Assessment of Farmers Market Practices and Characteristics to Inform the Development of Tailored Educational Materials

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Scientific abstract

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Farmers markets (FM) have become increasingly popular almost tripling over the past two decades due to the rising interest in local and/or organic foods. Within this same time period, notable farmers market foodborne illness outbreaks; such as *E. coli* O157:H7 and strawberries and *Salmonella* and peas; have occurred, and emphasize the importance of food safety practices at farmers markets. Some farmers may be encouraged to follow Good Agricultural Practices (GAPs) to limit the contamination of fresh produce; however, GAPs programs are complex and also very driven by wholesale buyers. Furthermore, many FM growers are unfamiliar with GAPs or do not believe it is applicable to them. The Food Safety Modernization Act (FSMA) was passed in 2011, and shifted the food safety paradigm from a reactive to proactive approach introducing seven different rules including the Preventive Controls for Human Foods (PCHFR) and the Produce Safety Rule (PSR). Each FSMA rule does contain exemptions for smaller-scale operations (e.g., farms, facilities) that allows them to be excluded from the rule, or excluded from certain aspects of the rule. Generally, most FM vendors may satisfy exemptions from the FSMA regulations (e.g., be exempt from the FSMA Produce Safety Rule because of commodities); however, to our knowledge, no studies have assessed the regulatory compliance requirements of FM vendors to the FSMA regulations. This dissertation explored the regulatory requirements of FM vendors, and the accessibility of FSMA materials for these audiences. Additionally, due to the sudden and unprecedented global COVID-19 pandemic, an objective was added that explored how COVID-19 influenced behavior

changes among this audience. Interviews were conducted and found that all vendors (100%) were exempt from the PCHFR and that most vendors (67%) were exempt from the PSR, some were qualified exempt (28%), and a few (5%) were covered. This study also found that farmers market vendors received information mainly from University Cooperative Extension sources. The COVID-19 pandemic greatly impacted hygiene and health practices at FMs. Market personnel (managers and vendors) implemented many different hygiene and health practices at their markets. The major source of COVID-19 food safety information for market personnel was local and federal government; as well as University Cooperative Extension. Accessibility analyses showed that many FM or COVID-19 resources were not accessible due to populations that rely on produce safety resources generated by Cooperative Extension due to (i) navigation or web accessibility errors, (ii) high literacy level requirements, and (iii) lack of keep (i.e., resources were not up-to-date, or continuously managed or monitored). These findings will inform the development of FM targeted resources, that are also, accessible to a more diverse and inclusive audience. One example is a produce safety resource on the updated agricultural water requirements that is developed to an 8th grade reading level, with no broken links or additional navigations errors, and if a PDF version is available, proper headers and titles.

Public abstract

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Farmers markets (FMs) have increased in popularity over the two decades with because of interest by consumers to support local agriculture, buy organic products, or because they believe these foods to be safer from bacteria and viruses. Shopping at a FMs does not necessarily make the products any safer compared to buying it from a grocery store. It is important that farmers markets follow proper food safety practices during the growing, harvesting, and preparation of produce for sale. One example is the prevention of animal feces from getting on the produce or in a water source that would be used. Another would be to follow proper hygiene practices such as handwashing after using the bathroom. These two examples and others are detailed in a law passed by President Obama in 2011 called the Food Safety Modernization Act (FSMA), which allows the Food and Drug Administration to begin its proactive instead of reactive food safety approach. FSMA does not have to be followed by all food entities. Depending on how much a farm makes in revenue (<$25,000) or if they grow products deemed as “not risky,”, they may be exempt. These types of products such as potatoes, beets, and corn are safer because they will be cooked before consumption killing any bacteria or viruses that may exist. Other products such as romaine lettuce and tomatoes are usually consumed fresh without cooking and are thus riskier if there are any bacteria or viruses on it. Interviews were conducted to understand if farmers market vendors need to comply with FSMA. Most vendors are not required to follow FSMA because they gross less than $25,000 or their products were already covered by other food safety regulations such as meat being

covered by the USDA. Additionally, how the COVID-19 pandemic influenced FMs was explored. Two surveys, one for vendors and one for managers, were distributed to stakeholders. FMs adapted really well to the challenging COVID-19 landscape and implemented COVID-19 preventive measures such as social distancing, mask wearing, and providing hand sanitizer and handwashing stations to continue to operate and keep their customers and employees safe. After understanding the characteristics and the unique challenges to food safety implementation that these market personnel may face, additional research was done to understand if currently available resources were accessible. Accessibility was evaluated using website and PDF accessibility checkers and a readability level checker. Resources should be easy to navigate and written to around a 8^{th} grade level to make it easy to understand. There is a lack of well-crafted, accessible resources that address the unique challenges that farmers market personnel may face. These considerations should be considered when creating these materials.

Dedication

This work is dedicated to my mom, dad, my two brothers (Duy and Will), and my partner Susan who have continually supported and encourage me to reach for the stars.

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Attribution.

Authorship of the manuscripts in this dissertation is shared with the following individuals: Dr. Renee Boyer, Dr. Benjamin Chapman, Dr. Tiffany Drape, Dr. Robert Williams, Dr. Laura Strawn, Dr. Nicole Arnold, Wenying Zhang, and Mohamed Salem.

Dr. Renee Boyer is the primary advisor and committee chair for this research. She is the head of the Department of Food Science and Technology at Virginia Tech. She has provided extensive guidance on all of the research conducted. She has assisted with research plan development, implementation, and evaluation. In addition, she has assisted with the development and editing of the manuscripts in this. She is an author on all the manuscripts.

Dr. Benjamin Chapman is a committee member from this research. He is a Professor in the Department of Agricultural and Human Sciences at North Carolina State University. He has extensive guidance, direction, and mentorship on all three studies with his expertise in food safety communication, consumer and retail food safety, and Extension education and outreach. He was instrumental in the development of all three studies providing insights into the data collection tools created, the studies' methodologies, and the data analytics. He has also provided connections to farmers market populations outside of Virginia and allowed for these studies to be conducted in multiple states. He is an author on all the manuscripts.

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Dr. Nicole Arnold is an Assistant Professor in the Department of Nutrition Science at East Carolina University. She has been instrumental in Study 3 where she has served as a secondary coder for qualitative data. She has provided much direction and guidance with the qualitative

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Wenying Zhang is 2019 Virginia Tech graduate from the Department of Food Science and Technology. She is currently working as a Quality Assurance Associate with Tulkoff Food Products. She was instrumental in the development of Study 1 assisting with the telephone interviews conducted and helping develop the data analyses instruments used. She was also the secondary coder for the data analyses performed. She is listed as the second author for Study 1.

Mohamed Salem is a doctoral student in the Department of Statistics at Virginia Tech. He was instrumental in statistical analyses for study 3 and is listed as the second author.

CHAPTER 1: INTRODUCTION

Background and rationale for research

Farmers markets (FMs) are defined by the United States Department of Agriculture (USDA) as fixed locations where farmers or producers sell their agricultural products (United States Department of Agriculture Food and Nutrition Services, 2015). Smithers and authors believe an essential element of farmers markets is the ability for consumers to develop personal relationships with farmers (Smithers et al., 2008). Over the past two decades, FMs have risen in popularity increasing from 1,775 markets listed in on the USDA's market directory to 8,771 in 2019. Farmers market shoppers believe that locally sourced produce grown on a small farm is safer compared to commercially grown products (Smithers et al., 2008). Although some consumers shop at farmers markets because they believe the food is safer, fresh produce from farmers markets may have greater bacterial contamination than produce from a supermarket (Conner et al., 2010; Park & Sanders, 1992; Soendjojo, 2012). Farmers markets have been associated with many outbreaks over the past decade such as strawberries and *E. coli* O157:H7 and *Salmonella* and peas (Canadian Food Inspection Agency, 2014; Schneider, 2017). Strawberry contamination was traced to deer feces in the fields (Canadian Food Inspection Agency, 2014). There was no determined contamination source for the peas outbreak, but messaging provided was by local health authorities on proper procedures for washing and preparing vegetables (Schneider, 2017).

An estimated 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths occur annually in the United States (US) from foodborne diseases leading to an economic cost of $78 billion dollars (Scallan, Griffin, et al., 2011; Scallan, Hoekstra, et al., 2011; Scharff, 2011). The

Food Safety Modernization Act (FSMA) was signed into law in 2011 by President Barack Obama reforming food safety in the US by shifting it from a reactive to proactive approach (Food and Drug Administration, 2019). The FSMA consists of seven rules that revamp food safety standards from animal food to foreign supplier verification. Two of these rules are the Current Good Manufacturing Practice and Hazard Analysis and Risk-Based Preventive Controls for Human Foods, which is more commonly referred to as the Preventive Controls for Human Foods Rule (PCHFR) and the Standards for Growing, Harvesting, Packaging, and Holding of Produce for Human Consumption, which is more commonly referred as the Produce Safety Rule (PSR) (FDA, 2016; United States Food and Drug Administration, 2021). FMs may satisfy exemption under the FSMA regulation, but to our knowledge, no studies have assessed regulatory compliance requirements of FM vendors to the FSMA regulations. Chapter 3 aims to assess and understand the regulatory compliance of farmers market vendors to the PCHF and PSR. Our hypothesis is that the majority will be exempt the PCHFR because they are classified as one a primary production farm or secondary production farm, manufacture/process, pack, or hold low-risk foods, or have small businesses with less than 500 full-time employees while very small businesses are those that average less than $2.5 million in sales. Similarly, we hypothesize that most farmers market vendors will be exempt due to the monetary requirements of the PSR being at less than $25,000 of all produce sales. Although farmers market vendors may fall outside these regulations, it does not mean that they should not practice proper food safety practices on their farm.

To understand how to develop food safety training materials for market personnel, a questionnaire was used to understand how the COVID-19 pandemic has impacted farmers

markets and how these personnel have adapted. With the majority of small-scale farms falling outside the PSR guidelines,

The final study of this dissertation (Chapter 5) evaluated existing produce safety resources from three information sources – Virginia Cooperative Extension, North Carolina Cooperative Extension, and the Produce Safety Alliance. The criteria accessed included the content quality, readability, PDF accessibility (if applicable), and navigability/web accessibility. The results from this study will guide the development of produce safety resources that can be more accessible not only for farmers market personnel but also those in the Cooperative Extension space.

Objectives

1. To assess the regulatory compliance of farmers market vendors to the Produce Safety Rule and Preventive Controls for Humans Food Rule and how they receive produce safety information.
2. To evaluate existing Produce Safety Rule resources from established educational programs and sources for: accessibility, and literacy level.
3. To assess the impact of the COVID-19 pandemic on farmers markets practices and how they receive COVID-19 farmers market information.

Hypotheses

Objective 1

H_0 The majority of farmers market vendors do not have to comply with the Produce Safety Rule
H_A The majority of farmers market vendors have to comply with the Produce Safety Rule

H_0 The majority of farmers market vendors do not have to comply with the Preventive Controls for Human Foods Rule
H_A The majority of farmers market vendors do have to comply with the Preventive Controls for Human Foods Rule

Objective 2

H_0 The preferred sources' do not score well for PDF accessibility.
H_A The preferred sources' score well for PDF accessibility.

H_0 The preferred sources' do not have updated information on the Produce Safety Standards
H_A The preferred sources' have updated information on the Produce Safety Standards

H_0 The preferred sources' websites do not have a general readability level.
H_A The preferred sources' websites do not have a general readability level.

H_0 The preferred sources' websites are not applicable to small farms.
H_A The preferred sources' websites are applicable to small farms.

Objective 3

H_0 The COVID-19 pandemic has not changed farmers markets' cleaning and disinfecting practices.
H_A The COVID-19 pandemic has changed farmers markets' cleaning and disinfecting practices.

H_0 Farmers market personnel have not implemented proper COVID-19 preventative measures.
H_A Farmers market personnel have not implemented proper COVID-19 preventative References

References

1. Canadian Food Inspection Agency. (2014). *Food Recall Warning - Unpasteurized apple cider processed by Rolling Acres Cider Mill recalled due to E. coli O157:H7*. http://www.inspection.gc.ca/about-the-cfia/newsroom/food-recall-warnings/complete-listing/2014-10-30/eng/1414720185030/1414720197088
2. Conner, D., Colasanti, K., Ross, R. B., & Smalley, S. B. (2010). Locally grown foods and farmers markets: Consumer attitudes and behaviors. *Sustainability*, *2*(3), 742–756. https://doi.org/10.3390/su2030742
3. FDA. (2016). FSMA Final Rule for Preventive Controls for Human Food. *U.S. Food and Drug Administration*. https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-preventive-controls-human-food
4. Food and Drug Administration. (2019). *Food Safety Modernization Act*. https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm247548.htm
5. Park, C. E., & Sanders, G. W. (1992). Occurrence of thermotolerant campylobacters in fresh vegetables sold at farmers' outdoor markets and supermarkets. *Canadian Journal of Microbiology*, *38*(4), 313–316. https://doi.org/10.1139/m92-052
6. Scallan, E., Griffin, P. M., Angulo, F. J., Tauxe, R. V., & Hoekstra, R. M. (2011). Foodborne illness acquired in the United states-Unspecified agents. *Emerging Infectious Diseases*, *17*(1), 16–22. https://doi.org/10.3201/eid1701.P21101
7. Scallan, E., Hoekstra, R. M., Angulo, F. J., Tauxe, R. V., Widdowson, M. A., Roy, S. L., Jones, J. L., & Griffin, P. M. (2011). Foodborne illness acquired in the United States-Major pathogens. *Emerging Infectious Diseases*, *17*(1), 7–15. https://doi.org/10.3201/eid1701.P11101
8. Scharff, R. L. (2011). Economic Burden from Health Losses Due to Foodborne Illness in the United States. *Journal of Food Protection*, *75*(1), 123–131. https://doi.org/10.4315/0362-028X.JFP-11-

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9. Schneider, D. (2017). Brown County salmonella cases blamed on peas from Green Bay farmers market. *USA Today*. https://www.greenbaypressgazette.com/story/news/2017/08/11/four-brown-county-salmonella-cases-blamed-peas-farmers-markets/560506001/
10. Smithers, J., Lamarche, J., & Joseph, A. E. (2008). Unpacking the terms of engagement with local food at the Farmers' Market: Insights from Ontario. *Journal of Rural Studies*, *24*(3), 337–350. https://doi.org/10.1016/j.jrurstud.2007.12.009
11. Soendjojo, E. (2012). Is Local Produce Safer? Microbiological Quality of Fresh Lettuce and Spinach from Grocery Stores and Farmers' Markets. *Journal of Purdue Undergraduate Research*, *2*(2), 54–63. https://doi.org/10.5703/jpur.02.1.09
12. United States Department of Agriculture Food and Nutrition Services. (2015). *What is a farmers' market?*
13. United States Food and Drug Administration. (2021). *FSMA Final Rule on Produce Safety*.

CHAPTER 2: LITERATURE REVIEW

History and growth of farmers markets in the United States

Farmers markets are defined by the United States Department of Agriculture (USDA) as a fixed location where farmers and/or producers selling their agricultural products (United States Department of Agriculture Food and Nutrition Services, 2015). This can vary; however, some define them as recurring markets where farmer and producers bring their produce for sale to the direct public (Brown, 2001; Smithers et al., 2008). This definition can be further expanded as a venue where consumers can develop personal relationships with farmers that grow their food and gain a better understanding of how their food is produced (Smithers et al., 2008).

The number of farmers markets registered by the USDA has increased from 1,775 in 1994 to 8,771 in 2019 (United States Department of Agriculture Agriculture Marketing Service Division, 2019). In a review of the consumer perceptions and preferences of local food, Feldmann & Hamm, 2015 determined that consumers preferred local food products compared to those purchased at retail supermarket counterparts. High quality products are the top motivator for why consumers purchase at farmers markets (Abel et al., 1999; Conner et al., 2010; Wolf et al., 2005). Other motives and beliefs for shopping at farmers markets include: to support local agriculture, for social appeal, for organic products that are pesticide free, and food safety (Abel et al., 1999; Byker et al., 2012; Conner et al., 2010; Gumirakiza et al., 2014). Although some consumers shop at farmers markets because they believe the food is safer, fresh produce from farmers markets may have greater bacterial contamination than produce from a supermarket (Conner et al., 2010; Park & Sanders, 1992; Soendjojo, 2012).

Park & Sanders (1992) sampled 1,564 fresh samples of ten vegetable types from farmers markets (n=533) and supermarkets (n=1,031) for thermotolerant *Campylobacter* species. Samples of spinach, lettuce, radishes, green onions, parsley and potatoes tested positive for *Campylobacter* species. The species identified on the farmers market samples were *Campylobacter jejuni* (80%), *C. lari* (8%), and *C. coli* (4%). Soendjojo (2012) sampled romaine lettuce, Bibb lettuce, and spinach (N=42) from grocery stores and farmers markets and found higher amounts of total mesophilic bacteria and yeasts and molds in the samples from farmers market.

The majority of food products (82%) available for purchase at farmers market are produce (Smathers, 2012). Consumers mainly purchase vegetables (91%, N=259) and fruits (76%, N=259) (Andreatta & Wickliffe, 2002). Produce products often available for purchase at markets include potentially hazardous food such as sprouts and cut leafy greens (Pollard et al. 2015). Fresh produce is not the only product sold at farmers markets. Other products available for purchase include value-added foods such as jams, jellies, pickles, and further processed vegetable products, as well as foods prepared on site. According to the 2015 USDA Local Food Marketing Practices Survey, about 109,000 farms sell value-added products at farmers markets valued at over $3.9 billion (United States Department of Agriculture, 2015). Meat and poultry products are also available from vendors from farmers markets. A microbiological comparison of poultry products at Pennsylvania farmers markets by Scheinberg et al., 2013 found that 90% (90 of 100) of whole chickens contained Campylobacter spp. and 28% (28 of 100) contained *Salmonella* spp. at farmers markets. Another study found that of the multi-drug resistant *Staphylococcus aureus* recovered from whole poultry carcasses from farmers markets, organic

and conventional retail supermarkets, poultry from farmers markets had the highest prevalence (25%, 8 of 32) (Teramoto et al., 2016). Young and authors (2017) compared these studies and others (n=10) and found that there is limited evidence in microbial comparison and prevalence studies indicating that we should be cautious in our conclusions made with these studies (Young et al., 2017).

Burden of Foodborne Illness in the United States.

An estimated 48 million cases of foodborne illness occur from known sources leading to 55,961 hospitalizations, 1,351 deaths, and an economic cost of $78 billion (Scallan et al., 2011; Scharff, 2011). Produce is a major vehicle for norovirus and *Salmonella* infection ranking fourth overall as a food commodity for estimated annual disease burden behind poultry, complex foods, and pork (Batz et al., 2012). Poultry leads to 14,457 quality adjusted life years (QALY) lost while complex foods, pork, and produce lead to 7,538, 7,891, and 6,336, respectively (Batz et al., 2012). Previously available outbreak data from 1998 – 2008 was analyzed by Painter and colleagues (2013) and attributed more illnesses to produce than any other commodity. Estimates of foodborne illness are difficult to assess because case numbers are underreported, sporadic, or depend on estimates where data may not be available (Jacob & Powell, 2009; Redmond & Griffith, 2003). In a systematic review by Young et al., 2017 Ten foodborne disease outbreaks and two case reports from 1994 to 2016 were identified leading to 411 illnesses, 38 hospitalizations, and 2 deaths. The majority of these illnesses identified in the review were associated with fresh produce (Young et al., 2017). Furthermore, foodborne outbreaks have been attributed to a variety of products sold at farmers markets. These pathogen-product combinations include the following: *E. coli* O157:H7 in unpasteurized apple cider, *Salmonella*

enterica serovar Newport in guacamole, *Escherichia coli* O157:H7 in strawberries, *Salmonella* in tomatoes, and *Salmonella* in peas.

Foodborne outbreaks at farmers markets.

***Salmonella* Newport and guacamole and salsa in Iowa.** A *Salmonella* Newport outbreak occurred in the summer of 2010 in Iowa where 44 cases of foodborne illness were reported (Iowa Department of Public Health, 2010). Through epidemiological interviews and laboratory testing, it was determined that guacamole and salsa sold at two farmers' markets in the state were produced by La Reyna Supermarket and Taqueria and was the vehicle of contamination (Iowa Department of Public Health, 2010). The business sold guacamole, salsas, and pork, chicken, and vegetable tamales at the markets.

According to the Iowa Department of Health, the stand was inspected during the time period when the contaminated products were sold. The health officials found that ice used for cooling the guacamole product was melted, increasing risk for temperature abuse of the product. Improper holding temperatures at the market allows for bacterial growth, especially since the temperature that day was greater than 80°F (Iowa Department of Public Health, 2010). Other risk food safety factors such as lack of proper sanitation practices, cross-contamination opportunities, and improper washing of avocados during preparation could have all contributed to the contamination.

***Escherichia coli* O157:H7 and strawberries.** An *E. coli* outbreak associated with strawberries occurred July 2011 in Oregon leading to fifteen cases of foodborne illness, four hospitalizations, two kidney failures, and one death (Laidler et al., 2013). Interviews with the Oregon Health Department with those who were sick helped the State determine that there

was a connection between the illnesses and the consumption of strawberries that were purchased through multiple farm stands (Laidler et al., 2013). The Heath Department determined that the farm stands purchased their strawberries from Jaquith Strawberry Farm and resold them to patrons (Oregon Health and Human Services Department, 2011).

Investigation of Jaquith Strawberry Farm determined that 10% of the environmental samples collected tested positive for *E. coli* O157:H7 and the outbreak strain was found in samples from fields in three separate locations. The pathogen matched the human isolates and also deer feces that was later isolated from nearby areas of the strawberry fields. It was suspected that the source of contamination of *E. coli* was from the deer, according to the Oregon Health Authority's press release of the outbreak (Oregon Health and Human Services Department, 2011).

***Escherichia coli* O157:H7 and unpasteurized Apple Cider in Ontario, Canada.** Unpasteurized apple cider from Rolling Acres Cider Mill was implicated in an *E. coli* O157:H7 outbreak in October 2014 (Canadian Food Inspection Agency, 2014). The agency conducted a food safety investigation of the unpasteurized product that was being sold at the St. Jacobs Farmers' Market in Waterloo, Ontario and the apple cider was recalled. There were reported illnesses associated with the consumption of these products but no information was provided on how many cases and hospitalizations (Canadian Food Inspection Agency, 2014).

***Salmonella* spp. and peas.** Health officials from Brown County, Wisconsin determined that seven people had become ill with *Salmonella* from shelled peas from a farmers' market in Green Bay (Schneider, 2017). One individual was hospitalized from this incident. Authorities released messaging on proper procedure for washing and preparing vegetables but no

information was provided regarding whether the peas were consumed raw or cooked, which would have determined if cross-contamination was a factor (Schneider, 2017).

Food Safety Modernization Act

The Food Safety Modernization Act (FSMA) was enacted in 2011 changing the Food and Drug Administration's (FDA) food safety regulatory approach from reacting to foodborne illness to preventing them (Food and Drug Administration, 2019). FSMA contains seven major rules to assist in ensuring the safety of the food supply chain. Two of the seven are the Hazard Analysis and Risk-Based Preventive Controls (HARPC) for Human Food and the Standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption, also known as the Produce Safety Rule (PSR). The act has allowed for the first time ever, FDA to oversee on-farm activities.

Hazard Analysis and Risk Based Preventive Controls for Human Food Rule (PCHFR)

The key requirements of the R are inclusion of current good manufacturing practices (CGMPs), and a written and implemented food safety plan. As part of the PCHFR standards and written plan, facilities must perform a hazard analysis to identify potential hazards, identify and institute Preventive Controls (PC), develop a written analysis, monitor effectiveness of PCs, take corrective actions if PCs fail, provide verification of processes, keep written records, and reanalyze the system when changes in the process or product occur.

Any facility that manufactures/processes, packs, or holds food for human consumption is covered by the PC rule. However, farms for the most part will not fall underneath the PC regulations and are defined as primary production farm (PPF) or secondary activities farm (SAF). A PPF is a farm under one management in one general location that is devoted to the growing

and harvesting of crops, the raising or animals (including seafood), or any combination. PPFs can pack and hold raw agricultural commodities (RAC) and can conduct certain manufacturing/processing activities. A SAF is an operation not located on a PPF that is used for harvesting, packing, and/or holding of RACs and are majority owned by the PPFs that supply the majority of the RACs. Farms can fall under a mixed-type facility if engage in activities that fall under the "farm" definition and those that are required to be registered.

Facilities may be exempt from the PC Rules requirements if they manufacture products covered by separate regulations such as juice, seafood, dietary supplement, alcoholic beverages, and low-acid canned foods. Additionally, small, or very small on-farm businesses may be exempt if they manufacture/process, pack, or hold low-risk foods. Small businesses are defined as those with less than 500 full-time employees while very small businesses are those that average less than $1 million in sales (adjusted for inflation). These businesses that do not fit under these exemption guidelines due to the type of product produced will follow a modified version of the rule that involves maintenance of qualification, implementation and monitoring of preventive controls, and providing complete business information with a sign or label at the point of sale. These individuals will fall under a "qualified facility" status and be required to submit Form FDA 3942a attesting to either addressing identified hazards through PCs and monitoring the PCs, or through compliance with applicable non-federal food safety laws. Compliance dates for the PC for Human Food were in effect for facilities engaged in packing and/or holding RACs January 2020 for very-small businesses and January 2019 for small businesses.

Produce Safety Rule

The key requirements of the Produce Safety Rule address the conditions in which produce is grown, including, treatment of agricultural water and biological soil amendments, sprouts, domesticated and wild animals, sanitary equipment design and maintenance, and worker training and health hygiene.

The size and scope of the operation will determine whether farms will need to comply with FSMA. Farms can be fully exempt from the PSR if they grow produce that is for personal or on-farm consumption, that is rarely consumed raw such as potatoes and squash, or that undergoes additional processing. Additionally, farms that gross an average of less than $25,000 over a three-year period from all produce sales are exempt. As of 2019, there are 2.02 million farms in the United States (United States Department of Agriculture Agricultural Marketing Service, 2020). The majority of the farms in the U.S. (51.1%) gross between $1,000 - $9,999 falling outside the monetary requirement of FSMA (United States Department of Agriculture National Agricultural Statistics Services, 2020).

Farms can be qualified exempt meaning they are subjected to modified requirements. These requirements are for farms that grow produce that average less than $500,000 of all food sales over the past three years and the majority of the food sold (>50%) is to a qualified end-user. A qualified end-user is defined by the FDA as a “consumer, or restaurant, or retail food establishment that is located in the same state as the farm that produced the food, or not more than 275 miles from that farm.” (United States Food and Drug Administration, 2021). Farms must keep financial records to prove they meet the monetary value for qualified-exempt and must label or provide signage of their produce product with name and address of the farm (Virginia Department of Agriculture and Consumer Services, 2019).

Economic Implications of the Produce Safety Rule

Not only do fresh produce farmers have to understand how (and if) they need to comply with regulations, but they also have to cater to changing consumer preferences. A study by Neill and Holcomb (2019) asked consumers to determine how much they would pay for tomatoes from farmers exempt and covered by the Produce Safety Rule and determined that consumers would pay less for tomatoes from exempt operations. The total value of the produce industry was $42.7 billion according to a 2012 USDA study. Neill & Holcomb (2019) determined that consumer preference in PSR could cost handlers between $1.4 billion and $1.9 billion 3.34% to 4.50% of the $42.7 billion due to consumer preferences.

Growing practices of small to medium sized farms

A survey of small to medium sized farms by Harrison et al., (2013) determined that these farms may have an increased risk of foodborne illness because of their on-farm practices. These practices include using raw manure (56%, 128 of 226), lack of providing available handwashing and bathroom facilities (67%, n=151, 66% n=150), harvesting crops with bare hands (50%, n=117), and using surface water from streams, ponds, untested well water, or rainwater for irrigation (31%, n=69). Of the farms reporting use of manure, 16% (n=30) do not compost it, 18% (n=23) mix it the composted manure with raw manure, and 59% (n=76) use it but do not mix with raw manure. Raw manure increases the risk of contamination of crops with pathogens such as *E. coli* O157:H7 and *Salmonella* being shown to survive in soil and manure for 150 plus days and up to 70 days, respectively (Rushing 2010). About half of the farms reported that their crops are harvested with bare hands, yet one-third lack accessible proper

handwashing or bathroom facilities for use, which may increase risk of foodborne illness (J. A. Harrison et al., 2013).

Food safety practices at markets

A 2017 meta-analysis of food safety at farmers' markets by Young et al. found that only 40 to 90% of the vendors in the studies analyzed provided proper refrigeration of potentially hazardous foods. In addition, only 0 to 29% of vendors across three studies used a thermometer to monitor these temperatures farmers' market vendors and managers lacked knowledge about recommended food safety practices such as temperature control and identification of potentially hazardous foods (Young et al., 2017). COVID-19 supply chain interruptions coupled with a surge in supermarket demand has led to an increase in local foods and outlets like farmers markets and community supported agriculture (Lusk et al., 2020; Richards & Rickard, 2020; Schmidt et al., 2020). There has also been a reduction in the number of grocery store trips consumers are taking (Hamidi & Zandiatashbar, 2021). IFIC reported that over 50% of consumers were going to the store less in April 2020 with only 33% doing this in June 2021 (International Food Information Council, 2020, 2021).

