outbreak given a high risk-tolerant culture manifested with low biosecurity is countered by the outcome of the scenario with a high risk-aversion culture in the system (i.e., high biosecurity) where the disease can be more easily controlled.

On the economic side, risk tolerance leads to unpredictable prices for market hogs. The cases with higher incidence led to increasing market hog prices. However, only 40 percent of producers were able to take advantage of this while 60 percent were unprofitable. In addition, evolution of hog production towards more specialized farms (three-stage production systems) since the mid-1900s also is shown by our ABM to increase exposure to this type of infection through the higher complexity of network movements both for hogs and feed.

As we investigate future developments of our ABM, we want to make behaviors as realistic as possible. Our agents are now only reacting to the presence of disease in the simulated system. However, humans have a memory and the ability to both learn from their experiences and actively adapt their behavior to the evolving environment.

These experimental gaming simulations provide data to study the learning process of participants as they move through each scenario. The inclusion of learning matters because there is interest in improving biosecurity engagement, messages and policies. Individuals who are open to learning could be a desirable population for targeted interventions and to optimize resource allocation.

In summary, the strategic level represented in our ABM provides a means to study the emerging properties of the collective actions of production stakeholders, and how they influence both epidemiological outputs (i.e., disease incidence) and economic outputs (i.e., hog market prices and farm budgets).

Stakeholders' individual risk attitudes and risk mitigation decisions can have system-wide ramifications and affect its resilience to disease. The ABM represents an innovative digital decision support system to develop policies as well as training and educational programs.

Risk Communication, the IDEA Model and Improving Biosecurity: PEDv as a Case Study

Timothy Sellnow and Deanna Sellnow, University of Central Florida

As risk and crisis communication specialists, our goal has been to create and test a model for designing effective instructional messages that will motivate receivers to take appropriate actions to protect themselves and those they care about. In this case, we focused on biosecurity messages that may ultimately mitigate PEDv's harm to swine.

To do so, we developed and employed the IDEA model, which is based on decades of rigorous research, is easy to employ, empowers people to make informed decisions, and results in appropriate protective actions. IDEA is actually an acronym that stands for:

- Internalization
- Distribution
- Explanation
- Action

(Sellnow & Sellnow, 2019; see Figure 2 on the next page). These four components need to be addressed for an instructional message to produce the desired results.

The "I" stands for internalization. This component is critical because it motivates receivers to attend to the message. The message ought to point to personal relevance and impact, as well as compassion.

Very often internalization may be achieved through storytelling from those that have been adversely affected by the crisis. In the case of PEDv, the message ought to focus on how easily PEDv is spread and its potential effects on swine.

The "D" stands for distribution. It is imperative that spokespersons send these messages through communication channels that will reach their target audiences, as well as through multiple channels to reach broad audiences. In the case of PEDv, such messages were distributed via telephone calls, fact sheets, print magazines, news releases, and regular updates on the Pork.org website (Sellnow, et al., 2017).

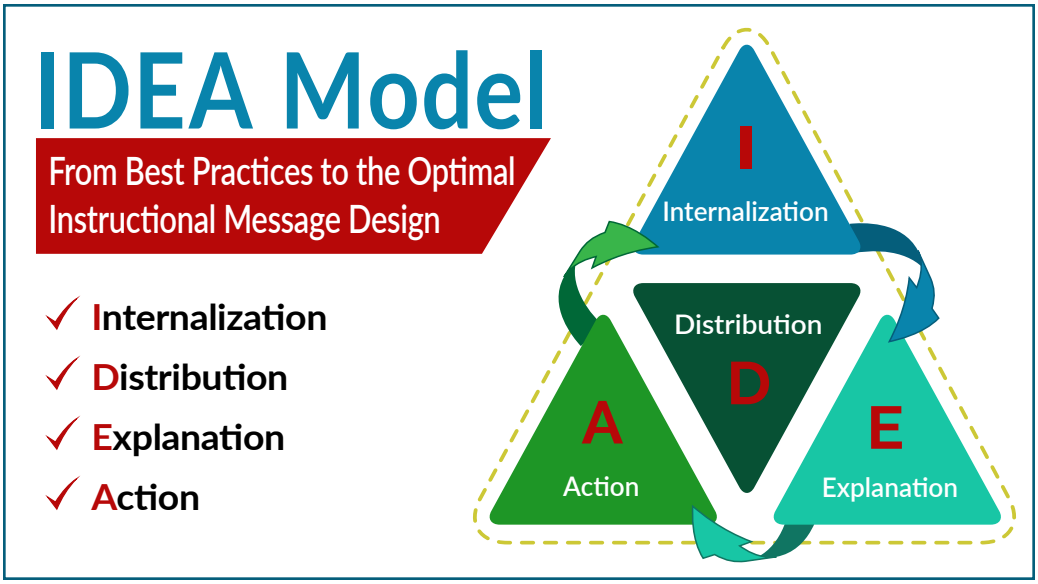


Figure 2: The IDEA Model for optimal instructional message design.

The "E" stands for explanation. Critical to success here is both ensuring the messages are being sent by a spokesperson or agency that the target audiences will perceive as credible, and ensuring the information is both accurate and put into terms people will understand. In the case of PEDv, a consistent message was communicated via a variety of sources because different audiences tend to put their trust in different sources (e.g., veterinarians, animal scientists, Extension agents, USDA, and fellow farmers) (Sellnow & Sellnow, 2019).

