Factors affecting growers' on-farm food safety practices: Evaluation findings from Penn State Extension programming

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A B S T R A C T

As a leading cause of outbreaks of foodborne illnesses, fresh produce has increasingly received national attention in the United States. In response, fresh produce growers are seeking to implement Good Agricultural Practices (GAPs) in order to maintain market viability. U.S. Cooperative Extension must fill a critical role to help growers appropriately adapt their on-farm food safety practices. In order to usefully serve produce growers, Extension must conduct evaluations that provide relevant information to foster program improvement. Using data collected among Pennsylvania growers who participated in Penn State Extension’s on-farm food safety programming, this study presents empirical evidence regarding the ways in which changes in growers’ GAP knowledge, attitudes, and skills affect the GAP tasks that they implemented. Findings indicate that increases in technical information among growers do not necessarily translate into their performing GAP activities. Other influences, such as farm size and a desire to contribute to the safety of the produce supply, help motivate growers’ decisions regarding their on-farm food safety practices. An understanding of the factors that determine growers’ GAP activities will better position Extension to adapt its programmatic approaches and content, as well as its evaluation frameworks, to best serve the diverse needs of fresh produce growers.

1. Introduction

As a leading cause of outbreaks of foodborne illnesses, fresh produce has increasingly received national attention in the United States. (DeWaal, Tian, & Plunkett, 2009; Doyle & Erickson, 2008; Sivapalasingam, Friedman, Cohen, & Tauxe, 2004). Fresh fruit and vegetable growers, consumers, university researchers and extension personnel, private businesses, and the federal government have all been participating in efforts to reduce the risk of microbial contamination. Additionally, both the public and private sectors are expecting fresh produce growers to adapt their on-farm food safety practices to comply with Good Agricultural Practices (GAPs). GAPs are a set of standards that help assure the safe production, harvesting, and handling of fresh produce (Food & Drug Administration, 1998).

As fresh produce growers seek to adhere to the food safety policies of their buyers and the regulations of the government in order to maintain market viability, U.S. Cooperative Extension must fill a critical role to help growers appropriately adapt their on-farm food safety practices and procedures (Eggers, Ackerlund, Thorne, & Butte, 2010; Tobin, Thomson, & LaBorde, 2012). The task for Extension to provide relevant educational programming to fresh produce growers is not easy. Uncertainty currently pervades the issue of on-farm food safety: “In response to public concern and market sensitivity, a nonsystematic array of fresh produce food safety educational programs, metrics, standards, rules and regulations...has emerged” (Parker, Wilson, LeJeune, Rivers, & Doohan, 2012, p. 108). As a result, growers and Extension alike are forced to navigate a situation riddled with overlaps and contradictions (Paggi, 2008; Parker, Wilson, LeJeune, Rivers, et al., 2012). Given this uncertain context, Extension must ensure that its food safety programming is usefully serving produce growers by conducting evaluations that provide relevant information to foster program improvement. The purpose of this research is to assess the degree to which on-farm food safety programming implemented by Penn State Extension is achieving its objectives and to identify factors that influence growers’ on-farm food safety decisions other than their access to technical information.

1.1. Background

In early 2011, President Obama signed into law the Food Safety Modernization Act (FSMA), which mandates the FDA to prescribe
produce growers who meet specific requirements will be exempt from compliance. Those growers who generate less than $500,000 in food sales annually and sell a majority of their produce directly to consumers or to restaurants or grocery stores either within state or within 275 miles of their farm if selling across state lines will be exempt. In addition, growers with food sales under $25,000, regardless of their sales outlets, will also be exempt (H.R. 2751-111th Congress, 2009).

Exemption from the FSMA does not mean that growers will not need to meet the food safety policies of the private sector (Palma, Ribera, Paggi, & Knutson, 2010; Ribera et al., 2012). In California and Arizona, produce growers and industry representatives have implemented their own Leafy Green Marketing Agreements (LGMA), which require participating producers of leafy greens to voluntarily verify their compliance with best food safety practices through third-party audits (Tobin et al., 2012). Currently, other states and commodity groups are contemplating similar arrangements, and a national leafy green agreement is also being considered (Ribera et al., 2012).

Private retailers, such as supermarkets, have also increasingly been implementing their own food safety policies that require their produce suppliers to provide evidence of compliance with GAPs (Palma et al., 2010; Ribera et al., 2012). In Pennsylvania, for example, supermarkets have indicated that their fresh produce suppliers increasingly will need to show their compliance with GAPs in order to maintain the business relationship (Tobin, Thomson, LaBorde, & Bagdonis, 2011). Varied supermarket policies mean that growers might need to provide different forms of evidence to maintain their various market outlets (Palma et al., 2010). While some supermarkets require growers to write a food safety plan for their operation, others insist that growers verify their on-farm food safety practices through third-party certification (TPC) (Tobin et al., 2011). TPC that verifies on-farm food safety practices is a process by which an independent auditor conducts an on-site inspection to determine whether a grower is adhering to GAPs (Hatanaka, Bain, & Busch, 2005). Some supermarkets even specify the audits that they will accept (Tobin et al., 2011).

