

## PEER-REVIEWED ARTICLE

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# Growers' Awareness of On-Farm Conservation and Food-Safety Co-Management Practices in the Southeastern United States

## ABSTRACT

This study evaluated the level of awareness of growers in the Southeastern U.S. regarding the on-farm co-management of conservation and food safety practices through a survey of 104 participants. Most respondents operated farms primarily in Georgia, employing conventional and mixed farming methods. Key findings indicated that prevalent food safety practices included deterrents for animal intrusion (60.4%) and partial vegetation removal from ditches or farm ponds (32.2%). For conservation, practices such as crop rotation (71.4%) and integrated pest management (59.3%) were prevalent. Principal Component Analysis demonstrated differences in management practices based on farming methods, with conventional and mixed growers engaged in a broader range of practices to address food safety and conservation. Notably, 21.1% of growers perceived a conflict between food safety and conservation, and nearly 60% were unaware of USDA conservation programs. These results highlight the challenges in integrating these practices and the need for improved awareness and

support from local authorities. The findings also reveal a communication gap between the USDA and growers, emphasizing the need for targeted marketing campaigns to outreach understanding and participation in available conservation initiatives.

## INTRODUCTION

The Centers for Disease Control and Prevention (CDC) estimates that nearly half (46%) of foodborne outbreaks in the United States are attributed to contaminated fresh produce (1, 3). These illnesses have emerged as a significant public health concern and have led to thousands of illnesses, hospitalizations, and even deaths over the past two decades (2). Large multistate outbreaks have been linked to produce in the past few years, mostly due to cross-contamination and poor agricultural practices in the field (1). To minimize the impact of these outbreaks on public health and improve the safety of food during growing, harvesting, and processing, in 2011, the U.S. Food and Drug Administration (FDA) established the Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption,

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or Produce Safety Rule (PSR), as a part of the Food Safety Modernization Act (FSMA) (8). The PSR includes mandatory key requirements regarding the microbial quality of agricultural water and soil amendments; management of wildlife and domesticated animals; hygiene requirements and training for workers; and cleaning and sanitation requirements for equipment, tools, and buildings. The rule also highlights the importance of balancing on-farm food safety and conservation practices to minimize food safety risks (7). However, limited information is provided in the regulation regarding conservation practices that also promote food safety.

Conservation practices on the farm are known to increase local biodiversity and ecosystem services (5), promote agricultural sustainability (16), and mitigate the effects of drought and flood from climate change (23). They also play an essential role in reducing food safety risks (11). Previous studies have demonstrated that removing or replacing vegetation areas can increase the prevalence of pathogenic microorganisms in produce fields (11, 12, 18). In 2006, a multistate *Escherichia coli* O157:H7 outbreak was linked to pre-packaged spinach from a California farm (2). Even though the source of the contamination was not determined, the same bacterial strain was found in fecal samples from wild hogs in the surrounding area, which at the time increased pressure on growers to control wildlife intrusion into produce fields. As a result, rapid removal of vegetation around produce fields occurred over the next five years to reduce food safety issues associated with wildlife (9). However, a further study conducted in the same area demonstrated that pathogen prevalence increased on most farms despite vegetation clearing at the farm field margins (11). This may be because vegetation removal eliminated the natural barrier, slowing wind and water movement across the field, which could be carrying contamination. Additionally, the vegetation may have been serving as a habitat, and its removal drove wildlife into fields.

Over the years, to support the co-management of conservation and food safety practices on the farm, the United States Department of Agriculture (USDA)-National Resources Conservation Service (NRCS) has established voluntary conservation programs, such as the Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP), to assist growers in optimizing agricultural practices that advance conservation. These programs offer technical services and financial support for agricultural producers. The USDA Farm Service Agency (FSA) administers the Microloan Program to focus on financing small farms and operations. While not an expressed goal of the program, producers are able to use the fund to gain consultation advice to evaluate the current farm management of natural resources. Additionally, the FSA administers a program to assist with the costs associated with food safety certification of produce crops. The National

Organic Program (NOP) from the USDA Agricultural Marketing Service (AMS) provides a path for growers to receive a market incentive for using environmentally friendly production and processing practices (19, 21). Despite the multitude of programs available to assist growers with implementing conservation practices or food safety practices, the lack of information on integrating these practices creates uncertainties among growers, influencing their decision-making.

This investigation aimed to estimate the awareness of growers and producers related to on-farm co-management of conservation and food safety. Also, it aimed to identify educational deficiencies and knowledge gaps among growers in the Southeastern United States to develop strategies to better address and incorporate those practices into the farm plan.

