

Bio-Security Proficiencies Project for Beginning Producers in 4-H

Abstract

Improving bio-security practices among 4-H members who raise and show project animals is important. Bio-security measures can reduce the risk of disease spread and mitigate potential health and economic risks of disease outbreaks involving animal and zoonotic pathogens. Survey data provided statistical evidence that the Bio-Security Proficiencies Project for Beginning Producers in 4-H advanced youth participants' knowledge and skills related to bio-security and financial risk management. Furthermore, the project provided youth with opportunities to apply their understanding and abilities to authentic settings and extend their learning to their communities.

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Introduction

Bio-security can be defined as "a series of management procedures designed to prevent or greatly reduce the risk of introducing new infectious agents to a farm" (California Department of Food and Agriculture [CDFA], 2014). Common bio-security practices for animal agriculture include quarantine procedures for new animals or animals that show signs or symptoms of disease; disinfecting stalls and equipment; reducing or eliminating contact with other animal species; and the management of housing, travel, and visitors (e.g., veterinarians, livestock haulers, and nutritionists) (Animal and Plant Health Inspection Service [APHIS], 2012; CDFA, 2014).

Research data have shown that a large-scale disease outbreak in the United States would have significant adverse economic impacts on commercial animal agriculture (Paarlberg, Seitzinger, Lee, & Mathews, 2008; Pedersen et al., 2004). Despite the fact that systematic and consistent bio-security among commercial animal agriculture operations is essential, management practices are mixed, which increases susceptibility to disease incursion (Anderson, 2010; APHIS, 2012; Brandt, Sanderson,

DeGroot, Thomson, & Hollis, 2008; Caraviello et al., 2006). One potential source of pathogens that can threaten large-scale animal agriculture is animals raised on backyard farms that come into contact with commercial herds and flocks (Food and Agriculture Organization of the United Nations, 1999; Nolen, 2003; World Health Organization, 2011). Thus, improved bio-security practices among backyard producers are essential.

Most 4-H Animal Science project animals can be considered of the backyard variety, and there is evidence of the need for improved bio-security practices among 4-H youth. An online survey of 252 4-H youth members from 40 California counties showed that 66% of project animals were housed in backyard herds of approximately 8-9 animals of the same or mixed species and that these animals were transported to an average of two 4-H club meetings each year where mixing with other animals occurred (Smith, 2009). In the context of club meetings with their animals present, 19% of the survey respondents reported applying no bio-security measures, and only 2% of youth respondents reported the use of extensive bio-security practices, including use of hand sanitizers, isolating animals, disinfecting footwear, and not using shared equipment (Smith, 2009). With respect to monitoring their animals for signs and symptoms of disease (early intervention), 25% of the youth who completed the survey reported never performing health checks on their project animals (Smith, 2009).

Survey data also revealed that 4-H youth showed their animals at an average of 2.5 public venues annually within and beyond their home counties (Smith, 2009). Animals exhibited at fairs and shows represent bio-security risks through additional animal-to-animal contacts and the possibility of disease transmission through other modes (e.g., indirect contact, airborne transmission, fecal-oral). Specifically, pathogens that cause animal diseases such as malignant catarrhal fever (e.g., Moore et al., 2010), as well as zoonotic illnesses (diseases transmissible between humans and animals) caused by enteric pathogens such as *E. coli* and *Campylobacter* and strains of the Avian Influenza virus, have been shown to be transmissible at public venues (e.g., Olson & Gray, 2006; Keen, Wittum, Dunn, Bono, & Durso, 2006; Roug, Byrne, Conrad, & Miller, 2012; Steinmuller, Demma, Bender, Eidson, & Angulo, 2006). Data collected at the California State Fair and eight county fairs in the north central region of California revealed specific bio-security transmission risks associated with exhibition practices involving 4-H animals, including issues related to housing, wash racks, judging arenas, and visitor contact (Smith & Meehan, 2012).

These risks highlight the need to provide effective bio-security education in 4-H. Thus, the current study focused on the implementation and evaluation of the Bio-Security Proficiencies Project for Beginning Producers in 4-H in three California counties. At the heart of the project were well-designed educational activities that emphasized the concepts of disease transmission, risk assessment, risk mitigation, and financial risk management through experiential learning and engaged youth in the application of knowledge and skills to authentic situations. Specifically, activities were organized into five proficiency levels (Figure 1) that advanced youth participants' learning over time.

