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Good Agricultural Practices Training for Limited-Resource Produce Growers and Extension Educators

Abstract

We delivered to growers and Extension educators a workshop addressing good agricultural practices (GAP) for produce safety. To assess the workshop's effects as applicable to behavioral intervention theory, we studied past behaviors, behavioral intentions, and changes in knowledge. Workshop participants had been aware of but did not fully understand certain GAP, such as implementing written food safety plans; after the workshop, both groups reported improved understanding of various concepts. Producers were mixed regarding intent to make GAP-related changes after workshop participation, whereas the educators overall were likely to make changes related to teaching GAP. We concluded that producers need more training on GAP and Extension educators should develop programs accordingly.

Keywords: good agricultural practices, produce growers, Extension education, food safety, Food Safety Modernization Act

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Introduction

Fresh produce is enjoyed in many households in the United States. However, outbreaks of food-borne illness linked to fruits and vegetables can put those who enjoy fresh produce at risk of getting sick. The number of documented infections associated with the consumption of fresh produce has increased in the United States (Erickson, 2012; Sivapalasingam, Friedman, Cohen, & Tauxe, 2004). Due to the increasing number of outbreaks associated with fresh produce, the consumer is concerned over food quality and safety of fresh produce (Warriner, Huber, Namvar, Fan, & Dunfield, 2009). Food-borne illness is a significant public health burden that is preventable.

Produce safety requirements set by the Food Safety Modernization Act (FSMA) shift the focus from responding to contamination to preventing contamination in the nation's food supply (Food Safety Modernization Act, 2011). FSMA aims to improve the culture of food safety and enforces a culture change for most food systems. How do farmers and producers become aware of changes in food systems? As with many policies and technologies implemented in agriculture over the years, the Extension educator is a major part of the equation, and Extension education related to produce safety practices exists. However, because Extension influences changes in local food systems, Extension educators must work with producers to codiscover new realities beneficial for both consumers and producers (Raison, 2010). Therefore, to explore new methods for building an understanding of food safety

