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## **IMPROVING AGRICULTURAL WORKERS FOOD SAFETY KNOWLEDGE THROUGH AN ONLINE CURRICULUM**

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### **Abstract**

A one-hour online food safety curriculum was developed to inform university farm workers on food safety hazards associated with production and harvesting of fresh produce. The farm curriculum consists of five sections (food safety importance, pre-harvest hazards, post-harvest hazards, personal hygiene, and regulations). Engagement activities and a user manual were developed to support the curriculum. Curriculum content was validated by an expert panel and a convenience panel of farm workers. The developed curriculum was piloted at two land grant universities (n=50). Multiple-choice quizzes were used to assess knowledge changes in each of the sections. Results indicated significant knowledge gains at both universities for all sections except the personal hygiene section. This pilot study provides evidence that an online format is effective in improving food safety knowledge. Because knowledge is a prerequisite for behavior, this curriculum can assist with mitigating food safety risk on university and other research farms.

**Keywords:** Food Safety Education, University Farms, Pilot Study, Online Training

### **Introduction**

Foodborne illness associated with fresh fruits and vegetables is a major concern in produce items as 46% of total reported foodborne diseases have been attributed to fresh fruits, vegetables, and nuts (Painter et al., 2013). Research and foodborne outbreaks have revealed that human foodborne pathogens are able to survive and reside on surfaces of fresh produce items (Beauchat and Jee-Hon, 1997; Harris et al., 2003). It is critical to utilize Good Agricultural Practices (GAPs) when growing fruits and vegetables to minimize the food safety risk. GAPs emphasize best practices associated with water supply; manure application; wildlife and domestic animals; cleaning and sanitation with tools, equipment and buildings, and employee training. Specifically, employees' practices can control food safety risks in the field and after harvest.

Higher education institutions are utilizing university produce farms to teach courses and conduct research. Courses include those in areas of study such as horticulture, natural resources, business, value added processing, and entrepreneurship. Further, produce grown at university farms may be part of research efforts, but often, the produce not used in projects may be given to employees or sold directly or indirectly at markets or to consumers. Frequently, in these farm settings, safety practices are not emphasized to the students or farm workers. It is important to educate these workers on GAPs prior to working in the fields.

Education through an online platform has been shown to increase knowledge and change behaviors. An online curriculum can be viewed multiple times, giving students or farm workers the opportunity to review content as needed and provide flexibility around their schedules (Hammonds, 2003; Neal et al., 2010). The online platform also makes it easy for viewing and for

facilitators to track access. Thus, higher education is taking advantage of the flexibility that online curriculum offers, and online trainings are a frequently used format to communicate expectations to students or farm workers.

The hypothesis of this pilot project was to determine if a food safety curriculum for farm workers delivered through an online platform would change their knowledge. To test this hypothesis, knowledge quizzes were administered pre- and post-viewing of each of the five sections of the online food safety curriculum. The purpose of this study was to determine if online teaching was an effective method to communicate food safety principles to farm workers.

### **Literature Review**

Education about proper handling of fresh produce from farm to fork has been shown to prevent contamination on the farm, during packing, processing, distribution and within retail settings (Lynch et al., 2009). GAPs and the new Food Safety Modernization Act (FSMA) Produce rule, emphasize food safety controls with guidance for (1) agricultural water quality and testing; (2) biological soil amendments (raw manure and compost); (3) sprouts; (4) wild and domestic animals; (5) worker training and health and hygiene; and (6) equipment, tools, and buildings. It is recommended that all produce farm workers be trained on principles of food hygiene and food safety. This training should include how to identify food safety risks in the field and how to avoid cross contamination (FDA, 2015). Dzubak et al. (2015) found that food safety education in school and university settings can be a way to reduce risks of outbreaks.

Online education has become popular in the United States due to flexibility and convenience it offers to the user, its ability to promote individual learning, and the capability for shared accountability (Coyner and McCann, 2004). Berge and Leary (2006) found an increased trend in providing education in agriculture-related fields through eLearning technology. Researchers have tested the efficacy of food science training to change knowledge, attitudes, and behaviors of workers in the field through the use of technology. For instance, Mathiasen et al. (2012) developed training videos to improve knowledge of agricultural workers on food safety in a greenhouse setting, and found that 12-minute training videos in English and Spanish improved awareness of and reinforced GAPs principles while providing enjoyable learning experiences to greenhouse workers. The researchers also observed improved food safety behaviors among workers.