Methods

Recruitment

4-H staff recruited adult volunteers to implement the Bio-Security Proficiencies Project for Beginning

Producers in 4-H with youth members in three counties. Recruitment strategies included presentations at 4-H meetings, information sessions held at 4-H county offices, and phone and e-mail contact. All participating 4-H volunteers (n=15) had prior experience leading Animal Science projects with youth members. Youth participants (n=120), members of 4-H clubs in their respective counties, were between the ages of 8 and 17, with the average age being 13.

Professional Development

Professional development for participating 4-H volunteers followed a modified version of the Step-Up Incremental Training Model (Smith & Enfield, 2002) that included face-to-face workshops and conference calls coupled with online technology. In particular, volunteers participated in an initial on-site professional development workshop with project staff where they engaged directly in the activities and procedures necessary for the implementation of Proficiency 1. The workshop focused on subject matter content, the use of effective pedagogy, including guided inquiry and questioning strategies, and the application of knowledge and skills in real-world situations.

Two subsequent professional development workshops for participating 4-H volunteers were held using teleconference and Web-conferencing technologies. These workshops included a review of all project materials and recommended implementation strategies for subsequent proficiency levels. Specifically, the second workshop focused on activities and procedures necessary for the implementation of Proficiency 2; the third workshop involved preparation for the implementation of Proficiencies 3, 4, and 5. This incremental approach has shown to be beneficial in that it provides participating volunteers time to reflect on previous implementations with youth participants, thus allowing them the opportunity to share challenges they encountered, as well as strategies they found to be effective (Smith & Enfield, 2002).

Implementation

The five-levels of bio-security proficiency were designed to build 4-H youths' knowledge and skills over time. Specifically, the implementation of the proficiencies occurred with 4-H youth following the sequences outlined in Figure 1. The numbered items shown in plain font indicate work completed by youth participants in a group setting (e.g., 4-H club); the numbered items shown in *italics* represent work completed by youth independently. Authentic assessments were built into the independent work associated with each proficiency level in the form of activities that required written tasks, the application of skills, and photo documentation. Specific examples included: keeping a daily animal health journal for two weeks; a bio-security risk assessment of 4-H members' home premises; the planning and execution of a bio-security risk mitigation plan for 4-H youth members' home premises; the development and delivery of a public presentation on bio-security; and the application of best practices at a public venue. Completion of these activities was required to attain proficiency at each level. Youth who completed the necessary requirements were awarded a pin and certificate for each proficiency level they achieved.

Figure 1.

Preferred Communication Methods of Different Audience Types

Bio-Security Proficiency Level 1

1. Complete group activity "Bio-Security: Assessing and Preventing the Spread of Disease (Smith et al., 2011) and review endemic and foreign animal disease matrix (provided).
2. *Individuals complete the activity "Animal Health Assessment" (Smith, Meehan et al., 2009).*
3. *Individuals complete two weeks of health journaling on your own animal.*
4. Submit independent work to 4-H volunteer.

Bio-Security Proficiency Level 2

1. Complete group activity "Assessing Critical Control Points Associated with Disease Transmission" (Smith et al., *in press*).
2. Review the on-farm Bio-security Risk Assessment Tool (Smith et al., 2011).
3. *Individuals complete the activity "Risk Assessment: A Picture Says a Thousand Words," Smith et al., 2011).*
4. *Using the Bio-security Risk Assessment Tool (Smith et al., 2011), individuals complete a bio-security risk assessment and document with photos or video.*
5. Submit independent work to 4-H Volunteer.

Bio-Security Proficiency Level 3

1. Complete group activities "Bio-Security and Financial Risk" (Techanun, Meehan, Chalfant, & Smith, 2013a) and "Risky Business" (Techanun, Meehan, Chalfant, & Smith, 2013b).
2. *Individuals and their parents/guardians develop a bio-security risk*

reduction plan based on risk assessments completed in Bio-Security Proficiency Level 2.

- 3. Individuals implement and document the execution of their bio-security risk reduction plan with photos or video.*
4. Submit independent work to 4-H Volunteer.

Bio-Security Proficiency Level 4

1. Groups discuss options and create plan for public presentation on bio-security principles learned and applied through Proficiency Levels 1-3.
2. Groups develop public presentation.
- 3. Groups deliver public presentation to 4-H parents, other 4-H youth, or commodity groups.*
4. Submit a summary of independent work to 4-H Volunteer.

Bio-Security Proficiency Level 5*

- 1. Groups work collaboratively with representatives from state or county fairs or exhibitions to **develop** a plan to improve education outreach and bio-security practices and at public venues.*
- 2. Groups work collaboratively with representatives from state or county fairs or exhibitions to **implement** plan to improve education outreach and bio-security practices and at public venues.*
3. Submit a summary of independent work to 4-H Volunteer.