Inconsistent requirements among supermarkets and unspecified government regulations combine to create a difficult environment for growers to anticipate the best ways to position themselves to maintain their market viability. Despite the uncertainty, a need still exists for growers to adhere to current and future requirements. The U.S. Cooperative Extension system is viewed by growers as a reliable source for GAP information (Eggers et al., 2010; Ivey, Lejeune, & Miller, 2012). Supported by federal, state, and local governments, Extension, which is based in each state’s land grant university, is mandated to provide non-formal educational opportunities and research-based information to citizens regarding issues related to agriculture and natural resources, family and consumer sciences, youth, and community development. Given this mission, along with growers’ expectations, Extension must work to provide up-to-date and relevant information regarding on-farm food safety, despite the uncertain environment. To do so, evaluation of food safety programming must be conducted and then utilized in order to adapt content and methods of presentation, as well as to address the needs and priorities of the producers who are most directly impacted by on-farm food safety policies. The evidence that emerges from systematic evaluations serves to indicate program strengths and limitations, identify ways in which programming can be improved, and help recruit new participants (Braverman & Engle, 2009; Radhakrishna & Relado, 2009).

1.1.1. Extension on-farm food safety programming

For over a decade, researchers have been investigating areas on which growers will need to focus in order to adhere to GAPs (Hultberg, Schermann, & Tong; 2012; Rangarajan, Pritts, Reiners, & Pederson, 2002). Most food safety programming is based on a knowledge-deficit model, in which a predetermined formula of information is transferred from experts to growers (Parker, Wilson, Lejeune, & Doohan, 2012). The knowledge-deficit framework of food safety programming is hardly surprising, given that traditional approaches to Extension programming have often assumed that access to expert knowledge will generate desired outcomes among end users (Foster, Norton, & Brough, 1995; Miller & Cox, 2006).

Common evaluation frameworks in Extension often follow a similar linear process. Assessing the degree to which gains in knowledge influence behavior changes is emphasized in Extension impact assessments (Clements, 1999; Jayaratne, Harrison, & Bales, 2009). One of the most common evaluation frameworks within Extension is Bennett’s Hierarchy, which outlines seven sequential steps that must exist in programming (Radhakrishna & Bowen, 2010; Workman & Shear, 2012). Inputs and resources (Level 1) are invested to implement activities (Level 2) which should encourage participation (Level 3) among the target audience. In a successful program, positive reactions (Level 4) will foster changes in knowledge, attitudes, skills, and aspirations (Level 5) leading to practice change (Level 6) and ultimately long-term impacts (Level 7) (Bennett, 1975).

Due to the complexity that on-farm food safety presents, evaluation framework models like Bennett’s Hierarchy may fail to account for key variables that determine on-farm food safety outcomes because these models are premised on top-down knowledge transfer. Providing technical information to an audience that does not utilize the knowledge fails to be an effective use of Extension resources (Clements, 1999). In the case of on-farm food safety, expert models that outline the primary areas that need to be addressed to reduce the risk of on-farm microbial contamination have overlooked important differences among growers, such as farm size (Parker, Wilson, Lejeune, & Doohan, 2012). Extension must also consider the various kinds of resources that different growers might need to adhere to GAPs. Although money is important, other valuable resources might also include time and educational support. For Extension to best serve the needs of all growers, their food safety outcomes must be assessed. Doing so requires that Extension also scrutinizes the appropriateness of the frameworks, such as Bennett’s Hierarchy, being utilized to evaluate its food safety programming.

The on-farm food safety educational programs of Penn State Extension offer an opportunity to assess the relationship between GAP knowledge, attitudes, and skills and GAP behaviors. Since 2009, Penn State Extension has been implementing educational workshops on on-farm food safety targeted at Pennsylvania produce growers. Most growers in Pennsylvania tend to have the diversified, small to medium-sized farms (USDA, 2009) likely to be most burdened by the resource demands required in order to adhere to private and/or federal on-farm food safety policies (DeLind & Howard, 2008). Based in Bennett’s Hierarchy, workshop content primarily consists of information related to the technical knowledge and skills that are necessary to implement GAPs. In addition, the content includes information related to the current regulatory environment in both the public and private sectors and the potential benefits growers can reap by adhering to GAPs. The goal of this programming is to provide growers with the necessary tools for them to take appropriate steps to properly implement GAPs. Given the current policies of private retailers and the coming regulations of the federal government, the long-term objective is for Pennsylvania growers to maintain their market viability.
The purpose of the research presented here is to study the factors associated with Pennsylvania growers’ behavior changes regarding GAP implementation. This study aims to also assess the appropriateness of using a program and an evaluation model based on a traditional Extension framework, Bennett’s Hierarchy. Through survey evaluation data, growers’ GAP behaviors were assessed according to their GAP knowledge, attitudes, and skills. The influence of farm size on GAP behaviors was also considered because of the prominent attention it has received from scholars (DeLind & Howard, 2008; Hatanaka et al., 2005; Parker, Wilson, LeJeune, & Doohan, 2012; Parker, Wilson, LeJeune, Rivers, et al., 2012). In addition, growers were asked to provide their reasons for either pursuing or not pursuing specific GAP activities. This research contributes to the understanding of the important factors that are driving grower decisions regarding GAP implementation. With this information, Extension will be better positioned to adapt its programmatic approaches and content, as well as its evaluation frameworks, to best serve the needs of growers of fresh produce in Pennsylvania and other states with similar conditions.