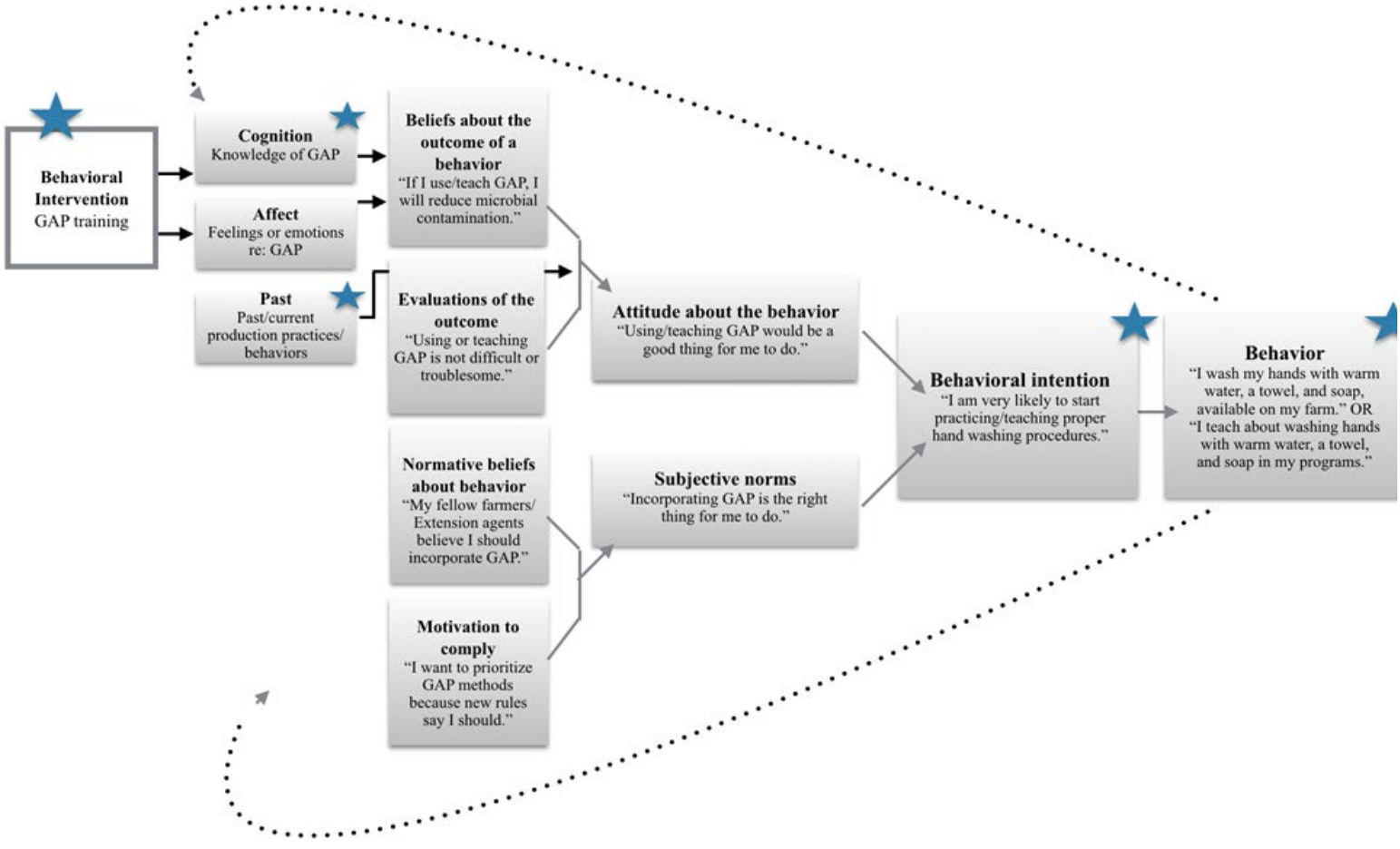
practices among produce growers and Extension educators, we developed a workshop targeted to both groups and based on behavioral intervention theory and then evaluated its effects on participants' intent to act and knowledge change related to the practices.

Theoretical and Conceptual Framework

We combined aspects of Fishbein and Ajzen's theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and Zanna and Rempel's conceptualization of attitudes (Zanna & Rempel, 1988) to form the theoretical framework supporting our study. The theory of reasoned action is a model that predicts human behavior (Fishbein & Ajzen, 2010). According to Fishbein and Ajzen (2010), attitudes, along with subjective norms, determine behavioral intentions, and those intentions determine the ultimate behavioral outcomes, which, relative to our study, involve producers' implementing good agricultural practices (GAP) prescribed by FSMA so that they remain compliant with efforts to provide a safe food supply. Zanna and Rempel's (1988) conceptualization of attitudes theory explains how attitude is developed from cognition (e.g., knowledge of GAP), affect (e.g., feelings and emotions related to GAP), and past behaviors. Figure 1 shows the conceptual model underlying our study; as designated by the stars on variables represented in the model, we designed our study to evaluate only cognition, past behaviors, and behavioral intention.

Figure 1.

Conceptual Model of Good Agricultural Practices (GAP) Behavior Change for Producers and Extension Educators



Note: Stars identify variables under investigation. Arrows represent how variables in the model relate to one another, and dotted lines indicate that changes in behavior may lead to further changes in knowledge and beliefs. Adapted from *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research* by Fishbein & Ajzen, p. 16. Copyright 1975 by Addison Wesley, Reading, MA.

Of variables related to future behavior, behavioral intention is most predictive (Godin & Kok, 1995), but intention is related to attitudes, which are affected by cognition/knowledge. The behavioral intervention GAP training we delivered to producers and Extension educators was applied to attitudes and cognition predictors of attitudes in our model. Ajzen (2011) espoused that applying a behavioral intervention to attitudes and their determinants (cognition/knowledge) is an effective method for creating behavior change. A limitation of our study was that we could not observe actual behaviors, but the power of the intention variable reduces this concern.