## MATERIALS AND METHODS

### Survey design and distribution

The survey was designed to estimate awareness regarding on-farm food safety and conservation practices and the awareness and usage of USDA programs currently available to assist growers in the Southeastern United States. The survey was approved for use with human subjects by the University of Georgia IRB PROJECT00000044. To protect participants' confidentiality, the survey responses were collected anonymously and distributed online or in a traditional "pen and paper" format. The online survey was distributed using the Qualtrics Survey Software (Qualtrics; Provo, UT; <http://www.qualtrics.com>). Data collection occurred from December 13, 2020, through July 23, 2021. During this period, the survey link was shared biweekly via email through the Listserv of local fruit and vegetable growers associations. Participants were also recruited via targeted email to previous training and workshop attendees. The survey was distributed during produce safety training, food safety workshops, and grower events, further ensuring that only those involved in growing fresh produce were invited to participate. To improve response rates and minimize response bias results, questions in the online version were set as "non-mandatory" to allow participants to skip questions if needed to move through the survey. The survey consisted of 19 questions, including multiple-choice, rating scale, and open-ended questions. Key questions included the geographical location of the farm and type/size of business, on-farm management practices on food safety and conservation, growers' awareness of most common federal conservation programs and local authorities, and information sources for food safety and conservation practices. Demographic information about survey participants was also collected.

### Data analysis

The survey responses were manually coded by assigning a unique number to each potential answer, and then these

**TABLE 1. Demographics of survey respondents (n = 104)**

Characteristics	Frequency	%
<b>Gender</b>		
Male	46	44.2
Female	36	34.6
Did not specify	22	21.2
<b>Age, yr</b>		
<18	0	0.0
18–24	5	4.8
25–34	23	22.1
35–44	12	11.5
45–54	17	16.3
55–64	15	14.4
65–74	8	7.7
75+	1	1.0
Did not specify	23	22.1
<b>Ethnicity</b>		
White	55	52.9
Black or African American	10	9.6
Asian	1	1.0
Native Hawaiian or Pacific Islander	1	1.0
Latino/Hispanic	8	7.7
Did not specify	29	27.9

codes were entered into a multivariate Excel spreadsheet (Microsoft® Excel®, Microsoft 365 MSO, version 2302). The PivotTable tool in Excel was used to calculate, summarize, analyze, and identify patterns and trends in the growers' responses to each question.

A principal component analysis (PCA) was performed in RStudio software (v. 4.2.1) using the *prcomp* function in the FactoMineR package as exploratory data analysis to identify the relationship between farming methods and the management practices used by farmers to address food safety and conservation concerns in the previous five years. The frequencies of farmers' responses related to the management practices for each farming method were used as the data for PCA.

## RESULTS

### Survey respondents

A total of 104 participants responded, with an estimated 3.6% of response rate. Demographic data is presented in

*Table 1*. The majority of respondents self-identified as male (44.2%) or female (34.6%), while 21.2% did not specify their gender identification. Respondents represented a wide range of ages and ethnicities (*Table 1*).

Farm location, business size, number of years farming, and method of farming data are presented in *Table 2*. Most produce farms were located in Georgia (62.5%), followed by Alabama (22.1%) and Florida (7.7%), representing mostly conventional (Con) and mixed farming methods (70.2%). The length of time respondents had been farming ranged from 0 to 55 years, with 27.9% in operation for 0 to 5 years (*Table 2*). The annual gross sales of the growers showed significant variation, spanning from \$2,000.00 to \$5,000,000.00. These sales were used to classify the business size following the guidelines of the FDA's PSR (21 CFR §112.3).

### Management practices

When growers were asked about management practices used on the farm operation to address food safety concerns

**TABLE 2. Farm location, business size, time farming, and method of farming of survey respondents (*n* = 104)**

Farm Location	Frequency	%
Georgia	65	62.5
Alabama	23	22.1
Florida	8	7.7
Mississippi	3	2.9
South Carolina	2	1.9
Louisiana	1	1.0
Tennessee	1	1.0
Other <sup>a</sup>	1	1.0
<b>Business Size<sup>b</sup></b>		
Exempt	19	18.3
Very small	25	24.0
Small	6	5.8
Large	22	21.2
Did not specify	32	30.8
<b>Time farming, yr</b>		
0–5	29	27.9
6–10	20	19.2
11–15	10	9.6
16–20	6	5.8
21–25	5	4.8
26–30	3	2.9
31–35	3	2.9
36+	12	11.5
Did not specify	16	15.4
<b>Method of Farming<sup>c</sup></b>		
Conventional	51	49.0
Mixed (organic and conventional)	22	21.2
Certified Naturally Grown	15	14.4
Certified organic	11	10.6
Regenerative	6	5.8
Other	8	7.7

<sup>a</sup>Other: farm location: Colorado; method of farming: hydroponic, pesticide-free, aspiring certified naturally grown, aspiring certified organic.

<sup>b</sup>The FDA's definitions of farm size from the Produce Safety Rule (21 CFR §112.3) were used to classify respondents as "very small business" if they reported annual sales above \$25,000 but no more than \$250,000 and "small business" farms if they reported annual sales between \$25,000 and \$500,000 per year; "large business" farms were categorized if they reported annual sales of \$500,000 or more, while "exempt" farms had annual sales of \$25,000 or less.

<sup>c</sup>Some farmers have more than one method of farming.