*Note: Bio-Security Proficiency 5 was optional for this study.

Data Collection

Three forms of data collection were approved by the Institutional Review Board (IRB) Administration through the University of California's Office of Research and conducted over the course of the Bio-Security Proficiencies Project for Beginning Producers in 4-H.

1. Surveys that measured changes in knowledge and skills were administered following each Proficiency Level. These surveys were designed using a retrospective (post-as-pre) format for the purpose of reducing response-shift bias, a threat to internal validity that can arise when using a pre/post survey design (Raidl et al., 2004). Specifically, surveys included five sets of paired questions, each with four response categories ranging from "Poor" to "Excellent." Four response categories were utilized to help ensure discriminating answers by participants and eliminate the potential misinterpretation of a mid-point (Croasmun & Ostrom, 2011). Question 1 asked about the youth's current level of knowledge or skills relative to a specific topic after the educational intervention (post); question 2 asked about the youth's level of knowledge or skills relative to the same topic prior to the educational intervention (pre). A sample set of paired questions from one retrospective survey is shown in Figure 2.

Figure 2.

Retrospective Survey Question Example.

Question 1	Question 2
My understanding of the critical control points for disease transmission is: 1. Poor; 2. Fair; 3. Good; 4. Excellent	<i>Before participating in this activity</i> my understanding of the critical control points for disease transmission was: 1. Poor; 2. Fair; 3. Good; 4. Excellent

2. As part of Proficiency Level 2, youth participants were required to complete a risk assessment of their home premises. The frequency that specific risks were reported across all participants was recorded.
3. Surveys were administered to adults who attended public presentations delivered by youth as part of Proficiency Level 4. These surveys collected basic information about the attendees' roles and experience with animal agriculture. A retrospective (post-as-pre) format was utilized to determine changes in knowledge relative to bio-security concepts.

Data Analysis

Survey data (youth and adults) were analyzed using paired *t*-tests to determine change in scores (Poor = 1 to Excellent = 4) between their pre- and post-intervention levels of knowledge and skills. Data analysis was executed using Minitab 16 statistical software (2010).

Results

Subjects

All 120 4-H youth who enrolled in the Bio-Security Proficiencies Project for Beginning Producers in California 4-H completed Proficiency Level 1; 104 youth (87%) completed levels 1 and 2; 86 (72%) accomplished levels 1, 2, and 3; and 63 (52%) accomplished proficiency levels 1, 2, 3, and 4 (Table

1). Additionally, 32 youth (26%) completed Proficiency Level 5, the optional component in this investigation (Table 1).

Table 1.

Youth participation in Bio-Security Proficiencies Project for Beginning Producers in California 4-H

Proficiency Level	Number of Participants	Number Surveyed**
Proficiency 1	120 youth	54
Proficiency 2	104 youth	50
Proficiency 3	86 youth	25
Proficiency 4	63 youth	23
Proficiency 5 (optional)	32 youth	Not Applicable
**Participants were not required to complete post-proficiency surveys as per IRB Human Subjects Protocol.		

Youth Survey Results

Scores on the retrospective surveys improved significantly at all Proficiency Levels. Changes in mean scores for paired sets of questions for each proficiency level (1-4) were calculated by comparing pre- and post-intervention mean scores for each survey. Mean scores are reported in Table 2. All improvements in mean scores reported were significant at $p < 0.001$.

Table 2.

Mean Pre- and Post-Scores for Youth Surveys at Proficiency Levels 1-4

Proficiency Level	Bio-Security Concepts	Pre Mean	Post Mean
1	Modes of disease transmission; making health observations; keeping health records	2.05	2.91
2	Critical control points; roles of vectors and vermin; assessment of bio-security risks	2.08	3.16
3	Identifying financial risks; cost-benefit analysis	2.15	3.10
4	Bio-security risk reduction planning and implementation; communicating with public	1.81	3.31

Bio-Security Risks Identified on Home Premises

Using the Bio-Security Risk Assessment Tool (Smith, Meehan, et al., 2009), participating youth

completed an analysis of their home premises and identified areas of low, moderate, and high risk. The risks they identified were organized into five main categories:

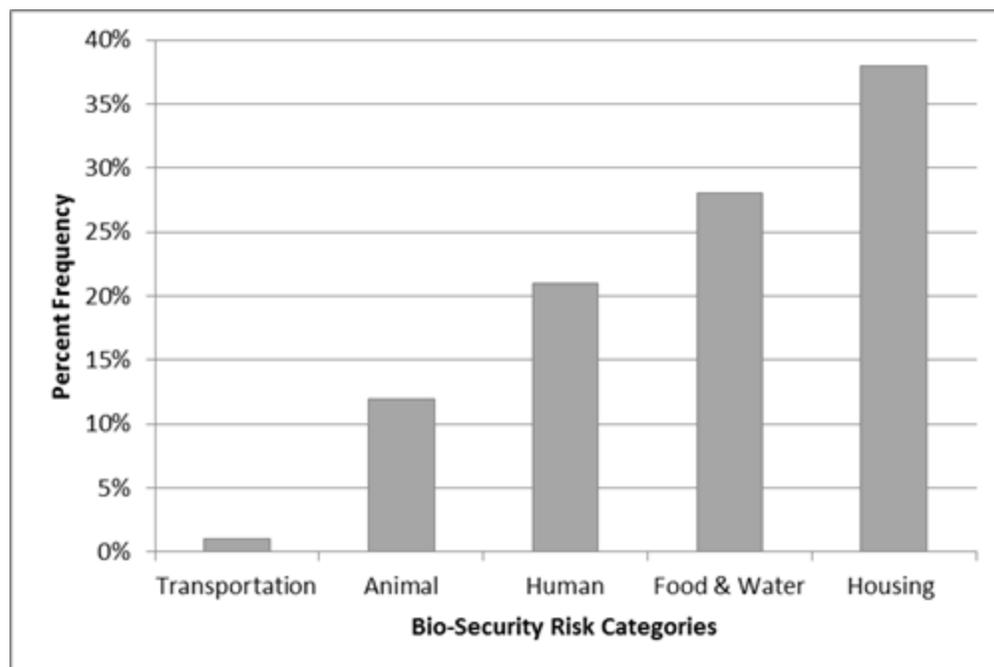
1. Transportation-related (e.g., transportation with other animals; cleanliness of trailers/vehicles).
2. Animal-related risks (e.g., quarantine practice; vaccination status; contact with wildlife).
3. Human-related (e.g., contact with visitors; use of appropriate clothing and footwear; hand-washing practices).
4. Food- and water-related (e.g., quantity and quality of food and water; access to food and water).
5. Housing-related (e.g., stocking density; cleanliness; vermin and vector control; sanitation of tools; sharing of tools; ventilation and climate).

A total of 110 risks at the moderate or high level were identified. Figure 3 displays the distribution of risks identified across the five categories described.

Figure 3.

Frequency of Bio-Security Risks

Frequency of bio-security risks identified by participating 4-H youth on their home premises.



Adult Community Member Survey Results

As a requirement for completing Proficiency Level 4, youth developed and delivered public presentations on bio-security for families and community members. Six different presentations were delivered between the three participating counties. A total of 140 adult community members attended. Attendees included parents of 4-H participants, local government representatives, 4-H staff,

fair board members, and representatives from agricultural associations (e.g., California Farm Bureau Federation; California Cattlemen's Association). Forty-one percent of the individuals in attendance reported that they were active in animal agriculture, either as producers or hobbyists.

All adult attendees were asked to answer an optional survey following the presentations by 4-H youth. Sixty-three surveys were completed. Survey results showed significant ($p < 0.05$) improvements in attendees' understanding of the modes of disease transmission, the role of critical control points in disease spread, and financial risks related to bio-security practices among young producers. Finally, of those attendees who identified themselves as active in animal agriculture, 95% reported that the information presented by the youth was directly applicable to their practice.

Proficiency Level 5

Proficiency Level 5, where youth were asked to assume the responsibility of planning and executing a bio-security-related service-learning project in collaboration with their county fair, was optional for this investigation. However, the youth participants (32) from one county elected to participate in this proficiency. The 4-H youth members worked collaboratively with the Chief Executive Officer of their county fair to address bio-security issues they identified as important. Specifically, all pens, tie stalls, wash racks, and scales were cleaned and disinfected. In addition, laminated signs with information about bio-security practices were posted in all barns, and participating 4-H youth spoke with fair attendees and other 4-H youth regarding bio-security practices. In particular, youth conveyed information about specific diseases these bio-security practices were targeting, including sore mouth, a zoonotic viral disease of sheep and goats (Leite-Browning, 2008) that had been a problem at the county fair in previous years.