2. Methods

2.1. Population

In winter 2011, Penn State Extension advertised its intent to conduct eight one-day, 5-h GAP workshops in locations across the state through its publicly accessible website and through local Extension offices. The workshops were conducted from January through March, 2011. In total, 219 participants attended the workshops. During the workshops, 176 participants completed evaluations for a response rate of 80.3%. Six months after the completion of the workshops, all participants were invited to complete the same evaluation survey, although five cases were found to be missing at random reducing the census to 214. In total, 144 completed surveys were returned for a response rate of 67.1%. A difference in the number of respondents between the two survey sets exists because individual responses were not tracked between the evaluation surveys completed during the workshops and the delayed post-evaluation survey completed six months later.

2.2. Instrumentation

The evaluation survey was guided by the Bennett’s Hierarchy framework and intended to assess growers’ GAP knowledge, attitudes, skills, and behaviors. The survey also collected information related to farm size. Based on the literature, the survey was developed by three specialists in agricultural communication, agricultural extension, and food safety. True/false questions, 5-point Likert scales and close-ended questions (yes/no) were used to assess technical GAP knowledge, confidence in specific GAP skills, attitudes toward GAPs, and activities (behaviors) that growers had completed in the process of GAP implementation. Open-ended questions allowed growers to explain their reasons for performing or not performing those activities. Demographic questions focused on farm size, which was determined by using the exemption criteria for the FSMA. Growers who qualified for exemption were classified as small/medium and those growers who failed to meet the criteria were considered large. These criteria were deemed an appropriate proxy for farm size because the purpose of exemption from FSMA is to relieve smaller-scale farms from the regulation (Hassanein, 2011).

2.3. Data collection

To enhance rigor of evaluations, pre-tests, post-tests, and delayed post-tests should be administered to track changes in participants and to more convincingly assert that those changes are due to the programming (Radhakrishna & Bowen, 2010). At the workshops, workshop facilitators explained to the participants that they would be completing a paper survey immediately before the workshop, the same survey immediately after the workshop ended, and would receive the same survey as a follow-up in the fall after the 2011 growing season. The failure to track individual responses across the surveys presents a major limitation. Statistical comparisons that include changes in knowledge, attitudes, skills, and behaviors cannot be made without the risk of significant selection and nonresponse error. For the purposes of this study, therefore, descriptive statistics of all three evaluations were considered to indicate overall trends, but only the data from the delayed post-evaluation were used for inferential statistical analyzes. The data from the delayed post-evaluation were deemed most appropriate to use because it documented the actual actions that growers had taken regarding GAPs for the 2011 growing season.

To conduct the delayed post-evaluation, a mixed-mode approach was utilized in order to achieve acceptable response rates at a reduced cost (Dillman, Smyth, & Christian, 2009; Millar & Dillman, 2011). Those participants who provided an email address were electronically sent a pre-notice and subsequently an email with a link to a Web-based survey hosted by SurveyMonkey. Those who provided only a mailing address were sent a pre-notice followed by a paper survey via postal mail. Three weeks after the electronic and paper mailings of the first survey, all non-respondents were mailed a paper survey. This change in communication method for those initially contacted via email was completed because no assurance existed that emails were successfully delivered to inboxes or that participants opened the messages (Dillman et al., 2009). Ten days after mailing the replacement surveys, telephone calls were made to encourage non-respondents to complete and return the survey. The contact method was switched to telephone calls in order to contrast the previous online and postal mailing communication attempts (Dillman et al., 2009).

2.4. Data analysis

The quantitative data collected from all evaluation surveys were analyzed using SPSS software version 19.0. A variety of descriptive and inferential statistics were utilized in order to understand the relationship between the independent variables of farm size, GAP knowledge, attitudes toward GAPs, and confidence in technical GAP skills and the dependent variables of GAP activities. To analyze the open-ended survey questions regarding growers’ motivations for either performing GAP activities or not performing GAP activities, responses were coded line-by-line, which generated emergent themes that allowed the responses to be coherently classified (Emerson, Fretz, & Shaw, 1995).

Descriptive statistics were first utilized to track the trends of growers’ GAP knowledge, attitudes, confidence in skills, and behaviors. Answers to the ten true/false technical knowledge questions were summated and means were calculated. Confidence in GAP technical skills were measured using three Likert items asking growers to indicate their confidence (1 = Not at all Confident through 5 = Very Confident) in writing a food safety plan, conducting a self-audit, and applying for TPC. Writing a food safety plan entails growers documenting the ways in which they will implement GAPs in their operations. Conducting a self-audit requires that growers assess their actual practices according to GAP standards, and applying for TPC means that growers believe that their GAP implementation has achieved a level that would pass an audit by a third-party inspector. These particular skills were deemed by the food safety extension specialist as essential steps in the process of GAP implementation. The confidence scale was
summated after its reliability (Cronbach’s α = .91) was determined to be higher than the acceptable alpha score of α = .70 (George & Mallery, 2003).