Food safety training

A few studies have looked at training farmers market personnel as an intervention method. Two pre- and post-intervention studies have been conducted on the effect of training on food safety knowledge (J. Harrison et al., 2015; J. A. Scheinberg et al., 2018). J. Harrison and authors (2015) trained 328 farmers market vendors and 114 market managers while Scheinberg and authors (2018) trained 38 vendors through in-person workshops. These studies

found a significant increase in knowledge from the pre- and post-results of their study. Knowledge increase, however, does not translate to behavior change (Richard et al., 2013) Two other studies by Pollard et al. (2015) and Smathers (2012) compared farmers market vendors that did not receive food safety training and those that did and found that there was no significant impact on the vendors' observed food safety practices. Findings from Pollard et al. (2015) recommend the development of training tools that are more specific for farmers market vendors. Similar recommendations were made in a meta-analysis on food safety at farmers markets by Young et al. (2017) to address the barriers and challenges that are unique to farmers market vendors.

Technology being used in agriculture

Training content for farmers market personnel should be different than that used for restaurant personnel (Choi & Almanza, 2012). Food safety content developed as a one size fits all model assuming that the applications and usability are the same for all is not very effective. Approaches to development of food safety standards need to consider the risks posed by specific farm structures such as the farm size, produce type, and production practices (Parker et al., 2016). The educational programming and information on management practices needs to provide scale-specific content for farms.

Norwood et al. (2019) developed food safety educational materials in the form of videos and presented them as screenshots to farmers market managers and vendors who did not have access to a computer. The educational videos were shown at grower and farmers market meetings and evaluated using a survey. It was determined that 98% (N=60) found the video easy to understand and 88% found the content engaging (Norwood et al., 2019); but there was

no follow up to determine if the novel training method was more effective in changing behavior.

A study done by Beza and colleagues (2017) determined from a survey of the Seeds for Need Initiative (an international initiative that aims to provide accessible information and seed variety to farmers), that over 90% of farmers owned a mobile phone with the primary function being receiving and making calls. The majority of Ethiopian farmers (77%) stated that they used their mobile phone to receive agricultural advice, to communicate with extension workers, and to get extension support. 90% of farmers in India, Ethiopia, and Honduras had mobile phones with the primary function of the phones being for making and receiving calls (Beza et al., 2017). Smartphone applications (SA) have been utilized as a means to collect observational data on farmers market personnel's food safety practices (Behnke et al., 2012; S. Pollard et al., 2016; J. A. Scheinberg et al., 2018; Vandeputte et al., 2015). A literature review by Baumüller, 2018 shows the utilization of mobile technologies focused on mobile-based cell service usage and their usage by farmers, but to our knowledge, no studies have been done in the United States with regards to cell service and access to phone-based technologies for farmers.

COVID-19 pandemic

COVID-19 was detected in Wuhan, China December 2019 and spread worldwide within a few months (World Health Organization, 2021). COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and is transmitted through inhalation of respiratory droplets and aerosol particles carry infectious virus, deposition of virus inhaled droplets and particles, or touching mucous membranes from contaminated surfaces (Centers

for Disease Control and Prevention, 2021b). As of June 2021, there are over 175 million confirmed cases worldwide with 33 million cases and 600,000 deaths from the United States (Centers for Disease Control and Prevention, 2021a). The pandemic resulted in all types of food businesses and food-purchasing consumers reevaluating how they sold food and purchased food, respectively.

COVID-19 and food safety practices.

There is no scientific evidence that supports the transmission of COVID-19 through food or food packaging (Food and Drug Administration, 2021). Transmission of COVID-19 spreads when an individual breathes in droplets and particles with from someone infected with SARS-CoV-2, or if the particles land on their eyes, noses, or mouth (Center for Disease Control and Prevention, 2020). Infected individuals with COVID-19 may also contaminate surfaces they touch. During the first few months of the pandemic, scientists were uncertain of the method of spread leading to many different practices being implemented to be careful (Katella, 2021) (Yale Medicine, 2019). Although we now know that COVID-19 does not spread through food or food packaging, preventive measures for SARS-CoV-2 can have an influence on preventing other diseases such as foodborne illness (Center for Disease Control and Prevention, 2020). A study by Kraay et al., 2020 discovered that non-pharmaceutical interventions (NPIs) such as social distancing, disinfecting surfaces, mask wearing, and handwashing have become common practice during the COVID-19 pandemic in an effort to reduce transmission. These NPIs may also have an influence on the transmission of pathogens such as norovirus. There has been a reported increase in handwashing practices due to the COVID-19 pandemic, however, the authors believe that this level will decrease after the pandemic as many consumers are not

connecting this practice with food safety (Thomas & Feng, 2021). Food thermometer use by consumers has also increased during the pandemic (Thomas & Feng, 2021). With an increase in good adoption of good practices due to the COVID-19 pandemic, consumers also adopted poor ones such as washing fruits with soap and water and vinegar (Thomas & Feng, 2021). Similar results were seen by the International Food Information Council's (IFIC) COVID-19 survey where from there was a decrease in rinsing fresh produce after purchase from April 2020 (35%) to June 2021 (29%) (International Food Information Council, 2021).

Farmers market during COVID-19 pandemic.

Farmers market sales in areas such as Washington D.C. decreased between 74-79% as a result of the pandemic (Broadaway & Wolnik, 2020; O'Hara et al., 2020). Farmers markets faced many challenges during this time including increased operation expenses related to safety measures, development and integration of online purchasing options or pre-packaging, and a decrease in revenue streams from vendors and funders (Broadaway & Wolnik, 2020). At the start of the pandemic, some farmers markets faced challenges with staying open because they were deemed as non-essential businesses or were awaiting guidance from their state and local health officials on how to reopen (*Executive Order No. 53*, 2020; Hadish, 2020). Although farmers markets operate similarly to grocery stores providing their customers with food, they did not fall under the same classification (Farmers Market Coalition, 2020). This distinction has led to a loss of funding opportunities such as SNAP online purchasing programs that were introduced during the pandemic spring 2020 for retailers like Walmart and Amazon but not farmers markets (Broadaway & Wolnik, 2020).

References

1. Abel, J., Thomson, J., & Maretzki, A. (1999). Extension's role with farmers' markets: Working with farmers, consumers, and communities. *Journal of Extension*, *37*(5), 47–58.
2. Andreatta, S., & Wickliffe, W. (2002). Managing farmer and consumer expectations: A study of a North Carolina farmers market. *Human Organization*, *61*(2), 167–176. https://doi.org/10.17730/humo.61.2.a4g01d6q8djj5lkb
3. Batz, M. B., Hoffmann, S., & Morris, J. G. (2012). Ranking the disease burden of 14 pathogens in food sources in the United States using attribution data from outbreak investigations and expert elicitation. *Journal of Food Protection*, *75*(7), 1278–1291. https://doi.org/10.4315/0362-028X.JFP-11-418
4. Baumüller, H. (2018). The Little We Know: An Exploratory Literature Review on the Utility of Mobile Phone-Enabled Services for Smallholder Farmers. *Journal of International Development*, *30*(1), 134–154. https://doi.org/10.1002/jid.3314
5. Behnke, C., Seo, S., & Miller, K. (2012). Assessing food safety practices in farmers' markets. *Food Protection Trends*, *32*(5), 232–239.
6. Beza, E., Steinke, J., Van Etten, J., Reidsma, P., Fadda, C., Mittra, S., Mathur, P., & Kooistra, L. (2017). What are the prospects for citizen science in agriculture? Evidence from three continents on motivation and mobile telephone use of resource-poor farmers. *PLoS ONE*, *12*(5), 1–27. https://doi.org/10.1371/journal.pone.0175700
7. Broadaway, D., & Wolnik, D. (2020). Iteration, innovation, and collaboration: Supporting farmers markets' response to COVID-19. *Journal of Agriculture, Food Systems, and Community Development*, *10*(1), 1–4. https://doi.org/10.5304/jafscd.2020.101.014
8. Brown, A. (2001). Counting Farmers Markets Allison Brown. *Geographical Review*, *91*(4), 655–674. https://www.jstor.org/stable/3594724?seq=1#metadata_info_tab_contents

9. Byker, C., Shanks, J., Misyak, S., & Serrano, E. (2012). *Characterizing Farmers ' Market Shoppers : A Literature Review*. 38–52. https://doi.org/10.1080/19320248.2012.650074

10. Canadian Food Inspection Agency. (2014). *Food Recall Warning - Unpasteurized apple cider processed by Rolling Acres Cider Mill recalled due to E. coli O157:H7*. http://www.inspection.gc.ca/about-the-cfia/newsroom/food-recall-warnings/complete-listing/2014-10-30/eng/1414720185030/1414720197088

11. Center for Disease Control and Prevention. (2020). *When and How to Wash Your Hands*. Handwashing: Clean Hands Save Lives. https://www.cdc.gov/handwashing/when-how-handwashing.html

12. Centers for Disease Control and Prevention. (2021a). *COVID Data Tracker: Variant Proportions*. Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html

13. Centers for Disease Control and Prevention. (2021b). *Scientific Brief: SARS-CoV-2 Transmission | CDC*. https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html

14. Choi, J. K., & Almanza, B. (2012). An assessment of food safety risk at fairs and festivals: A comparison of health inspection violations between fairs and festivals and restaurants. *Event Management*, *16*(4), 295–303. https://doi.org/10.3727/152599512X13539583374974

15. *Executive Order No. 53*, (2020) (testimony of Commonwealth of Virginia Office of the Governor).

16. Conner, D., Colasanti, K., Ross, R. B., & Smalley, S. B. (2010). Locally grown foods and farmers markets: Consumer attitudes and behaviors. *Sustainability*, *2*(3), 742–756. https://doi.org/10.3390/su2030742

17. Farmers Market Coalition. (2020). *Farmers Markets Respond to COVID-19 — Best Practices,*

Examples, and Resources. https://farmersmarketcoalition.org/covid-19-crisis-farmers-market-new-guidelines/

18. Feldmann, C., & Hamm, U. (2015). Consumers' perceptions and preferences for local food: A review. In *Food Quality and Preference* (Vol. 40, Issue PA, pp. 152–164). https://doi.org/10.1016/j.foodqual.2014.09.014
19. Food and Drug Administration. (2019). *Food Safety Modernization Act*. https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm247548.htm
20. Food and Drug Administration. (2021). *COVID-19 Update: USDA, FDA Underscore Current Epidemiologic and Scientific Information Indicating No Transmission of COVID-19 Through Food or Food Packaging*. https://www.fda.gov/news-events/press-announcements/covid-19-update-usda-fda-underscore-current-epidemiologic-and-scientific-information-indicating-no
21. Gumirakiza, J. D., Curtis, K. R., & Bosworth, R. (2014). Who attends farmers' markets and why? Understanding consumers and their motivations. *International Food and Agribusiness Management Review*, *17*(2), 65–82.
22. Hadish, C. (2020, April 14). Awaiting state guidance, Iowa farmers markets left in limbo as some put season on hold | Iowa Center for Public Affairs Journalism. *Iowa Watch*. https://www.iowawatch.org/2020/04/14/awaiting-state-guidance-iowa-farmers-markets-left-in-limbo-as-some-put-season-on-hold/
23. Hamidi, S., & Zandiatashbar, A. (2021). Compact development and adherence to stay-at-home order during the COVID-19 pandemic: A longitudinal investigation in the United States. *Landscape and Urban Planning*, *205*(May 2020), 103952. https://doi.org/10.1016/j.landurbplan.2020.103952
24. Harrison, J. A., Gaskin, J. W., Harrison, M. A., Cannon, J. L., Boyer, R. R., & Zehnder, G. W. (2013).

Survey of food safety practices on small to medium-sized farms and in farmers markets. *Journal of Food Protection*, *76*(11), 1989–1993. https://doi.org/10.4315/0362-028X.JFP-13-158

25. Harrison, J., Boyer, R., & Harrison, M. (2015). *Enhancing the Safety of Locally Grown Produce – Outcomes and Challenges of Food Safety Education for Small-scale Farmers and Market Managers*. https://iafp.confex.com/iafp/2015/webprogram/Paper8933.html
26. International Food Information Council. (2020). *COVID-19: June 2020*. https://foodinsight.org/wp-content/uploads/2020/10/COVID-19-Questions.June-2020.pdf
27. International Food Information Council. (2021). *COVID-19: June 2021*. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it
28. Iowa Department of Public Health. (2010). *Iowa surveillance of notifiable and other diseases: annual report 2010*. http://idph.iowa.gov/Portals/1/Files/CADE/IDPH_Annual_Rpt_2010_final.pdf
29. Jacob, C. J., & Powell, D. A. (2009). Where Does Foodborne Illness Happen—in the Home, at Foodservice, or Elsewhere—and Does It Matter? *Foodborne Pathogens and Disease*, *6*(9), 1121–1123. https://doi.org/10.1089/fpd.2008.0256
30. Katella, K. (2021). *5 Things Everyone Should Know About the Coronavirus Outbreak*. Yale Medicine. https://www.yalemedicine.org/news/2019-novel-coronavirus
31. Kraay, A. N. M., Han, P., Kambhampati, A. K., Wikswo, M. E., Mirza, S. A., & Lopman, B. A. (2020). Impact of non-pharmaceutical interventions for SARS-CoV-2 on norovirus outbreaks: an analysis of outbreaks reported by 9 US States. *MedRxiv*, 2020.11.25.20237115. https://doi.org/10.1101/2020.11.25.20237115

32. Laidler, M. R., Tourdjman, M., Buser, G. L., Hostetler, T., Repp, K. K., Leman, R., Samadpour, M., & Keene, W. E. (2013). Escherichia coli O157:H7 infections associated with consumption of locally grown strawberries contaminated by deer. *Clinical Infectious Diseases*, *57*(8), 1129–1134. https://doi.org/10.1093/cid/cit468

33. Lusk, J., Ellison, B., Featherstone, A. M., Low, S. A., Malone, T., Maples, J., Mccluskey, J. J., Schulz, L., Sheldon, I., Tanger, S. M., Coble, K., Hake, M., Dorfman, J. H., Mcfadden, B. R., Richards, T. J., Rickard, B. J., Anderson, J. D., Coble, K., Low, S., … Cochran, M. (2020). *Economic Impacts of COVID-19 on Food and Authors Reviewers*. 1–44.

34. Neill, C. L., & Holcomb, R. B. (2019). Does a food safety label matter? Consumer heterogeneity and fresh produce risk perceptions under the Food Safety Modernization Act. *Food Policy*, *85*(December 2018), 7–14. https://doi.org/10.1016/j.foodpol.2019.04.001

35. Norwood, H. E., Neal, J. A., & Sirsat, S. A. (2019). Food safety resources for managers and vendors of farmers markets in Texas. *Journal of Environmental Health*, *82*(2), 8–12.

36. O'Hara, J., Woods, T., Dutton, N., & Stavely, N. (2020). *COVID-19's Impact on Farmers Market Sales in Washington D.C. , Area*. https://doi.org/10.1017/aae.202

37. Oregon Health and Human Services Department. (2011). *Public Health Alert: Fresh Strawberries from a Farm Field in Washington County Implicated in E. Coli O157 Outbreak in NW Oregon*.

38. Painter, J. A., Hoekstra, R. M., Ayers, T., Tauxe, R. V, Braden, C. R., Angulo, F. J., & Griffin, P. M. (2013). *Attribution of Foodborne Illnesses , Hospitalizations , and Deaths to Food Commodities by using Outbreak*. *19*(3), 407–416.

39. Park, C. E., & Sanders, G. W. (1992). Occurrence of thermotolerant campylobacters in fresh vegetables sold at farmers' outdoor markets and supermarkets. *Canadian Journal of Microbiology*, *38*(4), 313–316. https://doi.org/10.1139/m92-052

40. Parker, J. S., DeNiro, J., Ivey, M. L., & Doohan, D. (2016). Are small and medium scale produce farms inherent food safety risks? *Journal of Rural Studies*, *44*, 250–260. https://doi.org/10.1016/j.jrurstud.2016.02.005

41. Pollard, S., Boyer, R., Chapman, B., Stefano, J. di, Archibald, T., Ponder, M. A., & Rideout, S. (2016). Identification of risky food safety practices at Southwest Virginia farmers' markets. *Food Protection Trends*, *36*(3), 168–175. http://login.ezproxy.lib.vt.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ffh&AN=2016-10-Cd2773&site=eds-live&scope=site

42. Pollard, S. K., Chapman, B., Ponder, M. A., Rideout, S. L., & Pollard, S. K. (2015). *Identification of food safety risks at Virginia farmers ' markets and development of a food safety plan to help farmers ' market m anagers Identification of food safety risks at Virginia farmers ' markets and development of a food safety plan to help farm*.

43. Redmond, E. C., & Griffith, C. J. (2003). Consumer food handling in the home: a review of food safety studies. *Journal of Food Protection*, *66*(1), 130–161. https://doi.org/10.4315/0362-028X-66.1.130

44. Richard, A. E., Brown, J. L., Radhakrishna, R. B., Yoder, E. P., Nieto-Montenegro, S., & Cutter, C. N. (2013). Development and implementation of a "counter-top" training program to increase retention of food safety knowledge, alter behavior, improve attitude and increase skills of spanishspeaking retail employees. *Food Protection Trends*, *33*(1), 10–19.

45. Richards, T. J., & Rickard, B. (2020). COVID-19 impact on fruit and vegetable markets. *Canadian Journal of Agricultural Economics*, *68*(2), 189–194. https://doi.org/10.1111/cjag.12231

46. Scallan, E., Hoekstra, R. M., Angulo, F. J., Tauxe, R. V., Widdowson, M. A., Roy, S. L., Jones, J. L., & Griffin, P. M. (2011). Foodborne illness acquired in the United States-Major pathogens.

Emerging Infectious Diseases, *17*(1), 7–15. https://doi.org/10.3201/eid1701.P11101

47. Scharff, R. L. (2011). Economic Burden from Health Losses Due to Foodborne Illness in the United States. *Journal of Food Protection*, *75*(1), 123–131. https://doi.org/10.4315/0362-028X.JFP-11-058

48. Scheinberg, J. A., Radhakrishna, R., Campbell, J. A., & Cutter, C. N. (2018). A comprehensive needs assessment of food safety practices of farmers' market vendors in Pennsylvania using direct concealed observations, self-reported surveys, and state sanitarian surveys. *Food Protection Trends*, *38*(6), 421–439.

49. Scheinberg, J., Doores, S., & Cutter, C. N. (2013). *A MICROBIOLOGICAL COMPARISON OF POULTRY PRODUCTS OBTAINED FROM FARMERS' MARKETS AND SUPERMARKETS IN PENNSYLVANIA*. https://doi.org/10.1111/jfs.12047

50. Schmidt, C., Goetz, S., Rocker, S., & Tian, Z. (2020). Google Searches Reveal Changing Consumer Food Sourcing in the COVID-19 Pandemic. *Journal of Agriculture, Food Systems, and Community Development*, *9*(3), 9–16.

51. Schneider, D. (2017). Brown County salmonella cases blamed on peas from Green Bay farmers market. *USA Today*. https://www.greenbaypressgazette.com/story/news/2017/08/11/four-brown-county-salmonella-cases-blamed-peas-farmers-markets/560506001/

52. Smathers, A. (2012). *Evaluation, Development, and Implementation of an Education Curriculum to Enhance Food Safety Practices at North Carolina Farmers' Markets*. North Carolina State University.

53. Smithers, J., Lamarche, J., & Joseph, A. E. (2008). Unpacking the terms of engagement with local food at the Farmers' Market: Insights from Ontario. *Journal of Rural Studies*, *24*(3), 337–350. https://doi.org/10.1016/j.jrurstud.2007.12.009

54. Soendjojo, E. (2012). Is Local Produce Safer? Microbiological Quality of Fresh Lettuce and Spinach from Grocery Stores and Farmers' Markets. *Journal of Purdue Undergraduate Research*, *2*(2), 54–63. https://doi.org/10.5703/jpur.02.1.09

55. Teramoto, H., Salaheen, S., & Biswas, D. (2016). Contamination of post-harvest poultry products with multidrug resistant Staphylococcus aureus in Maryland-Washington DC metro area. *Food Control*, *65*, 132–135. https://doi.org/10.1016/j.foodcont.2016.01.024

56. Thomas, M. S., & Feng, Y. (2021). Food Handling Practices in the Era of COVID-19: A Mixed-Method Longitudinal Needs Assessment of Consumers in the United States. *Journal of Food Protection*, *84*(7), 1176–1187. https://doi.org/10.4315/jfp-21-006

57. United States Department of Agriculture. (2015). *2015 Local Food Marketing Practices Survey*. https://www.nass.usda.gov/Publications/AgCensus/2012/Online_Resources/Local_Food/index.php

58. United States Department of Agriculture Agricultural Marketing Service. (2020). *Local food directories: national farmers market directory*. https://www.ams.usda.gov/local-food-directories/farmersmarkets

59. United States Department of Agriculture Agriculture Marketing Service Division. (2019). *National Count of Farmers Market Directory Listings*. https://www.ams.usda.gov/sites/default/files/media/NationalCountofFarmersMarketDirectoryListings082019.pdf

60. United States Department of Agriculture Food and Nutrition Services. (2015). *What is a farmers' market?*

61. United States Department of Agriculture National Agricultural Statistics Services. (2020). *National Farmers Market Managers*.

62. United States Food and Drug Administration. (2021). *FSMA Final Rule on Produce Safety*.

63. Vandeputte, E. G., Pivarnik, L. F., Scheinberg, J., Machado, R., Cutter, C. N., & Lofgren, I. E. (2015). An assessment of food safety handling practices at farmers' markets in Rhode Island using a smartphone application. *Food Protection Trends*, *35*(6), 428–439.

64. Virginia Department of Agriculture and Consumer Services. (2019). *Frequently Asked Questions about the Produce Safety Rule (PSR)*. https://www.ecfr.gov/cgi-bin/text-

65. Wolf, M. M., Spittler, a., & Ahern, J. (2005). A Profile of Farmers ' Market Consumers and the Perceived Advantages of Produce Sold at Farmers' Markets. *Journal of Food Distribution Research*, *36*(1), 192–201.

66. World Health Organization. (2021). *Listings of WHO's response to COVID-19*. https://www.who.int/news/item/29-06-2020-covidtimeline

67. Young, I., Thaivalappil, A., Reimer, D., & Greig, J. (2017). Food safety at farmers' markets: A knowledge synthesis of published research. In *Journal of Food Protection* (Vol. 80, Issue 12, pp. 2033–2047). https://doi.org/10.4315/0362-028X.JFP-17-193

CHAPTER 3

Research Note

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Assessment of regulatory compliance of Virginia and North Carolina Farmers Market Vendors to the Food Safety Modernization Act

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KEY WORDS: Farmers market, Food Safety Modernization Act, food safety, Produce Safety Rule.

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Abstract

Farmers markets (FMs) in the United States have grown rapidly over the past twenty years. Food producers and processors at these markets are diverse, with varying business scopes and sizes. Often, direct market food businesses receive little food safety education or oversight therefore it is unclear if they fall within the scope to comply with the newly implemented Produce Safety Rule (PSR) and Preventive Controls for Human Foods Rule (PCHFR). The purpose of this study was to understand size and scope of farmers market vendors businesses to determine their regulatory compliance requirements. Furthermore, their educational needs and interest in using a smart phone app related to food safety was assessed. Farmers market vendors were recruited in Virginia and North Carolina through e-mail listservs and asked to participate in a telephone interview to discuss their business practices. Questions were asked about food products produced, annual revenue, and food safety practices on the farm. Most farms sold a combination of both raw and rarely consumed raw agricultural commodities. Of the thirty-two FM vendors interviewed, only one was covered by the PSR; no participants were covered by PC; and two exclusively sold fresh meat. The majority of vendors (94%, 30 of 32) sold produce. Eighteen (60%, 18 of 30) of the produce vendors also sold value-added products. Seventy-five percent (n=24) of vendors were exempt from the PSR based on total sales; and the remaining were qualified exempt. A risky behavior identified was the use of untested well water. This study provides much-needed data on regulatory requirement trends associated with FM businesses and their educational needs. These interviews will aid in developing specialized, tailored training opportunities for vendors who do not fall under PSR or PC

requirements. Many vendors stated receiving their food safety information from Cooperative Extension and wanting to use a smartphone app to receive content.

Introduction

Farmers markets are defined by the United States Department of Agriculture (USDA) as a fixed location where farmers and/or producers sell their agricultural products (United States Department of Agriculture Food and Nutrition Services, 2015). This is further defined (Brown, 2001) as recurring markets where farmers and producers can bring their produce for sale to the direct public. The number of farmers markets registered by the USDA has increased from 1,775 in 1994 to 8,771 in 2019 (United States Department of Agriculture Agriculture Marketing Service Division, 2019). The majority of the food products (82%) available for purchase at farmers markets are produce (Smathers, 2012b). Consumers mainly purchase vegetables (91%) and fruits (76%) (Andreatta & Wickliffe, 2002). Some produce products available for purchase at markets include those requiring time and temperature control to ensure their safety potentially hazardous foods such as sprouts and cut leafy greens (S. K. Pollard et al., 2015). Other products such as cheeses, honey, bread, and other value-added products are less likely (8%) to be purchased by consumers at FMs (Andreatta & Wickliffe, 2002). Value-added products can be risky foods requiring acidification and processing to ensure safety. A survey of state regulatory personnel and state food safety educators by (J. A. Harrison et al., 2016) showed that owners and operators of small and very small food businesses may lack food knowledge of food safety and where to go to get information on the risks associated with their products.

Small to medium sized farms may have an increased risk of foodborne illness because of risky on-farm practices (J. A. Harrison et al., 2013). These practices include using raw manure (57%), not providing available handwashing and bathroom facilities (34%), harvesting crops with bare hands (50%), and using surface water from streams, pond, untested well water, or

rainwater for irrigation (31%). Of the farms reporting use of manure, 16% (n=30) do not compost it, 18% (n=23) mix it the composted manure with raw manure, and 59% (n=76) use it but do not mix with raw manure (J. A. Harrison et al., 2013).

The Food Safety Modernization Act (FSMA) has changed the food safety supply to be more preventive, rather than reactive to contamination issues. FSMA contains seven rules that encompass several avenues in the food system. Two of the seven are the Preventive Controls for Human Food Rule (PCHFR) and the Standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption, also known as the Produce Safety Rule (PSR). The act has allowed for the first time ever, FDA to oversee on-farm activities for produce. Since farmers markets primarily sell fresh produce and value-added products, these new regulations may impact vendors selling through these avenues. Both rules include exemptions for smaller-scale operations, but it is unclear how the diverse landscape of FM vendors fit.

The key requirements of the FSMA Produce Safety Rule address agricultural water, biological soil amendments; equipment, tools, and buildings; and worker health, hygiene, and training (United States Food and Drug Administration, 2021a). The size and scope of the operation determines whether farms will need to comply with specific FSMA rules. For example, under the FSMA PSR, farms can be fully exempt from the PSR if they grow produce that is for personal or on-farm consumption only, rarely consumed raw (ex. Potatoes, squash, etc.), or that undergoes additional processing (FDA, 2021). Additionally, farms that gross an average of less than $25,000 total produce sales over a three-year period are exempt (FDA, 2021). As of 2019, there are 2.02 million farms in the United States (United States Department of Agriculture National Agricultural Statistics Services, 2020). The majority of the farms in the

U.S. (51.1%) gross between $1,000 - $9,999 falling outside the monetary requirement of the FSMA's Produce Safety Rule (United States Department of Agriculture National Agricultural Statistics Services, 2020).

A few studies have investigated different training methods for various farmers market personnel. Generally, these studies indicate a significant increase in knowledge regardless of method, however, this does not translate to behavior change (Richard et al., 2013). Findings from Pollard and authors (2015) recommend the development of training tools highly specific for the farmers market vendors. Similar recommendations were made in a meta-analysis on food safety at farmers markets by Young et al. (2017) to address the barriers and challenges that are unique to farmers market vendors.

Smartphones have played a large role in agriculture in the 2010s being used in crop production and livestock management, but they have not found their way into food safety except for serving as instruments for data collection in observational studies (Ariff and Ismail, 2013, Ferreira et al., 2020; Pollard et al., 2015). In the health field, apps have become a platform to deliver simple and effective interventions targeting noncommunicable diseases such heart disease and cancer. A 2016 review by (Zhao et al., 2016) found that apps had statistically significant effects in achieving health-related behavior change with about one-third of the apps utilizing the Theory of Planned Behavior as a framework. The purpose of this study was to document size and scope of farmers market vendors businesses to determine their regulatory compliance requirements, to identify targeted training needs for this population, and determine the desirability of a smartphone app for food safety information.

Materials and Methods

The Virginia Tech Institutional Review Board approved the experimental protocol used in this study (IRB 19-474).

Interview guide questions development and validation. The interview guide was developed using exemption and covered status guidelines from the Produce Safety Rule (PSR) and Preventive Controls for Human Foods Rule (PC). The questions on PSR focused on annual revenue (specifically if FM vendors grossed over or under $25,000 all produce sales that may be covered); product type being grown (raw agricultural commodity versus rarely consumed raw); food safety practices on the farm; and where the food ends up post-harvest. The questions on PC focused on processing of products on the farm, annual revenue of processed products, and the presence or absence of a written food safety plan. The interview guide was validated by a panel of food safety experts and piloted with a group of university-level students to assess the questions for clarity and conciseness. The results from the pilot study are not included in the reported results here.