Ajzen (1991) developed a theory of planned behavior, and it states that attitudes shape behavioral intentions and actions. Relating this theory to food safety practices, Roberts et al. (2008) found that behaviors may change when attitudes, norms, and intentions of food workers are addressed. Thus, Chaifetz et al. (2012) found that improving knowledge on food safety resulted in attitude changes, which led to long-term changes in behavior. Shaw et al. (2015) also found that after completing GAPs educational courses, participating growers demonstrated improved knowledge and positive attitude changes toward food safety practices. This was manifested in self-reported behavior changes on their farms.

## **Methodology**

### **Development and Description of Online Curriculum**

A one-hour online food safety curriculum was developed to educate university farm workers about food safety hazards associated with growing and harvesting fresh produce. The food safety curriculum was divided into five separate segments (introduction and importance of training, pre-harvest and best practices prevention, post-harvest best practices and prevention, good handling practices and proper personal hygiene, and current regulations). Introduction and importance of training included overview of food safety risk associated with fresh produce, and overview of microbial hazards associated with farms and resources. Pre-harvest best practices prevention segment focused on water, soil, bio-solids, equipment/tool sanitation, and personnel practices from planting to harvest. The post-harvest best practices and prevention unit focused on the importance of good agricultural practices and good handling practices from harvest to consumer. The personal hygiene and cross-contamination risks segment addressed preventative measures to reduce risk of cross-contamination to fresh produce from workers, while the “regulations” section discussed regulations based on geographic location and specific distribution market with updated information on FSMA Produce Rule changes (Appendix).

The curriculum includes voice-over narration and video clips. Each section of the curriculum is less than ten minutes in length and accessed through the Iowa State University College of Agriculture and Life Science Safe Produce portal (<http://www.safeproduce.cals.iastate.edu/>). Activities were developed for each section with the aim of identifying food safety hazards at various stages of production and to improve workers’ hazard prevention techniques. A user manual was developed as a guide for the facilitator/supervisor to complement the online curriculum. The user manual included a glossary of terms, answer keys for activities and quizzes, additional references, and a complete script of the narration.

### **Validation of Curriculum**

An expert steering committee comprised of six individuals who interact directly with school, community, or university growers as part of their work reviewed and validated the developed materials. The committee had a wide range of expertise, including food safety, horticulture, food regulations, organizational and public policy, and school operations. Feedback and modifications were provided through oral and written means. After development and validation of the curriculum by the steering committee, a ten-question, multiple-choice quiz was developed for each section based on included content. The quizzes were reviewed for content validity by a convenience sample of university students who work on produce farms (n=3).

Approval was granted to pilot this curriculum at two land grant universities through the Institutional Review Board (IRB) in the Office of Responsible Research at Iowa State University (1/3/2014 IRB ID 13-598). An exemption to pilot the one-hour curriculum at the universities with a facilitator/supervisor present was given. Facilitators/supervisors provided additional feedback on layout, content, and suggestion for improvement after their workers completed the curriculum.

### **Statistical analysis**

University farm workers were given the quiz questions prior to and after viewing each of the curriculum sections. No individual identifiers were used as pooled data was analyzed. Quiz

results were collected by the facilitators/supervisors sent to the research team. Analysis was performed using SAS 9.3 to determine whether there were significant knowledge increases between all participants' pre-knowledge and post-knowledge quiz scores for each segment of the module. Comparison t-tests were performed to evaluate pre-knowledge and post-knowledge summary quiz scores for each segment of the curriculum used in university online trainings as well as determine whether differences existed between the two universities for each knowledge assessment. A 95% confidence was used to determine whether significant differences existed for quiz results between university farm workers before and after completion of the five sections of the curriculum.

### Results and Discussion

The study supports findings of previous studies, through comparison of pre- and post-curriculum knowledge based on mean quiz scores of farm workers at the two pilot universities ( $n_1 = 14$ ,  $n_2 = 11$ ; Table 1). A significant ( $p < 0.05$ ) knowledge increase was shown for each section of the developed material after viewing the curriculum, with the exception of one section. The section of the curriculum that showed no significant difference between pre- and post-knowledge mean quiz scores was personal hygiene practices and avoidance of cross contamination (all scores were 100% for all participants). These results can be explained by the established infrastructure at the two pilot universities with strict personal hygiene policies and developed standard operating procedures addressing cross-contamination risks.

Table 1. Mean percent of correct answers given in quizzes administered before and after viewing online food safety curriculum segments by groups of farm workers at two universities.