**TABLE 3. Management practices used in farm operations to address food safety and conservation concerns in the previous five years (*n* = 91)**

Management Practices	Frequency	%
<b>Practices Addressing Food Safety Concerns</b>		
Use of deterrents to prevent animal intrusion in the field	55	60.4
Partial vegetation removal from ditches or farm ponds	32	35.2
Irrigation water treatment	29	31.9
Stopped using contaminated water sources for pre-harvest use	21	23.1
Cleared vegetation to create bare ground buffers	20	22.0
Relocation of domesticated animals	19	20.9
Complete vegetation removal from ditches or farm ponds	14	15.4
Relocation of wild animals	7	7.7
Other <sup>a</sup>	3	3.3
<b>Practices Addressing Conservation Concerns</b>		
Crop rotation	65	71.4
Integrated pest management	54	59.3
Cover cropping	46	50.5
Composting or manure treatment	30	33.0
Direct planting	25	27.5
Use of hedgerows or windbreaks	20	22.0
Use of native plants to attract natural pest predators	16	17.6
Grassed waterways	13	14.3
Riparian-zone restoration	3	3.3
Other <sup>b</sup>	5	5.5

<sup>a</sup>Other food safety concerns: installed dry creek to prevent washout/flooding into the produce area; indoor grown; wildlife-kill permits.

<sup>b</sup>Other conservation concerns: tin cats/pet boxes.

in the previous five years, the use of deterrents to prevent animal intrusion in the field (60.4%) was the most used method, followed by partial vegetation removal from ditches or farm ponds (32.2%), and treatment of irrigation water (31.9%). Regarding conservation practices, 71.4% of growers reported practicing crop rotation, followed by integrated pest management (59.3%), cover cropping (50.5%), and composting or manure treatment (33.0%) as management practices on the farm field. Riparian-zone restoration and other methods accounted for less than 10% (Table 3).

The PCA was conducted in order to assess whether the farming method has an association with the management practices utilized by growers for addressing both food safety and conservation concerns on their farms (Fig. 1). In summary, the results of the PCA indicate variations in the management practices adopted by growers with different farming methods.

The positive loadings in the first principal component (PC1) indicate that the farming methods using Con and Mixed practices are more likely to use a range of management practices to address food safety and conservation concerns, including partial vegetation removal from ditches or farm ponds (PVR), complete vegetation removal from ditches or farm ponds (CVR), cleared vegetation to create bare ground buffers (CVC), use of deterrents to prevent animal intrusion in the field (DPA), stopped using contaminated water sources for preharvest use (SCW), irrigation water treatment (IWT), relocation of domesticated animals (RDA), integrated pest management (IPM), crop rotation (CR), cover cropping (CP), direct planting (DP), use of hedgerows or windbreaks (HW), riparian-zone restoration (RZR), and grassed waterways (GW). In contrast, the negative loadings in PC1 indicate that CNG, CO, Re, and other farming methods are less likely to use these management practices.