Recruitment letter and screening for interviews. Farmers market vendors were recruited in North Carolina and Virginia from September 2019 to March 2020. A recruitment letter summarizing the study's purpose, method for data collection, and potential incentive for completion were distributed using an existing network of partners which included Cooperative Extension Agents and grower organizations in North Carolina and Virginia. The recruitment letter instructed interested individuals to fill out a brief online questionnaire to determine study eligibility. To be eligible, an individual must 1) sell food to the public as part of their business, and 2) sell at a farmers' market.

Scheduled interviews. Interviews of eligible FM vendors were completed over the telephone. Sessions were not recorded but live transcribed using Microsoft Word (Redmond, WA). A previous study compared in-depth interviews done with and without voice recorders and concluded no difference in data quality. Each interviewee was asked 20 structured questions. Topics included types of products sold and annual revenue from these products, food safety practices of the business, and how businesses currently receive food safety information and if they would be interested in receiving that information via a smartphone app.

Data analyses. A quantitative codebook was developed based off the interview guide (Appendix A.) A quantitative based method was used for all but three questions due to the nature of these questions being closed-ended eliciting a specific response. Quantitative statistical analysis was performed using SPSS for Windows (IBM, Armonk, NY). A codebook was developed and refined until codes were stable with a final codebook achieving an inter-rater reliability of Cohen's kappa score of .86. Qualitative data were analyzed using a thematic analysis framework provided by (Roberts et al., 2019). The framework tested reliability of the codebook development, which includes elements of initial code development and codebook development, application, and review.

Results

Thirty-two FM vendors from Virginia and North Carolina were interviewed.

Produce Safety Rule Status. Of the 32 FM vendors interviewed, 65.6% (n=21) were exempt from the Produce Safety Rule requirements. Two of the twenty-one exempt vendors (9.5%) exclusively sold meat therefore they fell under inspection of the USDA and State Departments of Agriculture. The remaining nineteen vendors were exempt because they grossed less than $25,000 in revenue annually. Twenty-eight percent (9 of 32) of the vendors fell under qualified exempt status of PSR meaning they grossed over $25,000 but less than $500,000 annually and sold the majority of their food to a qualified end-user. Only two vendors (6%) interviewed self-identified as grossed over $500,000 annually, requiring compliance with the rule.

Preventive Controls for Human Foods Rule (PCHFR) None of the FM vendors interviewed were covered by PCHFR since they met the definition of either a primary production farm (PPF) or secondary activities farm (SAF). PPFs, as described in the section above, is an operation in one physical location used for growing crops, harvesting crops, raising animals, or any combination of these. Harvesting, packing, and holding of crops and processing and manufacturing activities such as drying and dehydrating product, treatment to manipulate ripening, or packaging and labeling of products fall underneath the definition of what a “farm” can do according to the FDA (FDA, 2015). SAFs are not located on a primary production farm but has operations that are devoted to those previously listed.

Vendor on-farm practices. Fifteen produce-growing vendors also reported having livestock on their farm, and all but one of these vendors used a fence or separate facility for their farm animals. Half of the total vendors (16 of 32) shared that their business had written

procedures for cleaning and sanitizing for areas such as the packing house, food contact surfaces, and vehicles used to transport produce. All vendors that sold produce (n=30) used potable water (tested well water, municipal water) for their on-farm practices when washing produce, in processing, or in cleaning and sanitizing. Three vendors reported using well water as their main source and only one of the vendors stated they tested their well water. The two vendors who reported not using potable water said they used pond water.

Food Safety Information on Fresh Produce or Processed Products. The majority (22/32, 69%) of vendors interviewed primarily obtain food safety information from the university or Cooperative Extension Service in their state. Three vendors (9%) used USDA or FDA websites as a resource for food safety information while eleven vendors (34%) used industry and grower organizations to obtain information. Some vendors (6 of 32, 19%) obtained information from state regulators such as the Department of Health or Department of Agricultural and Consumer Services. Two vendors (6%) cited their own experiences as their source for their farm's food safety choosing not to rely on any additional information.

Smartphone Application Use on a Farm. Thirty-four percent of vendors interviewed (n=11) said they would utilize a smartphone application dedicated towards providing food safety information while forty-one percent (n=13) would maybe consider using it. Eight vendors (25%) said they would not use a smartphone application for food safety information. The majority of vendors (n=28, 88%) provided ideas of what their farm would like to see in a smartphone application. These ideas included recordkeeping technology, crop information, networking and consultations with other farms or organizations, and guidelines on how to follow required rules and standards.

Discussion

PSR and PC estimations of coverage. Most interviewees (67%, 21 of 32) fell outside the scope of the monetary range for PSR and PC Rule compliance. The USDA 2017 Census of Agriculture Report reported that approximately 1.4 million farms (69%) gross less than $25,000 in sales (United States Department of Agriculture National Agricultural Statistics Service, 2017). These 69% of farms account for only 1.59% of the total agricultural products sold in the United States (United States Department of Agriculture National Agricultural Statistics Service, 2017). "Agricultural products" encompass total sales for two categories: 1) livestock, poultry, and their products, and 2) crops, (including nursery and greenhouse crops). According to the Census of Agriculture, farms falling into the $25,000 - $499,999 category account for about 482,000 farms (24%) that account for 17% in total agricultural product sales. The remaining 7% of farms grossing $500,000 or more in annual sales and account for about 85% of total sales (United States Department of Agriculture National Agricultural Statistics Service, 2017). Of the FM vendors interviewed, only two fell into this category.

As previously mentioned, this study was completed because it is unclear how many of the FM vendors nationwide may need to comply with these two FSMA rules. Using our data, we extrapolated the nationwide numbers. To do this, we used data available from the USDA AMS and USDA NASS, which estimates that there 8,700 farmers markets in the United States and an average of 25 vendors at a peak market day (United States Department of Agriculture Agricultural Marketing Service, 2020; United States Department of Agriculture National Agricultural Statistics Services, 2020). These estimates tell us there are approximately 217,500 vendors, nationwide. Based on the data we collected, we believe that about two-thirds of FM

vendors (n=143,550) will fall under the PSR classification of exempt with the majority (n=129,879) being because they gross less than $25,000 annually and some of these are likely to exclusively sell meat. About 28% (n=58,725) FM vendors will fall underneath the classification of qualified exempt while only 6% (n=13,593) will be covered by the PSR. No FM vendors fell under the requirements to be covered by the PC Rule because they were categorized as PPFs or SAFs. Food processing facilities may be exempt from the PC Rules requirements if they manufacture products covered by other, separate regulations such as juice, seafood, dietary supplement, alcoholic beverages, and low-acid canned foods. The two meat-exclusive vendors would be covered by the Meat and Poultry Hazard Analysis Critical Control Point. Small or very small on-farm businesses may be exempt if they manufacture/process, pack, or hold low-risk foods such as baked goods, snack chips from fruits and vegetables, or dried pasta. Small businesses are defined as those with less than 500 full-time employees while very small businesses are those that average less than $2.5 million in sales. Businesses that do not fit under these exemption guidelines due to the type of product produced will follow a modified version of the rule that involves maintenance of qualification, implementation and monitoring of preventive controls, and providing complete business information with a sign or label at the point of sale. Retail Food Establishments (RFE) are like farms and do not have to register as a food facility and be subject to the PC rule. A RFE is an establishment whose primary function is to sell food products directly to consumers and includes farm-operate businesses that may sell directly to consumers at farmers markets. As expected, the majority of FM vendors will be exempt from PSR and PC Rule compliance. Regardless of required compliance, these individuals should still be trained in food safety and

practice safe growing and harvesting techniques as well as safe handling and preparation practices to reduce the risk of foodborne illness.

Risky food safety behaviors A survey by Harrison et al. (2013) found that (31%) of farmers did not use recommended water sources. In this study, two vendors (6%) used pond water as their primary agricultural water source. Pond water falls into the category of surface water and has the highest risk of contamination when compared to well water or municipal water because of what might enter the water (Laborde & DuPont, 2020). There were three vendors who used well water and only one of those vendors explicitly stated testing their well water. No prompting questions were asked in this study on testing. Well water can become contaminated with microorganisms depending on their location (near manure, close to flood zones) or if they are not properly constructed and require testing (Laborde & DuPont, 2020).

Additionally, it has been documented that these vendors do practice some risky behaviors. However, food safety training and regulation has been reported to be a barrier. Many FM managers' report having no food safety standards in place for their market (J. A. Harrison et al., 2013) and the lack of specific food safety guidelines for can be a major barrier in implementing food safety practices (Mohammad et al., 2020). Tailored food safety resources should be developed specifically to address the barriers and challenges unique to FM vendors (S. K. Pollard et al., 2015; Young et al., 2017). Farmer's market-specific resources on topics such as biological soil amendments and water use are being redeveloped through the "Enhancing the Safety of Locally Grown Produce" curriculum (Boyer, 2019a, 2019b). These tailored resources can be transitioned into smartphone apps or mobile-friendly websites to increase access.

Smartphone application use. The majority of interviewed vendors stated they would use a smartphone application dedicated towards food safety with more than half citing the ability to access information readily. The development of a smartphone food safety application or even mobile-friendly website can address vendor concerns of the availability of food safety resources and information and assist with stressors they face day-to-day such as time. “Time” is a big stressor for farmers and having enough time to dedicate to things outside of agriculture is important (Kearney et al., 2014). Smartphone apps have shown to be effective in the health and nutrition fields at changing knowledge and behaviors (Nawaiseh & Mcintoch, 2019; Zhao et al., 2016), An app may allow for food safety educators to engage with vendors that require assistance in following proper guidelines and regulations. The app should include elements that address the interviewees’ requests for a networking and consultation system that would allow them to connect with their peers, or food safety educators who can offer support. A study conducted in Ethiopia, India, and Honduras showed the effectiveness of utilizing phones as a way to receive agricultural advice and receive extension support (Beza et al., 2018).

Limitations. Recruitment challenges were faced in North Carolina where only 3 of 33 participants were interviewed. Low participant numbers may have been due to issues associated with trust. Trust is the perceived credibility behind an individual’s actions and behaviors and is responsible for different reactions in uncertain situations (Larzelere & Huston, 2016). Trust plays a role in the behaviors of farmers to participate in programs and interact with those in their community (Diehl et al., 2018; Stallman & James, 2017). Stallman & James (2017) surveyed Missouri crop farmers (N=1,000) to explore the role of trust in an ecosystem service provision and found that the majority (67%) of farmers believed their fellow farmers to be

trustworthy but had low levels of trust for government officials (20%).

Conclusion. Based on our interview results, we discovered that most farmers market vendors are exempt from PSR and PC regulations. Future work should explore covered, exemption statuses in other states to better understand the extent of those outside these FSMA regulations. Future PSR and PC training materials should continue to address challenges and situations unique to farmers market vendors as Boyer (2019b) has done with the Enhancing the Safety of Locally Grown Foods curriculum.

Recommendations.

1. Develop a mobile-friendly or smartphone app for farmers to access food safety information. Components that should be included are information that is easily found using a website or app search bar, a forum or board for farmers to share with each other, and record keeping of food safety documents.
2. Agricultural water sources and testing of these sources as well as a proper farm food safety plan are topic areas to target future training materials specific to FM vendors. Components of a food safety plan that may be of use to farmers are the include but are not limited to wildlife and livestock management, general cleaning and sanitation, or other key requirements of the PSR.

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References

1. Andreatta, S., & Wickliffe, W. (2002). Managing farmer and consumer expectations: A study of a North Carolina farmers market. *Human Organization*, *61*(2), 167–176. https://doi.org/10.17730/humo.61.2.a4g01d6q8djj5lkb
2. Beza, E., Reidsma, P., Poortvliet, P. M., Belay, M. M., Bijen, B. S., & Kooistra, L. (2018). Exploring farmers' intentions to adopt mobile Short Message Service (SMS) for citizen science in agriculture. *Computers and Electronics in Agriculture*, *151*(February 2017), 295–310. https://doi.org/10.1016/j.compag.2018.06.015
3. Boyer, R. (2019a). Enhancing the Safety of Locally Grown Produce: Use of Manure and Other Soil Amendments of Animal Origin. *Virginia Cooperative Extension Educational Resources*. https://resources.ext.vt.edu/contentdetail?contentid=1930&contentname=Enhancing The Safety of Locally Grown Produce: Use of Manure and Other Soil Amendments of Animal Origin
4. Boyer, R. (2019b). *Enhancing the Safety of Locally Grown Produce: Water Use*. Virginia Cooperative Extension Educational Resources. https://resources.ext.vt.edu/contentdetail?contentid=1922&contentname=Enhancing The Safety of Locally Grown Produce: Water Use
5. Brown, A. (2001). Counting Farmers Markets Allison Brown. *Geographical Review*, *91*(4), 655–674. https://www.jstor.org/stable/3594724?seq=1#metadata_info_tab_contents
6. Diehl, D. C., Sloan, N. L., Garcia, E. P., Dourte, D. R., & Fraisse, C. W. (2018). Profitability,

Engaging Delivery, and Trust: How Extension Professionals Can Optimize Farmer Adoption of Climate-related Adaptation Strategies. *Journal of Human Sciences and Extension*, *6*(3), 107–121.

7. Harrison, J. A., Critzer, F. J., & Harrison, M. A. (2016). Regulatory and food safety knowledge gaps associated with small and very small food businesses as identified by regulators and food safety educators - Implications for food safety training. *Food Protection Trends*, *36*(6), 420–427.
8. Harrison, J. A., Gaskin, J. W., Harrison, M. A., Cannon, J. L., Boyer, R. R., & Zehnder, G. W. (2013). Survey of food safety practices on small to medium-sized farms and in farmers markets. *Journal of Food Protection*, *76*(11), 1989–1993. https://doi.org/10.4315/0362-028X.JFP-13-158
9. Kearney, G. D., Rafferty, A. P., Hendricks, L. R., Allen, D. L. ando., & Tutor-Marcom, R. (2014). A cross-sectional study of stressors among farmers in Eastern North Carolina. *North Carolina Medical Journal*, *75*(6), 384–392. https://doi.org/10.18043/ncm.75.6.384
10. Laborde, L., & DuPont, T. (2020). *Safe Uses of Agricultural Water*. https://extension.psu.edu/safe-uses-of-agricultural-water
11. Larzelere, R. E., & Huston, T. L. (2016). *The Dyadic Trust Scale : Toward Understanding Interpersonal Trust in Close Relationships *. *42*(3), 595–604.
12. Mohammad, Z., Yu, H., Neal, J., Gibson, K., & Sirsat, S. (2020). Food Safety Challenges and Barriers in Southern United States Farmers Markets. *Foods*, 1–12.
13. Nawaiseh, H., & Mcintoch, W. (2019). An m-Health Intervention Using a Smartphone

App to Improve Physical Activity in College Students: A Randomized Controlled Trial (P16-025-19). *Current Developments in Nutrition TA - TT -*, *3*(Supplement_1). https://doi.org/10.1093/cdn/nzz050.P16-025-19 LK - https://virginiatech.on.worldcat.org/oclc/8165548141

14. Pollard, S. K., Chapman, B., Ponder, M. A., Rideout, S. L., & Pollard, S. K. (2015). *Identification of food safety risks at Virginia farmers ' markets and development of a food safety plan to help farmers ' market m anagers Identification of food safety risks at Virginia farmers ' markets and development of a food safety plan to help farm*.
15. Richard, A. E., Brown, J. L., Radhakrishna, R. B., Yoder, E. P., Nieto-Montenegro, S., & Cutter, C. N. (2013). Development and implementation of a "counter-top" training program to increase retention of food safety knowledge, alter behavior, improve attitude and increase skills of spanishspeaking retail employees. *Food Protection Trends*, *33*(1), 10–19.
16. Roberts, K., Dowell, A., & Nie, J. B. (2019). Attempting rigour and replicability in thematic analysis of qualitative research data; A case study of codebook development. *BMC Medical Research Methodology*, *19*(1), 1–9. https://doi.org/10.1186/s12874-019-0707-y
17. Smathers, A. (2012). *Evaluation, Development, and Implementation of an Education Curriculum to Enhance Food Safety Practices at North Carolina Farmers' Markets*.
18. Stallman, H. R., & James, H. S. (2017). Farmers' Willingness To Cooperate in Ecosystem Service Provision: Does Trust Matter? *Annals of Public and Cooperative*

Economics, *88*(1), 5–31. https://doi.org/10.1111/apce.12147

19. United States Department of Agriculture Agricultural Marketing Service. (2020). *Local food directories: national farmers market directory*. https://www.ams.usda.gov/local-food-directories/farmersmarkets

20. United States Department of Agriculture Agriculture Marketing Service Division. (2019). *National Count of Farmers Market Directory Listings*. https://www.ams.usda.gov/sites/default/files/media/NationalCountofFarmersMarketDirectoryListings082019.pdf

21. United States Department of Agriculture Food and Nutrition Services. (2015). *What is a farmers' market?*

22. United States Department of Agriculture National Agricultural Statistics Service. (2017). United States Summary and State Data. *2017 Census of Agriculture*, *1*(Part 51), 820. http://www.agcensus.usda.gov/Publications/2012/

23. United States Department of Agriculture National Agricultural Statistics Services. (2020). *National Farmers Market Managers*.

24. United States Food and Drug Administration. (2021). *FSMA Final Rule on Produce Safety*.

25. Young, I., Thaivalappil, A., Reimer, D., & Greig, J. (2017). Food safety at farmers' markets: A knowledge synthesis of published research. In *Journal of Food Protection* (Vol. 80, Issue 12, pp. 2033–2047). https://doi.org/10.4315/0362-028X.JFP-17-193

26. Zhao, J., Freeman, B., & Li, M. (2016). Can mobile phone apps influence people's health behavior change? An evidence review. *Journal of Medical Internet Research*,

18(11), 1–12. https://doi.org/10.2196/jmir.5692

CHAPTER 4

Research Paper
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Working title: The Impact of the COVID-19 Pandemic on Farmers Market Practices Nationwide

RESEARCH PAPER

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Abstract

The COVID-19 pandemic has required that farmers markets (FM) adapt to changing federal and local regulations to remain open. The purpose of this study is to understand how farmers markets have altered their health, hygiene, and food safety practices in response to the COVID-19 pandemic in order to inform strategies on how best to assist the markets moving forward. Two separate questionnaires, one to FM managers and one to FM vendors, were distributed nationwide through various stakeholder email listservs. Survey results were collected from December 2020 – February 2021 for managers and February 2021 – April 2021 for vendors. Questions were asked about cleaning and sanitation and health and hygiene practices to prevent COVID-19 spread; as well as where they are obtaining COVID guidance. Completed surveys were collected from 123 managers and 168 vendors. Sixty-three percent were never closed during COVID, but some (36%) markets closed for a short time. For markets to remain open or reopen, FM managers implemented practices such as spacing booths apart, postponing market events, and placing physical markers for customers. As a result of COVID, about three-quarters of markets began providing hand sanitizer and started displaying hand washing signage. Ninety-four percent of markets reported both cleaning and disinfecting surfaces with non-porous tabletops and cash box/card readers being the most common. Two major challenges faced by FMs were mask compliance by vendors and customers and conflicting guidance on practices that reduce the spread of COVID. Farmers markets continue to struggle with obtaining funding yet have continued to demonstrate their resiliency by overcoming challenges of the COVID-19 pandemic. They have implemented proper practices to keep their employees and customers safe.

Highlights

- Farmers market personnel adapted hand and health practices to respond to COVID-19.
- Farmers market personnel were likely to clean and disinfect surfaces together.
- Developing tailored educational materials to address challenges unique to farmers.

Introduction

COVID-19 was detected in Wuhan, China December 2019 and spread worldwide within a few months (World Health Organization, 2021). COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and is transmitted through inhalation of SARS-CoV-2 droplets and aerosol particles, deposition of virus inhaled droplets and particles, or touching mucous membranes from contaminated surfaces (Centers for Disease Control and Prevention, 2021c). As of June 2021, there are over 175 million confirmed cases worldwide with 33 million cases and 600,000 deaths from the United States (Centers for Disease Control and Prevention, 2021b). There is no scientific evidence that supports the transmission of COVID-19 through food or food packaging (Food and Drug Administration, 2021).

Food supply chain interruptions occurred from the closure of restaurants, bars, and schools that normally served as avenues for these foods (Richards & Rickard, 2020). These interruptions coupled with surges in supermarket demand and a reduction of trips to grocery stores by many consumers led to an increased interest of local food products and outlets such as farmers markets (Hamidi & Zandiatashbar, 2021; Lusk et al., 2020; Richards & Rickard, 2020; Schmidt et al., 2020). Farmers markets are critical to a sustainable food system assisting in lower food insecurity (Clauss, 2020).

At the start of the pandemic, farmers markets faced challenges with staying open because they were deemed as non-essential businesses, or were waiting on guidance from state and local health officials (*Executive Order No. 53*, 2020; Hadish, 2020). A news update generated in April 2020 by Farmers Market Coalition showed that eight states could not open any farmers markets because state executive orders did not put farmers markets under the

same classification as grocery stores (Farmers Market Coalition, 2020b). Farmers markets that were open or reopened during this time were required to follow the same directives as grocery stores such as social distancing and mask-wearing, or considerations for outdoor farmers market generated by the CDC (Centers for Disease Control and Prevention, 2020; North Carolina Department of Agriculture and Consumer Services, 2020).

These measures resulted in decreased profits coupled with increased expenses related to COVID-19 preventative measures such as personal protective equipment (PPE) and handwashing stations (Broadaway & Wolnik, 2020; O'Hara et al., 2020). Additionally, many markets have accrued additional costs to implement other preventative measures such as online ordering systems and the need for additional staffing to rearrange markets and monitor customer traffic (Feldman, 2020). The purpose of this study was to understand how farmers market personnel have altered practices at their market in response to the COVID-19 pandemic, specifically focusing on practices that also reduce foodborne illness. Additionally, challenges and barriers farmers markets faced due to the pandemic were identified.

Materials and methods

The Virginia Tech Institutional Review Board approved the experimental protocol used in this study (IRB 20-751).

Questionnaire development and validation. Two questionnaires, one for farmers market managers and one for vendors was developed using the guidance and considerations for indoor and outdoor farmers markets recommended by CDC and FMC (Centers for Disease Control and Prevention, 2020; Farmers Market Coalition, 2020b). The questionnaire inquired about the farmer markets and ability to remain open during the pandemic, preventative measures and practices implemented in response to the COVID-19 pandemic, challenges associated COVID-19, and where farmers market personnel obtain their information. Some questions were unique to market managers such as those involving implementation of handwashing sinks or signage, or screening vendors before entry. Both questionnaires were validated using an expert panel review (n=9) and pre-testing with researchers and graduates students for content validity (Boateng et al., 2018; Jespersen et al., 2017). Experts were asked to evaluate the questions for understandability and clarity and their relevance to the COVID-19 preventative measures in place. Pre-testing was conducted with Food Science graduate students to determine if respondents would respond to questions in a consistent manner (Collins, 2003). The components of pre-testing of a questionnaire included objectives mentioned by Willis (2016), which include but are not limited to logical skip patterns and ease of use or completion.

Questionnaire dissemination and data collection. The questionnaire was disseminated to the listservs of Virginia and North Carolina Cooperative Extension, farmers market

organizations such as Virginia Farmers Market Association (VAFMA), and author's project collaborators nationwide. Questionnaire data collection occurred from December 2020 to February 2021 for farmers market managers and February 2021 to April 2021 for vendors.

Data analysis. All statistical analyses were performed using SPSS for Windows (IBM; Armonk, NY). McNemar's Tests were performed to assess the if farmers market personnel still have preventative measures in place that were implemented at the before the pandemic or due to it. Questionnaire respondents were asked "Which of the following health and hygiene practices to prevent the spread of disease existed prior the COVID-19 pandemic and which were a result of the COVID-19 pandemic?" The frequencies for farmers market who answered, "existed prior to COVID," or "as a result of COVID," to his question were coded as those who had the practice at their market. A follow-up question of "At this moment, do you still provide the (insert stated practice) at your market?" was asked to those who fell into this category. The results were compared to each other. Spearman's rho bivariate logistic regression analysis was used to measure the relationship of farmers market personnel's amount of cleaning and disinfecting for surface types. The frequencies that personnel performed both actions of cleaning and disinfected were compared to another. The cleaning and disinfection frequencies were compared to each other using Spearman's rho to determine if personnel performed one action in relation with the other. The average rate at which farmers market personnel cleaned or disinfected a surface type was calculated using the average hours a market was open and the frequency of the action over the course of a market session (*Appendix B*). The strength of dependency of variables was assessed using a Chi-square test and Phi (Φ) Coefficient.

Survey slider questions for farmers market vendors. Slider bars are used on Web-based surveys for discrete and/or continuous rating scales. For example, continuous rating scales will allow respondents to indicate an answer anywhere within a given range (Bickman & Rog, 2014; Chyung et al., 2018). In our survey, we utilized a scale from -1 to 10 to indicate the number of times a surface type was cleaned or disinfected (*Appendix B*). The value of "-1" indicated that market vendors were not responsible for the item or did not have the item at their market or business while 0-10 indicated the number of times cleaned or disinfected. The slider scale used started at "-1" for respondents but it was not filled in. A study limitation was respondents who did not touch the scale during the survey believing the value was at set at "-1" already. Some studies assumed untouched sliders should be assigned the default value if respondents indicated a response on any of the other sliders (Derham, 2011; Tejada, 2018). However, this methodology requires further exploration as the main method for missing data is to exclude it and perform a complete-case analysis (Karahalios et al., 2012). To limit future errors, a force response should be used (Tejada, 2018).

Results

124 farmers market managers and 183 farmers market vendors responded to the questionnaire. In *Table 1.,* both managers and vendors were predominantly located in the Mid-Atlantic (85 of 307; as defined by USDA's Food and Nutrition Service) or Southeast Regions (107 of 307) (United States Department of Agriculture Food and Nutrition Services, 2021).

MARKET MANAGER RESULTS

Cleaning and disinfecting practices. The most common surfaces that managers indicated responsibility for cleaning were non-porous surfaces (77%, n=95 of 124), cashbox or card reader (CBCR) (73%, n=90), and trash cans (68%, n=84). Non-porous and CBCR surfaces were cleaned at least once by about 70% of managers with time in between each surface cleaning was 128 minutes and 108 minutes, respectively. CBCRs were cleaned frequently, 108 minutes between each cleaning while trash cans were least frequent at 193 minutes. Produce display containers (56%, n=69) and porous tabletops (54%, n=67) had the fewest number of managers that indicated cleaning responsibility. More than half of the managers for both these groups indicated cleaning over half the time (55-57%). The average frequency for cleaning for these produce display containers and porous tabletops was every 130 and 148 minutes, respectively.

The most common surfaces that managers indicated responsibility for disinfecting were porous tabletops (77%, n=95), CBCRs (74%, n=92), and trash cans (66%, n=82). Both porous tabletops and CBCRs were disinfected at least once by at least 75% of market managers. Trash cans had the lowest disinfection percentage at 50% and had the longest time between each

disinfection period at 209 minutes. CBCRs were disinfected every 108 minutes, which was the lowest

More than three-quarters of managers (77%, 95 of 124) indicated responsibility for disinfecting porous surfaces with the majority of this group (76%, 72 of 95) completing this action at least once. The average rate for porous surfaces disinfection was once every 120 minutes. Almost half of managers (48%, 60 of 124) indicated not having non-porous tabletops at their market or that they were not responsible for disinfecting these surfaces. Of those who were responsible (64 of 124), the majority (59%, 38 of 64) reported disinfecting at least once. The average rate for disinfection was once every 160 minutes. Cashbox or card readers was the second highest disinfected surface (57%, 51 of 124) and was disinfected at an average rate of every 108 minutes. Trash cans were the responsibility of 82 managers with only half of those managers (41 of 82) disinfecting them at least once. The average rate for disinfection was 209 minutes, the highest of any surface. Some managers (39%, 48 of 124) indicated not having bathroom surfaces at their market or not being responsible for disinfecting these surfaces. Of those responsible (76 of 124), approximately 62% (47 of 124) disinfected the surface at least once. The average rate for disinfection of bathroom surfaces was 130 minutes. Produce display containers were the most frequently disinfected surface at a rate of 123 minutes, however, the many managers (44%, 55 of 124) reported not being responsible for this surface or not having them at their market.

Managers were asked to indicate if they mix their own disinfectant, buy commercially available disinfectant, or do both. Of the 118 managers that responded, the majority buy commercially available disinfectant (69%, n=81). Some market managers (13%, n=15) reported

mixing their own disinfectant. Twenty-two managers (19%) indicated they mixed their own disinfectant and bought commercially available disinfectant. Managers were asked to report how they applied disinfectant with the spraying using a spray bottle (n=83) and wiping using a wipe (n=81) being the most popular. A few managers reported using an electrostatic sprayer (n=3) or fogging (n=2).

Cashbox and card readers were the highest cleaned and disinfected surface (n=97) followed by non-porous tabletops (n=90), produce display containers (n=60), and trash cans (n=51). There was a statistically significant correlation at $p<0.001$ level for all surface types (*Table 3*). For example, Spearman's rho analysis indicated a positive correlation of $\rho=.921$ ($p<0.001$) for bathroom surfaces showing that the more frequently a farmer's market manager cleaned a bathroom surface, the more likely they were to also disinfect it. Positive correlations were also exhibited for the surfaces of produce display containers ($\rho=.822$, $p<0.001$), handwashing sink ($\rho=.783$, $p<0.001$), trash can ($\rho=.741$, $p<0.001$), non-porous tabletops (.636, $p<0.001$), cashbox or card readers ($\rho=.626$, $p<0.001$), and porous tabletops ($\rho=.485$, $p<0.001$) (*Table 3*).