Purpose and Objectives

The purpose of our project was to train small- and medium-scale produce growers and Extension educators on the practical applications of GAP, thereby fostering improvements in produce safety. The specific objectives of the study were as follows:

1. Describe farmers' current produce production practices.
2. Explain farmers' intentions regarding adopting GAP.
3. Determine Extension educators' current teaching practices regarding produce production.
4. Explain Extension educators' intentions regarding teaching GAP in produce production.
5. Identify changes in farmers' and educators' knowledge of overarching aspects of GAP as a result of the educational intervention (a GAP workshop).
6. Describe actual behavior change through follow-up visits to select participant farmers.

Methods

Development of GAP Workshop and Associated Instruments

Prior to developing the GAP workshop, we selected 12 progressive produce growers—four growers from each Tennessee region (East, Middle, and West)—to form a focus group. From the focus group data, we planned the content of the GAP workshop. Questionnaires linked to focus group data were developed for producers and Extension educators. The reliability of the questionnaires was established by using the coefficient Cronbach's alpha value of 0.76 (Cronbach, 1951). Cronbach's alpha values of 0.70 or more are acceptable. The producer instrument addressed producers' existing production practices and their intentions regarding adopting GAP learned at the workshop. The educator instrument addressed educators' existing practices regarding the teaching of GAP content and their intentions regarding incorporating GAP information in their educational programs. Topics covered in the workshop were tied to rules for produce safety as stipulated in FSMA. Workshop presenters provided technical training intended to empower participants to meet the consumer demand for safe produce.

Produce Grower and Train-the-Trainer GAP Workshop

Preventing microbial contamination requires widespread education; therefore, we invited Extension educators in our 1890 Extension system and the producers they served to participate in the workshop. Educated Extension agents are in a position to teach many more producers about the FSMA standards and GAP than we could reach with one workshop. Four months after conducting the focus group research, we held a 2-day workshop for produce growers and Extension educators (Day 1) and Extension educators only (Day 2) at Tennessee State University. Table 1 lists the specific topics covered at the workshop.

Table 1.

Topics Taught During Two-Day GAP Workshop

Day	Topic
Day 1 (for producers and Extension educators)	Food Safety Modernization Act Economic importance of food-borne illness Production issues related to water Production issues related to soils Production issues related to human health Production issues related to hygiene Testing of agricultural water Hand washing Harvest and postharvest handling issues Traceability, recall, and record keeping Food safety plans and how to write them Audits
Day 2 (for Extension educators only)	Audits Adult learning styles Introduction to GAP Production issues (related to humans and animals, soil, water) Water quality testing Irrigation water directly applied Hand washing Traceability, recall, and record keeping Resources and activities, follow-up visits

Note. GAP = good agricultural practices.

At the end of the workshop, the questionnaires we had developed were administered to participants. Producers and educators answered yes or no to questions about whether they were engaging in or teaching specific GAP at the time of the workshop. To identify their intentions related to various GAP presented during the workshop, participants selected one of four possible responses on a summated rating scale: 1 (*very unlikely*), 2 (*unlikely*), 3 (*likely*), or 4 (*very likely*). The producer questionnaire asked about implementing the GAP (e.g., "How likely are you to implement a written food safety plan after today"; "How likely are you to make changes regarding wearing

gloves?"), and the Extension educator questionnaire asked about teaching the GAP in their educational programs (e.g., "How likely are you to teach about written food safety plans in your training?"; "How likely are you to now incorporate glove wearing in your trainings?").