The "A" stands for action. The message must include specific actionable instructions people can enact. All too often such messages merely direct receivers to a website to get "more information" (Sellnow-Richmond, George, & Sellnow, 2018) rather than telling precisely what to do and in some cases what not to do. In the case of PEDv, this means describing what to do in terms of "shower in and shower out" as well as other actions to protect the line of separation (Sellnow, et al., 2017).

Based on several research studies, we determined one reason the swine industry was successful in containing PEDv in a relatively short amount of time was due to how they functioned as a community of practice (CoP) before and during the crisis and how they followed the IDEA model to send convergent messages when communicating to stakeholders throughout the crisis (Sellnow, Iverson, & Sellnow, 2017; Sellnow, Sellnow, Helsel, Martin, & Parker, 2018; Sellnow, Sellnow, & Martin, 2019).

Online Biosecurity Education for Youth: What a Great Idea!

Jeannette McDonald, TLCProjects, LLC

Many people talk about trickle-down education, which is knowledge from experts that trickles down to the mainstream or masses. The idea of educating youth about biosecurity could be called "trickle-up education," where the hope is a more educated population of youth will help not only future generations but influence current generations and communities. An example of this type of education would be children asking their parents to stop smoking, to recycle, or reminding them to wear their seatbelt in the car or helmet while riding a bicycle. Most likely their attempts to influence their parents' decision-making originated in a classroom or by similar education.

This project is the education arm of the ADBCAP, and is the culmination of four and a half years of weekly meetings with the team of five content experts, four of whom are veterinarians. Our goal was to create online modules that could be used in a classroom setting to introduce students—in this case grade 6 to 12 4-H and FFA members—to the concepts of animal biosecurity, and ultimately create more knowledgeable students and advocates for biosecure agricultural communities.

We wanted the modules we created to be interactive and tried to incorporate both the IDEA model (internalization, distribution, explanation and action) and the model of Bloom's taxonomy (remember, understand, apply, analyze, evaluate and create) into the modules. We also considered the population we were reaching and accessibility in our design. A teacher's guide was also created to support learning.

The second module focuses on how diseases spread in terms of routes of infection and means of transmission. Through stories, students learn about different diseases threatening biosecurity, how they enter the body (route of infection), and how they spread among animals (means of transmission).

We do not expect students to understand these concepts coming into the module, or to memorize and remember all the information after they complete the module. The main goal is for students to be introduced to terminology and gain a basic understanding of how disease transmission occurs.

The third module is when students start taking action. This module is a simulated game in which they play the role of a biosecurity inspector visiting a farm. As they travel around the farm, they must identify sources of potential risk. The risks can be discovered visually or through audio clips that students click on during the module.

The fourth module builds on the farm inspection activity by having youth select animal biosecurity strategies. There are many biosecurity measures to choose from, but a limited amount of money is available for these measures. A photo is slowly uncovered as they choose strategies: the better the plan, the more the photo is uncovered.

The students are faced with the tough reality that it is impossible to completely uncover the photo no matter how well designed their biosecurity plan is. This is to illustrate that no farm has the financial means to implement every strategy, nor can risk be eliminated completely.

The last modules allow students to complete the learning exercise by creating a public presentation. Students will learn not only about how to create a presentation step-by-step but also tips about public speaking. This component of the project will enable students to become biosecurity advocates to their families, clubs, communities and beyond.

We pilot tested all the modules and used feedback from both students and teachers to improve the curriculum during development. The completed modules are available for free on the Healthy Farms Healthy Agriculture website.

We hope to adapt the curriculum for adult audiences. We are open to suggestions in this area, but so far have considered the possibility of use within veterinary schools, the field of animal science, owners/managers of farms, farm workers and Spanish speaking audiences.

SCRUB: Science Creates Real Understanding of Biosecurity

Kris Hiney, Oklahoma State University

The acronym SCRUB stands for Science Creates Real Understanding of Biosecurity. SCRUB kits were developed through a collaboration between Oklahoma State University and the University of Arizona to complement the online learning modules developed by the ADBCAP education team.

The SCRUB kits link hands-on activities with science, technology, engineering and math (STEM) education, by incorporating science into fun activities and engaging youth in grades 6 to 12 with an existing interest in animal science. The SCRUB kits fill a need to teach youth about biosecurity because they take their animals places to exhibit them.

For example, in March of each year, Oklahoma hosts a Youth Expo that attracts approximately 7,000 youth, most of whom bring more than one animal to show. During the event, students house animals for the duration of the expo and then take them home. The contact between both students and animals during the Expo is a great example of why it is important to deliver early biosecurity education to those who have an interest in animal science.

The kits come with instructor and student guides and offer inexpensive hands-on activities. The goal is to demonstrate and reinforce key concepts of the online youth modules, and allow students to see real life

examples of the importance of biosecurity measures and compliance. The activities focus on four areas: disease transfer, cleaning and disinfecting, vaccine handling, and building a biosecure farm. The disease transfer activity includes a hands-on demonstration by students sharing liquids within cups. Some cups are "infected" while others are not. This educates students about how easily diseases can transfer when bodily fluids come in contact, either directly or indirectly.