Practices changed due to the pandemic for market managers. Thirty farmers market managers self-reported having handwashing stations at their market prior to the pandemic while 51 implemented handwashing stations due to the pandemic (*Table 6*). When managers were asked if their market had handwashing stations at the time of filling out the questionnaire, 63 of 81 reported having stations still. This was a significant change from the those who market managers who had handwashing stations prior or due to the pandemic. Only 11 managers reported utilizing handwashing signage prior to the pandemic with 68

implementing it due to it. There was a significant change from 79 to 63 market managers who still reported having handwashing signage. Hand sanitizer was implemented by 85% (n=105) of the managers at their markets. Some managers (n=15) reported having this practice prior to the pandemic. Of these 120 managers, only 109 reported continuing to provide hand sanitizer at the time of the questionnaire.

Implemented COVID-19 preventative measures. The top preventive measure market managers reported implementing was spacing stands and booths six feet apart (86%, n=107). Four other preventive measures implemented by managers included: providing hand sanitizer (84%, n=105), not handing out samples (80%, n=100), postponing of community events (75%, n=95), and providing proper personal protective equipment (PPE) (70%, n=88). The majority of managers (63%, n=79) reported requiring face masks to enter the market. Most managers (66%, n=83) reported having a sick policy for their vendors. Managers had the opportunity to upload a copy of their sick policy onto the questionnaire. Eight managers shared their sick policy with us. All policies contained messaging of staying home when sick. The three least implemented preventive measures reported by managers were utilizing mobile markets to reach those who could not attend the market (10%, n=13), reduced market hours (15%, n=19), physical barriers such as sneeze guards and partitions (18%, n=22), and screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry (23%, n=28). All managers that indicated screening for potential exposure used a screening checklist and half (n=14) used a temperature scan or check. Many market managers also implemented a variety of practices to reduce the number of market patrons at the market using strategies such as providing no or low touch purchasing opportunities such as pre-boxing or pre-bagging (61%, n=76),

implementing a pick-up service (45%, n=56), and restriction of the number of shoppers allowed (35%, n=44). Practices such as one-way flow of traffic (41%, n=51) and discouraging pets other than service animals from being brought (41%) were also implemented by managers to avoid crowding.

Handling of plastic or wooden tokens. Most managers (53%, n=66) reported not using wooden or plastic tokens at their market. Managers who did use tokens (47%, n=58), were asked to report their disinfection practices. The top three practices were quarantining tokens for a set number of days ranging from 3 -14 days, spraying with a disinfectant, or wiping with a disinfectant wipe. Two market managers reported using heat to disinfect with one "heat treating in a 250 °F oven" and the other "drying them out in the hot sun for a minimum of two hours".

Challenges and barriers. Major barriers faced by market managers included: getting customers and vendors to apply with mask wearing and social distancing policies, low-turnout at markets due to the pandemic, which led to financial strain, and implementing of COVID-19 preventive measures such as one-way traffic flow and customer counts.

COVID-19 information sources. Personnel were asked to provide us with information related to where they receive information on managing risks at their market. The most popular information source overall and for each preventive measure was local government (*Table* 10). The example given in the survey for respondents was the health department. The second most used source was federal government, which included federal agencies such as the Food and Drug Administration, Centers for Disease Control and Prevention, and the United States Department of Agriculture. University and Cooperative Extension sources were not as popular

being used by 36 – 44% of vendors depending on the preventive measure. The least popular source for information were industry or grower organizations (*Table* 10).

MARKET VENDOR RESULTS

Cleaning and disinfecting practices of market vendors. The most common surfaced market vendors reported responsibility for cleaning were cash box or card reader (CBCR) (n=117), non-porous tabletops (n=108), and produce display containers (n=78). Non-porous tabletops were cleaned by 77% (83 of 108) vendors while CBCRs were cleaned by 73% (85 of 117). The time in between each cleaning for these surfaces were 104 and 84 minutes, respectively. The shortest time in between each cleaning were handwashing sinks at 74 minutes with the longest being trash cans at 154 minutes. Many vendors indicated that bathroom surfaces (n=112) and porous tabletops (n=108) indicated that bathroom surfaces were not their responsibilities These surfaces were cleaned by approximately two-thirds of vendors, but the frequency of cleaning was over 110 minutes for both. The top three most commonly disinfected surfaces vendors indicated responsibility for were non-porous tabletops (n=102), CBCR (n=102), and produce display containers (n=65). All surface types were disinfected at least 50% of the time by those were responsible. CBCR was the highest at 82% (n=84) and produce display containers (n=41).

Farmers market vendors also exhibited similar results to market managers for C&D practices. There were significant positive correlations were exhibited for all surface types at $p<0.001$ (*Table 11*). For example, vendors (n=70) were very likely to clean and disinfect CBCRs ($\rho=0.925$, $p<0.001$). Porous tabletops (n=30) and non-porous tabletops (n=65) exhibited similar correlations at $\rho=0.891$ and $\rho=0.890$, respectively.

Implemented COVID-19 preventive measures for vendors. The top implemented practice for farmers market vendors was wearing of personal protective equipment (PPE) such as gloves and masks by employees (*Table 13*). The next three top practices were providing hand sanitizer for employees and customers to use (88%, n=147), providing PPE to customers and other market personnel (74%, n=125), and providing handwashing and social distancing at the booth (66%, n=111). Practices that could be used to reduce the amount of time spent at a market and reduce touchpoints included: bagging and packaging of foods (62%, n=104), cashless/touchless transactions, physical barriers such as sneeze guards and partitions (24%, n=41), and reducing the number of employees at the market (18%, n=30). Of the 44 vendors who indicated they provided their own handwashing stations at their booth, 38 (86%) display handwashing signage at the station. One-fifth of vendors (n=34) indicated screening for COVID-19 exposure and symptoms before employee entry. Vendors utilized temperature scans and checks (n=15) as well as checklists for COVID-19 screening.

Challenges and barriers vendors reported. Vendors expressed concerns with reduced number of customers at their market, which in turn has led to a decrease in capital. Two shared quotations are: “Some customers will not attend as they fear getting sick! We are outdoors!” and “limited amount of people allowed at one time. Customers feel rushed to get what they pre-ordered and don’t [browse].” A challenge has been managing employees and their exposure to COVID-19. One vendor stated that “we create a bubble with our employees and expect them to minimize out of work experiences…we can’t afford to pay people to stay home if they are sick.” A major theme was frustration with the regulations and guidance for COVID-19

not only by vendors but by customers who took it out on the vendors. “Customers were not happy about having to wear a mask” and “not as much room due to social distancing.”

Farmers market vendors’ COVID-19 information sources. The most popular information source overall and for each preventive measure category was “local government”, which was defined using the example of “health department” for questionnaire participants. Federal government was also a widely used source of COVID-19 information and was the second most used source behind local government for every category. University and Cooperative Extension (UCE) was indicated as a source by 19 – 29% of vendors. The top preventive measure that vendors received information on was handwashing followed by cleaning, social distancing measure, and disinfecting. A few (11%, n=19) vendors stated they do not get any handwashing information from any of the source.

Discussion

We hypothesize in this study that the pivot that farmers markets needed to make in 2020 to respond to the COVID-19 pandemic resulted in increasing or improving upon some behaviors that also can contribute to spread of foodborne illness. The incorporation and increase in things like handwashing and cleaning and disinfection practices reduce spread of COVID-19 but may also concurrently reduce spread of foodborne illness.

Hand hygiene practices. A scoping review by Young and authors (2017) found wide variability in markets having handwashing facilities available (7-73%, n=8) (Young et al., 2017). Handwashing is an effective tool in preventing COVID-19 and other diseases, including foodborne illness (Center for Disease Control and Prevention, 2020). The incorporation of handwashing stations and frequent handwashing has long been a recommendation for food vendors, especially those serving food on site at the market (Eifert, 2018). In this study, handwashing stations were implemented by 51 market managers for the markets they oversaw specifically in response to the COVID-19 pandemic. The increased attention to this behavior as a response to COVID may result in the continued adoption of this practice in the future. It is believed that handwashing practices will decrease post-pandemic due to consumers associating this practice with the COVID-19 and not food safety (Thomas & Feng, 2021b). Non-pharmaceutical interventions (NPIs) such as social distancing, disinfecting surfaces, mask wearing, and handwashing have become common practice during the COVID-19 pandemic in an effort to reduce transmission. These NPIs may also influence the transmissions of pathogens such as norovirus (Kraay et al., 2020).

In cases where handwashing stations are not available, an alcohol-based sanitizer containing at least 60% alcohol should be used (United States Food and Drug Administration, 2021b). The majority of market managers indicated they began providing hand sanitizer at their markets in response to the COVID-19 pandemic. Eighty-eight percent (147 of 168) market vendors provided hand sanitizer at their booths. Direct concealed observations by Scheinberg et al. (2018) found that only 3.9% (4 of 102) of vendors had hand sanitizers in their vending area so this is a drastic improvement (J. A. Scheinberg et al., 2018). There is no doubt that the COVID-19 pandemic has increased the demand of and use of hand sanitizers (Terlep, 2021). Statistically significant results ($p<0.001$) from this study showed that hand sanitizers were a practice adopted by many markets in response to the pandemic. In this cross-sectional study, results were collected on practices that managers reported existing prior to, or as a result of the pandemic. When data was collected on if market managers still this practice at their market had, there was a statistically significant change of the managers that indicated no longer providing hand sanitizer. A longitudinal mixed methods study by Thomas and Feng (2021) assessed consumer practices using surveys and focus groups and found an increase in hand sanitizer use from April to August, however, many study participants anticipated a stoppage of hand sanitizer use during or after the pandemic as it was an "additional step" (Thomas & Feng, 2021b).

Cleaning and disinfecting practices of market personnel. SARS-CoV-2 can survive on a variety of porous and non-porous surfaces with porous types reporting the inability to detect the virus within minutes to hours while non-porous types report viable virus from days to weeks (Centers for Disease Control and Prevention, 2021c). Cleaning and disinfecting surfaces

can reduce the risk of fomite transmission (Centers for Disease Control and Prevention, 2021c). The CDC recommends that high touch surfaces and objects be cleaned and disinfected frequently (Centers for Disease Control and Prevention, 2020). This may include things like bathrooms, equipment or tools, and counters (Penn State Extension, 2020). In many cases, these are the same surfaces that should be disinfected to prevent spread of foodborne illness. The difference is of course distinction between food contact and nonfood contact surfaces. In this study, all surface types but one was indicated to be cleaned and disinfected by at least half of the managers. Only non-porous surfaces (48%, 59 of 124) had less than half report cleaning and disinfecting together for market managers. All surface types in this study exhibited a significant positive correlation between cleaning and disinfected as well (*Table* 12). Farmers market vendors were less likely to clean and disinfect compared to mangers who. No surface type was cleaned by more than 50% of vendors with cashbox and card readers coming in at 42% (70 of 168). Non-porous tabletops had the second highest number with 65 vendors (39%) followed by produce display containers at 22 vendors. Every other surface type was under 20% (*Table* 12).

The CDC's farmers market guidance recommended following disinfection procedures for "Cleaning and Disinfecting Your Facility" (Centers for Disease Control and Prevention, 2020, 2021a). The CDC lists alternative disinfection methods may include sanitizing tunnels, fogging, or electrostatic spraying, among others. Some farmers market personnel used fogging to apply their disinfectant (*Table* 13). Using fogging or misting practices for disinfectant applications can be unsafe and ineffective for SARS-CoV-2 if used improperly with a common error being to use

an unregistered pesticide (Environmental Protection Agency, 2021). Additional research should be done to understand how farmers markets are applying disinfectants.

Innovation to respond to market demand and policy changes. Interest by consumers led to an increase of 360% of 360% for online local food sales between April and May 2020 and an increasing amount spent per transaction

Information sources for COVID-19 information. Local government was indicated as the most used COVID-19 farmers market information source for handwashing, cleaning, disinfecting, and social distancing measures. Farmers markets managers were encouraged to coordinate with state and local health officials to understand key considerations for farmers markets and implementing them to their community's needs (Centers for Disease Control and Prevention, 2020; Farmers Market Coalition, 2020a). A longitudinal study on consumer risk perception and trusted sources of food safety information by Thomas and Feng (2021a) found that respondents trusted the FDA significantly compared to other sources (Thomas & Feng, 2021a). For COVID-19 information, the CDC, WHO, and health professionals were the preferred sources (Thomas & Feng, 2021a).

Generalizing results and self-reported data. These questionnaire results and interpretations are biased and cannot be generalized to the greater farmers market personnel populations because convenience sampling was used (Wenzel, 2017). Convenience sampling is a nonprobability sampling where participants are hand-selected by meeting particular criteria or by being recruited from a specific location (Wenzel, 2017). This sampling is non-probabilistic meaning that each member of a population has an unequal chance of being selected (Vehovar et al., 2016). This type of sampling is the most efficient way to access hard-to-reach populations

and is appropriate when random sampling is not reliable such as our farmers market personnel (Vehovar et al., 2016; Wenzel, 2017). In addition, the data from this study is self-reported, which can be unreliable due to overreporting associated with the social-desirability bias (Katkin, 1964). There are likely inconsistencies between a consumer's self-reported practices and their actual practices (Bruhn, 2014; DUONG et al., 2020)

Pilot testing. Pre-testing was conducted with researchers for content validity. Pilot testing of the target population of farmers market personnel of at least 50 – 100 cases should be done as well to address validity and reliability measurements (Groves et al., 2010; Rothgeb, 2015). Due to the limited sample size available with this population, we could not perform pilot testing to generate a content validation ratio, a numerical value that indicates the instrument's degree of validity and is most often done by using an ordinal scale to determine the necessity/importance of the information (Rutherford-Hemming, 2018).

Conclusions. Farmers markets struggled with obtaining funding yet have continued to demonstrate their resiliency by overcoming challenges of the COVID-19 pandemic by implementing proper practices to keep employees and customers safe. Practices included providing handwashing stations and hand sanitizer and social distancing measures such as mask wearing and spacing booths, stands, and other structures apart. To our knowledge, no studies have evaluated the impact of COVID-19 pandemic on farmers market practices. Future work should evaluate the long-term effects of the pandemic on these changed behaviors.

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References

1. Bickman, L., & Rog, D. (2014). The SAGE Handbook of Applied Social Research Methods. *The SAGE Handbook of Applied Social Research Methods*, 413–434. https://doi.org/10.4135/9781483348858
2. Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quiñonez, H. R., & Young, S. L. (2018). Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Frontiers in Public Health*, *6*(June), 1–18. https://doi.org/10.3389/fpubh.2018.00149
3. Broadaway, D., & Wolnik, D. (2020). Iteration, innovation, and collaboration: Supporting farmers markets' response to COVID-19. *Journal of Agriculture, Food Systems, and Community Development*, *10*(1), 1–4. https://doi.org/10.5304/jafscd.2020.101.014
4. Bruhn, C. (2014). Chicken Preparation in the Home: An Observational Study. *Food Protection Trends*, *34*(5), 318–330. http://www.foodprotection.org/publications/food-protection-trends/article-archive/2014-09chicken-preparation-in-the-home-an-observational-study/
5. Center for Disease Control and Prevention. (2020). *When and How to Wash Your Hands*. Handwashing: Clean Hands Save Lives. https://www.cdc.gov/handwashing/when-how-handwashing.html
6. Centers for Disease Control and Prevention. (2020, September). *Considerations for Outdoor Farmers Markets | CDC*. https://www.cdc.gov/coronavirus/2019-ncov/community/outdoor-farmers-markets.html
7. Centers for Disease Control and Prevention. (2021a). *Cleaning and Disinfecting Your Facility*. https://www.cdc.gov/coronavirus/2019-ncov/community/disinfecting-building-facility.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-

ncov%2Fcommunity%2Forganizations%2Fcleaning-disinfection.html

8. Centers for Disease Control and Prevention. (2021b). *COVID Data Tracker: Variant Proportions*. Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html
9. Centers for Disease Control and Prevention. (2021c). *Scientific Brief: SARS-CoV-2 Transmission | CDC*. https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html
10. Chyung, S. Y. Y., Swanson, I., Roberts, K., & Hankinson, A. (2018). Evidence-Based Survey Design: The Use of Continuous Rating Scales in Surveys. *Performance Improvement*, *57*(5), 38–48. https://doi.org/10.1002/pfi.21763
11. Clauss, E. (2020). *Food Insecurity in Pittsburgh, Pennsylvania: A Case Study of the Lawrenceville Farmers Market* [University of Pittsburgh]. http://d-scholarship.pitt.edu/40073/3/Food Insecurity in Pittsburgh%2C Pennsylvania - A Case Study of the Lawrenceville Farmers Market_Elisabeth Clauss %282%29.pdf
12. Collins, D. (2003). Pretesting survey instruments: An overview of cognitive methods. In *Quality of Life Research* (Vol. 12, Issue 3). https://doi.org/10.1023/A:1023254226592
13. *Executive Order No. 53*, (2020) (testimony of Commonwealth of Virginia Office of the Governor).
14. Derham, P. (2011). Using preferred, understood or effective scales? How scale presentations effect online survey data collection. *Australasian Journal of Market & Social Research*, *19*(2). https://researchsociety.com.au/documents/item/482
15. Duong, M., Shumaker, E. T., Cates, S. C., Shelley, L., Goodson, L., Bernstein, C., Lavallee, A., Kirchner, M., Goulter, R., Jaykus, L. A., & Chapman, B. (2020). An observational study of thermometer use by consumers when preparing ground Turkey patties. *Journal of Food Protection*, *83*(7), 1167–1174. https://doi.org/10.4315/JFP-19-594

16. Eifert, J. (2018). *Enhancing the Safety of Locally Prepared Foods: What do I need to know to provide samples at the farmers market?*
17. Environmental Protection Agency. (2021). *Can I use fogging, fumigation, or electrostatic spraying or drones to help control COVID-19?* 1–2. https://www.epa.gov/coronavirus/can-i-use-fogging-fumigation-or-electrostatic-spraying-or-drones-help-control-covid-19
18. Farmers Market Coalition. (2020a). *Farmers Markets Respond to COVID-19 — Best Practices, Examples, and Resources*. https://farmersmarketcoalition.org/covid-19-crisis-farmers-market-new-guidelines/
19. Farmers Market Coalition. (2020b, April). *Farmers Markets Respond to COVID-19 — Daily Updates and Announcements - Farmers Market Coalition*. https://farmersmarketcoalition.org/farmers-markets-covid19/
20. Feldman, B. (2020, May). *Farmers Markets Across Nation Face Potential Economic Crisis From COVID-19 - Farmers Market Coalition*. Farmers Market Coalition Newsletter. https://farmersmarketcoalition.org/farmers-markets-across-the-nation-face-a-precarious-economic-situation-due-to-covid-19/
21. Food and Drug Administration. (2021). *COVID-19 Update: USDA, FDA Underscore Current Epidemiologic and Scientific Information Indicating No Transmission of COVID-19 Through Food or Food Packaging*. https://www.fda.gov/news-events/press-announcements/covid-19-update-usda-fda-underscore-current-epidemiologic-and-scientific-information-indicating-no
22. Groves, R. M., Singer, E., Lepkowski, J. M., Heeringa, S. G., & Alwin, D. F. (2010). Survey methodology. In *A Telescope on Society: Survey Research and Social Science at the University of Michigan and Beyond*. https://doi.org/10.4324/9780429314254-2

23. Hadish, C. (2020, April 14). Awaiting state guidance, Iowa farmers markets left in limbo as some put season on hold | Iowa Center for Public Affairs Journalism. *Iowa Watch*. https://www.iowawatch.org/2020/04/14/awaiting-state-guidance-iowa-farmers-markets-left-in-limbo-as-some-put-season-on-hold/

24. Hamidi, S., & Zandiatashbar, A. (2021). Compact development and adherence to stay-at-home order during the COVID-19 pandemic: A longitudinal investigation in the United States. *Landscape and Urban Planning*, *205*(May 2020), 103952. https://doi.org/10.1016/j.landurbplan.2020.103952

25. Jespersen, L., Griffiths, M., & Wallace, C. A. (2017). Comparative analysis of existing food safety culture evaluation systems. *Food Control*, *79*, 371–379. https://doi.org/10.1016/j.foodcont.2017.03.037

26. Karahalios, A., Baglietto, L., Carlin, J. B., English, D. R., & Simpson, J. A. (2012). A review of the reporting and handling of missing data in cohort studies with repeated assessment of exposure measures. *BMC Medical Research Methodology*, *12*, 1–10. https://doi.org/10.1186/1471-2288-12-96

27. Katkin, E. S. (1964). The Marlowe-Crowne Social Desirability Scale: Independent of Psychopathology? *Psychological Reports*, *15*(3), 703–706. https://doi.org/10.2466/pr0.1964.15.3.703

28. Kraay, A. N. M., Han, P., Kambhampati, A. K., Wikswo, M. E., Mirza, S. A., & Lopman, B. A. (2020). Impact of non-pharmaceutical interventions for SARS-CoV-2 on norovirus outbreaks: an analysis of outbreaks reported by 9 US States. *MedRxiv*, 2020.11.25.20237115. https://doi.org/10.1101/2020.11.25.20237115

29. Lusk, J., Ellison, B., Featherstone, A. M., Low, S. A., Malone, T., Maples, J., Mccluskey, J. J., Schulz, L., Sheldon, I., Tanger, S. M., Coble, K., Hake, M., Dorfman, J. H., Mcfadden, B. R.,

Richards, T. J., Rickard, B. J., Anderson, J. D., Coble, K., Low, S., … Cochran, M. (2020). *Economic Impacts of COVID-19 on Food and Authors Reviewers*. 1–44.

30. North Carolina Department of Agriculture and Consumer Services. (2020). *Frequently asked questions about COVID-19 and agriculture*. https://www.ncagr.gov/disaster/documents/documents/FrequentlyaskedquestionsaboutCOVID.pdf
31. O'Hara, J., Woods, T., Dutton, N., & Stavely, N. (2020). *COVID-19's Impact on Farmers Market Sales in Washington D.C. , Area*. https://doi.org/10.1017/aae.202
32. Penn State Extension. (2020, October 20). *Guidance for Indoor Farmers Markets Under COVID-19*. https://extension.psu.edu/guidance-for-indoor-farmers-markets-under-covid-19
33. Richards, T. J., & Rickard, B. (2020). COVID-19 impact on fruit and vegetable markets. *Canadian Journal of Agricultural Economics*, *68*(2), 189–194. https://doi.org/10.1111/cjag.12231
34. Rothgeb, J. (2015). Pilot Test. In *Encyclopedia of Survey Research Methods* (pp. 44–45).
35. Rutherford-Hemming, T. (2018). Content Validity Ratio. *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*, 397–398. https://doi.org/10.4135/9781506326139
36. Scheinberg, J. A., Radhakrishna, R., Campbell, J. A., & Cutter, C. N. (2018). A comprehensive needs assessment of food safety practices of farmers' market vendors in Pennsylvania using direct concealed observations, self-reported surveys, and state sanitarian surveys. *Food Protection Trends*, *38*(6), 421–439.
37. Schmidt, C., Goetz, S., Rocker, S., & Tian, Z. (2020). Google Searches Reveal Changing Consumer Food Sourcing in the COVID-19 Pandemic. *Journal of Agriculture, Food Systems, and Community Development*, *9*(3), 9–16.
38. Tejada, K. (2018). *Affective Perspective-Taking and Anger Regulation in Adolescent Peer and*

Parent Conflicts [Fuller Seminary]. https://www.fuller.edu/wp-content/uploads/2019/06/KimberlyTejada-Masters-Thesis-Final.pdf

39. Terlep, S. (2021, January 22). Hand Sanitizer Sales Jumped 600% in 2020. Purell Maker Bets Against a Post-Pandemic Collapse. *The Wall Street Journal*. https://www.wsj.com/articles/hand-sanitizer-sales-jumped-600-in-2020-purell-maker-bets-against-a-post-pandemic-collapse-11611311430
40. Thomas, M. S., & Feng, Y. (2021a). Consumer risk perception and trusted sources of food safety information during the COVID-19 pandemic. *Food Control*, *June*, 108279. https://doi.org/10.1016/j.foodcont.2021.108279
41. Thomas, M. S., & Feng, Y. (2021b). Food Handling Practices in the Era of COVID-19: A Mixed-Method Longitudinal Needs Assessment of Consumers in the United States. *Journal of Food Protection*, *84*(7), 1176–1187. https://doi.org/10.4315/JFP-21-006
42. United States Department of Agriculture Food and Nutrition Services. (2021). *FNS Regional Offices | USDA-FNS*. https://www.fns.usda.gov/fns-regional-offices
43. United States Food and Drug Administration. (2021). *Q&A for Consumers: Hand Sanitizers and COVID-19*. https://www.fda.gov/drugs/information-drug-class/qa-consumers-hand-sanitizers-and-covid-19
44. Vehovar, V., Toepoel, V., & Steinmetz, S. (2016). Non-probability Sampling In: The SAGE Handbook of Survey Methodology. *The SAGE Handbook of Survey Methodology*, 329–345. https://dx.doi.org/10.4135/9781473957893
45. Wenzel, A. (2017). Convenience Sample. *The SAGE Encyclopedia of Abnormal and Clinical Psychology*, 197–198. https://doi.org/10.4135/9781483365817.n338
46. Willis, G. B. (2016). The SAGE Handbook of Survey Methodology. In *The SAGE Handbook of Survey Methodology*. SAGE Publications Ltd. https://doi.org/10.4135/9781473957893

47. World Health Organization. (2021). *Listings of WHO's response to COVID-19*. https://www.who.int/news/item/29-06-2020-covidtimeline

48. Young, I., Thaivalappil, A., Reimer, D., & Greig, J. (2017). Food safety at farmers' markets: A knowledge synthesis of published research. In *Journal of Food Protection* (Vol. 80, Issue 12, pp. 2033–2047). https://doi.org/10.4315/0362-028X.JFP-17-193

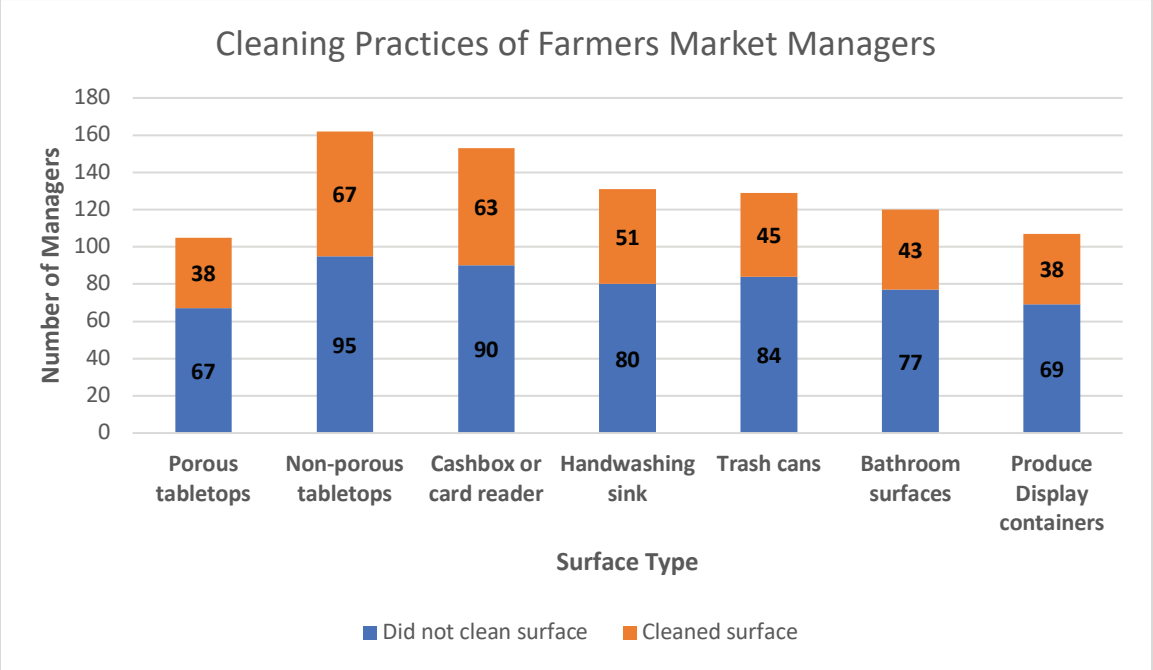

Figure 1. Number of Farmers market managers responsible for cleaning various surfaces at the market, that actually followed through with cleaning the surface.