We also implemented a retrospective "pre-post" model of survey research (Davis, 2003; Rohs, 1999) that involved a summated rating scale to determine changes in knowledge of seven overarching aspects of GAP as a result of the workshop. Growers and Extension educators were asked to indicate what their levels of awareness of these aspects of GAP had been before the workshop and what their levels of awareness of the aspects were after the workshop. The response set of the scale was as follows: 1 = *Not at all*, 2 = *Heard of it*, 3 = *Aware, but no understanding*, 4 = *Aware & understood*, and 5 = *Very aware & understood clearly*.

Follow-Up Visits

During a time period that was 4 months after the GAP workshop and 6 months into the growing season, Extension educators and food safety consultants visited individual farms to determine whether a written food safety plan had been implemented, what GAP had been implemented, and specifically how GAP had been implemented. Due to limitation of funds for the study, we followed up with only six farmers. Farm selection was based on whether the grower was progressive with regard to embracing recommended farming practices.

Results

The attendees of the workshop included 35 produce growers, 15 Extension educators, and six researchers. These attendees represented the convenience sample being studied. The majority of the respondents, 20 farmers and 10 Extension educators, returned completed questionnaires.

Farmers' Existing Practices and Intentions

Tables 2 and 3 show data related to farmers' practices before participating in the workshop and intent to apply GAP after the workshop. Farmers' implementation of GAP prior to attending the workshop was varied. For example, only 5% of respondents kept a written food safety plan, whereas 95% ensured that crop production areas and livestock production facilities were separated. Farmers were mixed as well with regard to their intent to apply GAP after participation in the workshop. Respondents were likely to develop a food safety plan but unlikely or very unlikely to make changes related to certain other GAP that they had not been implementing previously.

Table 2.

Percentages of Farmers Using GAP Associated with Fresh Produce Production Prior to GAP Workshop (*n* = 20)

GAP	%
Have a written food safety plan	5
Spin/dry produce	15
Test water annually	30
Avoid use of improper soil amendments (e.g., raw, partially treated, and treated manure)	30

Use gloves when handling produce	40
Use water/ice in direct contact with produce during harvest	40
Limit raw manure use to at least 2 weeks prior to planting and 120 days prior to harvest	45
Keep records for the farm	45
Make hand-washing facilities with warm water, soap, and towels available	55
Clean harvest/transport containers	65
Use cold water to wash produce	65
Wash produce after picking	70
Wash hands at appropriate times (before/after eating, smoking, visiting restroom)	80
Separate crop production areas and livestock production facilities	95

Note. GAP = good agricultural practices.

Table 3.

Farmer Intent to Make GAP Changes Associated with Fresh Produce Production After GAP Workshop (*n* = 20)

	Likelihood of changing	
GAP	***M***	***SD***
Implement a written food safety plan	2.90	1.44
Test water appropriately	2.20	1.91
Keep records	2.15	1.69
Wash picked produce	2.10	1.80
Use proper soil amendments	2.00	1.84
Spin/dry produce	1.95	1.61
Clean harvest containers	1.90	1.68
Use raw manure properly	1.75	1.77
Wear gloves	1.65	1.42
Incorporate hand washing facilities	1.60	1.60
Use appropriate water temperature	1.25	1.41
Properly use water/ice in direct contact with produce	1.10	1.21
Wash hands correctly	0.90	1.20
Separate production areas and livestock facilities	0.25	0.91

Note. GAP = good agricultural practices. Questions asked how likely participants were to

start implementing a behavior or change a behavior on the basis of what they learned in the workshop. Response options were 1 = *Very Unlikely*, 2 = *Unlikely*, 3 = *Likely*, 4 = *Very Likely*. In some circumstances, a participant may have responded as unlikely to change because he or she was already performing the desired behavior.

Extension Educators' Existing Practices and Intentions

Tables 4 and 5 display data related to Extension educators' teaching practices before participating in the workshop and intent to teach certain produce food safety information after the workshop. For half of the GAP topics, 50% or more of the Extension educators were addressing the topic prior to participating in the workshop. Overall, the educators indicated that they were likely or very likely to make teaching and curricular changes related to all the GAP topic areas.

Table 4.