Growers were also asked to respond to four attitude statements measured on a Likert scale (1 = Do not agree through 5 = Very much agree). These attitude statements related to grower perceptions of their responsibility to keep the produce supply safe, the financial benefits of adhering to GAPs, and their access to the support and resources they need in their effort to comply with GAPs. Descriptive analysis found that responses to two of the statements were severely skewed; meaning that only two individual attitude statements were considered. These two items were collapsed into three nominal categories (Disagree/Neutral/Agree) to facilitate data analysis and considered individually.

Growers’ GAP behaviors were measured using the same three activities that were used to measure confidence in skills. Using a multi-pronged measurement avoided the assumption that TPC was the only activity that indicated GAP implementation and thus recognized that different growers might use different strategies to achieve their own food safety goals and objectives (Parker, Wilson, LeJeune, Rivers, et al., 2012). The delayed post-evaluation asked growers to indicate (yes/no) whether they had completed each of the three activities. Given the scale of measurement, the responses were treated nominally and statistical tests were selected accordingly. Using the data from the follow-up evaluation, a series of bivariate analyses were utilized in order to assess the relationship between each of the independent variables and each of the GAP activities. Point-biserial correlations were used in order to analyze the relationship between knowledge and GAP activities as well as confidence in skills and GAP activities. Chi-squares were used in order to assess the relationship between farm size and GAP activities as well as attitudes and GAP activities.

In order to facilitate generalization to the entire census, 20 non-respondents were contacted two months after the completion of the delayed post-evaluation and asked questions on key variables. Statistical analyses were then conducted to assess whether differences existed between early, late, and non-respondents. No differences on key variables were found, allowing the findings to be generalized to the entire census (Radhakrishna & Doamekpor, 2008).

3. Results

3.1. Farm size and GAP knowledge, attitudes, skills, and behaviors

Descriptive statistics revealed that a nearly even split occurred among growers with small/medium and large operations. Among the growers who responded to the pre-/post-evaluation, 46.8% had small/medium operations, whereas 48.3% of growers who responded to the delayed post-evaluation had small/medium operations. These growers will likely be exempt from the FSMA when it is implemented. In terms of GAP knowledge, the trend indicated an overall increase in mean scores from the pre-evaluation. Mean scores could theoretically range from 0 (low knowledge) to 10 (high knowledge). Mean scores increased by 1.95 from the pre-evaluation to the post-evaluation, although knowledge decreased over the course of time. A comparison of pre-evaluation knowledge scores to delayed post-evaluation scores indicated that mean scores were only 0.97 higher six months after the workshop.

Although agreement for the attitude statement regarding the effect of a food safety audit on produce sales increased by 7.0% between pre- and post-evaluations, agreement decreased by 7.1% when comparing the delayed post-evaluation, to the pre-evaluation. For the attitude statement regarding the degree to which growers perceived that they had adequate resources to prepare for and pass a GAP audit, agreement increased by 46.2%

from the pre-evaluation to the post-evaluation. Although a decrease (24.1%) in agreement occurred between the post-evaluation and delayed post-evaluation, agreement on the delayed post-evaluation was still higher by 22.1% than on the pre-evaluation. A similar trend occurred for growers’ confidence in skills, in which mean scores for the delayed post-evaluation were higher by 2.49 than the pre-evaluation scores but lower by 1.83 than the post-evaluation scores. Mean scores for confidence in skills could range from a low of 3 to a high of 15. Table 1 presents the data related to farm size, knowledge mean scores, agreement with attitude statements, and means scores for confidence in skills.

Analysis of GAP behaviors revealed that a minority of respondents completed any of the three GAP activities. According to data from the post-evaluation, more growers wrote food safety plans than anticipated. Although only 15 growers indicated that it was likely they would write a food safety plan for the 2011 growing season, 39 growers reported completing the task on the delayed post-evaluation. Fewer growers, however, actually conducted a self-audit or applied for TPC than had planned to do so. Before the 2011 growing season, 112 growers indicated that they planned to conduct a self-audit, but only 48 growers accomplished the activity. Only 39 growers indicated that they would apply for TPC for the 2011 growing season, and even fewer (21) growers reported doing so on the delayed post-evaluation. Table 2 presents frequencies and percentages related to growers’ GAP behaviors.

3.2. Relationship between farm size and GAP actions taken

In order to assess the relationship between growers’ farm size and the GAP actions (writing a food safety plan, conducting a self-audit, applying for TPC) that they had taken for the 2011 growing season, Chi-square tests were used for analysis. In each case, no significant relationship was found. Based on the results, farm size did not influence growers’ likelihood to write a food safety plan, conduct a self-audit, or apply for TPC.