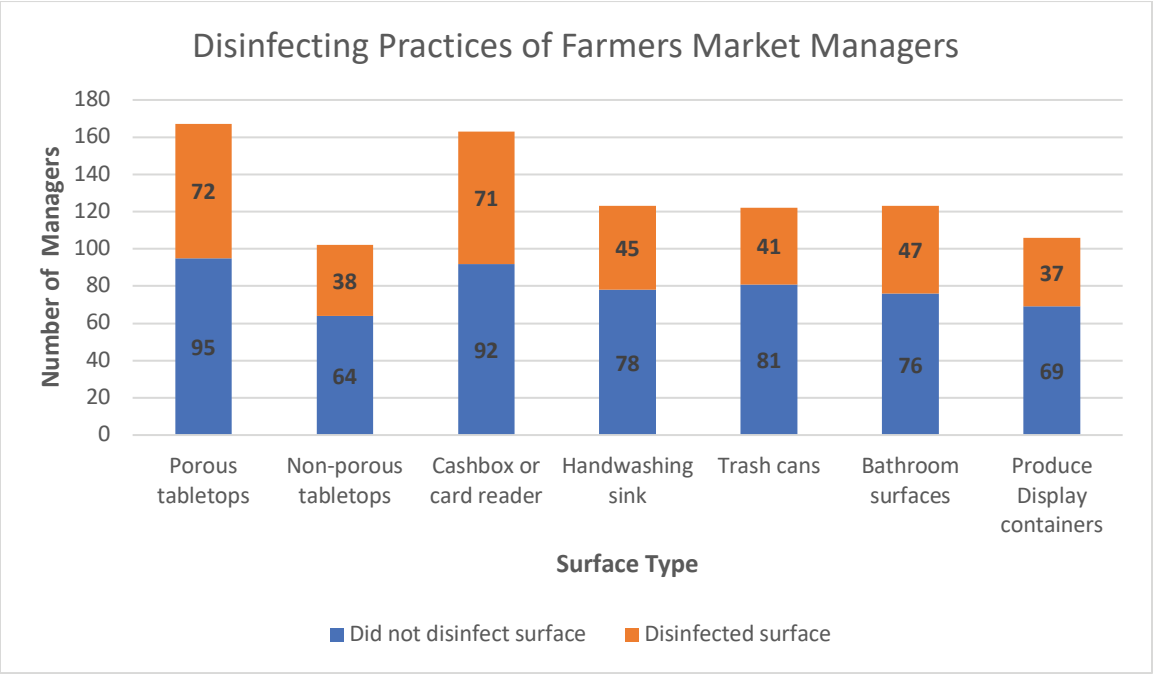

Figure 2. Descriptive statistics of farmers market managers indicating responsibility for disinfecting.

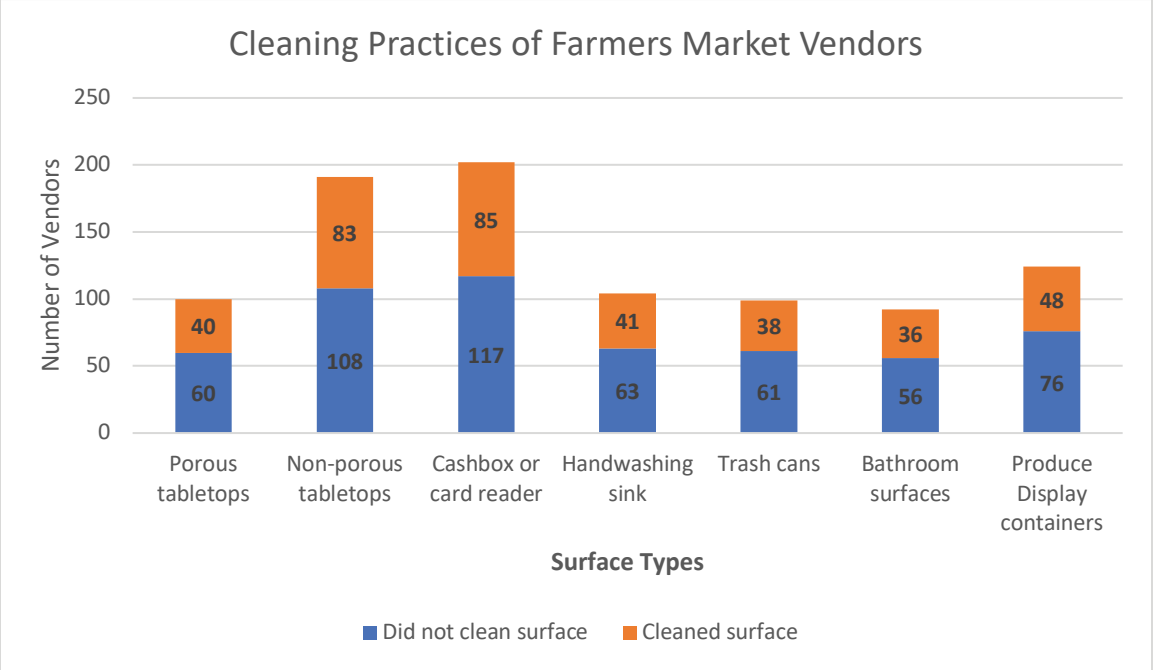

Figure 3. Descriptive statistics of farmers market vendors indicating responsibility for cleaning.

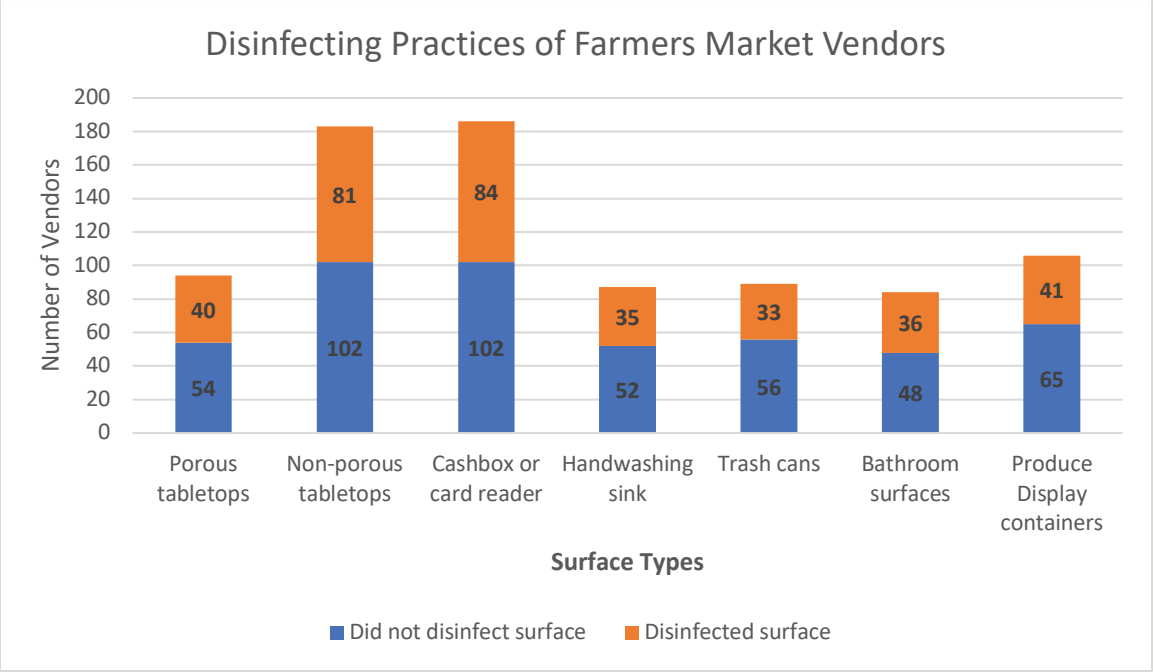

Figure 4. Descriptive statistics of farmers market vendors indicating responsibility for disinfecting.

Table 1. Percentage of FM managers and vendors Characteristics of farmers market respondents.

	Managers (N=124) [a]	Vendors (N=169) [a]
Outdoors	75.0% (93)[b]	72.7% (123) [b]
Indoors	2.4% (3)	2.9% (5)
Both outdoors and indoors	22.5% (28)	24.2% (41)
Regions		
Mid-Atlantic	25.8% (32)	27.1% (46)
Midwest	27.4% (34)	2.9% (5)
Mountain Plain	4.0% (5)	0.6% (1)
Northeast	10.5% (13)	7.6% (13)
Southeast	24.2% (30)	42.4% (72)
Southwest	7.25% (9)	7.6% (13)
Western	0.8% (1)	11.8% (20)
Closed at some point during pandemic but reopened	36.3% (45)	
Closed and still closed	0.8% (1)	
Open during the pandemic	62.9% (78)	
Ability to remain open		
Deemed an essential operation/business by governor (state government)	62.9% (51)	NA
Deemed an essential operation/business by the local government	24.2% (30)	NA
Able to comply with requirements to remain open	50.8% (63)	NA
Other	8.1% (10)	NA

[as] the total number of manager and vendor survey responses collected. This is the denominator for each column.
[b] the parentheses for each column are the number of managers and vendors that fit each characteristic.

Table 2. Cleaning and disinfecting practices of different surface types for managers.

	Practice reported (N=124)							
Surface Types	Did not have surface at market or not responsible for cleaning	Did not clean surface	Cleaned surface	Time in between each surface cleaning (minutes) MEAN±SD	Did not have surface at market or not responsible for disinfecting	Did not disinfect surface	Disinfected surface	Time in between each surface disinfection (minutes) MEAN±SD
Porous tabletops	45.9% (57)	43.3% (29)	56.7% (38)	147.77±100.73	23.4% (29)	24.2% (23)	75.8% (72)	119.48±100.04
Non-porous tabletops	23.4% (29)	29.5% (28)	70.5% (67)	128.17±102.96	48.4% (60)	40.6% (26)	59.4% (38)	159.95±108.32
Cashbox or Card reader	27.4% (34)	30.0% (27)	70.0% (63)	107.85±96.76	25.8% (32)	22.8% (21)	77.2% (71)	107.85±96.76
Handwashing Sink	35.5% (44)	36.3% (29)	63.7% (51)	131.50±98.64	37.1% (46)	42.3% (33)	57.7% (45)	155.07±112.17
Trash Can	32.3% (40)	46.4% (39)	53.6% (45)	192.60±112.17	33.9% (42)	50% (41)	50% (41)	209.45±249.90
Bathroom Surfaces	37.9% (47)	44.2% (34)	55.8% (43)	146.74±96.17	38.7% (48)	38.2% (29)	61.8% (47)	130.33±92.54
Produce Display Containers	44.4% (55)	44.9% (31)	55.1% (38)	129.75±89.19	44.4% (55)	46.4% (32)	53.6% (37)	123.37±94.54

a The responsibility for each surface was determined using “During your market hours, how many times does your market clean, disinfect these items?” where a value of “-1” indicated not having the item or no responsibility for cleaning it. Did not clean or disinfect was determined by respondents who indicated “0” on the scale. An answer of “1” to “10” indicated the action was performed.

b Time in between each cleaning or disinfecting was determined taking an average of the number of times cleaned/disinfected and the number of hours farmers market personnel indicated operating for.

Table 3. Farmers market managers that clean and disinfect together (N=124).

Surface Type	Number of Market Managers that Cleaned and Disinfected	Correlation Coefficient[a] (Spearman's rho)[b]	95% Confidence Interval of the Correlation
Porous tabletops	24.2% (30)	0.485	0.576 – 0.838
Non-porous tabletops	46.8% (58)	0.494	0.266 – 0.670
Cashbox or Card reader	46.8% (58)	0.626	0.473 – 0.743
Handwashing Sink	33.9% (42)	0.783	0.671 – 0.860
Trash Can	29.0% (36)	0.741	0.616 – 0.830
Bathroom Surfaces	35.5% (44)	0.921	0.875 – 0.950
Produce Display Containers	26.6% (33)	0.822	0.718 – 0.890

a Significant at $p<0.001$

b Spearman's Rho was calculated using Spearman's Rank Correlation Test where question of "During your market hours, how many times does your market clean/disinfect these items?" and directly comparing those numbers for personnel who performed both actions to each other.

Table 4. Percent of FM market managers implementing various COVID-19 preventive measures at their market.

Preventive Measure Implemented	Managers (N=124)
Stands/booths spaced 6 feet apart	86% (107)
Providing hand sanitizer at market	85% (105)
No samples handed out	81% (100)
Postponing all community events (music, entertainment, community tables)	76% (94)
Providing proper personal protective equipment (masks, disposable gloves)	71% (88)
Having sick policy for vendors/workers	67% (83)
Requiring face masks to enter the market	64% (79)
Providing no touch or low touch purchasing opportunities (pre-boxing/pre-bagging of food items)	61% (76)
Physical guides (tape on floors and signage) to ensure customers are spaced 6 feet apart	60% (75)
Providing handwashing signage at market	55% (68)
Using single-use packaging or bags	47% (58)
Implementing a pick-up service	45% (56)
One-way flow of traffic	41% (51)
Discouraging pets (except service animals) from being brought	41% (51)
Providing handwashing stations at market	41% (51)
No cloth table coverings	40% (49)
Reduced number of vendors considered essential	39% (48)
Using touchless payment systems	37% (46)
Restricting number of shoppers in the market	35% (44)
Not allowing use of reusable bags	28% (35)
Screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry	23% (28)
Providing separate operating hours for vulnerable customers	18% (22)
Physical barriers (sneeze guards, partitions)	18% (22)
Reduced market hours	15% (19)
Implemented mobile markets	10% (13)

a The total number of FM managers that completed the survey. This number serves as the denominator for the percentages calculated.

b The percentage and number of managers out of 124 that indicated implementing that COVID-19 preventive measure.

c The list of preventive measures was collated from the following questions: (1) Which measures has your farmers market implemented to prevent the spread of COVID-19? ; (2) Has your market altered or changed any of these other practices to prevent the spread of COVID-19? ; (3) Which of the following health and hygiene practices to prevent the spread of disease

existed prior to the COVID-19 pandemic and which were implemented as a result of the pandemic?

Table 5. Farmers market managers with sick policy.

	Manager (N=35)
Temperature scans/checks	14
Screening checklist	31

Table 6. Percentage and frequency of hand and hygiene practices implemented by market managers (N=124).

Practice	Had practice at market prior to the pandemic[a]	Implemented practice due to the pandemic[a]	We do not have this practice at our market[a]
Handwashing Station	(30)	(51)	(43)
Handwashing Signage	(11)	(68)	(45)
Hand Sanitizer	(15)	(105)	(4)
Screening Vendors	(16)	(28)	(80)

a The total number of managers (N=124) who completed survey used to calculate each column.
b The number in parentheses is the number of managers who implemented the practice
c The number of managers in the implemented practice due to the pandemic was calculated by combining the answers to the "implemented practice prior to the COVID-19 pandemic" or "implemented practice during the COVID-19 pandemic"

Table 7. Implementation of hand and hygiene practices at farmers markets prior to or during the pandemic and at time of data collection.

Practice	Had implemented practice either prior to or during the pandemic	Still have practice at market
Handwashing Station	81	63[a]
Handwashing Signage	79	63[a]
Hand Sanitizer	120	109[a]
Screening Vendors	44	36b

a Significant at $p<0.001$

b Significant at $p=0.008$

c Significance calculated using McNemar's Test.

Table 8. Disinfectant practices reported by market managers.

	Managers (N=124)
Mix own disinfectant	12.1 % (15)
Buy commercially available disinfectant	65.3% (81)
Both – mix own disinfectant and buy commercially available disinfectant	17.7% (22)
Disinfectant Application	
Spraying using sprayer bottle	66.9% (83)
Spraying using electrostatic sprayer	2.41% (3)
Wiping using wipe	65.3% (81)
Fogging	1.61% (2)

*Respondents were able to select multiple options for disinfectant application. “Other” responses were recoded into these categories.

Table 9. Information sources for farmers market managers for COVID-19 preventive measures (N=124)

Preventive Measure	University/ Cooperative Extension	Federal Government	Local Government	Industry or Growers Organization	I do not get this information on this practice from any source
Handwashing	44.35% (55)[c]	54.03% (67)	59.68% (74)	31.45% (39)	6.45% (8)
Cleaning	36.29% (45)	54.03% (67)	59.68% (74)	25.00% (31)	6.45% (8)
Disinfecting	35.48% (44)	54.84% (68)	57.26% (71)	22.58% (28)	6.45% (8)
Social distancing measures	36.29% (45)	59.68% (74)	67.74% (84)	25.00% (31)	0.81% (1)

a Respondents were able to select all that apply.
b The percentage was calculated using the numerator of 124 total farmers market vendor responses.
c The parentheses for indicate the numerator or the number of vendors who received information on a preventive measure from an information source.

Table 10. Cleaning and disinfecting practices of market vendors.

	Practice reported (N=168)							
Surface Types	Did not have surface at market or not responsible for cleaning	Did not clean surface	Cleaned surface	Time in between each surface cleaning (minutes) MEAN±SD	Did not have surface at market or not responsible for disinfecting	Did not disinfect surface	Disinfected surface	Time in between each surface disinfection (minutes) MEAN±SD
Porous tabletops	64.3% (108)	33.3% (20)	66.7% (40)	138.83±133.45	69.64% (117)	25.9% (14)	74.1% (40)	111.77±106.53
Non-porous tabletops	35.7% (60)	23.1% (25)	76.9 (83)	103.82±95.60	39.29% (66)	20.6% (21)	79.4% (81)	102.13±96.63
Cashbox or Card reader	30.4% (51)	27.4% (32)	72.6% (85)	83.63±85.80	39.29% (66)	17.6% (18)	82.4% (84)	96.39±97.40
Handwashing Sink	62.5% (105)	34.9% (22)	65.1% (41)	73.87±70.09	69.05% (116)	32.7% (17)	67.3% (35)	88.75±89.47
Trash Can	63.6% (107)	37.7% (23)	62.3% (38)	154.01±153.30	66.67% (112)	41.1% (23)	58.9% (33)	124.24±147.88
Bathroom Surfaces	66.7% (112)	35.7% (20)	64.3% (36)	110.56±95.34	71.43% (120)	25.0% (12)	75.0% (36)	123.75±107.45
Produce Display Containers	54.7% (92)	36.8% (28)	63.2% (48)	90.59±78.11	61.31% (103)	36.9% (24)	63.1% (41)	119.87±110.46

a The responsibility for each surface was determined using “During your market hours, how many times does your market clean, disinfect these items?” where a value of “-1” indicated not having the item or no responsibility for cleaning it. Did not clean or disinfect was determined by respondents who indicated “0” on the scale. An answer of “1” to “10” indicated the action was performed.

b Time in between each cleaning or disinfecting was determined taking an average of the number of times cleaned/disinfected and the number of hours farmers market personnel indicated operating for.

Table 11. Farmers market vendors that clean and disinfect together.

Surface Type	Number of Market Vendors that Cleaned and Disinfected	Correlation Coefficient[a] (Spearman's rho)[b]	95% Confidence Interval of the Correlation
Porous tabletops	17.9% (30)	0.891	0.778 – 0.948
Non-porous tabletops	38.6% (65)	0.890	0.822 – 0.932
Cashbox or Card reader	41.7% (70)	0.925	0.880 – 0.954
Handwashing Sink	18.5% (31)	0.609	0.315 – 0.796
Trash Can	18.5% (31)	0.721	0.483 – 0.859
Bathroom Surfaces	17.8% (30)	0.745	0.517 – 0.874
Produce Display Containers	22.0% (37)	0.782	0.608 – 0.885

a Significant at $p<0.001$

b Spearman's Rho was calculated using Spearman's Rank Correlation Test where question of "During your market hours, how many times does your market clean/disinfect these items?" and directly comparing those numbers for personnel who performed both actions to each other.

Table 12. Disinfectant practices reported by market vendors.

	Vendors (N=168)
Mix own disinfectant	12.5% (21)
Buy commercially available disinfectant	54.2% (91)
Both – mix own disinfectant and buy commercially available disinfectant	22.0% (37)
We do not use any disinfectants	15.3% (19)
Disinfectant Application*	
Spraying using sprayer bottle	79.8% (99)
Spraying using electrostatic sprayer	2.42% (3)
Wiping using wipe	76.6% (95)
Fogging	1.61% (2)

*Respondents were able to select multiple options for disinfectant application. “Other” responses were recoded into these categories.

Table 13. Practices implemented by vendors to address COVID-19 at their market.

Preventive Measure Implemented	Number of Vendors (N=168)[a]
Wearing of protective equipment (gloves, masks)	93% (156)[b]
Providing hand sanitizer for employees and customers to use	88% (147)[b]
Providing proper personal protective equipment (masks, disposable gloves)	74% (125)[b]
Signage (handwashing, social distancing)	66% (111)[b]
Bagging and packaging of foods	62% (104)[b]
Not providing food samples	61% (102)[b]
Cashless/touchless transactions	45% (75)[b]
Having sick policy for employees	35% (58)[b]
Not allowing the use of reusable bags	27% (46)[b]
Providing handwashing stations at booth	26% (44)[b]
Physical barriers (sneeze guards, partitions)	24% (41)[b]
Screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry	20% (34)[b]
Displaying hand washing signage at the handwashing station	22% (38)[b]
Reduced number of employees working at the market	18% (30)[b]

a The number of total vendors that participated in the survey (denominator)
b The number of vendors who implemented a preventive measure is in parentheses (numerator)
c The preventive measures were collated from the questions of: (1) Which measures has your business implemented at your stand, booth, or selling location to address COVID-19? ; (2) What hand hygiene practices has your business implemented to address COVID-19? ; (3) Which of the following procedures are in place to address employee health of people working at farmers markets?

Table 14. Information sources for farmers market personnel for COVID-19 preventive measures (N=168)

Preventive Measure	University/ Cooperative Extension	Federal Government	Local Government	Industry or Growers Organization	I do not get this information on this practice from any source
Handwashing	29.16% (49)	44.04% (74)	51.79% (87)	18.45% (31)	11.31% (19)
Cleaning	23.81% (40)	42.86% (72)	44.05% (74)	15.48% (26)	7.74% (13)
Disinfecting	22.62% (38)	44.04% (74)	43.45% (73)	15.48% (26)	6.55% (11)
Social distancing measures	19.05% (32)	47.02% (79)	48.21% (81)	15.48% (26)	4.17% (7)

a Respondents were able to select all that apply.
b The percentage was calculated using the numerator of 168 total farmers market vendor responses.

CHAPTER 5.
Research paper

Evaluation of Produce Safety Rule Resources for Website Accessibility, Readability, and Content Quality.
Formatted for: Journal for Food Protection

Author details

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Key Words: produce safety, accessibility, readability, small-scale, farms

Abstract

Farm workers play an essential role in agriculture in the United States assisting in greenhouse and nursery (43%) and fruit and tree nut operations (39%). More than one-third of farmers workers do not have a high school diploma. Health fields have shown the importance of literacy levels in comprehension of resources with the recommendation that of these resources being readable at an 8th grade level. Farmers markets personnel get their resources mainly from University/Cooperative Extension sources. The purpose of this study was to evaluate existing produce safety resources from three information sources for website accessibility/navigability, content quality, and readability. The top 30 results from each of the five search terms generated from website analytics of two of the information sources were downloaded, cleaned, and analyzed. The evalution tools of Web Content Accessibility Checker (WAVE), PDF accessibility checker, and the Flesch-Kincaid (FK) method were used in this study. The results showed that all websites were not accessible with an average of 10.7 errors per website page, an Flesch Reading Ease score of 35.4., and 72% of PDFs analyzed (13 of 18) violating accessibility rules. All web pages provided references through citations or additional website links, but 40% (27 of 67) failed to provide a last updated date. This study provides insights into the development of more accessible produce safety resources for farmers market personnel.

Introduction

The United States agricultural workforce is made up of self-employed farm operators and their family members and hired workers (United States Department of Agriculture Economic Research Service, 2020). Hired farmworkers are essential in agriculture accounting for 43% of greenhouse and nursey operations and 39% of fruit and tree nut operations (United States Department of Agriculture National Agricultural Statistics Service, 2017). Furthermore, family farmworkers accounted for 2.06 million while hired farmworkers accounted for 1.13 million. The American Community Survey (ACS) from the United States Department of Commerce further distinguishes farm workers into categories such as farm laborers, graders, and sorters; farm managers, inspectors, and inspectors; and all other occupations in agriculture, which are those that do not fit under the first two (US Census Bureau, 2018). Overall, 38% of all farm workers lack a high school diploma; This result is higher when narrowing in on farm laborers specifically, where 48% do not have a high school diploma.

The majority of farmworkers (77%, N=5,342) reported that Spanish was their most comfortable language while 21% reported that English was and the remaining 2% reported that Indigenous language was (United States Department of Labor, Employment, 2018). When asked to rate their language skills and their ability to read English, 30% of farmworkers reported that they could not speak English “at all” and 41% reported they could not read English “at all” (United States Department of Labor, Employment, 2018).

An assessment on adult literacy levels conducted by the National Center for Education Statistics (NCES) found that 52% (N=19,258) of United States adults had a literacy achievement level of 1 or 2, 19% and 33%, respectively while 48% were at level 3 or above (Hogan et al.,

2012) . Assessment participants are required to complete a list of tasks and scores are correlated to a literacy achievement level ranging from 1 (0 to 176 points) to 5 (376-plus points) where tasks at level 1 require basic vocabulary knowledge and can locate single pieces of information while tasks at level 5 require constructing syntheses of ideas or points of views (Allen et al., 2013). There are no grade-level (K-12) equivalents for literacy levels since adult-learners are classified differently than students in school; however, data is provided on the average scores of those who didn't graduate high school and those that did with, which are 230.3 and 260.9 points, respectively (Allen et al., 2013).

Health fields have shown the importance of identifying and prioritizing the audience's perceptions, wants, and demands and tailoring this messaging to their needs, concerns, and interests (Graham & Andreasen, 1997). Prioritizing and identifying audience needs and perceptions attempts to address gaps in health literacy. The term health literacy, defined by Friedman and Hoffman-Goetz (2006) as the "capacity to obtain, interpret, and understand basic health information and services and the competence to use such information and services to enhance health (Friedman & Hoffman-Goetz, 2006). Health literacy has been shown as an important predictor for an individual's health (Badarudeen & Sabharwal, 2010). The ability to read and comprehend results allows for health field patients to understand the factors that influence their health such as anxiety levels and emotional distress (Estey et al., 1994). Jacob and authors (2010) applied the importance of audience needs idea to food safety communication and messaging and found similar results concluding that the importance of messaging that is easy to receive and to understand for specific populations (C. Jacob et al., 2010).

Studies evaluating the accuracy of information on websites have utilized popular search engines such as Google, Yahoo, and Bing to gather the websites and resources (Dy et al., 2012; Fabricant et al., 2013). The information generated from these search engines vary significantly for quality and accuracy depending on the search term, website author, and order of the search results (Dy et al., 2012). Modave et al. (2014) found that information sources from medical, government, or university organizations was of higher quality compared to news/media or blog outlets but were further down in searches due to news/media blog investment with search engine optimization (Modave et al., 2014). Cooperative Extension websites are great for those seeking research-based and unbiased information, however, they are unpopular and rank very low when searched using Google (Rader, 2011). Although these resources may be hard to find, many farmers market personnel indicated in interviews and surveys conducted that they utilize university and Cooperative Extension sources as their primary means for produce safety and COVID-19 food safety information (Duong et al., 2021). The purpose of this study was to evaluate existing produce safety resources from sources that may be used by growers at farmers markets for website accessibility, readability, content accuracy, and if available, PDF accessibility.

Methods

This study analyzed online Produce Safety Rule (PSR) resources from three online information sources: Virginia Cooperative Extension, North Carolina Cooperative Extension (NCCE), and the Produce Safety Alliance (PSA). The PSA is the training and education outlet for the Food Safety Modernization Act's Produce Safety Rule (PSR) (Association of Food and Drug Officials, 2016). These sources were picked due to projects, grants, and work with other collaborators that utilize these main sources. Search terms of "produce safety," "produce safety rule," "COVID-19", "rarely consumed raw", and "farmers markets" were developed using the website analytics from two of the three previously stated information sources. The website analytics' correlations used included the number of downloads, the number of clicks, and the frequently most searched terms. Previous studies selected search terms based on the topic of interest such as "nutrition and diet," "hip dislocation," and "weight loss" (Dy et al., 2012; Modave et al., 2014; Sutherland et al., 2005). The search was performed on July 8, 2021, during a single session using Google Chrome browser (Mountain View, CA) on the main VCE, NCCE, and PSA websites described in *Table 1*. Each search term was entered into the search bar of the website and the top 30 search results were downloaded. After eliminating duplicates and those not applicable, 67 of 317 unique website links remained for analysis (*Figure 1*). The criteria for applicability were determined by seeing if the resource could be utilized by farmers market personnel. Website pages that were removed included those advertising scheduled training date information and contact information to the organization's employees.

Website accessibility was used in place of usability from Sutherland's website analysis model, which focused on quality of links, ease of navigation, and organizational scheme.

(Sutherland et al., 2005). Website accessibility is the design and development of websites and technologies for diverse users, including people with disabilities and those without, so that any user can understand, navigate, interact, and contribute to the Web without any barriers (W3C WAI, 2019). Accessibility of a website is measured by its conformance to web accessibility guidelines such as the Web Content Accessibility Guidelines (WCAG) (W3C WAI, 2021). This study used the Web Accessibility Visual Evaluator (WAVE) was used (Kasday, 2000). WAVE performs automated checks of accessibility and helps users make decisions to determine if a web page is universally accessible to persons with and without disabilities (Kasday, 2000). WAVE evaluations can be performed directly through their online form by posting the URL of the web page or by using the Firefox or Chrome extensions (Rysavy & Michalak, 2020; Web Accessibility in Mind (WebAIM), n.d.). WAVE does not provide "pass" or "fail" results but provides "alerts" and "errors" as areas of feedback that involves follow-up from the researcher (Web Accessibility in Mind (WebAIM), n.d.). Studies have used the presence of alerts and errors as an indication of accessibility issues (Rysavy & Michalak, 2020; Solovieva & Bock, 2014). If web pages opened as PDFs, these were categorized into the "PDF" source type and WAVE testing was skipped.