Discussion

Approximately 34,000 youth participate in 4-H Animal Science projects annually in California; nationally, this number exceeds 1,866,000 (USDA, 2011). The majority of these projects focus on the rearing, care, husbandry and, in many cases, showing and marketing of live animals, including poultry, ruminants, and swine. In most cases, 4-H members house their animals at home or on local farms, meet collectively as a club once or more monthly, and convene in larger groups on exhibition days and at county or state fairs. As such, these projects have the potential to be associated with animal or zoonotic disease outbreaks (Amass, Schneider, & Kenyon, 2004). In addition, research indicates that these risks are particularly present in fair and exhibition settings. For example, Rough, Byrne, Conrad, & Miller (2012) demonstrated the presence of fecal-borne zoonotic pathogens among livestock exhibited at a county fair in California. In another study, Keen, Wittum, Dunn, Bono, & Durso (2006) found that of 2,919 fecal specimens from 29 county fairs in two states and at three state fairs, 186 (6.4%) were positive for *E. coli* O157, an enteric zoonotic pathogen. Furthermore, these researchers collected four samples from fair grounds 10-11 months following the fairs when no animals were present and found them to be positive for *E. coli* O157, indicating that this pathogen remains in the environment for extended periods of time.

The scale of the national 4-H Animal Science Program, evidence of insufficient on-farm and at-fair practices to reduce the transmission of pathogens, and the potential of animal or zoonotic disease

outbreaks underscore the need for systematic dissemination of bio-security education among 4-H youth who raise project animals (Smith, 2009; Smith & Meehan, 2012). Developing good bio-security practices among 4-H members who raise and show animals can help mitigate potential animal disease outbreaks involving animals within backyard flocks and herds, with backyard animals that come into contact with commercial growers, and among animals exhibited at public venues. Best practices can also help protect human health by decreasing the likelihood of the spread of zoonotic pathogens. Furthermore, the monetary investment by 4-H youth who raise 4-H project animals is not insignificant (e.g., Harrison & Eborn, 2012; Kirkpatrick & Neel, n.d.), and improved bio-security can help reduce potential adverse financial risks, including the potential loss of animal life, disruption in production, or costly disease recovery.

Recommendations on bio-security practices are available to 4-H youth in published form from numerous private, state, and national sources, including commodity groups (e.g., American Sheep Industry Association, 2014), university Extension services (e.g., Leite-Browning, Browning, Vaughn, Andries, & Simon, 2011), state departments of agriculture (e.g., CDFA, 2014), and the United States Department of Agriculture (USDA) (e.g., USDA, 2012). However, the vast majority of these publications lack specific suggestions regarding conducting on-farm risk assessments, and few provide tools necessary to carry out a risk assessment (Moore et al., 2007). Moore et al. (2007) stress the importance of engaging producers in on-farm risk assessments as a strategy that can help serve as a motivation to adopt bio-security practices.

A key component of the Bio-Security Proficiencies Project for Beginning Producers is the use of a scaled risk assessment tool (low risk; moderate risk; high risk) for on-farm assessments. Specifically, youth implement on-farm risk assessments that, subsequently, inform risk mitigations and effect changes in their bio-security practices. This "learning by doing" approach is a foundational educational strategy of 4-H programming and is considered the "backbone" of the 4-H experience (Enfield, 2001). Other important pedagogical strategies employed in the sequence of proficiencies include: inquiry-based activities facilitated in group settings that promote reflection and dialogue, components of learning in a social environment that are critical to knowledge development (Lave & Wenger, 1991; Vygotsky, 1978); and the application of knowledge and skills to real-world problems, a strategy that helps youth foster critical thinking skills and gain a deeper understanding of content (Jones, 2012).

Although the results from the study reported here cannot be generalized beyond the scope of the investigation, the Bio-Security Proficiencies Project for Beginning Producers has the potential to provide 4-H programs nationally with a comprehensive and effective approach to educating youth and facilitating positive change in their bio-security practices. Specifically, the outcome data from the investigation revealed that the project was successful in improving youths' conceptual understanding of bio-security, biological and financial risk management, and risk mitigation; advancing their skills associated with best bio-security practices; and supporting the mitigation of disease transmission risks on their home farms and at public venues. Additionally, project impacts were extended to community members and members of the animal agriculture industry and allied professions.

Results also showed regular attrition in youth participation over time. The project required a sustained commitment over an extended period by youth and their families; accordingly, some youth, due to various reasons, were unable to complete the proficiencies. Thus, project staff recognized that future

efforts must include additional strategies to help reduce the number of youth that attrite.

Conclusion

Animal owners are the first line of defense against disease incursion. The Bio-Security Proficiencies Project for Beginning Producers in California 4-H supported youth in the advancement of their knowledge and skills related to bio-security and financial risk management; the project also provided youth with opportunities for the authentic application of their understanding and abilities to their on-farm practices. Furthermore, participating 4-H members were able to extend their knowledge, skills, and practices to their communities.

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