3.3. Relationship between GAP knowledge and GAP actions taken

Point biserial correlations indicated that while no significant relationship existed between knowledge and the GAP activity of

<table>
<thead>
<tr>
<th>Variable and level</th>
<th>Pre-evaluation N (%)</th>
<th>Post-evaluation N (%)</th>
<th>Delayed post-evaluation N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small/Medium</td>
<td>81 (46.8)</td>
<td>56 (48.3)</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>92 (52.3)</td>
<td>60 (51.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>173 (100.0)</td>
<td>116 (100.0)</td>
<td></td>
</tr>
<tr>
<td>Knowledge*</td>
<td>6.69 (M), 1.46 (SD)</td>
<td>8.64 (M), 1.24 (SD)</td>
<td>7.66 (M), 1.47 (SD)</td>
</tr>
<tr>
<td>Preparing for a food safety audit</td>
<td>13 (8.2)</td>
<td>5 (3.1)</td>
<td>30 (22.9)</td>
</tr>
<tr>
<td>Disagree</td>
<td>35 (22.0)</td>
<td>16 (10.1)</td>
<td>32 (24.4)</td>
</tr>
<tr>
<td>Neutral</td>
<td>111 (68.9)</td>
<td>138 (86.8)</td>
<td>69 (52.7)</td>
</tr>
<tr>
<td>Agree</td>
<td>159 (100.0)</td>
<td>159 (100.0)</td>
<td>131 (100.0)</td>
</tr>
<tr>
<td>I have adequate resources to prepare for and pass a GAP audit</td>
<td>49 (31.0)</td>
<td>6 (3.8)</td>
<td>22 (17.1)</td>
</tr>
<tr>
<td>Disagree</td>
<td>57 (36.1)</td>
<td>27 (17.1)</td>
<td>36 (27.9)</td>
</tr>
<tr>
<td>Neutral</td>
<td>52 (32.9)</td>
<td>125 (79.1)</td>
<td>71 (55.0)</td>
</tr>
<tr>
<td>Agree</td>
<td>158 (100.0)</td>
<td>158 (100.0)</td>
<td>129 (99.0)</td>
</tr>
<tr>
<td>Confidence in skills</td>
<td>7.78 (M)</td>
<td>12.10 (M)</td>
<td>10.27 (M), 3.56 (SD) 2.11 (SD) 3.20 (SD)</td>
</tr>
</tbody>
</table>

* Farm size was measured only once on the pre- and post-evaluations. Given that growers completed the pre- and post-evaluation during the workshops, no need existed to collect the data twice.

1 Mean scores of knowledge could theoretically range from 0 to 10.
2 Mean scores of confidence in skills could theoretically range from 3 to 15.
writing a food safety plan, significant, low, positive relationships ($p < .05$) existed between knowledge and conducting a self-audit ($r = 0.22$) as well as knowledge and applying for TPC ($r = 0.19$) (Table 3). Despite the significance, a correlation ($r = 0.25$) translates to a weak relationship (Fink, 1995).

### 3.5. Relationship between confidence in GAP skills and GAP actions taken

Significant relationships ($p < .01$) existed between growers' confidence in their GAP skills and their GAP behaviors. Significant, low to moderate correlations were found between confidence in skills and writing a food safety plan ($r = 0.30$) as well as confidence in skills and conducting a self-audit ($r = 0.34$) (Fink, 1995). A weak relationship existed between confidence in skills and applying for TPC ($r = 0.24$). Table 5 presents the results for the point biserial correlations.

### 3.6. Growers' motivations for pursuing GAP activities

An open-ended question on the delayed post-evaluation asked growers who had completed any of the GAP activities to indicate their reasons for doing so. In total, 37 participants responded to the question. Coding indicated that customer requirements provided the most prevalent motivation for growers to pursue GAP activities. Of the 37 respondents, 21 (56.8%) indicated that external expectations of evidence of GAP compliance from the outlets to which they sold provided the incentive to take action. Of these 21 respondents, 17 (76.2%) indicated that their customers currently require evidence of GAP adherence. For example, "My buyer said I needed to do it if I plan to continue to sell to him." While current requirements provided the most common motivation, four growers took action because they anticipated coming requirements from customers: "I think a GAP audit will soon be required by the grocery chain I sell to. I am trying to be proactive instead of reactive."

While customer requirements were the primary motivation for taking action, other growers were motivated to contribute to the safety of the food supply. As opposed to feeling external pressure to implement GAPs, 8 of the 37 respondents (21.6%) indicated the intrinsic desire to deliver a safe product and protect consumers of their produce. For example, one grower responded, "I feel these practices make sense; I want my product to be safe to the public. It is more important than making money, that my customers are safe." Another respondent explicitly recognized that because growers fill a crucial role in the produce supply chain, they must take the necessary steps to ensure produce safety: "Realizing farmers are responsible for safe foods."