The cleaning and disinfecting activities stress the importance of compliance, understanding best practices, and following instructions. One of the activities includes a handwashing exercise using Glo Germ™ to show how many "germs" remain after hand washing. An instructional video is then viewed by students about proper hand-washing techniques, and then the exercise is repeated to view improvement. Vaccine handling often includes equipment that would be too expensive to replicate in our activities, so we were able to develop an inexpensive exercise involving simple materials to demonstrate the physics behind cooling and maintaining temperatures for proper handling of vaccines.

To educate students about how to build a biosecure farm, we use a real-life example of handling the cleaning of various types of materials present at a livestock show, such as the Oklahoma Youth Expo. Simulated manure is created from potting soil and a Glo Germ™ product; then teams compete against each other to provide the cleanest place to house their animals. We are currently evaluating how the activities translate into the classroom and adjusting as needed.

The Healthy Farms Healthy Agriculture Website

Joanna Cummings, University of Vermont

Development of this website considers the needs of its audiences and research findings (including findings of the ADBCAP). The site will serve as a 24/7 resource for agricultural producers. Initially the website will be directed toward animal biosecurity, but we hope to eventually include plant biosecurity. In addition to providing information, the site will be complemented by forums for building communities of practice, and offer plan building and training resources.

Three terms are showcased on the website for our targeted audiences: **prevent, detect, respond**. They represent how to prevent disease outbreaks, how to observe animals for signs of illness, and how to respond to an outbreak. Within these areas we chose not to include specific information about diseases that affect a particular type of animal. Many resources are already available online about disease specifics. We want to create a resource that is reliable, easy to use and not redundant.

Preventing a disease outbreak before it starts is an excellent management strategy for livestock producers. We designed the website in a user-friendly way as a practical guide toward protecting animal health. A biosecurity plan is a good step in that direction, and the site offers templates, risk assessments and instructions on how to create a prevention and response plan.

Agricultural Biosecurity: Pre-Crisis and Risk Communication

Matthew Seeger, Wayne State University

My work has focused on crisis and risk communication related to public health, and I have worked extensively with the Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), the Federal Emergency Management Agency (FEMA), and Homeland Security, among others.

The main question I was asked to address today is, "How do we communicate, in both sending and receiving messages, so that appropriate actions and behaviors will be implemented to protect agricultural production units from threats including diseases, pests or contamination?"

The anthrax letter crisis occurred in 2001, and the CDC knew they had a major role to play in the response, but no idea of how to go about creating an action plan. This was a wake-up call for the CDC, and we were able to go in and begin a dialogue with the CDC about how risk and crisis, which have always been viewed as separate entities, should be viewed as an integrated process. At that point, they began using a more holistic approach with the better understanding that every crisis has a life cycle. They developed a very useful and comprehensive document about crisis and emergency risk communication that is still used widely today in public health emergencies.

The CDC developed a crisis and emergency risk communication (CERC) approach with five stages. The first stage is **Pre-crisis**. We can think of this as "before it hits the fan." This is when we are creating risk messages and warnings, making preparations, and building and testing communication systems.

The second stage is **Initial**. This is the trigger event when it hits the fan. We seek to manage the amount of uncertainty during this time as well as the loss of normalcy. During this stage we offer reassurance and self-efficacy. The third stage is **Maintenance**. We still have ongoing uncertainty, but typically the crisis is contained. The fourth stage is **Resolution**. The crisis is passing and we are returning to some sense of normalcy, even if it's a new normal. The fifth and last stage is **Evaluation**. This is when we should be creating after-action plans and learning from the crisis, though this is an area that unfortunately is often neglected.

By definition, a crisis is surprising, unanticipated, and uncertain. It is also threatening to high priority goals such as family or jobs, requires a rapid response, can be complex and cascading and have multiple causes. According to the EPA, "Risk communication is the process of informing people about potential hazards to their person, property, or community. Scholars define risk communication as a science-based approach to communicating effectively in situations of high stress, high concern or controversy."

The EPA's definition focuses solely on experts speaking to the public. I prefer the National Research Council's definition: "Risk communication is a process of exchange of information and opinion among individuals,

groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions, or reactions to risk messages or to legal or institutional arrangements for risk management."

> **"A crisis is surprising, unanticipated and uncertain. It is also threatening to high priority goals such as family or jobs, requires a rapid response, can be complex and cascading and have multiple causes."**

Risk communication is a complex, dynamic process occurring within a high consequential context. It requires strategic decision-making under conditions of high uncertainty and is fundamental to managing risk and managing crises.

Risk communication characteristics include messages of known and unknown. Our messages can be technical in nature (hazards) and subjective (emotional). Humans rely on a combination of both technical and emotional reasoning when making decisions, so messages must be crafted to address both. We should be relying on technical, scientific, subject matter experts, as well as community members and leaders with the goal of reducing and containing harm. This may be especially true in farming communities, which are often multi-generational, and in which people may have experienced disease before. Messages should be informative and persuasive.

What are some things that can be done pre-crisis to reduce risk? These include promoting changes in behavior to comply with biosecurity measures, developing key relationships before a crisis strikes (e.g., whom to call in a crisis), promoting understanding of risk and possible adverse outcomes, developing consensual response strategies, and monitoring and evaluating risks.

Failure to monitor risks can lead to inadequate responses and miscommunication, including conflicting messaging. Pre-event failures to identify and monitor risks include risk recognition (culturally having a different definition of risk), signal-to-noise ratio (being too busy/distracted to notice a risk), enactment problems (not having the capacity to deal with a risk), network deficiencies, and inefficient upward communication.