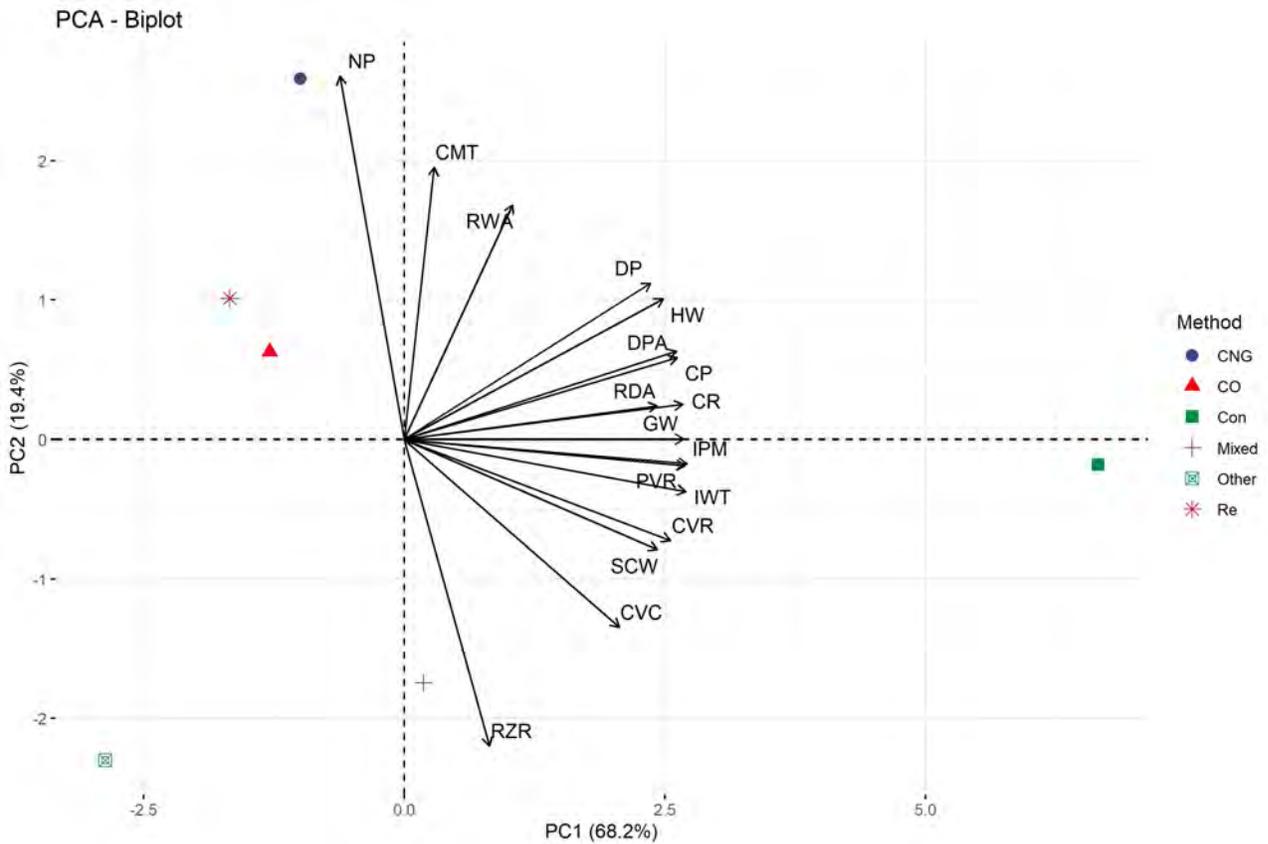


Figure 1. PCA biplot of management practices adopted by growers with different farming methods for addressing food safety and conservation concerns.

Abbreviations: CNG: Certified Naturally Grown. CO: Certified Organic. Con: Conventional. Mixed: Mixed (organic and conventional). Re: Regenerative. PVR: partial vegetation removal from ditches or farm ponds. CVR: complete vegetation removal from ditches or farm ponds. CVC: cleared vegetation to create bare ground buffers. DPA: use of deterrents to prevent animal intrusion in the field. SCW: stopped using contaminated water sources for preharvest use. IWT: irrigation water treatment. RDA: relocation of domesticated animals. IPM: integrated pest management. CR: crop rotation. CP: cover cropping. DP: direct planting. HW: use of hedgerows or windbreaks. GW: grassed waterways. RZR: riparian-zone restoration. RWA: use relocation of wild animals. CMT: composting or manure treatment. NP: use of native plants to attract natural pest predators.

The positive loadings in PC2 indicate that CNG, CO, and Re farming methods are more likely to use relocation of wild animals (RWA), composting or manure treatment (CMT), and use of native plants to attract natural pest predators (NP). In contrast, the negative loadings in PC2 indicate that the Con, Mixed, and other farming methods are less likely to use these management practices.

### Growers' perception of food safety and conservation practices

Based on respondents' perceptions, 21.1% of growers perceived that food safety and conservation practices are in conflict, 36.0% perceived that developing a whole farm plan that incorporates food safety and conservation is difficult, and 64.2% reported that food safety and conservation have an impact on their land management decisions (Fig. 2).

### Food safety and conservation programs

Figure 3 demonstrates growers' awareness of the current U.S. conservation programs that may indirectly facilitate improvements in food safety. Nearly 60% of the survey respondents reported that they were not aware of the USDA conservation programs. Contrarily, 30.5% of growers indicated being aware of at least one of these conservation programs, and 3.2% reported having applied to one of them. Notably, 13.3% of growers reported having been approved for the USDA-NRCS EQIP, 4.8% for the USDA-NRCS CSP, and 2.4% for the USDA-FSA Microloan, indicating a modest but significant uptake of these program's adoptions.

Figure 4 displays growers' consideration of local authority in food safety and conservation programs. Most growers identified extension as the local authority for food safety (55.0%) and conservation (57.3%) practices. The States Department of Agriculture (50.0%) and USDA NRCS