Percentages of Extension Educators Teaching Selected GAP Topics Prior to GAP Workshop (*n* = 10)

GAP topic	**%**
Spinning/drying produce	0
Testing water	30
Washing produce after picking	30
Using water/ice in direct contact with produce	40
Keeping records	40
Managing crop production areas and livestock facilities	40
Using soil amendments	50
Using gloves while handling produce	50
Washing hands at appropriate times	50
Incorporating hand washing facilities	60
Cleaning harvest containers	60
Writing food safety plans	70

Note. GAP = good agricultural practices.

Table 5.

Extension Educators' Intent to Make Changes Related to Teaching Produce Food Safety GAP After GAP Workshop (*n* = 10)

	Likelihood of changing	
GAP topic	***M***	***SD***

Keeping records	3.83	0.41
Washing hands	3.71	0.49
Using water/ice in direct contact with produce	3.71	0.49
Writing food safety plans	3.63	0.52
Applying raw manure properly	3.63	0.52
Wearing gloves	3.57	0.53
Using soil amendments	3.50	0.54
Incorporating hand washing facilities	3.50	0.84
Cleaning picked produce	3.38	0.74
Testing water	3.33	1.32
Spinning/drying produce	3.20	0.63
Cleaning containers	3.13	1.36
Separating crop production and livestock facilities	3.12	0.75

Note. GAP = good agricultural practices. Questions asked how likely participants were to change their educational program to address desired behaviors on the basis of what they learned in the workshop. Response options were 1 = *Very Unlikely*, 2 = *Unlikely*, 3 = *Likely*, 4 = *Very Likely*. In some circumstances, a participant may have responded as unlikely to change because the participant was already addressing the desired behavior in his or her trainings.

Knowledge of GAP Before and After GAP Training

Producers' and Extension educators' knowledge of seven aspects of GAP addressed by the content of the workshop significantly improved from before the workshop to after it (Table 6). Not only were changes in participants' knowledge of the seven aspects of GAP significant, but the changes had a large effect size for nearly all items. The significance of the pre-post mean scores was determined by Cohen's *d* test (corrected effect size) (Table 6). Cohen's *d* values provided a way to estimate the actual size of observed differences in pre-post means, whether the differences were small, medium, or large.

Table 6.

Farmers' and Extension Educators' Knowledge of Overarching Aspects of GAP Before (Retro) and After (Post) GAP Workshop

	Producers (*n* = 20)					**Extension educators (*n* = 10)**				
	Retro		**Post**			**Retro**		**Post**		
Item addressing aspect of GAP	***M***	***SD***	***M***	***SD***	***d***	***M***	***SD***	***M***	***SD***	***d***

I am aware of what Good Handling practices implies.	2.90	1.59	4.30*	1.52	0.88	3.70	0.95	4.80*	0.42	0.32
I understand the implications of a foodborne diseases outbreak from farm produce.	3.35	1.50	4.25*	1.52	0.60	4.10	0.88	4.70*	0.48	0.68
I know that washing hands and hygiene is a good practice.	4.15	1.50	4.45*	1.54	0.20	4.50	0.53	4.90*	0.32	0.76
I know that keeping equipment and tools clean will reduce contamination of produce.	3.60	1.57	4.35*	1.57	0.48	4.20	0.79	4.90*	0.32	0.89
I know that using properly composited fertilizer reduces the chances of contamination of fresh produce.	3.50	1.61	4.35*	1.53	0.53	3.80	1.40	4.80*	0.42	0.71
I understand that water and manure could cause contamination of disease causing organisms at form levels.	3.20	1.71	4.40*	1.54	0.70	3.60	1.17	4.90*	0.32	1.11
I understand that a food	2.75	1.52	4.40*	1.54	1.09	3.20	1.14	4.90*	0.32	1.49

					safety plan is necessary for all farms (small and large).