An example on farms of an upward communication problem that occurs is when lower level workers are the ones who really know what is going on but may not feel they have a voice. Pre-event planning is essential. It is helpful to think of planning as a process, not a product. Figure out who needs to be at the table and then work to develop the plan. Keep the dialogue going.

Post-event, the designated spokespeople should already be trained in risk communication and channels of communication should already be identified.

Be prepared to address what we are doing, why we are doing it, what you should do, why you should do it, what others are doing, and how you should do it. Even if social media is not how you are communicating with people post-event, know that people will be heavily using social media after a crisis, so social media should be monitored to correct misinformation. Be prepared to answer questions of cause, even if there is still a high level of unknowns. In addition, cooperation with agencies is key post-event.

Elements of risk communication include: audiences (media, public, consumers, those affected, etc.), channel source features (credibility, familiarity, honesty, etc.), message features (timing/speed, specificity, frequency, simplicity, consistency and legal concerns), self and social efficacy (belief in ability to take action, capacity to take action, collective capacity and competency), reasons why and how (IDEA model), elements of efficacy (experiences, vicarious rehearsal, persuasion and getting their attention), cultural and demographic features (age, gender, race, class, culture and cultural beliefs about risk), and challenges (uncertainty, speeds, social media, clutter, risk fatigue, rumors and fake news and social amplification of risks).

Crises will happen, so the better prepared we are, the more effectively we will be able to communicate the right information when it is most needed.

Economist Perspective on "So What?"

Glynn Tonsor, Kansas State University

This is the first of three presentations helping us think about how we might use stories in our work. In answering the "so what?" question about the value of our work economically, what should we be considering? Here are three examples.

A vaccine against E. coli exists that could reduce shedding of potentially pathogenic E. coli in beef cattle, reducing the risk of this foodborne pathogen to beef consumers. That would benefit public health. So why is the vaccine not being used? Because the feedlot owner/decision maker regarding using the vaccine has no incentive to do so. It is hard to justify known costs for purchasing and administering vaccines without an estimate of the public benefit or translation of that value to the feedlot owner through higher priced product.

To go about generating an estimate, we need to suppose an adoption pathway whether because of regulatory mandate or higher premiums paid by the packer. Then we need to estimate the increase in consumer demand or willingness to pay more, due to believing beef is safer or offset in food safety costs that the packer doesn't need to expend because the vaccine is being used.

Finally, we need to go to the decision maker and find out how likely our hypothetical scenario is. By building a scenario with a net benefit cost and finding out how likely it is for the scenario to play out, we can back into understanding the

economic value of the decision to vaccinate. It is easier to get answers to the likelihood of the benefits playing out than to get estimates of true cost savings or how much more consumers are willing to pay.

Here's another example: complex situations like foreign animal disease outbreak responses require multi-disciplinary approaches to optimize decision-making. Costs include response activities conducted by the government and lost income and other costs to impacted producers. Several researchers at Kansas State University have looked at incorporating both types of economic impacts into ranking alternative strategies for dealing with, in this case, foot and mouth disease (FMD).

Running a simulation model with no vaccine strategy resulted in $11 billion in costs to the government and $188 billion in losses to private industry. Running a simulation model with a high-capacity vaccine strategy resulted in $1 billion in government costs and $56 billion in private losses. Ignoring economics or ignoring disease spread science will lead to very different answers. Considering both can lead to cost savings for both the government and affected industry sectors. The best answer requires a multi-disciplinary approach.

Here's a final example: partial adoption of animal identification. Private and public incentives are very different. The trigger for public action is social benefit cost comparisons, whereas the trigger for private action is an individualized benefit cost comparison. For some producers in the beef production chain, participation in traceability is not worthwhile even though the industry overall would probably be better off. For instance, maintaining the ability to export beef to South Korea could be viewed as covering the cost of a national identification system being in place. However, there would still be producers in the system that are worse off.

Biosecurity adoption overall reflects this unequal allocation of public benefits versus private costs. If we don't find a way to change the benefit cost to those who don't have a direct incentive, we won't get voluntary adoption. We need to remember the individual decision maker who has to decide whether to use soap or not.

Social Marketing to Save Farmers' Lives

Matthew Myers, CBD Educational Services

The Vermont Rebates for Rollbars Program was a four-year social marketing campaign in Vermont, in partnership with the National Institute for Occupational Safety and Health (NIOSH) and the New York Center for Agricultural Medicine and Health. Tractor rollovers are the leading cause of death and injury for farmers. Rollbars can be 99 percent effective if seatbelts are worn. This study used a social marketing approach to promote the installation of rollbars. The social marketing campaign was focused on the specific behavior of calling a hotline to learn about the rebate program. Social marketing is the application of commercial marketing techniques to solve social problems.

This technique can be used in many applications, including public health. By using commercial marketing techniques of identifying the target population, finding that population's motivators and creating focus groups, efforts can be made to change a behavior within the target group.

After the target group and behavior to be changed have been determined, it is important to identify and reduce barriers. In our case, farmers found it hard to find the time to research rollbars and were deterred by the cost. It is also imperative to pretest your images. The first images we were given for our campaign were very dated and did not match how modern farmers look in Vermont. It's important that your target audience can see themselves in the marketing images. After marketing materials and narratives are created, use earned media and multiple channels to spread your message. For example, we knew if we told the story of a female farmer in Vermont whose children were getting to the age where they would be using the family's tractor with the grandfather chopping wood in the background, this would create a narrative about the need for rollbars not only to protect the current generation of farmers, but future generations as well. Lastly, a thorough assessment of results is needed after a campaign has been implemented.