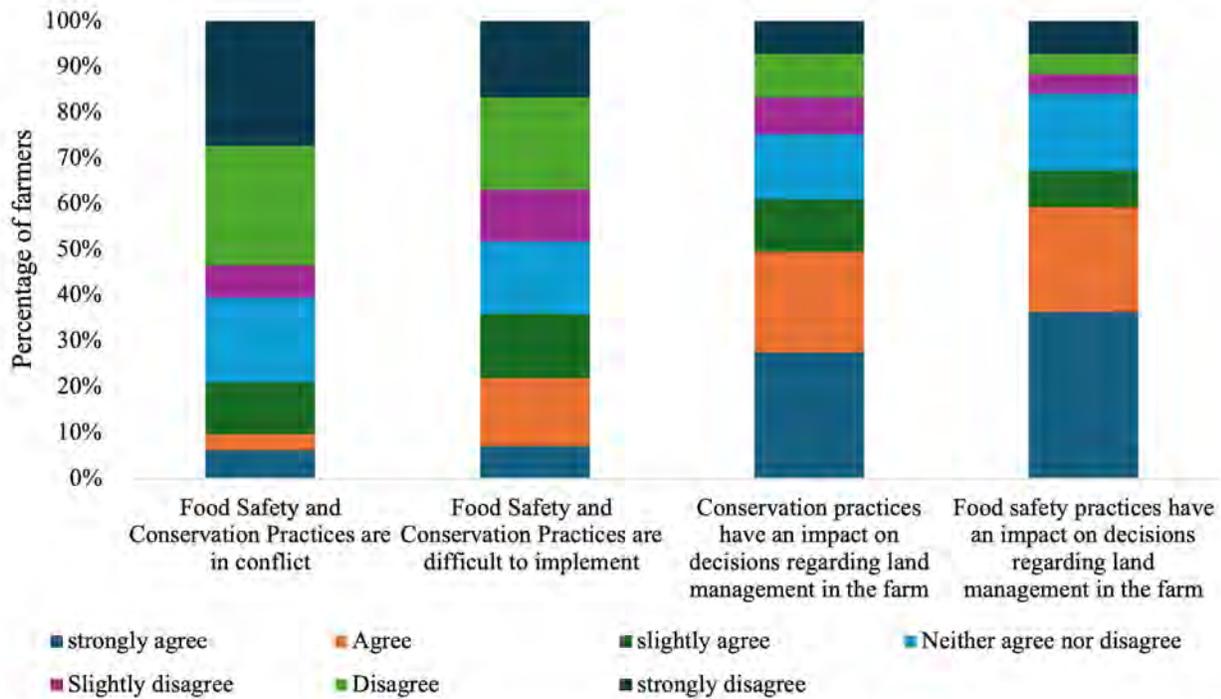


Figure 2. Growers' perception of food safety and conservation practices on the farm (n = 104).

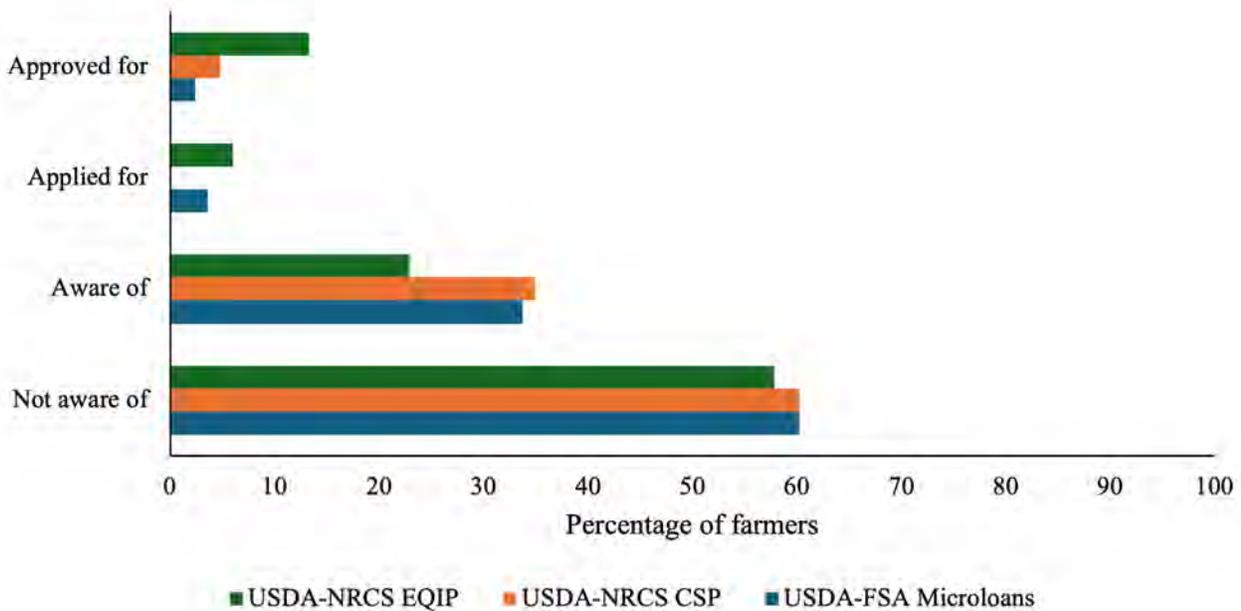


Figure 3. Growers' awareness of the current U.S. conservation programs (n = 83).

Abbreviations: USDA: United States Department of Agriculture. NRCS: Natural Resources Conservation Service. EQIP: Environmental Quality Incentives Program. CSP: Conservation Stewardship Program. FSA: Farm Service Agency.