### 3.7. Growers' motivations for not pursuing GAP activities

Among the growers who had not completed any of the GAP activities, 43 of 50 respondents (86.0%) indicated in the open-ended portion of the survey that doing so simply was not necessary. Growers provided several reasons for their perception of not needing to implement GAPs. Providing a counter to the growers who completed GAP activities due to customer requirements, eight respondents indicated that they were not taking action because their buyers currently did not require it: "Don't yet see the need. My customers don't demand it." Another 12 growers, alluding to the FSMA, explained that the small scale of their farms placed them in a situation in which following GAPs is not necessary. For example, one grower responded, "The scale of the farm operation does not warrant it" while another grower explained, "We don't qualify because our sales are way below the requirement." Eight other respondents pointed to another element of FSMA exemption, indicating that their reliance on direct marketing channels made GAP implementation unnecessary: "We sell directly to consumers and wholesale to small co-ops. At this point I do not think it is necessary for us to become GAP certified." Seven respondents indicated that following GAP protocol was not necessary because they already had their own systems to monitor the safe production of produce. As one grower explained, "Don't feel it is necessary at this time. Our quality control standards are pretty good." Another grower indicated that external policies and regulations made practices that growers were already doing burdensome and redundant: "During my daily work on the farm I know what needs [to be] done pretty well, no need for a paper self-audit. Less paperwork = better life.

Lack of resources was another theme that emerged from analysis regarding reasons why growers are not completing GAP tasks. Among the 50 respondents, 16 (32.0%) indicated that they did not feel like they were currently in a position to successfully implement GAPs. Of these 16 respondents, 7 explained that the intensity of farm work did not leave sufficient time to complete GAP activities:
Table 4
Chi-square tests for attitude statements and GAP actions taken.

<table>
<thead>
<tr>
<th>Attitude statement</th>
<th>Write a food safety plan (%)</th>
<th>Cramer’s V</th>
<th>Conduct a self-audit (%)</th>
<th>Cramer’s V</th>
<th>Apply for TPC (%)</th>
<th>Cramer’s V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing for a food safety audit to help my farm maintain produce sales</td>
<td>No (N = 131)</td>
<td>Yes (N = 130)</td>
<td>No (N = 129)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>27.2</td>
<td>12.8</td>
<td>4.88</td>
<td>0.19</td>
<td>29.3</td>
<td>12.5</td>
</tr>
<tr>
<td>Neutral</td>
<td>26.1</td>
<td>20.5</td>
<td>(2)</td>
<td>25.6</td>
<td>20.8</td>
<td>(2)</td>
</tr>
<tr>
<td>Agree</td>
<td>46.7</td>
<td>66.7</td>
<td></td>
<td>45.1</td>
<td>66.7</td>
<td></td>
</tr>
<tr>
<td>I have adequate resources to prepare for and pass a GAP audit</td>
<td>No (N = 129)</td>
<td>Yes (N = 128)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>20.9</td>
<td>7.9</td>
<td>12.44**</td>
<td>0.31</td>
<td>23.2</td>
<td>6.4</td>
</tr>
<tr>
<td>Neutral</td>
<td>34.1</td>
<td>13.2</td>
<td>(2)</td>
<td>27.3</td>
<td>27.7</td>
<td>(2)</td>
</tr>
<tr>
<td>Agree</td>
<td>45.1</td>
<td>78.9</td>
<td></td>
<td>49.4</td>
<td>66.0</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at p < .05.
** Significant at p < .01.

“I probably won’t unless it is mandatory because I don’t have the time to do the lengthy process.” Four other growers focused primarily on the financial burden of GAP implementation: “I would need more than one audit yearly for the crops I have – costs too much.” A lack of knowledge and skills was the primary concern of another five respondents: “I feel I do not have enough training yet to feel comfortable in doing any of the [GAP activities].” The belief that insufficient resources were available to successfully adhere to the complex GAP policies and regulations was detailed by another grower, who suggested that materials needed to be adapted to growers’ needs: “Feels daunting and unclear. Don’t have time to put much time/resources toward it. Need a clear and concise step by step manual to follow – or at least that would make it more approachable.”

4. Discussion

Evaluation findings indicate that Penn State Extension’s food safety programming is accomplishing its objectives by improving participants’ GAP knowledge, attitudes, and skills. From the perspective of Bennett’s Hierarchy, the Penn State GAP educational workshops can claim some success. Although the failure to track individual responses from the pre- and post-evaluation to the delayed post-evaluation prevents definitive conclusions, the descriptive statistics provide preliminary evidence that long-term changes in participants’ knowledge, attitudes, and skills were due to the workshops. Increases in knowledge, attitudes, and confidence in skills appear to have occurred except for the perception that an audit would help maintain produce sales. Less success appears to have been achieved when considering the programming objective of behavior change. Writing a food safety plan was the only activity in which more growers actually performed the task than had indicated they would. The delayed post-evaluation indicated that only 48 respondents had conducted a self-audit, although 112 had initially indicated they would so do. In terms of applying for TPC, only 16.2% of respondents had done so, the activity that many supermarkets have already or will soon require in order to have evidence that their produce suppliers are adhering to GAPs (Hatanaka et al., 2005; Tobin et al., 2011).