Our target audience was chosen by determining which commodity group in Vermont was most ready to put a rollbar on their tractors using Prochaska and DiClemente's Stages of Change model, which includes the stages of pre-contemplation, contemplation, preparation, action, maintenance, and relapse. We found very few farmers surveyed had moved beyond pre-contemplation. The most vulnerable commodity group was determined to be vegetable and berry farmers. Through surveys and interviews, we discovered the barriers to putting rollbars on tractors and addressed them. The solutions in our case were to set up a hotline with information and defray the cost via fundraising.

Using the strategies of commercial marketing (identifying a population, finding their motivators, and creating focus groups) to create a social marketing campaign can be an effective way to influence behavioral changes in a target population and can be applied in many fields.

Narratives as Storytelling: Implications of the IDEA Model

Tim Sellnow and Deanna Sellnow, University of Central Florida

C.S. Lewis is credited with saying our inner world is tied to the stories we tell (Martindale & Root, 1990). We concur. Narratives (or stories) structure our reality. We are storytelling animals making decisions based on what we perceive to be "good reasons" gleaned from them (Fisher, 1987).

When people experience a dramatic event, they often justify their actions by telling a story about the event. Risk and crisis events create a narrative space we use to tell stories that help us make meaning out of chaos. The IDEA model, which consists of internalization, distribution, explanation and action, is often addressed in crisis situations through narratives.

Case in point: when interviewing Dr. Steve Van Wie (Steve) about the FMD crisis that occurred in the United Kingdom in 2001, Steve helped us internalize the devastation by telling a story about his experience. More specifically, he talked about a farmer who called him to explain why he was going to end his life. The devastation of having to put all his cattle down was too much to bear. The farmer called Steve because he trusted him and wanted him to understand why he saw no other course of action. Steve continues to tell that story to help those not directly impacted by FMD to internalize the personal impact it had on farmers.

Regarding distribution, stories are a key element of what we share through a variety of channels. In terms of explanation, stories help people comprehend and retain the message because they make the science come to life. For example, an animal science expert from the University of Minnesota told stories to explain how trucks from feed mills can transport a disease to a farm. In this case, her stories were about highly pathogenic avian influenza.

Illustrating through stories is a powerful means by which to explain how a disease spreads. In terms of action, success stories are a compelling way to convince producers to enact appropriate biosecurity behaviors (i.e., maintaining a clear line of separation on farms). When farmers tell stories about what they did to successfully protect their animals from PEDv, for example, they essentially act as what Bandura (1977) calls models to be replicated by others. People engage in social learning through model behaviors they share in the form of stories.

In sum, we can share numbers and statistics with people, but levels of literacy regarding numeracy can make such messages unintelligible to producers (Sellnow & Sellnow, 2019). On the other hand, people do understand stories. Thus, weaving them into our messages can make them more effective.

Storytelling is a universal means by which we make meaning out of lived experiences, including experiences focused on risk and crisis. A full list of references is available upon request.

What is a Community of Practice and How Do We View CoPs?

Joel Iverson, University of Montana

"A community of practice is different from a team in that the shared learning and interest of its members are what keep it together. It is defined by knowledge rather than by tasks, and it exists because participation has value to its members. It does not appear the minute a project is started and does not disappear with the end of a task. It takes a while to come into being and may live long after a project is completed or an official team has disbanded." Wenger, E. (1998)

Effective biosecurity requires multiple stakeholders to coordinate their responses utilizing the best practices of biosecurity. We systematically analyzed the way key personnel communicate to coordinate and respond to biosecurity threats as well as maintain ongoing biosecurity practices. Additionally, we brought together key stakeholders in the ADBCAP symposium to explore their experiences communicating biosecurity practices and engaging in Communities of Practice (CoPs). (See Figure 3.)

Our research to this point finds CoP theory a useful framework for understanding disease responses, as well as a framework for building better biosecurity practices in communities. Engaging in CoPs also facilitates an open dialogue to share opportunities and challenges in the creation of effective biosecurity communities.

Early analysis reveals:

- Complex problems like biosecurity require multiple stakeholders to come together.
- Effective action doesn't happen in isolation.
- Communication is critical to monitoring spread and response within communities.
- A CoP theory approach explains the process of PEDv response and provides a model for analyzing biosecurity systems.
- How biosecurity knowledge is communicated impacts resulting biosecurity.

Analysis of the PEDv response in 2013 in the United States demonstrates a variety of organizations and individual stakeholders (swine industry organizations, Extension, veterinarians, production owners, staff, feed providers, transporters, and so on) had to communicate and coordinate a complex and rapid response. Actors had to quickly bridge many fissures between various organizations and the wide array of people within organizations to effectively deal with the spread of PEDv. Key actors stressed the need for communication and sharing effective practices throughout communities through the existing array of actors. A key finding of the ADBCAP research demonstrates complex responses requiring biosecurity practices is best understood through a CoP approach.