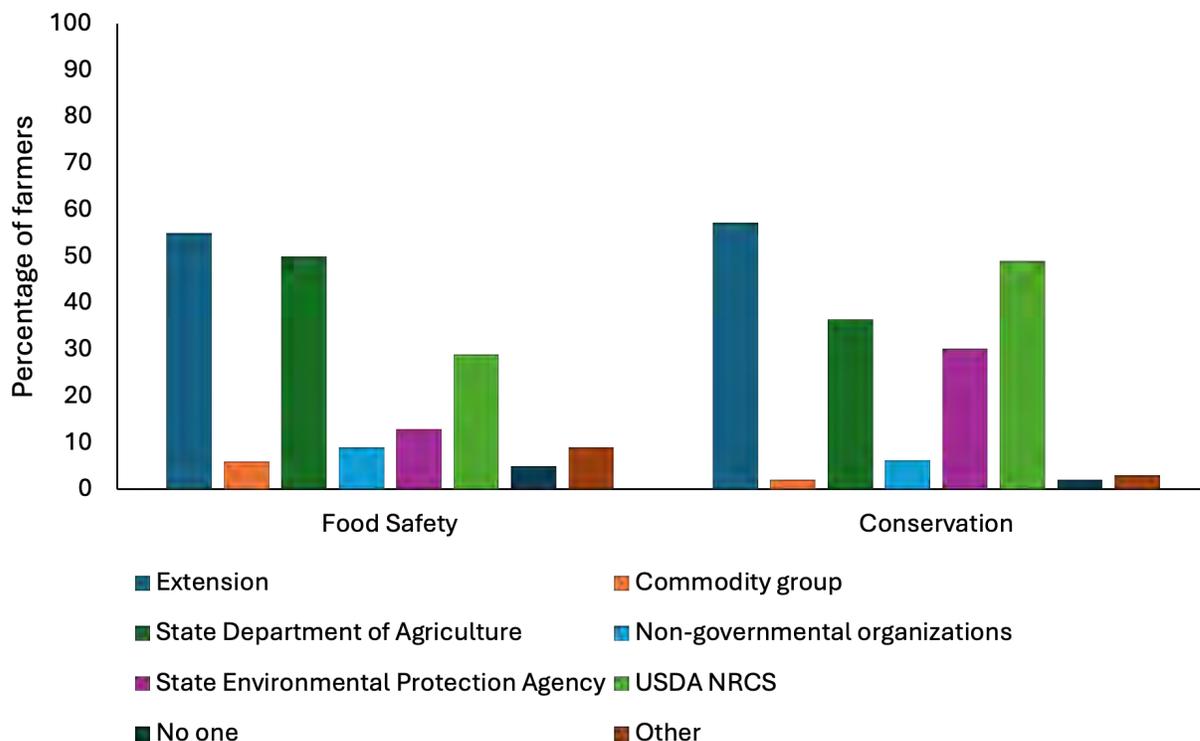


Figure 4. Growers' awareness of local authority of food safety ( $n = 100$ ) and conservation programs ( $n = 96$ ).

Other food safety practices: the inspector that does GAPs audit; National Farmers Union; FDA. Other conservation practices: Department of Natural Resources. Note: the sum of % more than 100 was due to multiple responses.

(29.0%) were ranked second and third for food safety, while USDA NRCS (49%), State Department of Agriculture (36.5%), and State Environmental Protection Agency (30.2%) followed the rank for conservation practices.

#### Access to information

Growers were also asked about the frequency and type of valuable online resources used to support on-farm food safety and conservation practices. The frequency of online access varied from 0 to 20 ( $3.9 \pm 4.4$ ) times per month for food safety and 0 to 15 ( $2.1 \pm 3.3$ ) times per month for conservation practices. Growers' responses to the open text question about the online farm food safety and conservation resources accessed are listed in *Table 4*. The most frequent resource for food safety was Primus (17.9%), followed by Extension (15.4%) and USDA (10.3%). For conservation information, other universities (10.3%), USDA (7.7%), and Extension (7.7%) were among the most used resources. Notably, 25.6% of growers reported using "Other" resources for food safety, while 17.9% used "Other" resources for conservation, including training materials and guidelines. The response rate for this question was lower, possibly due to survey fatigue, as the question was asked at the end of the survey.

#### Farm expenditures

The amount of money estimated to be spent on farm food safety and conservation practices over the last 5 years varied considerably from grower to grower, ranging from \$0 to \$1,500,000 on food safety and \$0 to \$250,000 on conservation practices. Most growers invested between \$10,001 and \$20,000 in food safety practices, and between \$1,000 and \$5,000 on conservation practices (data not shown).

#### DISCUSSION

Growers play an active role as caretakers of the land on their farms, safeguarding soil and water quality while preserving wildlife habitats. All of this must be done while ensuring that their crops are free from contamination to prevent foodborne illnesses. Farm food safety and conservation practices play an important role in ensuring the well-being of both farmers and consumers while also contributing to sustainable agriculture. By integrating food safety and conservation practices, farmers can enhance consumer confidence, preserve natural resources, and promote long-term agricultural viability. It is important to note that all farms can take action to reduce food safety

**TABLE 4. List of online resources of food safety and conservation practices listed by respondents (*n* = 39)**

Online resources	Food Safety		Conservation	
	Frequency	%	Frequency	%
Primus	7	17.9	0	0.0
USDA	4	10.3	3	7.7
State Department of Agriculture	3	7.7	0	0.0
Google/YouTube	3	7.7	2	5.1
FDA	2	5.1	1	2.6
GAPs	2	5.1	0	0.0
Extension	6	15.4	3	7.7
Other Universities	3	7.7	4	10.3
United Fresh	2	5.1	0	0.0
OSHA	1	2.6	1	2.6
USDA National Organic Program	1	2.6	1	2.6
USDA NRCS	0	0.0	2	5.1
Department of Natural Resources	0	0.0	1	2.6
Local news	0	0.0	0	0.0
Other <sup>d</sup>	10	25.6	7	17.9