Note. GAP = good agricultural practices. 1 = *Not at all*, 2= *Heard of it*, 3= *Aware, but not understanding*, 4= *Aware & understood*, 5= *Very aware & understood clearly*. *Retrospective and post means are significantly different, $p < .05$; Cohen's *d* effect size interpretation: 0.20 = small effect size, 0.50 = medium effect size, 0.80 = large effect size.

Follow-Up Visits

Four months after the GAP workshop, we visited six farmer participants from our workshop, evaluated their records, and found that four (66.6%) had made changes that would better prepare them to undergo a third-party audit in the future. Three of the farmers had begun using water that was tested and washing produce appropriately. Evidence of record keeping was found for all six farms as all of the farmers provided receipts of produce items that were purchased by customers and two of the farmers had implemented bar codes for traceability of their products. Producers also were taking steps to eliminate contamination from wild and domestic animals (e.g., using fake howling sounds, plastic snakes, electric fencing). However, some growers had not secured water sources, and there were a few signs of wild animal feces on the farms. Growers were reminded that contaminated water could facilitate food-borne outbreaks associated with fresh produce.

Discussion

Growers' limited familiarity with GAP implies a need for food safety education, which trained Extension educators should deliver. The intervention of the GAP workshop had significant impacts on cognition and intentions, which lead to new behaviors. Producers had limited knowledge of aspects of GAP prior to the workshop, but their knowledge improved to a large degree following the workshop. Extension educators had more knowledge prior to the workshop, but their scores improved too. The low rate of intention to separate production areas and livestock facilities probably related to the fact that participants already were practicing the desired behavior. An important takeaway is that Extension programming about food safety practices is effective in increasing knowledge and, therefore, more programs should be planned and delivered by Extension to make producers aware of and help them adopt GAP.

The most striking and undesirable results in our study related to lack of written food safety plans and limited testing of irrigation water. Future train-the-trainer activities conducted by Extension specialists and community-based programs for growers should focus on written plans and water testing. Additionally, few growers (30%) avoided using raw or partially treated manure; therefore, more education on the risks of using such soil amendments is recommended. Animal manure often contains zoonotic pathogenic bacteria (Gerba & Smith, 2005) that can be harmful to humans. For maximum effect, future GAP programs should highlight these and other dangers, not just the applicable GAP.

The FSMA Produce Safety Rule is final and institutes science-based minimum standards for the safe growing, harvesting, packing, and holding of fruits and vegetables grown for human consumption (U.S. Food and Drug Administration, Office of the Federal Registrar, 2016). Tobin, Thomson, LaBorde, and Bagdonis (2011) reported

that many local growers are concerned that meeting food safety policies will be overly demanding. Nevertheless, producers now must show evidence that they have implemented food safety plans on their farms. According to Holloway et al. (2007), many consumers prefer local foods or foods sold directly by producers. Due to these circumstances, there is a substantial need to empower small-scale produce farmers to meet government requirements and consumer demand for safe produce and to be competitive in the fresh produce industry.

The GAP workshop described herein better equipped Extension educators to train and assist farmers in their counties and to evaluate those clients' food safety practices on the farm. Educators gained knowledge needed to communicate the GAP information and assist in facilitating change toward practices that will lead to safer produce. Our conceptual model, shown in Figure 1, was supported when some of the actual GAP (behaviors) farmers said they would implement were observed during follow-up visits. Even though the follow-up visits were with a small number of producers, researchers and Extension educators should be encouraged by the positive results, which showed that participants were able to transform GAP information into action after a 2-day workshop.

Our *workshop and study* involved application of a theoretical and conceptual framework and evaluation of cognition, past behaviors, and behavioral intention, an approach that has not been used extensively with previous trainings. Our application of the theory of reasoned action and conceptualization of attitudes adds to the literature Extension professionals can use. In conclusion, we determined that producers need more training on GAP and that Extension educators should develop programs accordingly. The new agricultural marketplace requires produce growers to be not only aware of but also highly knowledgeable about food safety as it relates to their products, farms, and processing procedures.

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