Bennett’s Hierarchy outlines that changes in knowledge, attitudes, and skills should lead to changes in practice (Bennett, 1975). Initial analysis provided by the descriptive statistics offered evidence that changes in behavior were not typically occurring when participants experienced changes in knowledge, attitudes, and skills. Bivariate analyses provided limited support for the assumptions of Bennett’s Hierarchy. Weak significant correlations existed between knowledge and two of the GAP activities, and moderate relationships existed between confidence in skills and all three GAP activities. The importance of technical knowledge and skills was reinforced by growers’ responses in open-ended questions. Several growers perceived that they still lacked the technical ability to implement GAPs, despite their participation in the GAP workshops. The perception among growers that they are still not technically prepared to comply with GAPs is hardly surprising, given the uncertainty that they confront regarding public and private on-farm food safety policies. Given these findings, technical knowledge and skills can be understood as important components of programming. However, a knowledge-deficit approach would have limited impact since other important factors, including farm size, use of diverse marketing channels, and growers’ personal goals and objectives, that motivate growers’ GAP behaviors would remain unaddressed (Parker, Wilson, LeJeune, Rivers, et al., 2012).

Evidence regarding growers’ attitudes toward GAPs varied. For all three activities, growers who agreed that they had adequate resources were significantly more likely to perform the GAP tasks. This finding not only aligns with Bennett’s Hierarchy but also with the assertion by Ivey et al. (2012) that growers’ attitudes and perceptions are essential to understand in order to develop relevant educational materials. Because GAP behaviors are more likely to change when growers believe resources are available and accessible, Extension must assess the communication outlets and methods that growers prefer (Parker, Wilson, LeJeune, Rivers, et al., 2012). Future studies should further investigate the types of resources that growers perceive are important in order to follow GAPs. Educational support offers one type of resource to growers, but time and money are other important resources that must be considered separately, especially since they both have been identified as significant barriers for growers to comply with GAPs (DeLind & Howard, 2008; Eggers et al., 2010; Hatanaka et al., 2005). Findings from open-ended responses from this study confirm that growers perceive financial and time burdens as a deterrent to verify GAP compliance. Developing materials that guide growers through the process in ways that conserve time and cost, therefore, will be essential for Extension programming to pursue.

Table 5
Point biserial correlations between confidence in GAP skills and GAP actions taken.

<table>
<thead>
<tr>
<th>GAP activity</th>
<th>Prepare a food safety plan (N = 128)</th>
<th>Conduct a self-audit (N = 127)</th>
<th>Apply for TPC (N = 127)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence in skills</td>
<td>0.30*</td>
<td>0.34*</td>
<td>0.24*</td>
</tr>
</tbody>
</table>

*Significant at p < .01.
Scant evidence was found linking growers’ attitudes related to the financial benefits of adhering to GAPs with completing GAP activities. This finding is hardly surprising, given that analyses of costs and benefits of GAP implementation are difficult to conduct (Ribera et al., 2012). Growers, therefore, have little verification to believe that confronting the burdens that GAPs present translate into financial benefits. Without discernable advantages, growers have little reason to proactively take the necessary steps to comply with GAPs. Growers explained their passivity in their open-ended responses, in which they indicated that the primary reason that they did not complete GAP activities was that no mandate existed for them. Conversely, the most prevalent reason that growers performed GAP tasks was due to the external requirements of their buyers. Given these results, growers appear to most commonly take action when they are required to do so rather than due to any positive attitude they hold about the benefits of GAPs. However, as indicated by the open-ended responses, some growers are motivated to adhere to GAPs based on the intrinsic desire to contribute to the safety of the food supply. Continuing to make growers aware of the ways in which on-farm food safety can help reduce the risk of microbial contamination is important to emphasize in educational programming. This strategy appeals to growers who are intrinsically motivated to contribute to the safety of the produce supply.

When considering the conclusions presented from this research related to attitudes, the findings of this study should be tested in future studies, for two individual Likert items are insufficient to come to any definitive conclusions. Comprehensive attitude scales measuring growers’ perceptions of barriers and benefits of GAPs should be utilized in order to collect robust data.

While this study’s intent was to assess the degree to which relationships exist between the independent variables of GAP knowledge, attitudes, and skills and the dependent variables of on-farm food safety practices, it also considered farm size, given the attention farm scale has received from scholars (DeLind & Howard, 2008; Hatanaka et al., 2005; Parker, Wilson, LeJeune, & Doohan, 2012; Parker, Wilson, LeJeune, Rivers, et al., 2012). The government also recognized the importance of farm size when it included an exemption to the FSMA which intends to target smaller-scale growers (Hassenein, 2011). Using the criteria for the FSMA exemption, this study assessed whether growers were more likely to perform GAP activities based on their farm size. Although quantitative analysis found no variance, open-ended responses indicated that farm size does influence grower decisions regarding GAP activities. When explaining reasons for not completing GAP activities, most growers cited doing so was not necessary, commonly noting that the size of their farm and reliance on direct marketing outlets exempted them from federal regulation and allowed them to avoid private governance requirements. The discrepancy in findings between the quantitative and qualitative analyses is likely due to the ambiguity of using the FSMA criteria to measure farm size. Exemption from the FSMA does not mean that growers do not utilize markets that have GAP requirements in place. Multi-pronged measurements that determine both exemption from the FSMA and engagement in private markets that commonly require GAP adherence would offer more precise and comprehensive indicators for farm size.