<sup>d</sup>Other: HACCP training, BMPs guide, e-books, Natural Farm Union. Abbreviations: USDA: United States Department of Agriculture. NRCS: Natural Resources Conservation Service. OSHA: Occupational Safety and Health Administration. GAPs: Good Agricultural Practices. FDA: Food and Drug Administration.

risks, regardless of their size, location, or commodities grown. Although awareness and understanding of the importance of integrating conservation and food safety practices are evolving, there is a knowledge gap among growers on how to best co-manage them. The results of this survey show that the most common management practices used by growers to address food safety concerns include the use of deterrents to prevent animal intrusion in the field and partial vegetation removal from ditches or farm ponds. Although growers identify these measures as ways to reduce the risk of pathogenic microorganisms entering the produce fields and potentially contaminating the crops, the efficacy of these methods can be variable and, in some instances, exacerbate food safety risks. For instance, animal intrusion can lead to the transmission of human pathogens through feces and spread contamination by tracking feces through the field (10). However, previous studies have demonstrated that removing vegetation around water sources as a means to reduce wildlife intrusion does not improve food safety and instead results in impaired water quality due to increased erosion (4, 22). Our survey indicated that only a small percentage of growers reported using riparian zone restoration as a conservation practice. Previous studies have

demonstrated that riparian zones can act as natural filters, which could reduce the transport of sediments, nutrients, and microbial contaminants and improve water quality, but they may also increase wildlife habitats (17, 21). Thus, growers should exercise caution when implementing these practices on their farms. Proper planning and consultation with conservation and food safety experts are recommended to mitigate potential risks.

Survey results also indicated that growers recognize water treatment as a way to reduce food safety hazards. This is particularly important because water can act as a carrier for many microorganisms, such as pathogenic *E. coli*, *Salmonella enterica*, *Vibrio cholerae*, and *Shigella* spp. (6). However, preharvest water treatment does require rigorous monitoring to ensure microbial hazards are being controlled (21 CFR 112.43(b)) at levels that will not result in crop damage. By adopting these management practices, growers can take positive steps toward ensuring the safety and quality of produce.

The survey results also indicated that growers commonly use crop rotation, integrated pest management, and cover cropping as conservation practices. These practices can significantly minimize on-farm food safety risks by reducing

the use of chemical pesticides, boosting soil health, and reducing the risk of pathogen contamination. A previous study conducted by Zhao et al. (24) found that cover cropping can significantly reduce the levels of *E. coli* in contaminated agricultural soil over time, indicating that cover crops can be an effective strategy for improving microbial safety in agricultural environments.

The results of the PCA suggest that the growing methods used at a particular farm may predict the farm's level of awareness regarding the implementation of conservation practices. Farmers using Con and mixed methods appear to be more actively removing vegetation around the farm and water sources than CNG, CO, and Re methods, which can consequently lead to an increase in water source contamination and prevent them from using these water sources. Thus, the misperception and misunderstanding regarding conservation methods among these groups of farming methods is a critical knowledge gap identified by this survey. This finding suggests that there is a need for greater awareness and science-based education about the benefits of co-management to conserve the environment while protecting produce safety among farmers using Con and mixed farming methods.

The relocation of wild animals can lead to a disruption of local wildlife balance and attract predatory invasive species (13, 14). Also, growers need to exercise caution when using compost to ensure that it has been properly treated to reduce the number of pathogens to safe levels. Raw manure can introduce harmful pathogens like *E. coli*, *Salmonella*, and *Listeria* into the soil, which can then contaminate fresh produce (15). Proper treatment methods, such as composting, are essential to reduce these microbial risks, as highlighted by the FDA PSR (7). Although the survey did not collect specific details about participants' growing practices or experiences, the results indicate that practices such as using deterrents to prevent animal intrusion, treating irrigation water, and composting or manure treatment are commonly implemented. These findings suggest that these practices are relevant to many growers, regardless of the specific challenges they face. Future research could explore how individual experiences, such as dealing with animal intrusion or reliance on irrigation, influence the adoption of these practices.

The findings from Figure 4 indicate that growers have a good understanding of local authorities and are knowledgeable about food safety and conservation practices. Extension was identified as the primary authority for both food safety and conservation management, which is not surprising given their role in providing educational resources and technical assistance to farmers. However, awareness of all available resources and programs is not always comprehensive. Many growers are unaware of USDA programs that could help them implement co-management practices, such as the USDA-NRCS EQIP, USDA-NRCS

CSP, and USDA-FSA Microloan programs. Several barriers contribute to this gap, including limited access to information, time limitations, perceived conflicts between food safety and conservation, and logistical or financial challenges. For example, limited or unreliable internet access can restrict growers from obtaining educational resources or applying for USDA programs. Additionally, many small-scale growers face challenges in attending training sessions, reviewing regulatory documents, or implementing new practices due to limited time or labor. A common barrier, as indicated in this survey, is the perception that food safety and conservation practices are in conflict, which may discourage growers from adopting conservation measures. This perception underscores the need for clearer, science-based guidance on co-management strategies that balance conservation and food safety. Logistical and financial constraints also prevent some growers from fully engaging with conservation programs. The costs associated with implementing conservation practices can be expensive, particularly for small-scale growers and individuals in underserved regions. While USDA programs offer financial assistance, the application process can be complex and time-consuming. Simplifying access to funding and providing technical assistance could help increase engagement.