The readability of the websites was analyzed with the Flesch-Kincaid (FK) method of analysis used in health and nutrition studies (Dy et al., 2012; Sutherland et al., 2005; Tutty et al., 2019). The text was prepared, imported into Microsoft Word (Redmond, WA), and analyzed using health and nutrition methods previously stated. The Flesch Reading Ease Formula is calculated using the average sentence length and average number of syllables for word (Rudolph Flesch, 1948) . Scores range from 0 – 100 where scores closer to 100 are very easy to

read and scores closer to 0 are very difficult to read. The Flesch-Kincaid Reading Grade Level (FKGL) test uses the average number of words in a sentence and the average number of syllables per word. The FKGL test translates the 0 to 100 score to a grade level (Kincaid et al., 1975).

Content accuracy was determined by if the content was referenced, if the website has been updated within the past year, and if the content is within the current recommendations of the PSR. For example, the Agricultural Water requirements for the PSR have new compliance dates so making sure this information is updated will provide necessary time for those impacted to ensure their water is safe for use (FDA, 2019).

PDF Accessibility Checker (PAC) has been utilized in numerous as a primary method to analyze PDFs (J. Nganji, 2015, 2018; J. T. Nganji, 2018; Uebelbacher et al., 2014). In this study, accessibility of PDFs was analyzed using PDF Accessibility Checker 3 (PAC), a tool that checks PDF files by the PDF/Universal Accessibility (UA) standards (International Association of Accessibility Professionals, n.d.). PDF/UA is an International Organization for Standardization (ISO) standard that requires that PDF documents and applications meet specific requirements to ensure accessibility for persons with disabilities and is currently equivalent to WCAG 2.0 content (Drümmer, Olaf; Chang, 2013). Requirements that are assessed may include criteria such as against criteria such as “images have alt text” and “document has a logical reading order” (International Association of Accessibility Professionals, n.d.; J. T. Nganji, 2018).

Data analysis. Descriptive statistics were conducted using Microsoft Excel (Redmond, WA) and Statistical Package for Social Sciences (SPSS) (Armonk, NY). One-way multi-analysis of variances (MANOVA) was conducted to determine if any factor exerted a statistically significant

effect on the mean vector of the response variables, in this case, if the information sources of VCE, NCCE, and PSA had significant differences for the WAVE accessibility alerts. One way analysis of variances (ANOVA) was performed on readability statistics.

Results

Website characteristics. A total of 67 out of 391 web pages were analyzed from the three information sources. Of the 67, 12 from Virginia Cooperative Extension (VCE), 38 from North Carolina Cooperative Extension, and 17 from the Produce Safety Alliance. Fifty of the sixty-seven URL links were categorized as web pages (74.6%) with the remainder falling into the PDF category.

WAVE assessment. VCE had the highest number of errors with an average of 10.7 accessibility errors on each web page. Most of these accessibility errors were categorized as empty links (n=86). Some of these errors (n=10) were categorized as "empty heading", which is defined as a website element containing no heading, which will introduce navigation issues for users. NCCE web pages had zero accessibility errors. Both VCE and NCCE had over 10 contrast errors per web page while PSA had an average of about 1 contrast error per web page. There was a total of 417 alerts with the majority falling into the category of "link to PDF document" (n=138). For the "link to PDF document" category, 12 links all from VCE failed because the links were broken with the remaining 126 failing because they did not inform the user that the link would open a PDF document. There was a statistically significant difference between different WAVE evaluation categories such as accessibility errors and alerts based on the information source ($F(12,86) = 55.25$, $p<0.001$, Pillai's $V = 1.770$, partial $\eta^2 = .885$

Readability. The Flesch-Kincaid Grade Level (FKGL) was 12.3 for VCE, 11.4 for NCCE, and 16.5 for PSA. There was a statistically significant difference between the information sources and FKGL ($F(2,64) = 6.14$, $p=0.004$). The average Flesch Reading Ease (FRE) score was 39.1 for

VCE, 42.5 for NCCE, and 24.7 for PSA. There was a statistically significant difference between the information sources and FRE score ($F(2,64)=9.77$, $p<0.001$).

Content quality. Approximately 40% (27 of 67) of the web pages from this study did not provide a last updated date. Of those that did, only four were not updated within the past five years. All web pages provided some form of references whether it was a citation or a link to the website being referred to.

PDF accessibility. Eighteen PDFs were analyzed using Adobe Acrobat's PDF Accessibility Checker. Five PDFs, all from PSA, contained violated zero PDF accessibility rules. The remaining 13 documents (72%) violated one of the PDF accessibility rule(s). VCE had zero violations for the page content, forms, tables, lists, and headings rules. Somewhat concerning were the NCCE PDFs analyzed, which had complete violations for the alternate text, tables, lists, and heading rules and had over 50% violations for the document rule.

Discussion

The resources from our three information sources of VCE, NCCE, and PSA differed in their web accessibility, readability, content quality, and PDF accessibility. Resources from VCE faced the highest amount of web accessibility errors while NCCE had zero errors during the WAVE assessment. Most of these errors were categorized as an "empty link" meaning that the link on the web page contained no text. Links without text do not provide function or purpose to a user and can introduce confusion for keyboard and screen readers (WebAIM, 2021). Both VCE and NCCE these information sources had a high number of contrast errors on their web pages. Contrast errors are important for persons with visual acuity or with color perception problems (WebAIM, 2018; Western Michigan University, 2020). The most common alert for the WAVE assessment was "link to PDF document", which meant the presence of a link to a PDF document. This required additional analysis by the researchers of this study to determine if the PDF links were broken or if they informed the user that the link will open a PDF document. PDF documents often have accessibility issues already, but they require viewing in a separate application or plug-in that may lead to navigation challenges. There were 168 alerts to analyze, and it was determined that 12 links (9%) were broken. Of the links that worked, all failed to provide a notification that the link would open a PDF.

All the resources analyzed fell into the "difficult to read" to "very difficult to read" categories, which can be interpreted reading materials for college to college graduates (Rudolf Flesch, 2004; Jindal & MacDermid, 2017). The National Institute for Health and the American Medical Association recommend that the readability of materials be no greater than a sixth-grade reading level because the average United States adult reads at an 8th grade level (B D

Weiss & Coyne, 1997; Barry D Weiss, 2009). Having resources that can accommodate to the average farmer's comprehension level is important as 38% of farm workers and 48% of farm laborers lack a high school diploma (US Census Bureau, 2018). Additionally, a sizeable farm personnel population does not read English fluently and is likely to comprehend these resources effectively.

In this study, we found that there were many errors related to website links, which can provide navigations errors and lead to accessibility issues. Working, up-to-date links on the website page that link directly to other elements on the website or related websites are important to the quality of a website (Hasan & Abuelrub, 2010). There were some outdated links in this study that have not been updated within the past 3 years. Somewhat concerning was the lack of a last updated or reviewed date on 27 website pages. Up-to-date information is important, especially as the Produce Safety Rule's compliance requirement dates have changed for the agricultural water standard and new scientific knowledge is published on produce safety as a whole.

Limitations and future work. The results of this study cannot be generalized to all produce safety resources online because we limited our search to a specific set of domains. Future research should explore additional produce safety websites such as other state Cooperative Extension websites. In addition, only one data evaluation tool was used for each of the following variables: website accessibility (WAVE), readability (Flesch-Kincaid), and PDF accessibility (Adobe Acrobat Pro). Future work should attempt to address reliability, validity, and consistency by introducing additional evaluation tools such as AChecker and SortSite. Finally, to further understand the usability of these resources for growers, resources should be

developed with these accessibility and readability parameters in mind and be evaluated by this population.

Conclusions.

Producing web content that is accessible and readable ensures that the information will allow the intended audience member to make the decision needed. Health literacy level and the ability to understand information plays a large role in how you process and evaluate information (Diviani et al., 2015). Developing resources that are frequently updated, web-accessible, and navigable, readable to the intended audience, and if applicable, PDF accessible need to be done by researchers, educators, and trainers to help personalize messaging and communication to consumers.

Recommendations.

1. Consider the target audience of resources and their preferred means for obtaining information. This may be through a printed-out handout or on an online webpage.
2. Understand the target audience's background and characteristics. This may include education level, English as a second language, and technological savviness. Other examples may pertain particularly to produce being grown and harvested, or products being sold at farmers markets.
3. Check resources using previously stated tools of WAVE, Adobe Acrobat Pro Accessibility Checker, and the Flesch-Kincaid Method of Analysis.
4. Evaluate resource effectiveness with audience. Ensure that resources can be understood, and the information processed. Make sure the resources are able to be found if they are on a website.

Acknowledgements

References

1. Allen, J., van der Velden, R., Helmschrott, S., Martin, S., Massing, N., Rammstedt, B., Zabal, A., von Davier, M., Ferrari, A., Wayrynen, L., Behr, D., Upsing, B., Goldhammer, F., Schnitzler, M., Baumann, R., Johannes, R., Barkow, I., Rölke, H., Jars, I., … Wagner, M. (2013). *Survey of Adult Skills Technical Report*. https://www.oecd.org/skills/piaac/_Technical Report_17OCT13.pdf
2. Association of Food and Drug Officials. (2016). *Produce Safety Alliance Training – Association of Food and Drug Officials*. https://www.afdo.org/training/producesafetyalliance/
3. Badarudeen, S., & Sabharwal, S. (2010). Assessing readability of patient education materials: Current role in orthopaedics. *Clinical Orthopaedics and Related Research*, *468*(10), 2572–2580. https://doi.org/10.1007/s11999-010-1380-y
4. Diviani, N., Van Den Putte, B., Giani, S., & Van Weert, J. C. M. (2015). Low health literacy and evaluation of online health information: A systematic review of the literature. *Journal of Medical Internet Research*, *17*(5), 1–17. https://doi.org/10.2196/jmir.4018
5. Drümmer, Olaf; Chang, B. (2013). *PDF/UA in a Nutshell – Accessible documents with PDF*. 19.
6. Duong, M., Zhang, W., Drape, T., Strawn, L., Williams, R., Chapman, B., & Boyer, R. (2021). Assessment of regulatory compliance of Virginia and North Carolina Farmers Markets Vendors to the Food Safety Modernization Act (FSMA). *Food Protection Trends*.
7. Dy, C. J., Taylor, S. A., Patel, R. M., McCarthy, M. M., Roberts, T. R., & Daluiski, A. (2012). Does the quality, accuracy, and readability of information about lateral epicondylitis on the internet vary with the search term used? *Hand*, *7*(4), 420–425. https://doi.org/10.1007/s11552-012-9443-z
8. Estey, A., Musseau, A., & Keehn, L. (1994). Patient's understanding of health information: a multihospital comparison. *Patient Education and Counseling*, *24*(1), 73–78.

https://doi.org/10.1016/0738-3991(94)90027-2

9. Fabricant, P. D., Dy, C. J., Patel, R. M., Blanco, J. S., & Doyle, S. M. (2013). Internet search term affects the quality and accuracy of online information about developmental hip dysplasia. *Journal of Pediatric Orthopaedics*, *33*(4), 361–365. https://doi.org/10.1097/BPO.0b013e31827d0dd2
10. FDA. (2019). *FDA Finalizes New Compliance Dates for Agricultural Water Requirements*. U.S. Food & Drug Administration. https://www.fda.gov/food/cfsan-constituent-updates/fda-finalizes-new-compliance-dates-agricultural-water-requirements
11. Flesch, Rudolf. (2004). How to write plain english. *English*, 1–5.
12. Flesch, Rudolph. (1948). A new readability yardstick. In *Journal of Applied Psychology* (Vol. 32, Issue 3, pp. 221–233). American Psychological Association. https://doi.org/10.1037/h0057532
13. Friedman, D. B., & Hoffman-Goetz, L. (2006). A systematic review of readability and comprehension instruments used for print and web-based cancer information. *Health Education and Behavior*, *33*(3), 352–373. https://doi.org/10.1177/1090198105277329
14. Graham, J. L., & Andreasen, A. R. (1997). Marketing Social Change: Changing Behavior to Promote Health, Social Development, and the Environment. *Journal of Marketing Research*, *34*(2), 294. https://doi.org/10.2307/3151867
15. Hasan, L., & Abuelrub, E. (2010). *Assessing the quality of web sites*. https://doi.org/10.1016/j.aci.2009.03.001
16. Hogan, J., Thornton, N., Diaz-Hoffmann, L., Mohadjer, L., Krenzke, T., Li, J., Van De Kerckhove, W., Yamamoto, K., & Khorramdel, L. (2012). *U.S. Program for the International Assessment of Adult Competencies (PIAAC) 2012/2014: Main Study and National Supplement Technical Report*. *November 2019*.

17. International Association of Accessibility Professionals. (n.d.). *Access for All PDF Accessibility Checker (PAC 3)*. Retrieved July 15, 2021, from https://www.access-for-all.ch/ch/pdf-werkstatt.html

18. Jacob, C., Mathiasen, L., & Powell, D. (2010). Designing effective messages for microbial food safety hazards. *Food Control*, *21*(1), 1–6. https://doi.org/10.1016/j.foodcont.2009.04.011

19. Jindal, P., & MacDermid, J. (2017). Assessing reading levels of health information: uses and limitations of flesch formula. *Education for Health*, *30*(1), 84–88. https://doi.org/10.4103/1357-6283.210517

20. Kasday, L. R. (2000). A tool to evaluate universal web accessibility. *Proceedings of the Conference on Universal Usability*, *Fig lc*, 161–162. https://doi.org/10.1145/355460.355559

21. Kincaid, J. P. J., Jr, R. F., Rogers, R. L., Chissom, B. S. B., Fishburne Jr, R. P., Rogers, R. L., & Chissom, B. S. B. (1975). Derivation of new readability formulas (automated readability index, fog count and flesch reading ease formula) for navy enlisted personnel (No. RBR-8-75). Naval Technical Training Command Millington TN Research Branch. *Naval Technical Training Command Millington TN Research Branch*. http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA006655

22. Modave, F., Shokar, N. K., Peñaranda, E., & Nguyen, N. (2014). Analysis of the accuracy of weight loss information search engine results on the internet. *American Journal of Public Health*, *104*(10), 1971–1978. https://doi.org/10.2105/AJPH.2014.302070

23. Nganji, J. (2015). The Portable Document Format (PDF) accessibility practice of four journal publishers. *Library & Information Science Research*, *37*(3), 254–262.

https://www.sciencedirect.com/science/article/abs/pii/S0740818815000134?via%3Dihub

24. Nganji, J. (2018). An assessment of the accessibility of PDF versions of selected journal articles published in a WCAG 2.0 era (2014–2018). *Learned Publishing*, *31*(4), 391–401. https://doi.org/10.1002/leap.1197
25. Nganji, J. T. (2018). Supporting the information journey of students with disabilities through accessible learning materials. *Information and Learning Science*, *119*(12), 721–732. https://doi.org/10.1108/ILS-07-2018-0062
26. Rader, H. (2011). Extension Is Unpopular--On the Internet. *The Journal of Extension*, *49*.
27. Rysavy, M. D. T., & Michalak, R. (2020). Assessing the Accessibility of Library Tools & Services When You Aren't an Accessibility Expert: Part 1. *Journal of Library Administration*, *60*(1), 71–79. https://doi.org/10.1080/01930826.2019.1685273
28. Solovieva, T. I., & Bock, J. M. (2014). Monitoring for Accessibility and University Websites: Meeting the Needs of People with Disabilities. *Journal of Postsecondary Education and Disability*, *27*(2), 113–127. http://proxy.library.brocku.ca/login?url=http://search.proquest.com/docview/1651856804?accountid=9744
29. Sutherland, L. A., Wildemuth, B., Campbell, M. K., & Haines, P. S. (2005). Unraveling the web: An evaluation of the content quality, usability, and readability of nutrition web sites. *Journal of Nutrition Education and Behavior*, *37*(6), 300–305. https://doi.org/10.1016/S1499-4046(06)60160-7
30. Uebelbacher, A., Bianchetti, R., & Riesch, M. (2014). *PDF Accessibility Checker (PAC 2): The First Tool to Test PDF Documents for PDF/UA Compliance* (pp. 197–201). http://www.access-for-all.ch/ch/pdf-werkstatt/pdf-accessibility-checker-pac.html

31. United States Department of Agriculture Economic Research Service. (2020, April). *USDA ERS - Farm Labor*. https://www.ers.usda.gov/topics/farm-economy/farm-labor/

32. United States Department of Agriculture National Agricultural Statistics Service. (2017). United States Summary and State Data. *2017 Census of Agriculture*, *1*(Part 51), 820. http://www.agcensus.usda.gov/Publications/2012/

33. United States Department of Labor, Employment, and T. A. O. of P. D. (2018). *Findings from the National Agricultural Workers Survey (NAWS), 2015-2016: A Demographic and Employment Profile of United States Farmworkers*. *13*.

34. US Census Bureau. (2018). *Understanding and using American Community Survey data: What all data users need to know*. *July*, 1–84. https://www.census.gov/content/dam/Census/library/publications/2018/acs/acs_general_handbook_2018.pdf

35. Web Accessibility in Mind (WebAIM). (n.d.). *WAVE Web Accessibility Evaluation Tool*. https://wave.webaim.org/

36. WebAIM. (2018). *Contrast and Color Accessibility Understanding WCAG 2 Contrast and Color Requirements*. https://webaim.org/articles/contrast/

37. WebAIM. (2021). *Web Content Accessibility Guidelines*. https://webaim.org/standards/wcag/

38. Weiss, B D, & Coyne, C. (1997). Communicating with patients who cannot read. *The New England Journal of Medicine*, *337*(4), 272–274. https://doi.org/10.1056/NEJM199707243370411

39. Weiss, Barry D. (2009). *Help patients understand. Manual for clinicians.* 62.

40. Western Michigan University. (2020). *Using Accessible Colors and Contrast – Help Hub*. https://helphub.wmich.edu/hc/en-us/articles/360052603171-Using-Accessible-Colors-and-Contrast

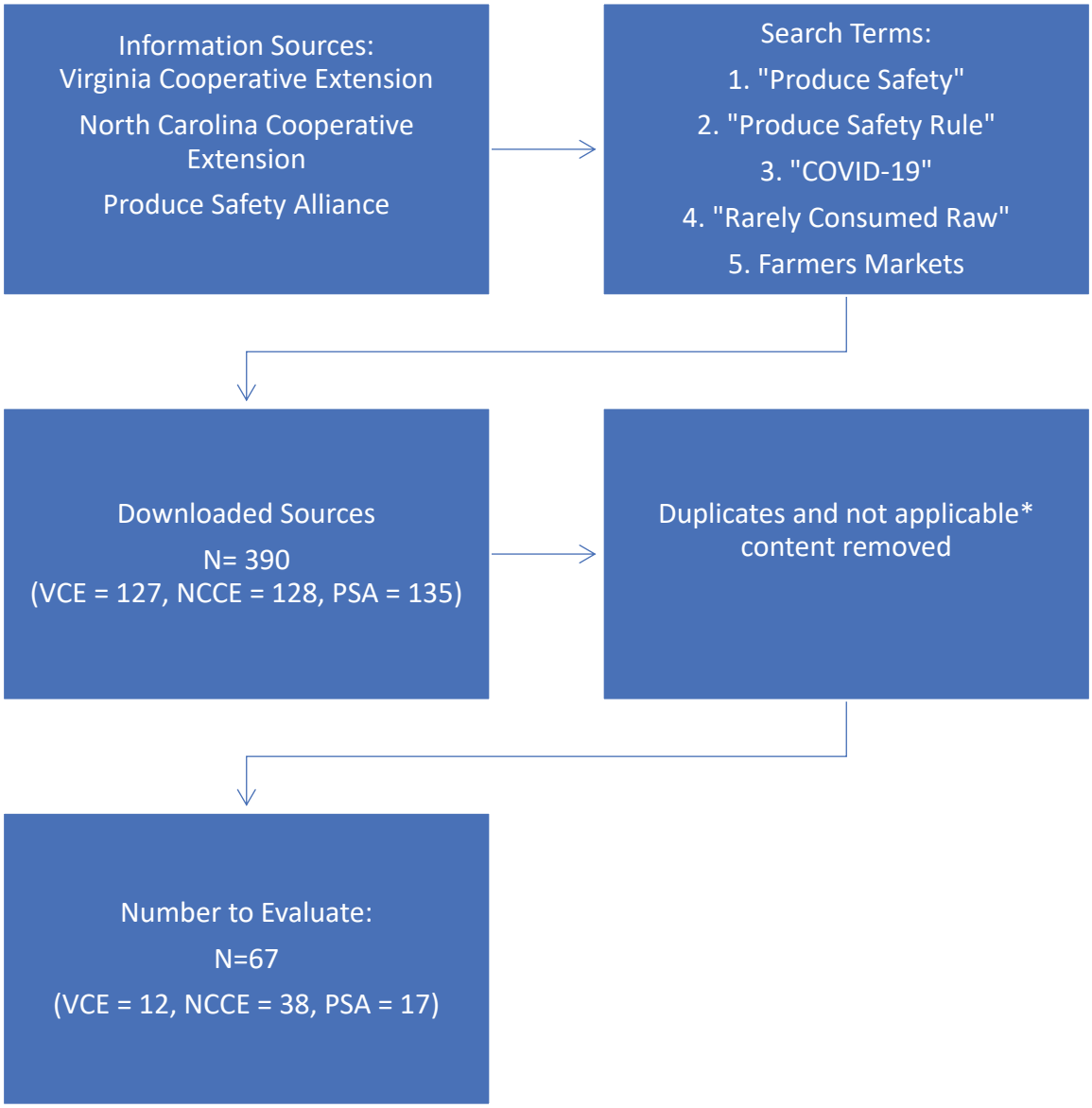


Figure 1. Sorting of produce safety sources from information website sources.

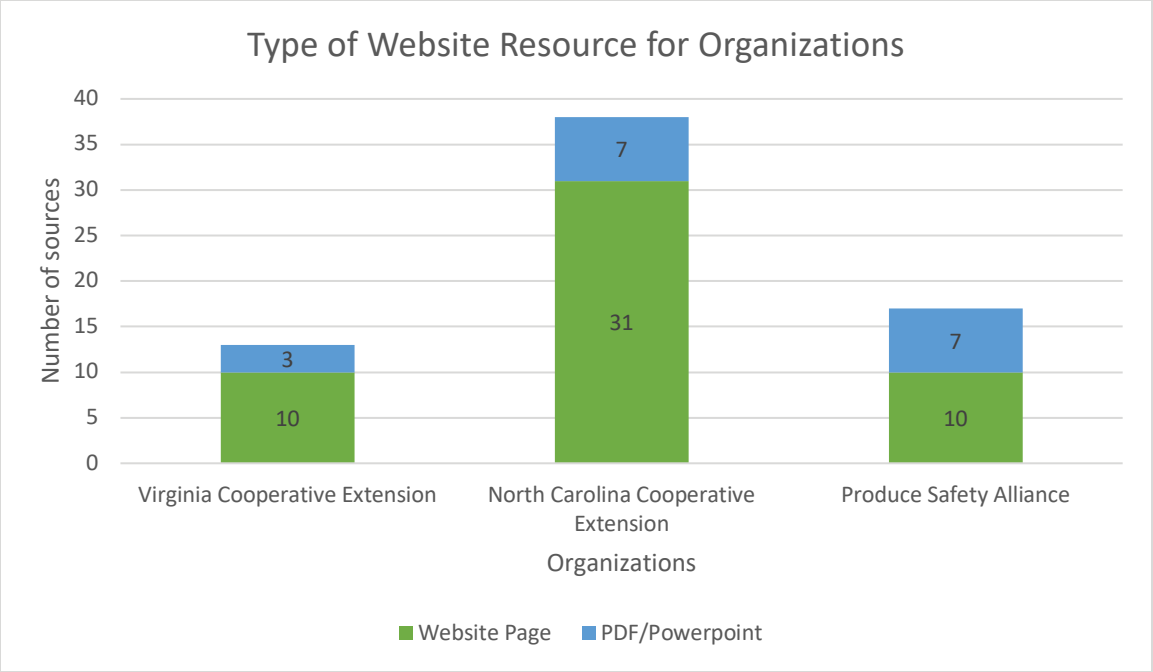


Figure 2. Type of website resources for organizations analyzed.

Table 1. Website URLs from produce safety sources analyzed.

Source ID	URL
Search site VCE	https://ext.vt.edu/
VCE-1	https://ext.vt.edu/agriculture/commercial-horticulture/on-farm-food-safety.html
VCE-2	https://ext.vt.edu/food-health/food-innovations.html
VCE-3	https://ext.vt.edu/content/dam/ext_vt_edu/topics/agriculture/agritourism/files/presentations/direct-marketing.pdf
VCE-4	https://ext.vt.edu/food-health/food-safety.html
VCE-5	https://ext.vt.edu/food-health/food-innovations/rules.html
VCE-6	https://ext.vt.edu/agriculture/commercial-horticulture/greenhouse-vegetables.html
VCE-7	https://ext.vt.edu/content/dam/ext_vt_edu/small-fruit/Ideas%20and%20Considerations%20PYO%20farms.pdf
VCE-8	https://ext.vt.edu/food-health/food-innovations/business.html
VCE-9	https://ext.vt.edu/content/dam/ext_vt_edu/topics/agriculture/agritourism/files/presentations/Safety-on-the-Agritourism%E2%80%93Farm_Smithfield.pdf
VCE-10	https://ext.vt.edu/agriculture/market-ready.html
VCE-11	https://ext.vt.edu/lawn-garden/home-vegetables.html
VCE-12	https://ext.vt.edu/food-health/food-security-systems.html
Search site NCCE	https://www.ces.ncsu.edu/
NCCE-1	https://ncfreshproducesafety.ces.ncsu.edu/
NCCE-2	https://ncfreshproducesafety.ces.ncsu.edu/defining-farm-and-covered-produce/
NCCE-3	https://ncfreshproducesafety.ces.ncsu.edu/how-do-gap-certifications-compare-to-fsmas-produce-safety-rule/
NCCE-4	https://ncfreshproducesafety.ces.ncsu.edu/how-is-produce-classified-under-the-produce-safety-rule/
NCCE-5	https://ncfreshproducesafety.ces.ncsu.edu/2020/05/fda-releases-spanish-translation-of-the-produce-safety-rule/
NCCE-6	https://foodsafetyprocessors.ces.ncsu.edu/2017/03/produce-safety-rule-the-basics/
NCCE-7	https://ncfreshproducesafety.ces.ncsu.edu/produce-safety-rule/

NCCE-8	https://ncfreshproducesafety.ces.ncsu.edu/2021/04/where-does-my-farm-fall-under-the-produce-safety-rule-in-2021/
NCCE-9	https://ncfreshproducesafety.ces.ncsu.edu/2017/03/fsmas-produce-safety-rule/
NCCE-10	https://farmlaw.ces.ncsu.edu/2019/03/produce-safety-fda-issues-fsma-agricultural-water-rule-extension/
NCCE-11	https://ncfreshproducesafety.ces.ncsu.edu/2016/10/how-is-fda-under-fsma-produce-safety-rule-defining-covered-produce/
NCCE-12	https://ncfreshproducesafety.ces.ncsu.edu/2019/03/fda-guidance-documents-to-industry-issued-for-the-fsma-produce-safety-rule/
NCCE-13	https://peaches.ces.ncsu.edu/wp-content/uploads/2017/01/Produce-Safety-Rule-Basics-Peach-growers.pdf?fwd=no
NCCE-14	https://ncfreshproducesafety.ces.ncsu.edu/what-is-the-food-safety-modernization-act-fsma/
NCCE-15	https://ncfreshproducesafety.ces.ncsu.edu/template-for-2020-determine-where-your-farm-falls-under-the-psr/
NCCE-16	https://foodsafetyprocessors.ces.ncsu.edu/wp-content/uploads/2018/01/FDA-versus-USDA.pdf?fwd=no
NCCE-17	https://ncfreshproducesafety.ces.ncsu.edu/exemptions-produce-safety-rule/
NCCE-18	https://ncfreshproducesafety.ces.ncsu.edu/wp-content/uploads/2018/03/4-MacMullan-Produce-Prof-Meeting-March-14-2018.pdf?fwd=no
NCCE-19	https://ncfreshproducesafety.ces.ncsu.edu/wp-content/uploads/2016/11/Stepping-thru-PS-Rule.pdf?fwd=no
NCCE-20	https://ncfreshproducesafety.ces.ncsu.edu/2020/08/helping-farm-workers-at-produce-farms-understand-covid-19/
NCCE-21	https://foodsafety.ces.ncsu.edu/2020/04/covid-19-and-produce-food-safety/
NCCE-22	https://ncfreshproducesafety.ces.ncsu.edu/2020/03/covid-19-resources-for-fruit-and-vegetable-producers/
NCCE-23	https://ncfreshproducesafety.ces.ncsu.edu/2020/04/new-covid-19-guidance-from-fda/

NCCE-24	https://madison.ces.ncsu.edu/2020/04/covid-19-and-produce-food-safety-2/
NCCE-25	https://hyde.ces.ncsu.edu/2020/03/food-safety-portal-covid-19-resources/
NCCE-26	https://ncfreshproducesafety.ces.ncsu.edu/ncfreshproducesafety-growers-farmers-market-resources/
NCCE-27	https://foodsafety.ces.ncsu.edu/community-food-safety-resources/spfarmers-markets/
NCCE-28	https://growingsmallfarms.ces.ncsu.edu/2020/03/local-farmers-markets-do-their-part-to-flatten-the-curve-on-coronavirus/
NCCE-29	https://localfood.ces.ncsu.edu/local-food-marketing-markets/local-food-farmers-markets/
NCCE-30	https://ncfreshproducesafety.ces.ncsu.edu/ncfreshproducesafety-commodity-specific-guidance-strawberry-notebook/
NCCE-31	https://foodsafety.ces.ncsu.edu/wp-content/uploads/2015/07/Farmers-market-questions-FSinfosheet-1.pdf?fwd=no
NCCE-32	https://ncfreshproducesafety.ces.ncsu.edu/definition-of-a-farm/
NCCE-33	https://localfood.ces.ncsu.edu/local-food-marketing-markets/
NCCE-34	https://foodsafety.ces.ncsu.edu/wp-content/uploads/2019/02/SPFM-Module-1_01.19.pdf?fwd=no
NCCE-35	https://www.ces.ncsu.edu/wp-content/uploads/2020/03/Farmer%E2%80%99s-Market-Food-Safety.pdf?fwd=no
NCCE-36	https://richmond.ces.ncsu.edu/2015/04/farmers-markets-provide-economic-and-social-benefits/
NCCE-37	https://ncfreshproducesafety.ces.ncsu.edu/ncfreshproducesafety-gaps-food-safety-plans/
NCCE-38	https://strawberries.ces.ncsu.edu/2020/03/covid-19-farming-resources/

PSA search site	https://producesafetyalliance.cornell.edu/
PSA-1	https://producesafetyalliance.cornell.edu/
PSA-2	https://producesafetyalliance.cornell.edu/training/grower-training-courses/
PSA-3	https://producesafetyalliance.cornell.edu/training/
PSA-4	https://producesafetyalliance.cornell.edu/resources/general-resource-listing/
PSA-5	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/Records-Required-by-the-FSMA-PSR.pdf
PSA-6	https://producesafetyalliance.cornell.edu/food-safety-modernization-act/produce-safety-rule-compliance-dates-timeline/
PSA-7	https://producesafetyalliance.cornell.edu/food-safety-modernization-act/produce-safety-rule/
PSA-8	https://producesafetyalliance.cornell.edu/curriculum/
PSA-9	https://producesafetyalliance.cornell.edu/resources/fsma-produce-safety-rule-water-requirements%c2%a0insights-get-you-organized/
PSA-10	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/Audits-and-regulations.pdf
PSA-11	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/FSMA-PSR-Documentation-Requirements-for-Commercial-Soil-Amendment-Suppliers.pdf
PSA-12	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/FSMA-Regulatory-Table.pdf
PSA-13	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/Water-Analysis.pdf
PSA-14	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/2017%20GM%20STV%20Worksheet%20v1.0.pdf
PSA-15	https://producesafetyalliance.cornell.edu/food-safety-modernization-act/
PSA-16	https://producesafetyalliance.cornell.edu/resources/soil-summits/questions-sess-atlanta/
PSA-17	https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/Chapman.pdf

Table 2. WAVE Accessibility errors for analyzed produce safety sources.