Those in CoPs "share a concern, a set of problems, or a passion about a topic, who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger, McDermott, & Snyder, 2002, p. 4). Functional CoPs require productive engagement, sharing of ideas and strategies,

and a place for stakeholders to determine their future direction together.

While many CoPs such as professional training groups work together closely and frequently (Wenger, 1998), CoP theory provides a useful framework for studying the communication of practices in loosely connected groups that share practices (Iverson & McPhee, 2008). Thus, CoP theory uses components of CoPs as a lens to understand the accomplishments of various groups (Getchell & Iverson, 2017; Iverson, 2013; Iverson & McPhee, 2008; Sellnow, Iverson, Sellnow, 2017).

Three interactive elements of CoP describe how knowledge is practiced (Wenger, 2013):

- Mutual engagement
- Shared repertoires
- Negotiation of a joint enterprise

First, **mutual engagement** is described as collaborative practices allowing members to offer insights, adopt practices, and share frustrations. This element of CoPs looks beyond how often people engage; rather mutual engagement focuses on the meaningfulness of such engagements.

Second, **shared repertoires** describe a community's mutual understanding of best practices. In other words, specialized knowledge such as terminology, stories, skills, and activities are created and understood through shared repertoires.

The third element of CoPs refers to the decision-making process in a community through **negotiation of joint enterprise**. This element is represented through a negotiated response to a shared situation and larger context.

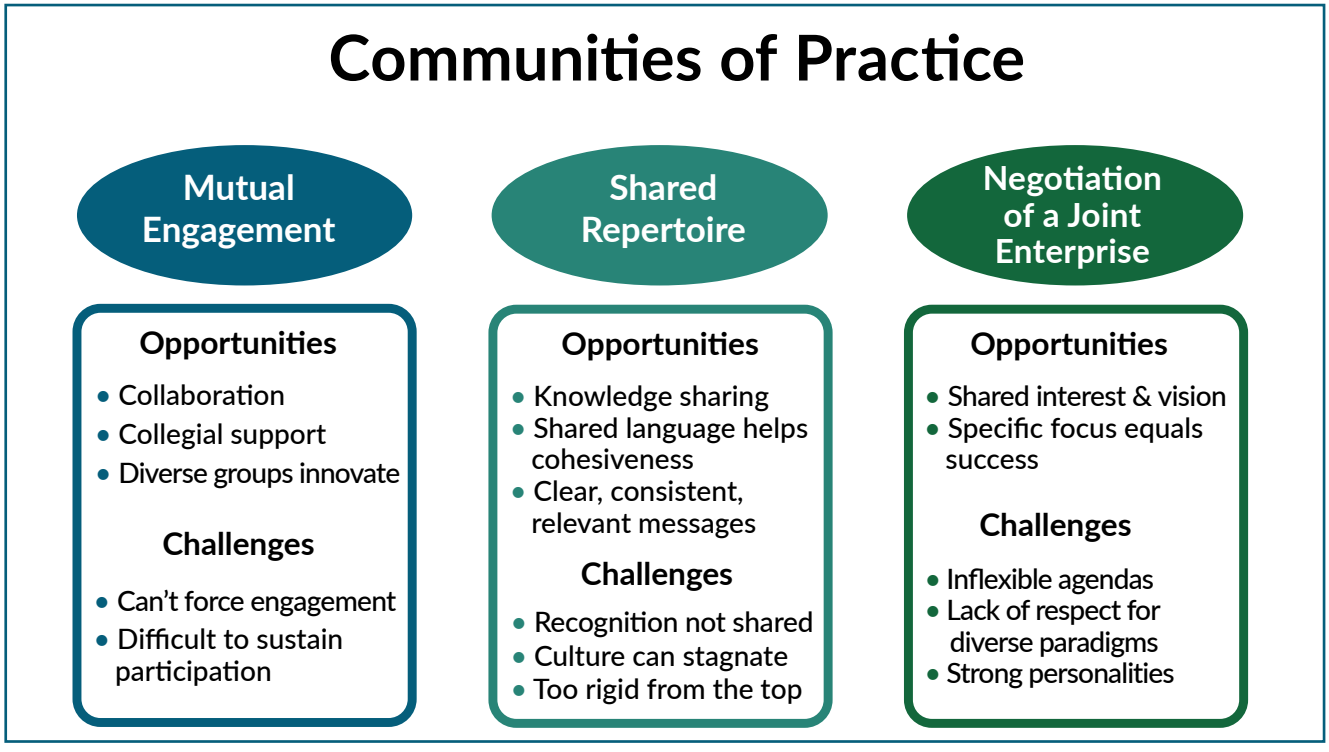


Figure 3. Biosecurity stakeholders express key opportunities and challenges in each facet of CoP theory. CoPs provide a means for sharing knowledge, collaboration, and clear, consistent messaging. CoPs work best when they are supported from the top, but not through forced participation.

Mutual engagement creates opportunities to collaborate, innovate and provide collegial support. Each of these advantages can be fostered through development of shared biosecurity practices before an outbreak occurs. The challenges to mutual engagement come from attempts to force participation and the difficulty to maintain consistent practices and participation in the CoP when stakeholders do not perceive a need.

Shared repertoire is the outcome of biosecurity practices. This is knowledge sharing as well as a chance to create clear, consistent, and relevant messages to members through storytelling. Knowing the terminology and the shared language allows one to join a particular CoP more easily.