To improve food safety and conservation practices, greater efforts are needed to increase awareness and encourage participation in USDA programs. Although the USDA currently conducts targeted marketing campaigns, workshops, training sessions, and partnerships with local organizations to reach underserved communities, additional outreach and educational initiatives are necessary. Expanding in-person workshops and webinars tailored to the specific needs of regional growers, focused on food safety and conservation, would provide valuable hands-on training and encourage direct interaction with experts. Furthermore, developing plain language factsheets, step-by-step guidelines, and videos can support growers in understanding how to effectively co-manage conservation and food safety practices. Increased understanding of federal programs, their benefits, and how to access them will increase program visibility, expand participation, and ultimately facilitate the integration of conservation and food safety practices on farms.

Finally, the survey results provide insights into the most used online resources by growers for co-management practices. The finding that Primus was the most frequently cited resource for food safety is not surprising, given that it is a widely used food safety certification program. Other universities and Extension were among the most cited resources for conservation. This suggests that growers may value information from a variety of sources, including other academic institutions and government agencies. The fact that 17.9% of growers used "Other" resources for conservation further emphasizes the importance of providing a range of accessible and relevant information sources. The frequency

of online access to food safety and conservation practices was relatively low, with an average of fewer than four times per month for food safety and two times per month for conservation. This could suggest that growers may face barriers to accessing information, such as a lack of time, resources, or reliable internet access. Alternatively, growers may not need to access this information more frequently. It may be worthwhile to investigate grower needs and barriers related to accessing information online to further develop strategies to address growers' needs.

Overall, the findings highlight the importance of making high-quality information on co-management practices readily available to growers and promoting the integration of conservation and food safety practices into farming operations. The wide range of five-year spending reported by growers on farm co-management practices is a notable finding of this study. The fact that some growers reported spending zero on either food safety or conservation suggests that there may be a lack of awareness or understanding of the importance of these practices in ensuring the sustainability and safety of agricultural operations or that growers are implementing practices but do not associate them with conservation or food safety. For example, a grower may be using cover crops for soil health and have not identified that as a conservation practice from the way the question was worded. On the other hand, the relatively high reported spending of up to \$1,500,000 on food safety and \$250,000 on conservation practices indicates that some growers are making significant investments in these areas. It is worth noting that the reported spending may be influenced by the size of the farm operation and the type of crops growing. Larger operations with more diversified crops and higher production volumes may require more extensive and expensive food safety and conservation practices, while smaller operations may be able to implement these practices at a lower cost. Additionally, certain crops may require more specialized practices and equipment, which could result in higher costs for growers.

The limited sample size of our study may represent a potential limitation for the broader audience. However, this sample provides critical insights specific to the Southeastern U.S., where unique agricultural practices and environmental conditions play a significant role in shaping both conservation and food safety approaches. Although the study's focus on the Southeastern U.S. may limit its applicability to other regions, as practices and perceptions of conservation and food safety can vary based on local

environmental, economic, and regulatory conditions, the insights gained from this focused sample are particularly relevant for informing regional policy and intervention strategies. Moreover, this study establishes a foundational dataset on the integration of conservation and food safety practices among growers in this specific region. Future research should aim to include more diverse geographic areas and larger participation numbers to assess whether the trends identified in this study are consistent across different regions. In addition, further research should consider open-ended questions or interviews to gain a better understanding of the challenges growers face when balancing food safety and conservation practices. Exploring these experiences will provide valuable insights into the factors that influence decision-making and the adoption of these practices.

## CONCLUSIONS

In conclusion, this study provides valuable insights into the awareness, perception, and implementation of co-management practices among growers in the United States. The results indicate that while many growers are making efforts to address conservation and food safety concerns, there is still a need for greater awareness, education, and support to encourage integrating these practices into their farming operations. The findings also suggest a potential gap in communication between the USDA and growers regarding available conservation programs, indicating the need for targeted marketing campaigns and partnerships to reach underserved communities. Additionally, the perception of a conflict between food safety and conservation practices and the challenges in implementing practices that address both concerns simultaneously emphasize the need for more training, research, and innovation. The study underscores the importance of providing high-quality information on food safety and conservation practices readily accessible to growers in the Southeastern, promoting their integration into farming operations, and investing in these practices to ensure the sustainability and safety of agricultural operations.

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## DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

No AI or AI-assisted technologies were used in any phase of this manuscript's development and writing.

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