Source ID	Source Type	Accessibility Errors	Alerts	Contrast Errors	Structural Elements	Features	HTML & ARIA
VCE-1	Website	10	11	5	70	16	28
VCE-2	Website	10	20	8	112	17	63
VCE-3	PPT	NA	NA	NA	NA	NA	NA
VCE-4	Website	10	11	10	70	17	43
VCE-5	Website	10	9	3	94	31	48
VCE-6	Website	10	10	6	68	16	31
VCE-7	PDF	NA	NA	NA	NA	NA	NA
VCE-8	Website	10	8	3	77	19	57
VCE-9	PPT	NA	NA	NA	NA	NA	NA
VCE-10	Website	10	9	7	68	17	34
VCE-11	Website	15	14	3	98	21	69
VCE-12	Website	11	10	5	68	17	28
VCE MEAN±SD		10.7±1.66	11.3±3.67	5.56±2.46	11.3±3.67	19.0±4.76	44.6±15.6
NCCE-1	Website	0	6	17	90	27	8
NCCE-2	Website	0	2	17	80	13	8
NCCE-3	Website	0	4	17	82	14	7
NCCE-4	Website	0	2	17	83	13	7
NCCE-5	Website	0	3	17	81	17	8
NCCE-6	Website	0	4	0	80	15	8
NCCE-7	Website	0	4	17	88	14	8
NCCE-8	Website	0	4	17	82	16	8
NCCE-9	Website	0	6	17	89	16	8

NCCE-10	Website	0	3	1	73	16	8
NCCE-11	Website	0	3	17	83	16	8
NCCE-12	Website	0	4	17	81	16	8
NCCE-13	PDF	NA	NA	NA	NA	NA	NA
NCCE-14	Website	0	3	17	81	14	7
NCCE-15	Website	0	9	17	83	14	8
NCCE-16	PDF	NA	NA	NA	NA	NA	NA
NCCE-17	Website	0	2	17	83	14	8
NCCE-18	PDF	NA	NA	NA	NA	NA	NA
NCCE-19	PDF	NA	NA	NA	NA	NA	NA
NCCE-20	Website	0	6	17	90	16	8
NCCE-21	Website	0	18	0	84	14	8
NCCE-22	Website	0	8	17	81	16	8
NCCE-23	Website	0	3	17	81	16	8
NCCE-24	Website	0	3	4	80	22	8
NCCE-25	Website	0	4	4	79	21	8
NCCE-26	Website	0	7	17	72	13	8
NCCE-27	Website	0	9	0	79	13	8
NCCE-28	Website	0	10	17	74	20	7
NCCE-29	Website	1	16	2	95	16	8
NCCE-30	Website	0	14	17	72	13	8
NCCE-31	PDF	NA	NA	NA	NA	NA	NA
NCCE-32	Website	0	11	17	93	13	7
NCCE-33	Website	0	7	2	82	17	8

NCCE-34	PDF	NA	NA	NA	NA	NA	NA
NCCE-35	PDF	NA	NA	NA	NA	NA	NA
NCCE-36	Website	0	3	4	82	23	8
NCCE-37	Website	0	6	17	73	13	8
NCCE-38	Website	0	53	0	172	17	7
NCCE MEAN+SD		.0322±.180	12.1±7.33	7.65±9.37	16.1±3.36	84.7±17.2	7.81±.402
PSA-1	Website	2	5	2	36	17	13
PSA-2	Website	1	5	1	45	9	12
PSA-3	Website	1	4	1	35	9	12
PSA-4	Website	1	23	1	62	9	10
PSA-5	PDF	NA	NA	NA	NA	NA	NA
PSA-6	Website	1	5	1	38	9	10
PSA-7	Website	1	9	1	8	9	44
PSA-8	Website	1	9	1	44	9	13
PSA-9	Website	1	7	1	41	9	10
PSA-10	PDF	NA	NA	NA	NA	NA	NA
PSA-11	PDF	NA	NA	NA	NA	NA	NA
PSA-12	PDF	NA	NA	NA	NA	NA	NA
PSA-13	PDF	NA	NA	NA	NA	NA	NA
PSA-14	PDF	NA	NA	NA	NA	NA	NA
PSA-15	Website	1	5	1	42	9	12
PSA-16	Website	0	6	1	43	8	10
PSA-17	PPT	NA	NA	NA	NA	NA	NA
PSA MEAN±SD		1.00±.470	1.1±.316	7.80±5.61	9.7±2.58	39.4±13.4	14.6±10.6
TOTAL MEAN		2.14±4.07	8.70±7.32	8.34±7.90	15.3±4.55	74.9±23.8	15.8±15.7

Table 3. Classification and summary of the WAVE accessibility errors category (N=98).

Error	What it means	Why it matters	Frequency	Percentage
Empty link	A link contains no text	If a link contains no text, the function or purpose of the link will not be presented to the user. This can introduce confusion to the keyboard and screen reader users	88	89.8%
Missing alternative text	Image alternative text is not present	Each image must have an alt attribute. Without alternative text, the content of an image will not be available to screen-reader users or when the image is unavailable.	0	0%
Empty heading	A heading contains no content.	Some users, especially keyboard and screen-reader users, often navigate by heading elements. An empty heading will present no information and may introduce confusion.	10	10.2%
Linked image missing alternative text	An image without alternative text results in an empty link.	Images that are the only thing within a link must have descriptive alternative texts. If an image is within a link that contains no text and that image does not provide an alternative text, a screen-reader has no content to present to the user regarding the function of the link.	0	0%
Missing form label	A form control does not have a corresponding label.	If a form control does not have a properly associated text label, the function or purpose of that form control may not be presented to screen-reader users. Form labels also provide visible descriptions and larger clickable targets for form controls.	0	0%
Empty button	A button is empty or has no value text.	When navigating to a button, descriptive text must be presented to screen-reader users to indicate the function of the button.	0	0%
Image button missing on alternative	Alternative text is not present for a form image button.	Image buttons provide important function that must be presented an in alternative text. Without an alternative text, the function of an image button is not made available to screen-reader users or when images are disabled or unavailable.	0	0%
		TOTAL	98	100%

Table adapted from Ahmi and Mohamad (2016)

Table 4. Classification and summary of the WAVE accessibility alerts category (n=313).

Alert	What it means	Why it matters	Frequency	Percentage
Redundant title text	Title attribute text is the same as text or alternative text.	The title attribute value is used to provide advisory information. It typically appears when the users hover the mouseover an element. The advisory information presented should not be identical to or very similar to the element text or alternative text.	6	1.91%
Redundant alternative text	The alternative text for an image is the same as nearby or adjacent text.	Alternative text that is the same as nearby or adjacent text will be presented multiple times to screen readers or when images are unavailable.	2	0.638%
Possible list	Text is structured like a list but lacks proper list semantics.	Ordered and unordered lists, when properly defined, provide useful information to users, such as an indication of the list type and number of list items. When text alone is used to present list structures and content, these benefits are lost.	5	1.59%
Broken same-page link	A link to another location within the page is present but does not have a corresponding target.	A link to jump to another position within the page assists users in navigating the web page, but only if the link target exists.	31	9.90%
Layout table	Spacer images are used to control layout or positioning. Because they do not convey content, they should be given empty/null alternative text (alt="") to ensure that the content is not presented	Ensure that the image is a spacer image and that it does not convey content. Consider using CSS instead of spacer images for better control of positioning and layout.	10	3.19%

	to screen reader users and is hidden when images are disabled or unavailable.			
fLong alternative text	An image has very long alternative text	Ensure the alternative text is succinct, yet descriptive. Ensure that no content is being presented in alternative text that is not available to sighted users viewing the image. When possible, either shorten the alternative text or provide the text alternative via another method (e.g., in text near the image, through a separate description page, etc.).	6	1.92%
Justified text	Fully justified text is present.	Large blocks of justified text can negatively impact readability due to varying word/letter spacing and 'rivers of white' that flow through the text.	1	0.319%
Suspicious alternative text	Alternative text is likely insufficient or contains extraneous information.	If the alternative text for an image does not provide the same content or information conveyed by the image, that content will not be available to screen reader users and when images are unavailable.	3	0.958%
Unlabeled form control with title	A form control does not have a label but has a title.	The title attribute value for unlabeled form controls will be presented to screen reader users. However, a properly associated text label provides better usability and accessibility and should be used unless the purpose of the form control is intuitive without the label.	0	0%

Skipped heading level	A heading level is skipped.	Headings provide document structure and facilitate keyboard navigation by users of assistive technology. These users may be confused or experience difficulty navigating when heading levels are skipped.	6	1.92%
Suspicious link text	Link text contains extraneous text or may not make sense out of context.	Links, which are often read out of context, should clearly describe the destination or function of the link. Ambiguous text, text that does not make sense out of context, and extraneous text (such as "click here") can cause confusion and should be avoided.	4	1.28%
Redundant link	Adjacent links go to the same URL.	When adjacent links go to the same location (such as a linked product image and an adjacent linked product name that go to the same product page) this results in additional navigation and repetition for keyboard and screen reader users.	55	17.6%
Noscript element	A <noscript> element is present.	Content within <noscript> is presented if JavaScript is disabled. Because nearly all users (including users of screen readers and other assistive technologies) have JavaScript enabled, <noscript> cannot be used to provide an accessible version of inaccessible scripted content.	26	8.31%
Underlined text	Underlined text is present.	Underlines almost universally indicates linked text. Consider removing the underline from the	13	4.15%

		non-link text. Other styling (e.g., bold or italics) can be used to differentiate the text.		
Very small text	Text is very small.	Text which is very small is difficult to read, particularly for those with low vision.	2	0.639%
YouTube video	An embedded or linked YouTube video is present.	For video content with audio, ensure that synchronized captioning is available. While YouTube can auto-generate captions using voice recognition, these are typically not of sufficient quality to be considered equivalent.	12	3.83%
Link to PDF document	A link to a PDF document is present.	Unless authored with accessibility in mind, PDF documents often have accessibility issues. Additionally, PDF documents are typically viewed using a separate application or plug-in, and can thus cause confusion and navigation difficulties.	118	37.7%
Link to Word Document	A link to a Microsoft Word document is present.	Unless authored with accessibility in mind, Microsoft Word documents often have accessibility issues. Additionally, Word documents are typically viewed using a separate application, and can thus cause confusion and navigation difficulties.	4	1.28%
Plugin	An unidentified plugin is present.	Plugins allow the introduction of non-HTML content, media players, etc. Because of limitations in non-HTML content, these often introduce accessibility issues.	9	2.88%
		Total	313	100%

Table 5. MANOVA results of the effect of information source on different WAVE indicators

Information Sources for Produce Safety[a]	Accessibility Errors	Indicated Alerts	Contrast Errors	HTML5 and ARIA	Structural Elements
VCE	10.667	11.333	5.556	44.56	80.56
NCCE	.0320	7.645	12.07	7.806	84.77
PSA	1.000	7.800	1.100	14.60	39.40

[a] Significant at $p<0.001$

[b] Significant differences were found using a Multi-Analysis of Variance test with Pillai's Trace.

[c] Pillai's Trace was used in place of Wilks' Lambda due to violation of homogeneity of covariance matrices.

Table 6. Readability of produce safety resources.

Source number	Flesch Reading Ease	Flesch-Kincaid Grade Level
VCE-1	21.2	14.9
VCE-2	43	11.7
VCE-3	54	7.7
VCE-4	8.1	18
VCE-5	41.2	12.6
VCE-6	26.7	15.4
VCE-7	60.9	7.6
VCE-8	41.1	11.9
VCE-9	79.5	4.2
VCE-10	16.4	18.7
VCE-11	50.7	10.4
VCE-12	26.5	14.8
VCE MEAN±SD	39.1±20.4	12.3±4.36
NCCE-1	43.9	10.5
NCCE-2	67.4	4.6
NCCE-3	46.4	11.4
NCCE-4	45.7	9.1
NCCE-5	20.4	19.4
NCCE-6	35.4	13.3
NCCE-7	36.5	13.3
NCCE-8	43.5	12.9
NCCE-9	32	14.2
NCCE-10	26	16.3
NCCE-11	45.5	9.1
NCCE-12	18.8	17.8
NCCE-13	43.5	11.1
NCCE-14	36.3	11.8
NCCE-15	51.8	9.6
NCCE-16	43.5	11.1
NCCE-17	55.4	6.8
NCCE-18	59.2	6.9
NCCE-19	55.5	7.9
NCCE-20	38.3	13.4
NCCE-21	64.6	7.5
NCCE-22	26.8	12.8
NCCE-23	24.3	11.7
NCCE-24	62.1	8.5
NCCE-25	42.7	11.1
NCCE-26	35.9	10.7

NCCE-27	45.8	10.2
NCCE-28	51.3	11.7
NCCE-29	33.3	12.6
NCCE-30	43.3	13.2
NCCE-31	56	9.1
NCCE-32	30	13.9
NCCE-33	35.2	13.9
NCCE-34	49.3	9.3
NCCE-35	66.3	6.3
NCCE-36	36.8	13.3
NCCE-37	24.8	16
NCCE-38	42.7	10.6
NCCE MEAN±SD	42.5±12.7	11.4±3.17
PSA-1	26.1	14.2
PSA-2	34.8	13.6
PSA-3	19.9	16.3
PSA-4	42.2	14
PSA-5	30.9	13.8
PSA-6	28.3	15.1
PSA-7	29.1	15
PSA-8	19	16.7
PSA-9	36	14
PSA-10	43.8	11.6
PSA-11	26	15.3
PSA-12	11.8	12.8
PSA-13	15	28.8
PSA-14	12	34.7
PSA-15	21.7	14
PSA-16	13.9	30.5
PSA-17	9.6	0
PSA MEAN±SD	24.7±10.6	16.5±8.04
TOTAL MEAN±SD	37.4±15.5	12.9±5.35

Table 7. The number of passes for each Adobe accessibility rule.

	Document (Out of 8)	Page Content (Out of 9)	Forms (Out of 2)	Alternate text (Out of 5)	Tables (Out of 4)	Lists (Out of 2)	Headings (Out of 1)
VCE-3	6	9	2	4	4	2	1
VCE-7	7	9	2	5	4	2	1
VCE-9	5	9	2	4	4	2	1
NCCE-13	3	7	2	0	0	0	0
NCCE-16	3	7	2	0	0	0	0
NCCE-18	2	7	2	0	0	0	0
NCCE-19	4	6	2	0	0	0	0
NCCE-31	3	6	2	0	0	0	0
NCCE-34	5	6	2	0	0	0	0
NCCE-35	4	7	2	0	0	0	0
PSA-5	6	9	2	4	4	2	1
PSA-10	8	9	2	5	4	2	1
PSA-11	8	9	2	5	4	2	1
PSA-12	8	9	2	5	4	2	1
PSA-13	8	8	2	5	4	2	1
PSA-14	8	9	2	5	4	2	1
PSA-16	3	6	2	0	0	0	0
PSA-18	8	9	2	2	4	2	1

CHAPTER 6: CONCLUSION

In summary, farmers market personnel require tailored and specialized training materials that address the unique challenges and barriers they face. Training materials should be tailored to address different languages and literacy levels as well as time, money, and material resources that these market vendors may have available. The majority of farmers market vendors will be exempt from the Produce Safety Rule (PSR) (66%) and Preventive Controls for Human Foods Rules (PCHF) (100%). For the PSR, vendors were exempt because they do not gross $25,000 annually. Some market vendors will be exempt because they sell exclusively meat and poultry products and will fall underneath HACCP. For the PCHFR, most vendors fell into the primary activities farm or secondary activities farm category, so they were exempt. Although vendors may be exempt from these food safety regulations, vendors should still follow proper food safety practices.

In addition to understanding the regulatory compliance of farmers market vendors to the PSR and PCHRF, a questionnaire was conducted to understand how farmers market personnel have altered their hand hygiene and health practices in response to the COVID-19 pandemic and the challenges and barriers they faced in implementation due to the pandemic. The results indicated that farmers market managers adopted hand hygiene practices for their market such as implementation of handwashing stations, providing hand sanitizer, and introducing handwashing signage. Both managers and vendors implemented preventive measures such as physical distancing, postponing of community events, and providing personal protective equipment to patrons and employees. The major challenges reported by market managers included customer and vendor compliance of mask wearing and social distancing

policies, low-turnout at markets, and implementation of preventive measures due to limited resources. Similar challenges and barriers were faced by vendors who expressed challenges with a fewer number of shoppers and the compliance of social distancing and preventive measures by employees and customers.

Data from both the regulatory compliance and COVID-19 studies revealed that farmers market personnel utilized a variety of sources for their information. The top information food safety sources from these studies were University/Cooperative, local government, and federal government. These results suggest that utilizing these sources to reach this population would be effective. Although University/Cooperative Extension sources are popular, the results from a study analyzing three sources, Virginia Cooperative Extension (VCE), North Carolina Cooperative Extension (NCCE), and the Produce Safety Alliance (PSA), indicate that these resources are not accessible from a website navigability standpoint and literacy level. Resources most fell into the category of “difficult to read” to “very difficult to read”, which can be interpreted as reading materials for college to college graduates (Rudolph Flesch, 1948). Resources should be developed no greater than a sixth-grade reading level for health-related content (Barry D Weiss, 2009). Additionally, many farmer workers (38%) and laborers (48%) lacked a high school diploma or do not read English fluently (41%).

This dissertation work consisting of three studies had some limitations. The first limitation was that the data collected using interviews and questionnaires fall into the category of self-reported data. This type of data is associated with social desirability bias, which is where participants may answer in specific way to favorably present themselves due to current social normal and standards (Katkin, 1964; Zerbe & Paulhus, 1987). Secondly, the data collected in

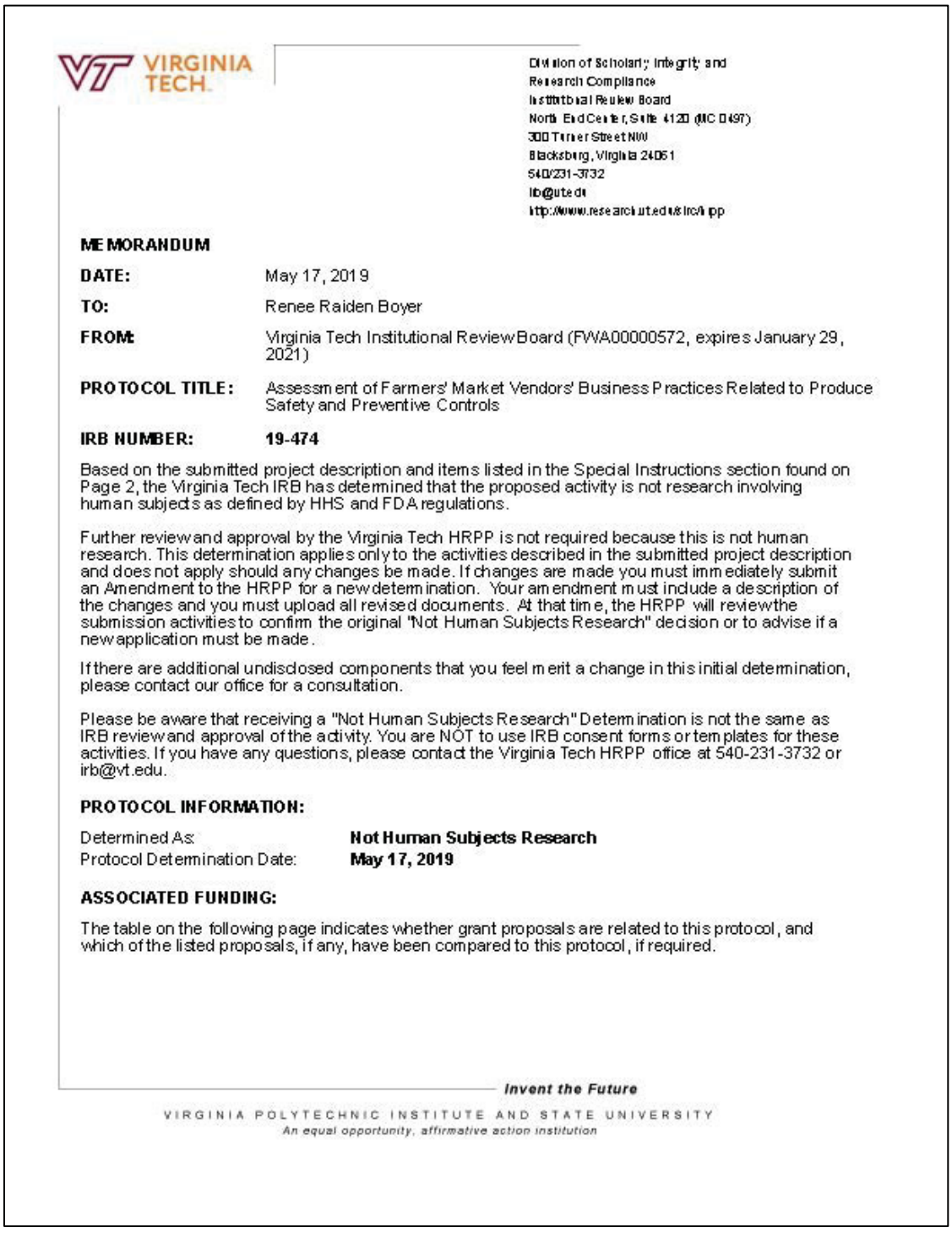
these experiments used convenience sampling because the population is hard-to-reach and due to geographical limitations, however, this means that the results suffer from the inability to be generalized (Wenzel, 2017). To further address the geographical limitations of this dissertation, specifically in Chapter 3, future work should explore the practices of farmers market vendors for regulatory compliance across other states in the United States to ensure that the results of this are not unique to Virginia and North Carolina vendors. In addition, the COVID-19 questionnaire should attempt to target Food and Nutrition Services regions where there were a limited number of responses such as the Mountain Plain, Western, or Southwest regions (United States Department of Agriculture Food and Nutrition Services, 2021). Finally, future research in this area should develop training materials for farmers market populations with consideration of this dissertation's findings in mind of unique challenges and barriers, website navigability and accessibility, and literacy level. To understand if these resources meet the needs of these populations, focus groups should be used to understand if the developed resources are effective in communicating the topic to the targeted audience (Rennekamp & Nall, 2005; Trenkner & Achterberg, 1991).

References

1. Flesch, R. (1948). A new readability yardstick. In *Journal of Applied Psychology* (Vol. 32, Issue 3, pp. 221–233). American Psychological Association. https://doi.org/10.1037/h0057532
2. Katkin, E. S. (1964). The Marlowe-Crowne Social Desirability Scale: Independent of Psychopathology? *Psychological Reports*, *15*(3), 703–706. https://doi.org/10.2466/pr0.1964.15.3.703
3. Rennekamp, R. A., & Nall, M. A. (2005). *report - Using focus groups in program development and evaluation*. https://psd.ca.uky.edu/files/focus.pdf
4. Trenkner, L. L., & Achterberg, C. L. (1991). Use of focus groups in evaluating nutrition education materials. *Journal of the American Dietetic Association*, *91*(12), 1577–1581.
5. United States Department of Agriculture Food and Nutrition Services. (2021). *FNS Regional Offices | USDA-FNS*. https://www.fns.usda.gov/fns-regional-offices
6. Weiss, B. D. (2009). *Help patients understand. Manual for clinicians.* 62.
7. Wenzel, A. (2017). Convenience Sample. *The SAGE Encyclopedia of Abnormal and Clinical Psychology*, 197–198. https://doi.org/10.4135/9781483365817.n338
8. Zerbe, W. J., & Paulhus, D. L. (1987). Socially desirable responding in organizational behavior: A reconception. *Academy of Management Review*, *12*(2), 250–264. https://doi.org/10.5465/AMR.1987.4307820

APPENDIX A.

APPENDIX A1. Virginia Tech Institutional Review Board Approval Letter



VIRGINIA TECH

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MEMORANDUM

DATE: May 17, 2019

TO: Renee Raiden Boyer

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)

PROTOCOL TITLE: Assessment of Farmers' Market Vendors' Business Practices Related to Produce Safety and Preventive Controls

IRB NUMBER: **19-474**

Based on the submitted project description and items listed in the Special Instructions section found on Page 2, the Virginia Tech IRB has determined that the proposed activity is not research involving human subjects as defined by HHS and FDA regulations.

Further review and approval by the Virginia Tech HRPP is not required because this is not human research. This determination applies only to the activities described in the submitted project description and does not apply should any changes be made. If changes are made you must immediately submit an Amendment to the HRPP for a new determination. Your amendment must include a description of the changes and you must upload all revised documents. At that time, the HRPP will review the submission activities to confirm the original "Not Human Subjects Research" decision or to advise if a new application must be made.

If there are additional undisclosed components that you feel merit a change in this initial determination, please contact our office for a consultation.

Please be aware that receiving a "Not Human Subjects Research" Determination is not the same as IRB review and approval of the activity. You are NOT to use IRB consent forms or templates for these activities. If you have any questions, please contact the Virginia Tech HRPP office at 540-231-3732 or irb@vt.edu.

PROTOCOL INFORMATION:

Determined As: **Not Human Subjects Research**
Protocol Determination Date: **May 17, 2019**

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

APPENDIX A2. Recruitment letter for study

Hello,

I am reaching out to you on behalf of a team of researchers from North Carolina State University and Virginia Polytechnic Institute and State University. Our team is seeking input from farmers and producers of produce products in North Carolina and Virginia to help us collect data about current practices related to growing and producing these products. We hope to use this data to determine how North Carolina Cooperative Extension and Virginia Cooperative Extension can best serve these groups.

We are recruiting participants through an online survey administered by a software company called Qualtrics. The seven-question screening survey provides additional background about the study and collects contact and other information about the potential participant relevant to the study. If participants meet selection criteria and are interested in participating in the study, they will be contacted by a member of our research team to set up a 20-minute phone interview. After completing the interview, participants will be offered a $10 Amazon gift card for their time.

The recruitment survey can be accessed through the following link:

https://go.ncsu.edu/farmersmarketfsma

We ask that you share this survey within your networks, including past and current farmers market vendors. We hope to collect data from as many farmers and producers, because the more responses we get, the better able we will be to understand current practices around growing and producing produce products.

Please do not hesitate to reach out to me if you have any questions about this survey or the research it supports.