Negotiation of a joint enterprise describes how the CoP is enacted. The way the CoP is created changes the nature of the CoP and impacts how the community thrives or fails. ADBCAP symposium participants emphasized the opportunity for communicating the common interest of farmers and other key stakeholders. Additionally, CoPs offer the chance to focus on collaboration rather than competition. The challenges come from mandated, top-down, inflexible approaches to communicating biosecurity practices.

Overall, these themes reflect the enhanced opportunity for engagement and knowledge sharing among stakeholders that have a common goal of animal biosecurity.

ADBCAP symposium participants stressed CoPs can be developed with the right approach. A key outcome was the metaphor of cultivating rather than managing or mandating that emerged as an important means to build strong communities of biosecurity.

Future directions of our research will focus on the kinds of specific messages used in communicating future risks with biosecurity threats such as African swine fever. Additionally, we will continue to explore details of biosecurity and other agricultural CoPs for insight into successful sharing of biosecurity practices.

APPENDIX A: COMPLETE AGENDA

May 15, 2019

Welcome and Opening Remarks
Julie M. Smith, DVM, PhD, University of Vermont and Project Director
Michelle Colby, DVM, MS, USDA NIFA Program Leader for Animal Biosecurity

Overview of Systems Approach - Overview of the Gaming and Simulation of Biosecurity in the Swine Industry: Opportunities for Policy and Practice
Christopher Koliba, PhD, University of Vermont

Decision-Making at the Operational Level - Explanation and Discussion of Key Learnings from the Compliance Game
Scott Merrill, PhD, University of Vermont
Luke Trinity, University of Vermont

Decision-Making at the Tactical Level - Explanation and Discussion of Key Findings from Surveys, the Protocol Adoption Game, and Other Data Analysis
Scott Merrill, PhD, University of Vermont
Eric Clark, PhD, University of Vermont
Ollin Langle, University of Vermont

Decision-Making at the Tactical Level - U.S. Swine Survey Insights
Glynn Tonsor, PhD Kansas State University

Decision-Making at the Tactical Level - Information Sharing in the Beef Cattle Industry
Glynn Tonsor, PhD, Kansas State University

Decision-Making at the Tactical Level - Socio-Psychological Determinants of Cattle Producers' Intent to Comply with Animal Disease Control Practices
Asim Zia, PhD, University Of Vermont

Idea Generation and Discussion 1
Facilitated Session to Identify Future Extensions of this Work that are Important to Stakeholders in Attendance

Decision-Making at the Strategic Level – Explanation and Demonstration of Agent-Based Models (ABM) that Account for Human Behavior
Gabriela Bucini, PhD, University of Vermont
Eric Clark, PhD, University of Vermont
Ollin Langle, University of Vermont

May 15, 2019

Idea Generation and Discussion 2
Facilitated Session to Identify Future Extensions of this Work that are Important to Stakeholders in Attendance.

Communication and Education Outreach Briefs – The Utility of the IDEA Model for Effective Biosecurity Risk Communication: PEDv as a Case Study
Tim Sellnow, PhD, University of Central Florida
Deanna Sellnow, PhD, University of Central Florida

Communication and Education Outreach Briefs – Online Biosecurity Education: A Great Idea!
Jeannette McDonald, DVM, PhD, TLCProjects, LLC

Communication and Education Outreach Briefs – Scrub: Science Creates Real Understanding of Biosecurity
Kris Hiney, PhD, Oklahoma State University

Communication and Education Outreach Briefs – Overview of the New Healthy Farms, Healthy Agriculture Biosecurity Website
Joanna Cummings, University of Vermont

Idea Generation and Discussion 3
Facilitated Session to Identify Future Extensions of this Work that are Important to Stakeholders in Attendance

Evening Funding and Network Panels

Panel 1: Funding Agencies and Foundations
Peter Johnson, DVM, PhD, USDA, National Institute of Food and Agriculture
Robert O'Connor, PhD, National Science Foundation Directorate for Social, Behavioral and Economic Sciences
Timothy Kurt, DVM, PhD, Foundation for Food and Agriculture Research

Panel 2: National Animal Health Laboratory Network Overview
Christina Loiacono, DVM, PhD National Animal Health Laboratory Network (by phone)
Cheryl Skjolaas, Extension Disaster Education Network
Rubella Goswami, PhD, National Plant Diagnostic Network

Panel Q & A: National Animal Health Laboratory Network & Funding Agencies and Foundations

May 16, 2019

Opening Remarks from the ADBCAP Project Director
Julie M. Smith, DVM, PhD, University of Vermont

Communication Channels and Messages
Facilitated Brainstorming Session About Message Channels and Success Factors

Storytelling Panel: 1. Economist Perspective on "So What?"
Glynn Tonsor, PhD, Kansas State University

Storytelling Panel: 2. A Social Marketing Approach to Agricultural Safety
Matthew Myers, CBE Educational Services

Storytelling Panel: 3. A Risk Communication Model
Tim Sellnow, PhD, University of Central Florida

Reflection on Storytelling
Facilitated Discussion Reflecting on Messaging Approaches and Their Application

What Is a Community of Practice (CoP)?
Joel Iverson, PhD, University of Montana

Reflection on Communities of Practice
Facilitated Session Reflecting on Previous Experience with Communities of Practice

Envisioning a New Biosecurity CoP - Facilitated Session Exploring Stories to Share
Julie M. Smith, DVM, PhD, University of Vermont