5. Conclusions

The findings from this study offer little support for the assumption that a linear process exists between the increase of technical knowledge and skills and a change in on-farm food safety practices. Although Bennett’s Hierarchy includes the importance of attitudes and aspirations, the issue of produce safety presents a level of complexity beyond the scope of the framework. More intricate models need to be introduced to account for the array of factors that influence growers’ decisions regarding GAPs. Parker, Wilson, LeJeune, Rivers, et al. (2012) came to a similar conclusion when they argued that the knowledge-deficit model that currently predominate the issue of food safety overlooks important differences among growers. Extending beyond the transfer of expert knowledge, Parker, Wilson, LeJeune, Rivers, et al. (2012) proposed one viable framework that includes growers’ current knowledge, preferred communication outlets and methods, scale of operation, social and cultural factors, public and private mandates, and growers’ own goals and objectives. Given the multi-dimensionality of this framework, growers need to more actively engage in selecting and implementing appropriate food safety practices for their particular operations (Parker, Wilson, LeJeune, Rivers, et al., 2012). Growers who are not exempt from the FSMA or private retailer policies will likely need to document their on-farm food safety practices. Those growers who are exempt will likely need less emphasis on documentation and more focus on simply implementing specific best practices, such as water testing or safe manure-based composting, to assure safe produce.

More complex models for food safety programming do not mean that knowledge, attitudes, and skills should lose their importance. Technical information will continue to be crucial to convey to growers as they are increasingly required to adhere to the FSMA and meet the policy requirements of private retailers. Growers who do not have sufficient educational resources will be ill-equipped to meet public and private expectations. However, given the diversity of growers’ farm sizes and marketing arrangements, growers have different needs related to GAPs, meaning that Extension must build flexibility into its programming. While some growers will likely need to verify their GAP compliance through TPC, others might find writing a food safety plan or participating in training to be adequate for their purposes. As a starting point, Extension must develop multi-pronged classifications of growers in order to determine whether they are exempt from the FSMA, private retailers’ requirements, or both.

Growers who are compelled to adhere to GAPs because of public regulation or private requirements will likely need more emphasis on technical knowledge and skill. To target growers who sell to private retailers that require evidence of GAP compliance, Extension can provide on-farm food safety training in conjunction with those private retailers. Partnerships with retailers will allow Extension to adapt its programming to the specific policies of the particular retailer. This type of flexibility is particularly important since food safety requirements can vary by retailer (Tobin et al., 2011). Training growers to prepare for a particular audit that is not accepted by the retailer will not serve those growers well and is not an effective use of Extension’s resources.

For growers who are exempt from the FSMA and do not sell to retailers that require evidence of GAP compliance, a different programming approach is required. Based on the findings from this study, growers are not likely to proactively engage in GAP activities unless compelled to do so. An emphasis on technical knowledge and skills is not likely to serve these growers well. In order to encourage these growers to take actions that will help reduce the risk of on-farm microbial contamination, more emphasis on background information related to common on-farm food safety risks and potential benefits of on-farm food safety practices is appropriate. A greater focus on the threat of microbial contamination at the farm level is useful to help growers understand that they have an important role to contribute to the effort to enhance the safety of the produce supply. Since these growers will likely have diverse needs, they will need to become increasingly active in order to determine the most appropriate steps for their own particular operation, meaning that measuring CAP behaviors solely based on writing a food safety plan, conducting a self-audit, and applying for TPC is not likely appropriate. Instead, Extension programming can
incorporate activities in workshops that encourage growers to consider their current on-farm food safety practices, farm size, marketing outlets, and personal goals and objectives to select the best strategy for their particular case. Extension should then use these individualized aspirations as the basis for comparison when follow-up evaluations are conducted.

Given the coming implementation of the FSMA and the increasingly common on-farm food safety requirements of private retailers, growers’ needs regarding GAPs will likely intensify in the coming years. Unspecified government regulations and varied private policies create uncertain conditions for growers and make it difficult for Extension to provide relevant support to growers statewide. To navigate this unsettled atmosphere, Extension must engage in the complexity by incorporating more comprehensive theoretical frameworks in its program design, delivery, and evaluation. Traditional Extension models that assume that the transfer of technical information will result in desirable outcomes must be adapted to recognize the diversity of growers’ needs. Different populations of growers will require different kinds of programming. Extension must spend the time and resources upfront in the form of needs assessments to determine the kind of content that best suits these various subgroups, and then conduct evaluations that account for both short-term and long-term impacts. Assuming that all growers need to pursue the same strategy to meet their on-farm food safety objectives and goals will waste valuable Extension resources and will risk failing to best serve growers.

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