Regards,

Benjamin Chapman, Ph.D.
Associate Professor, Food Safety Extension Specialist
NC State University
(919) 515-8099
bjchapma@ncsu.edu

Renee Boyer, Ph.D.
Professor, Extension Specialist
Virginia Tech
(540) 231-4330
rrboyer@vt.edu

APPENDIX A3. Qualtrics Recruitment Eligibility Survey

Assessment of farmers' market vendors business practices related to produce safety and preventive

Start of Block: Description of Study

Q1 Purpose of Research The purpose of this study is for us to learn about your business practices on your farm. This research study involves conducting one-on-one interviews via telephone with participants who identify as farmers' market vendors and/or growers. We are asking that you participate in an interview that will last no longer than twenty minutes. During the interview, we would like for you to share with us some information about your business practices. This research is being conducted as part of a dissertation research project, and may be published. Your answers and participation in the interview will be kept confidential. We will use this information to improve our outreach efforts for farmers' markets.
Procedures Your participation will involve responding to interview questions asked by a member of the investigation team on your farms' business practice. The total time for the interview should take about twenty minutes . The interview will not be audio-recorded to protect your identity. Instead, we will take notes to capture your answers. The written notes will be secured in a lockbox inside a locked office. Electronically used notes will be kept on a secured computer and will not be shared with anyone.
Risks There are no known risks or discomforts associated with this study.
Benefits There are no direct benefits to you. No promise or guarantee of benefits has been made to encourage you to participate. You may contact the researchers for a summary of the study results.
Extent of Anonymity and Confidentiality Protecting you is a top priority of researchers. The data collected about you in this study is for research purposes only. Your information will be kept strictly confidential and will not be shared with any outside party. The Institutional Review Board or the Business Office may require us to submit a list of participants given a gift card, but your name and identity will no way be associated with your responses.

Compensation At the completion of the interview, you will receive a $10 gift card to Walmart to thank you for participating. Upon sending the gift card for completion, your contact information will be deleted.
Freedom to Withdraw You are free to withdraw from this study at any time without penalty. There may be circumstances under which the investigator may determine that you should not continue as a subject. If you withdraw before completion of the study, you may not be compensated.

Q9 Please check one of the boxes after reading the description.

- ☐ I would like to participate in this study and will complete the rest of the form. (1)
- ☐ I would NOT like to participate in this study. Thank you for your time. (2)

Skip To: Q1 If Please check one of the boxes after reading the description. = I would like to participate in this study and will complete the rest of the form.

Skip To: End of Survey If Please check one of the boxes after reading the description. = I would NOT like to participate in this study. Thank you for your time.

Q1 Name

_____

Q2 Farm and/or Company Name

_____

Q3 E-mail

_____

Q4 Phone Number

_____

Q5 Preferred form of contact

- [ ] Phone number (1)
- [ ] E-mail (2)

Q9 Does part of your business include selling food to the public?

- ○ Yes (1)
- ○ No (2)

End of Block: Description of Study

Start of Block: Thank you

Q10 Thank you for completing the form. We will be in contact soon to schedule a date.

Skip To: End of Survey If Thank you for completing the form. We will be in contact soon to schedule a date. Is Displayed

End of Block: Thank you

APPENDIX B.

APPENDIX B1. Institutional Review Board Study Approval Letter.

VIRGINIA TECH

Division of Scholarly Integrity and
Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/irb.pp

MEMORANDUM

DATE: May 17, 2019

TO: Renee Raiden Boyer

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)

PROTOCOL TITLE: Assessment of Farmers' Market Vendors' Business Practices Related to Produce Safety and Preventive Controls

IRB NUMBER: **19-474**

Based on the submitted project description and items listed in the Special Instructions section found on Page 2, the Virginia Tech IRB has determined that the proposed activity is not research involving human subjects as defined by HHS and FDA regulations.

Further review and approval by the Virginia Tech HRPP is not required because this is not human research. This determination applies only to the activities described in the submitted project description and does not apply should any changes be made. If changes are made you must immediately submit an Amendment to the HRPP for a new determination. Your amendment must include a description of the changes and you must upload all revised documents. At that time, the HRPP will review the submission activities to confirm the original "Not Human Subjects Research" decision or to advise if a new application must be made.

If there are additional undisclosed components that you feel merit a change in this initial determination, please contact our office for a consultation.

Please be aware that receiving a "Not Human Subjects Research" Determination is not the same as IRB review and approval of the activity. You are NOT to use IRB consent forms or templates for these activities. If you have any questions, please contact the Virginia Tech HRPP office at 540-231-3732 or irb@vt.edu.

PROTOCOL INFORMATION:

Determined As:	**Not Human Subjects Research**
Protocol Determination Date:	**May 17, 2019**

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

APPENDIX B2. Qualtrics survey: The Impact of COVID-19 on Farmers Markets [Managers]

The Impact of COVID-19 on Farmers Markets

Start of Block: Survey Introduction

Q1 This survey is designed by researchers at Virginia Tech and North Carolina State University to understand how farmers market managers have altered their practices in response to the COVID-19 pandemic. We hope to use these responses from this survey to help inform strategies to assist farmers markets across the United States during this time. Your participation in this survey is voluntary. Your information will be kept confidential. This survey will take approximately 10 minutes. Please answer honestly to each question. There is minimal risk involved with completing this survey and you may withdraw at any point. If you have any questions about this study, please contact
Minh Duong, MS Doctoral Student Department of Food Science and Technology Virginia Tech
minhd16@vt.edu

End of Block: Survey Introduction

Start of Block: Information on Farmers Market

Q2 Where are the markets that you manage located?

Q3 State

▼ Alabama (1) ... Wyoming (52)

Q4 County or counties of markets managed

_____

Q5 Is your market operated outdoors, indoors, or both?

- ○ Outdoors (1)
- ○ Indoors (2)
- ○ Both (3)

End of Block: Information on Farmers Market

Start of Block: Operations

Q6 Was your market closed for any time during COVID-19?

- ○ Yes, but we are now reopen. (1)
- ○ Yes, and we are still closed. (2)
- ○ No, we were never closed. (3)

Display This Question:

If Was your market closed for any time during COVID-19? = No, we were never closed.

Q7 You indicated that your market was never closed during COVID-19. What allowed for you to stay open? (Select all that apply)

- ☐ Deemed an essential operation/business by the governor (state government) (1)
- ☐ Deemed an essential operation/business by the local government (2)
- ☐ Able to comply with requirements to remain open (3)
- ☐ Other (please indicate): (4) _____

Display This Question:

If Was your market closed for any time during COVID-19? = Yes, and we are still closed.

Q8 You indicated that your market was closed during COVID-19 and is still closed. Why were you closed? (Select all that apply)

- ☐ Not deemed an essential operation/business by the governor (state government) (1)
- ☐ Not deemed an essential operation/business by the local government (2)
- ☐ Unable to comply with requirements to remain open (3)
- ☐ Other (please indicate): (4) _____

Display This Question:

If Was your market closed for any time during COVID-19? = Yes, but we are now reopen.

Q9 You indicated that your market was closed for a period of time during COVID-19. What allowed you to reopen? (Select all that apply)

- ☐ Market was later deemed an essential operation/business (1)
- ☐ We re-opened during one of the phases (1,2,3) (2)
- ☐ We implemented practices that allowed us to reopen (3)
- ☐ Other (please indicate): (4) _____

Display This Question:

If You indicated that your market was closed for a period of time during COVID-19. What allowed you... = We re-opened during one of the phases (1,2,3)

Q10 You indicated that you reopened during one of your state's reopening phases. Which phase did you reopen during?

- ○ Phase 1 (1)
- ○ Phase 2 (2)
- ○ Phase 3 (3)
- ○ The "phase" terminology do not apply to me or my state. (4)

Display This Question:

If You indicated that you reopened during one of your state's reopening phases. Which phase did you... = The "phase" terminology do not apply to me or my state.

Q11 You indicated that the "Phase 1, 2, or 3" terminology does not apply to you or your state. What conditions were required for you to open?

_____

_____

_____

_____

_____

End of Block: Operations

Start of Block: Market Practices

Q12 Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all that apply)

- ☐ Stands/booths spaced 6 feet apart (1)
- ☐ Physical guides (tape on floors and signage) to ensure customers are spaced 6 feet apart (2)
- ☐ Restricting number of shoppers in the market (3)
- ☐ Postponing all market community events (music, entertainment, community tables) (4)
- ☐ One-way flow of traffic (5)
- ☐ Requiring face masks to enter market (6)
- ☐ Physical barriers (sneeze guards, partitions) (7)
- ☐ Reduced market hours (8)
- ☐ Reduced the number of vendors considered essential (9)
- ☐ Discouraging pets (except service animals) from being brought (10)
- ☐ Not allowing the use of reusable bags (11)
- ☐ Other (please indicate): (12) _____
- ☐ My market does none of the above (13)

Q13 Has your farmers market altered or changed any of these other practices to prevent the spread of COVID-19? (Select all that apply)

- ☐ No cloth table coverings (1)
- ☐ No samples handed out (2)
- ☐ Using single-use packaging or bags (3)
- ☐ Implementing a pick-up service (4)
- ☐ Using touchless payment systems (5)
- ☐ Mobile markets (6)
- ☐ Providing separate operating hours for vulnerable customers (7)
- ☐ Providing no touch or low touch purchasing opportunities (pre-boxing/pre-bagging of food items) (8)
- ☐ Other (please indicate): (9) _____
- ☐ My market has not altered or changed any of the practices above (10)

Q14 Which of the following health and hygiene practices to prevent the spread of disease existed prior to COVID pandemic and which were implemented result of COVID pandemic?

	Existed prior to COVID (1)	As a result of COVID (2)	We do not have any of this practice at our market (3)
Providing hand washing stations (1)	○	○	○
Displaying hand washing signage (2)	○	○	○
Providing hand sanitizer (3)	○	○	○
Screening vendors (4)	○	○	○

Display This Question:

If Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Providing hand washing stations [Existed prior to COVID]

Or Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Providing hand washing stations [As a result of COVID]

Q15 At this moment, do you still provide hand washing stations at your market?

○ Yes (1)

○ No (2)

Display This Question:

If Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Displaying hand washing signage [Existed prior to COVID]

Or Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Displaying hand washing signage [As a result of COVID]

Q16 At this moment, do you still provide hand washing signage at your market?

- Yes (1)
- No (2)

Display This Question:

If Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Providing hand sanitizer [As a result of COVID]

Or Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Providing hand sanitizer [Existed prior to COVID]

Q17 At this moment, do you still provide hand sanitizer at your market?

- Yes (1)
- No (2)

Display This Question:

If Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Screening vendors [Existed prior to COVID]

Or Which of the following health and hygiene practices to prevent the spread of disease existed prio... = Screening vendors [As a result of COVID]

Q18 At this moment, do you still screen vendors at your market?

- Yes (1)
- No (2)

Display This Question:

If Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Stands/booths spaced 6 feet apart

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Physical guides (tape on floors and signage) to ensure customers are spaced 6 feet apart

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Restricting number of shoppers in the market

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Postponing all market community events (music, entertainment, community tables)

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = One-way flow of traffic

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Requiring face masks to enter market

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Physical barriers (sneeze guards, partitions)

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Reduced market hours

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Reduced the number of vendors considered essential

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Discouraging pets (except service animals) from being brought

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Not allowing the use of reusable bags

Or Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... Other (please indicate): Is Not Empty

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Other (please indicate):

Q19 You indicated that you implemented practices that allowed you to stay open? What practices did you implement? You may also upload a copy of your written, implemented practices below.

_____

_____

_____

_____

_____

Display This Question:

If Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Stands/booths spaced 6 feet apart

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Physical guides (tape on floors and signage) to ensure customers are spaced 6 feet apart

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Restricting number of shoppers in the market

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Postponing all market community events (music, entertainment, community tables)

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = One-way flow of traffic

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Requiring face masks to enter market

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Physical barriers (sneeze guards, partitions)

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Reduced market hours

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Reduced the number of vendors considered essential

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Discouraging pets (except service animals) from being brought

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Not allowing the use of reusable bags

Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... = Other (please indicate):

Or Or Which measures has your farmers market implemented to prevent the spread of COVID-19? (Select all... Other (please indicate): Is Not Empty

Q20 Please upload a copy of your written, implemented practices.

End of Block: Market Practices

Start of Block: Block 3

Q21 Which of the following procedures are in place to address the health of the vendors at your market?

- ☐ Screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry (3)
- ☐ Providing proper personal protective equipment (masks, disposable gloves) (4)
- ☐ Having a policy for sick vendors/workers (5)

Display This Question:

If Which of the following procedures are in place to address the health of the vendors at your market? = Having a policy for sick vendors/workers

Q22 You indicated that you have a sick policy. Please upload a copy of it below.

Display This Question:

If Which of the following procedures are in place to address the health of the vendors at your market? = Screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry

Q24 You indicated that you screen vendors for entry before allowing entry. How are you screening vendors?

- ☐ Temperature scans/checks (1)
- ☐ Screening checklist (2)
- ☐ Other (please indicate): (3) _____

Display This Question:

If You indicated that you screen vendors for entry before allowing entry. How are you screening vend... = Screening checklist

Q23 You indicated that you have a screening checklist, which of the following do your screening questions look for? (Select all that apply)

- ☐ Symptoms (fever, chills, fatigue, cough, shortness of breath, etc.) (1)
- ☐ Close contact to someone with suspected or confirmed case of COVID-19 (2)
- ☐ Travel out of state, country, or another specified region the past 14 days (3)
- ☐ Being asked to self-isolate or quarantine by medical or local public health official within last 14 days (4)
- ☐ Other (please indicate): (5) _____

End of Block: Block 3

Start of Block: Block 6

Q25 On an average day, how many hours is your market open for currently (during COVID)?

_____

Q26
Cleaning is the physical removal of soils (including food debris). During your market hours, how many times does your market clean these items? (ex. using soap to remove debris).

Please select "-1" if your market does not have this item or you are not responsible for cleaning it. If you have this item but do not clean it, please select "0".

Average number of times cleaned

-1 0 1 2 3 4 5 6 7 8 9 10

Porous tabletops (wood, carboard) ()	
Non-porous tabletops (glass, plastic, metal, varnished wood) ()	
Cash box or card reader ()	
Handwashing sink ()	
Trash can ()	
Bathroom surfaces ()	
Produce display containers ()	
Click to write Choice 8 ()	

Q27 Disinfecting is the act of killing bacteria and viruses used an EPA-approved chemical. During your market hours, how many times does your market clean these items? (ex. using bleach to disinfect).

Please select "-1" if your market does not have this item or you are not responsible for disinfecting it. If you have this item but do not disinfect it, please select "0".

Average number of times

-1 0 1 2 3 4 5 6 7 8 9 10

Porous tabletops (wood, carboard) ()	
Non-porous tabletops (glass, plastic, metal, varnished wood) ()	
Cash box or card reader ()	
Handwashing sink ()	
Trash can ()	
Bathroom surfaces ()	
Produce display containers ()	

Q28 Do you mix your own disinfectant for use (ex. mixing bleach with water) or do you buy a commercially available disinfectant?

- ○ I mix my own disinfectant (1)
- ○ I buy a commercially available disinfectant (2)
- ○ I do both - I buy commercially available disinfectant and mix it myself (3)

Display This Question:

If Do you mix your own disinfectant for use (ex. mixing bleach with water) or do you buy a commercia... = I mix my own disinfectant

Or Do you mix your own disinfectant for use (ex. mixing bleach with water) or do you buy a commercia... = I do both - I buy commercially available disinfectant and mix it myself

Q29 You indicated that you mix your own disinfectant. Please take a picture of the manufacturer's mixing instructions and upload it.

End of Block: Block 6

Start of Block: Block 8

Q30 Please provide the name of any disinfectant(s) you use below. Some examples you may list are: Lysol spray, Clorox wipes and Clorox Bleach Spray, and Purell spray.

_____

_____

_____

_____

_____

Q31 You indicated disinfectant(s) you use above. Please take a picture of the disinfectant product label(s) and upload it. An example picture of the disinfectant label is provided below.

Q32

Q33 Take a picture of your disinfectant label(s) and upload it below.

Q34 How do you apply your disinfectant? (Select all that apply)

- ☐ Spraying using sprayer bottle (1)
- ☐ Spraying using electrostatic sprayer (2)
- ☐ Wiping using wipe (3)
- ☐ Fogging (4)
- ☐ Other (5) _____

End of Block: Block 8

Start of Block: Block 7

Q35 Does your farmers market use wood or plastic tokens as currency?

- ☐ Yes (1)
- ☐ No (2)

Display This Question:

If Does your farmers market use wood or plastic tokens as currency? = Yes

Q36 You indicated that your market uses wood or plastic tokens as currency. How do you clean and disinfect these tokens?

_____

_____

_____

_____

_____

End of Block: Block 7

Start of Block: Block 10

Q38 What other challenges than the ones discussed above has your market faced, if any?

_____

_____

_____

_____

_____

Q37 What COVID-19 prevention practices not currently in place would you consider implementing at future farmers market sessions (next season)?

_____

_____

_____

_____

_____

End of Block: Block 10

Start of Block: Block 4

Q39 How are you interacting with your local health officials as it relates to farmers market regulations?

- ○ Local health officials are providing me with guidance on COVID-19 and I implement it (1)
- ○ Local health officials are providing with guidance on COVID-19 but I don't implement it (2)
- ○ I do not interact with my local health officials (3)

Q40 Where do you get information on COVID-19 as it relates to farmers markets? What information do you obtain from these sources? Check the boxes below for source and information type.

	University/Cooperative Extension (1)	Federal Government (e.g., FDA, CDC, USDA) (2)	Local Government (e.g., Health Department) (3)	Industry or Growers Organization (4)	I do not get information on this practice from any of these sources (5)
Handwashing practices (1)	☐	☐	☐	☐	☐
Cleaning Practices (2)	☐	☐	☐	☐	☐
Disinfecting Practices (3)	☐	☐	☐	☐	☐
Social distancing measures (4)	☐	☐	☐	☐	☐

End of Block: Block 4

Start of Block: Block 5

Q41 Would you be willing to distribute a similar survey to your vendors?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Would you be willing to distribute a similar survey to your vendors? = Yes

Q42 Please provide your email below for us to contact you

_____

End of Block: Block 5

APPENDIX B3: Qualtrics survey: The Impact of COVID-19 on Farmers Markets [Vendors]

The Impact of COVID-19 on Farmers Market Vendors

Start of Block: Survey Introduction

Q1 This survey is designed by researchers at Virginia Tech and North Carolina State University to understand how COVID-19 has impacted farmers markets, specifically **farmers market vendors**. We hope to use these responses from this survey to help inform strategies to assist farmers markets across the United States during this time. Your participation in this survey is voluntary. Your information will be kept confidential. This survey will take 5 minutes. Please answer honestly to each question. There is no more than minimal risk involved with completing this survey. You may withdraw from this study at any point. If you have any questions about this study, please contact
Minh Duong, MS Doctoral Student Department of Food Science and Technology Virginia Tech minhd16@vt.edu

End of Block: Survey Introduction

Start of Block: Information on Farmers Market

Q2 Please provide some information on where the farmers market your business sells at is located

Q38 State

▼ Alabama (1) ... I do not reside in the United States (53)

Q4 County or counties of farmers markets your business sells at

_____

_____

_____

_____

_____

Q40 Is the market your business sells at outdoors, indoors, or both?

- Outdoors (1)
- Indoors (2)
- Both (3)

Q5 With the COVID-19 pandemic, has your business continued selling at farmers markets? Why or why not?

_____

_____

_____

_____

_____

End of Block: Information on Farmers Market

Start of Block: Block 3

Q6 Which measures has your business implemented at your stand, booth, or selling location to address COVID-19? (Select all that apply)

- ☐ Wearing of protective equipment (gloves, mask) (1)
- ☐ Bagging and packaging foods (2)
- ☐ Cashless/touchless transactions (3)
- ☐ Not providing food samples (4)
- ☐ Physical barriers (sneeze guards, partitions) (5)
- ☐ Reduced number of employees working at the market (6)
- ☐ Signage (Handwashing, social distancing) (7)
- ☐ Not allowing the use of reusable bags (8)
- ☐ Other (please indicate): (9) _____
- ☐ My business has implemented none of the above (10)

Q7 What hand hygiene practices has your business implemented to address COVID-19? (Select all that apply)

- ☐ Providing handwashing stations at our booth (1)
- ☐ Displaying hand washing signage at the handwashing station employees (2)
- ☐ Providing hand sanitizer for employees and customers to use (3)
- ☐ Other (please indicate): (4) _____

Q8 Which of the following procedures are in place to address employee health of people working at the farmers market? (Select all that apply)

- ☐ Screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry (3)
- ☐ Providing proper personal protective equipment (masks, disposable gloves) (4)
- ☐ Sick policy (5)

Display This Question:

If Which of the following procedures are in place to address employee health of people working at th... = Screening for potential exposure to COVID-19 and symptoms of COVID-19 before entry

Q9 You indicated that you screen vendors for entry before allowing entry. How are you screening vendors? (Select all that apply)

- ☐ Temperature scans/checks (1)
- ☐ Screening checklist (2)
- ☐ Other (please indicate): (3) _____

Display This Question:

If Which of the following procedures are in place to address employee health of people working at th... = Sick policy

Q10 You indicated that you have a sick policy. Please upload a copy of it below.

Q12 What other challenges than the ones discussed above has your business faced, if any?

_____

_____

_____

_____

_____

End of Block: Block 3

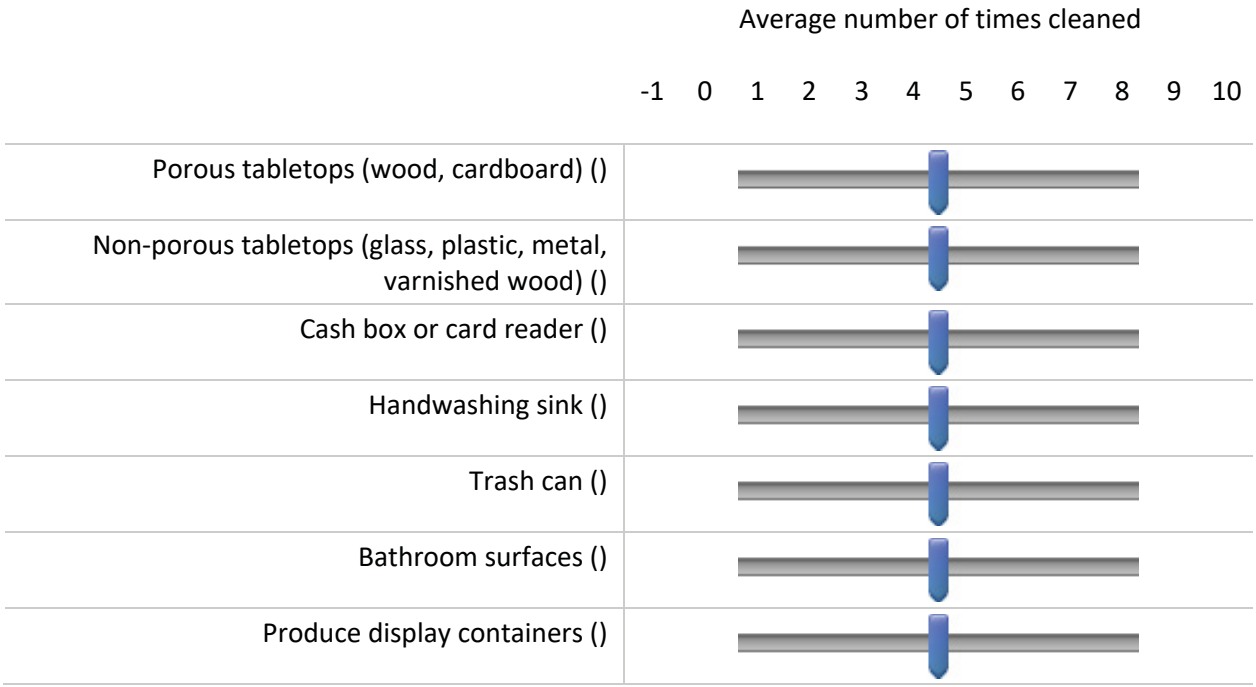
Start of Block: Block 5

Q13 On an average day, how many hours is your business open currently open at the market during COVID?

_____

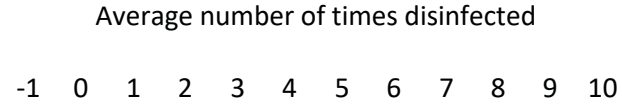
Q14 Cleaning is the removal the physical removal of soils (including food debris). During your market hours, how many times does your market clean these items? (ex. using soap to remove debris).

Please select "-1" if your market does not have this item or you are not responsible for cleaning it. If you do have this item but do not clean it, please select "0".



Q15 Disinfecting is the act of killing bacteria and viruses used an EPA-approved chemical. During your market hours, how many times does your market disinfect these items? (ex. using bleach to disinfect).

Please select "-1" if your market does not have this item or you are not responsible for disinfecting it. If you do have this item but do not disinfect it, please select "0".



Porous tabletops (wood, cardboard) ()	
Non-porous tabletops (glass, plastic, metal, varnished wood) ()	
Cash box or card reader ()	
Handwashing sink ()	
Trash can ()	
Bathroom surfaces ()	
Produce display containers ()	

Q16 Do you mix your own disinfectant for use (ex. mixing bleach with water) or do you buy a commercially available disinfectant?

- I mix my own disinfectant (1)
- I buy a commercially available disinfectant (2)
- I do both - I buy commercially available disinfectant and mix it myself (3)
- We do not use any disinfectants (4)

Display This Question:

If Do you mix your own disinfectant for use (ex. mixing bleach with water) or do you buy a commercia... = I mix my own disinfectant

Or Do you mix your own disinfectant for use (ex. mixing bleach with water) or do you buy a commercia... = I do both - I buy commercially available disinfectant and mix it myself

Q17 You indicated that you mix your own disinfectant. Please take a picture of the manufacturer's mixing instructions and upload it below.

End of Block: Block 5

Start of Block: Block 6

Q18 Please provide the name of any disinfectant(s) you use below. Some examples you may list are: Lysol spray, Clorox wipes and Clorox Bleach Spray, and Purell spray.

_____

_____

_____

_____

_____

Q39 You indicated disinfectant(s) you use above. Please take a picture of the disinfectant product label(s) and upload it. An example picture of the disinfectant label is provided below.

Q40

Q20 Take a picture of your disinfectant label(s) and upload it below.

Q19 How do you apply your disinfectant? (Select all that apply)

- ☐ Spraying using sprayer bottle (1)
- ☐ Spraying using electrostatic sprayer (2)
- ☐ Wiping using wipe (3)
- ☐ Fogging (4)
- ☐ Other (please indicate): (5) _____

End of Block: Block 6

Start of Block: Block 4

Q21 How are you interacting with your local health officials as it relates to farmers market regulations?

- ○ Local health officials are providing me with guidance on COVID-19 and I implement it (1)
- ○ Local health officials are providing with guidance on COVID-19 but I don't implement it (2)
- ○ I do not interact with my local health officials, but I do interact with my farmers market manager. (3)
- ○ I do not interact with my local health officials nor do I interact with my farmers market manager. (4)

Q22 Where do you get information on COVID-19 as it relates to farmers markets? What information do you obtain from these sources? Check the boxes below for source and information type.

	University/Cooperative Extension (1)	Federal Government (e.g., FDA, CDC, USDA) (2)	Local Government (e.g., Health Department) (3)	Industry or Growers Organization (4)	I do not get information on this practice from any of these sources (5)
Handwashing practices (1)	☐	☐	☐	☐	☐
Cleaning Practices (2)	☐	☐	☐	☐	☐
Sanitizing Practices (3)	☐	☐	☐	☐	☐
Social distancing measures (4)	☐	☐	☐	☐	☐

Q23 What coronavirus prevention practices not currently in place would you consider implementing at future farmers market sessions (next season)?

_____

_____

_____

_____

_____

End of Block: Block 4

APPENDIX C.

APPENDIX C1. Rubric for resources

Source ID	
Top links	
Format	
Error Types	**Fail Number, Reason**
Image button missing on alternative text	
Empty heading	
Empty link	
Missing Alternative text	
Linked image missing alternative text	
Missing form label	
Empty button	
Total error number	
Alert Type	**Fail Number, Reason**
Indicated Alerts	
Redundant title text	
Redundant alternative text	
Possible list	
Broken same-page link	

Layout table	
Long alternative text	
Justified text	
Suspicious alternative text	
Unlabeled form control with title	
Skipped heading level	
Suspicious link text	
Redundant link	
Noscript element	
Underlined text	
Very small text	
Youtube video	
Link to PDF document	
Link to Word Document	
Plugin	
Features	
Structural Elements	
HTML5 and ARIA	

APPENDIX C2: Readability rubric for website pages analyzed.

Source number	
Website	
Type	
Counts	
Words	
Characters	
Paragraphs	
Sentences	
Averages	
Sentences per paragraph	
Words per sentence	
Characters per word	
Readability	
Flesch Reading Ease Score	
Flesch-Kincaid Grade Level	
Passive Sentences	

APPENDIX C3: PDF Accessibility Checker Rubric.

Source ID		
URL		
PDF Accessibility Category	**PDF Rule**	**Frequency**
Document	Accessibility permission flag	
	Image-only PDF	
	Tagged PDF	
	Logical Reading Order	
	Primary language	
	Title	
	Bookmarks	
	Color contrast	
Page Content	Tabbed content	
	Tabbed annotations	
	Tab order	
	Character encoding	
	Tagged multimedia	
	Screen flicker	
	Scripts	
	Timed responses	
	Navigation links	
Forms	Tagged form fields	
	Field descriptions	
Alternate text	Figures alternate text	
	Nested alternate text	
	Associated with content	
	Hides annotation	
	Other elements alternate text	
Tables	Rows	
	TH and TD	
	Headers	
	Regularity	
	Summary	
Lists	List items	
	Lbl and Lbody	
Headings	Appropriate nesting	