Keynote: Agricultural Biosecurity, Pre-Crisis and Risk Communication
Matthew Seeger, PhD, Wayne State University

Planting, Fertilizing and Growing a Community of Practice
Joel Iverson, PhD, University of Montana

APPENDIX B: REFERENCES CITED

Risk Communication, the IDEA Model and Improving Biosecurity: PEDv as a Case Study
Timothy Sellnow and Deanna Sellnow, University of Central Florida

Sellnow, D. D., Sellnow, T. L., & Martin, J. M. (2019). Strategic message convergence in communicating biosecurity: The case of the 2013 porcine epidemic diarrhea virus. Communication Reports, 32(3), 125-136. https://doi.org/10.1080/08934215.2019.1634747

Sellnow, D. D., & Sellnow, T. L. (2019). The IDEA model for effective instructional risk and crisis communication by emergency managers and other key spokespersons. Journal of Emergency Management, 17(1), 67-78. https://doi.org/10.5055/jem.2019.0399

Sellnow-Richmond, D. D., George, A. M., & Sellnow, D. D. (2018). An IDEA model analysis of instructional risk communication messages in the time of Ebola. Journal of International Crisis and Risk Communication Research, 1(1), 135-165. https://doi.org/10.30658/jicrcr.1.1.7

Sellnow, T. L., Sellnow, D. D., Helsel, E. M., Martin, J., & Parker, J. S. (2019). Risk and crisis communication narratives in response to rapidly emerging diseases. Journal of Risk Research. 22(7), 897-908. https://doi.org/10.1080/13669877.2017.1422787

Sellnow, T. L., Parker, J. S., Sellnow, D. D., Littlefield, R. R., Helsel, E. M., Getchell, M. C., Smith, J. M., and Merrill, S. C. (2017). Improving biosecurity through instructional crisis communication: Lessons learned from the PEDv outbreak. Journal of Applied Communications, 101(4), Article 2. http://dx.doi.org/10.4148/1051-0834.1298

Narratives As Storytelling: Implications of the IDEA Model
Timothy Sellnow and Deanna Sellnow, University of Central Florida

Bandura, A. (1977). Social learning theory. New York: General Learning Press.

Fisher, W. R. (1987). Human communication as narration: Toward a philosophy of reason, value, and action. Columbia, SC: University of South Carolina Press.

Martindale, W., & Roote, J. (Eds). (1990). The Quotable Lewis. Wheaton, IL: Tyndale House.

Sellnow, D. D., & Sellnow, T. L. (2019). The IDEA model of effective instructional risk and crisis communication by emergency managers and other key spokespersons. Journal of Emergency Management, 17(1), 67-78. doi: 10.5055/jem.2017.000.

What is a Community of Practice and How Do We View CoPs?
Joel Iverson, University of Montana

Wenger, E. (1998). Communities of practice: Learning as a social system. Systems thinker, 9(5), 2-3.

FINAL THOUGHTS

Looking back on what we shared during the 2019 ADBCAP Symposium—and what we have accomplished since—gives me great pride. However, I am saddened to report that post-symposium, changes at USDA NIFA resulted in the departure of program leaders associated with this project who faithfully served in their roles. Margo Holland bravely battled cancer and Peter Johnson retired from NIFA after the move to Kansas City was announced. Michelle Colby, former national program leader for animal biosecurity, is now the National Security Division chief at USDA.

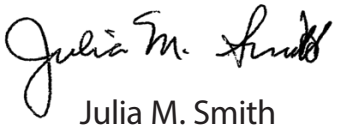
In the process of finalizing the progress report for year five of the ADBCAP, I was struck by the sheer volume of outreach accomplished in the past year. Through presentations to disciplinary peers and workshops for educators and end-users of our materials, this project team has touched people around the world. Collectively, the team produced:

- eight peer-reviewed journal articles;
- 18 conference presentations (proceedings, papers or posters) to national and international audiences;
- 16 symposium presentations at our own project symposium;
- three theses; and
- several other products including a website, symposium summary, project report, policy brief, and features in outreach publications (Scientia and Futurum).

Members of the team further engaged stakeholders in a variety of (43) other outreach venues—seminars, classes and workshops—described under other products. The progress reports submitted annually to USDA NIFA are posted to our project site at agbiosecurityproject.org.

The vision described for the website and forums is becoming a reality. The Healthy Farms Healthy Agriculture (HFHA) website went live in January 2020 at healthyagriculture.org. A series of web meetings called Biosecurity Community Conversations—intended to foster community and sharing through private forums related to biosecurity—began in March 2020. The first Community Conversations series featured speakers with expertise in on-farm mortality composting. Links to recordings of the web meetings are located on the HFHA forums website at forums.healthyagriculture.org. During the fall of 2020, we plan a series of conversations around youth biosecurity education.

After bringing this team together, watching connections develop, seeing the results of innovative lines of questioning and approaches to collecting data, and connecting with more members of the biosecurity community in a variety of ways, I can say without a doubt that the effort involved in this project has been highly rewarding, and I am optimistic that new opportunities lie ahead. I encourage the development of bold collaborative, multi-disciplinary projects in the area of biosecurity. Team members have been busy developing proposals for funding extensions of the work started with the ADBCAP. I hope that our work and that which follows will help all agricultural stakeholders continue to live well and biosecurely.



Julia M. Smith
May, 2020