Section	Before Module Scores (n = 25)	After Module Scores (n = 25)
<b>Introduction/ Importance Of Produce Training</b>		
University 1 (n = 14)	98.21 <sup>Aa</sup>	100.00 <sup>Ab</sup>
University 2 (n = 11)	98.00 <sup>Aa</sup>	100.00 <sup>Ab</sup>
Composite *	98.12	100.00
<b>Pre-Harvest Best Practices</b>		
University 1 (n = 14)	94.71 <sup>Aa</sup>	100.00 <sup>Ab</sup>
University 2 (n = 11)	96.45 <sup>Aa</sup>	100.00 <sup>Ab</sup>
Composite *	95.48	100.00
<b>Post-Harvest Best Practices</b>		
University 1 (n = 14)	98.21	100.00 <sup>Ab</sup>
University 2 (n = 11)	97.73	100.00 <sup>Ab</sup>
Composite *	98.00	100.00

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**Table 1 continued**

**Personal Hygiene/ Cross-Contamination**

University 1 (n = 14)	100.00 <sup>Aa</sup>	100.00 <sup>Aa</sup>
University 2 (n = 11)	100.00 <sup>Aa</sup>	100.00 <sup>Aa</sup>
Composite	100.00	100.00

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**Regulations Associated With Fresh Produce**

University 1 (n = 14)	98.93 <sup>Aa</sup>	100.00 <sup>Ab</sup>
University 2 (n = 11)	99.27 <sup>Aa</sup>	100.00 <sup>Ab</sup>
Composite *	99.08	100.00

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**Note:** Asterisks (\*) indicate significance of knowledge changes ( $p < 0.05$ ) within composite groups (e.g., within same row).

-Different upper case letter superscripts (e.g., <sup>A,B</sup>) indicate significant differences ( $p < 0.05$ ) between knowledge quizzes between the two universities for the same assessment (e.g., within the same column).

-Different lower case letters superscripts (e.g., <sup>a,b</sup>) indicate significant differences ( $p < 0.05$ ) between scores within the same university for different assessments (e.g., within same row).

To explore if the two universities were different in the knowledge before and after viewing the modules, additional statistical analysis was conducted between workers at the two universities for pre- and post-knowledge gains for each section. There were no statistically significant differences ( $p > 0.05$ ) between the universities when results were compared by each segment of the curriculum (Table 1). These results were not expected as the two pilot universities are in different regional areas of the U.S. (Midwest and Northeast) with different acreage sizes and numbers of employees/students. The Midwest farm produces fruits and vegetables on 10 acres of land with 9 full-time employees and 30 student workers, while the Northeast farm produces fruits and vegetables on 5 acres with 4 full-time employees and 12 student workers.

Overall, in addition to improving knowledge of hazards in and around production areas, completing the developed curriculum may help change attitudes about, and subsequently, behaviors related to food safety practices. A change in behavior for farm workers could help reduce foodborne disease risk in harvested produce.

### **Conclusion**

Although this pilot study is limited to a relatively small sample, the data support inclusion of the online food safety curriculum in university farm trainings. The findings of the study suggest that online food safety trainings increase the knowledge of those working in a university farm setting. Inclusion of the online trainings to farm workers is one way organizations, such as universities and other research farms providing produce to consumers, can reduce the risks of foodborne illness to consumers, and mitigate threats from other farm hazards to workers. Further, the 24/7 availability of the online curriculum allows for training to occur at the convenience of the worker and at a time when the learner will be receptive to the material. In addition, online platforms, such as the food safety curriculum, which are available in the public domain, are a cost-effective

training tool. Future studies are suggested, and these studies should capture medium- and long-term effects of the food safety modules with larger samples of the targeted populations.

### **Acknowledgments**

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### **Appendix**

#### **List of topics covered in each segment of the curriculum**

##### Introduction and importance of training

- Overview of food safety risk associated with fresh produce
- Overview of microbial hazards associated with farms and resources

##### Pre-harvest best practices and prevention

- Water quality and safety
- Soil risks
- Biosolids and compost use
- Wildlife and domestic animals food safety risk
- Equipment, tools, and harvest bins sanitation
- Floods and food crop risks

##### Post-harvest best practices and prevention

- Sanitation of harvesting tools
- Recognition of spoiled produce
- Storage temperature controls
- Storage conditions
- Processing facilities sanitation and design
- Transportation

##### Personal hygiene and cross-contamination

- Hygienic Practices
- Illness symptoms to stay home
- Clean up of bodily fluids and disease transmission
- Hand hygiene
- Clothing, boots, and jewelry use
- Eating and drinking policies
- Appropriate glove usage

##### Regulations associated with fresh produce

- At-risk populations
- Resources for federal, statewide, and local regulations of fresh produce

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