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Cleaning and Sanitizing in Produce Facilities: Identifying Compliance Gaps and Associated Training Needs, Opportunities and Preferences

ABSTRACT

Inspections of fresh produce operations for compliance with the Produce Safety Rule (PSR) have identified cleaning and sanitizing (C/S) as a significant challenge. To better understand C/S practices in the produce industry a national survey was administered over a 3-week period in summer 2020 to fresh produce operations in U.S. Survey responses (n = 162) represented 135 produce operations from 18 different states. The most common materials reported for harvesting containers (n = 50 responses) were plastic (80%), wood (30%), cardboard (16%), and canvas (12%), while stainless steel (81%) and plastic (71%) were most commonly used for post-harvest equipment (n = 42 responses). Bleach (40/63), quaternary ammonium compounds (32/63), and peracetic acid (26/63) were the most commonly reported sanitizers. Respondents indicated there is a need for resources on principles and practical implementation of C/S, identification of hazards and prioritizing C/S activities, establishing a C/S program, and verification of C/S effectiveness, in English, Spanish and other languages. High turnover and seasonal workforce (37/65) and no time to C/S (19/65) were indicated as major barriers for improving C/S in a facility. The results of the survey helped guide a virtual C/S workshop in 2021, and an in-person workshop currently in development.

INTRODUCTION

The year 2019 began a new era of federal regulatory oversight for food safety on produce farms across the United States (U.S.). U.S. Food and Drug Administration (FDA) and State Departments of Agriculture are enforcing the "Produce Safety Rule" (PSR) *(21)*. Under the umbrella of the Food Safety Modernization Act (FSMA), the PSR requires farms to implement practices to reduce the likelihood of microbial contamination of raw agricultural products on farm. The PSR is complex and comprehensive, but also prescriptive and vague which makes it challenging for farms to be confident in their compliance. To ease farms and regulators into the new rule, compliance dates were staggered based on farm size. Compliance for the largest business categories (>$500,000 annual produce sales) began

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in 2018, with first inspections occurring in the 2019 growing season. Based on the FDA data collected during the first year of inspections, inadequate cleaning and sanitizing was one of the top four observations and citations *(23)*. In addition, observations collected from 220 farms in 13 Western States through a voluntary On-Farm Readiness Review (OFRR) program, indicated that harvest and post-harvest sanitation was among the top three deficiencies identified *(12)*. The language in the PSR (21 CFR 112.123(d)*(1)*) states that a farm, "must inspect, maintain, and clean and, when necessary and appropriate, sanitize all food contact surfaces of equipment and tools used in covered activities as frequently as reasonably necessary to protect against contamination of covered produce" *(21)*. Vague terms, including "when necessary and appropriate" and "as frequently as reasonably necessary" are necessary to allow flexibility for different operations; however, these terms can also create confusion as they do not provide sufficient context to understand regulatory expectations on the performance of cleaning and sanitizing activities. The assumption is that farms would have the knowledge to determine and justify appropriate activities and frequencies; however, often growers do not have the level of training nor resources to meet FDA's expectations during inspections. Aside from a lack of training, there is also a dearth of scientific data to identify optimal cleaning and sanitizing procedures in fresh produce environments. As such, there is a critical need for more applied research in this area to provide targeted training to growers on effective cleaning and sanitizing practices needed to align with FDA's enforcement of the PSR.

Produce farming occurs in diverse, complex and dynamic environments where produce can become contaminated with spoilage and pathogenic microorganisms by a wide variety of mechanisms *(3)*. Regional practices or environmental factors such as growing location, type of irrigation, seasonality, and nature of produce surface and handling practices may influence the likelihood of crop contamination *(1, 5, 18)*. Farm-level activities, such as hygienic management of harvest and packinghouse equipment and containers via cleaning and sanitizing programs (e.g., sanitizer selection, application frequency) have been identified as important practices for improving food safety *(6, 18)*. From previous outbreak investigations, we know that washing and fluming steps, commingling of produce, and infrequent monitoring of sanitizer concentration are processes that can contribute to the spread of foodborne pathogens, and therefore require a deliberate and careful management on each farm *(4, 18)*. Since fresh produce operations inherently lack a 'kill step', preventing microbial contamination and minimizing the potential for cross-contamination are essential in these environments. While few studies have investigated contamination sources on produce farms *(1, 9, 24)*, there remains a lack of organized information on the diversity of surfaces commonly encountered on produce farms, and the methods and frequencies of cleaning and sanitizing of these surfaces. In order to provide effective and targeted education on best practices for cleaning and sanitizing surfaces in farm environments, it is critical to understand the types of surfaces most often encountered in these environments and how often they are cleaned and sanitized. To address these gaps, our study surveyed the produce growers to gain a better understanding of barriers for cleaning and sanitizing in produce handling environments, the extent of the use of different surface materials, and industry preference for educational materials and their delivery. These findings clarify grower needs to make informed decisions on practical and effective solutions for compliance and food safety risk mitigation.

MATERIALS AND METHODS

An anonymous, voluntary survey was administered by Oregon State University and the Western Regional Center to Enhance Food Safety (WRCEFS) using Qualtrics, over a three-week period from June 15 to July 7, 2020. The survey targeted produce growers, packers and processors of various sizes. It was shared through WRCEFS listserv, website and social media, and emailed to Southern, North Central and Northeast Regional FSMA Centers, Western region FSMA trainers and stakeholders, including the United Fresh Produce Association and Oregon Department of Agriculture Produce Safety Program. The survey was also shared by the United Fresh Produce Association and ODA Produce Safety Program through their listservs. The questionnaire had two parts. Part one included 14 questions, focused on: 1) respondent demographics (job description, type and size of operation, commodities grown/handled); 2) positions with assigned duties related to cleaning and sanitizing; 3) preferred format for educational workshops on food safety, and 4) ranking of importance for educational topics on cleaning and sanitizing. At the completion of part one of the survey, participants were given the option to end the survey or complete a second part of the survey related to cleaning and sanitizing practices.

The second part of the survey included 30 questions. The questions were grouped into five categories: 1) description of tools, containers and equipment used in the operation; 2) management of cleaning and sanitizing practices; 3) cleaning and sanitizing activities; 4) major barriers for improving cleaning and sanitation; and 5) preferences for educational opportunities formats and resources. Description of tools, containers and equipment section focused on: i) types of tools, containers, equipment and building materials; and ii) primary food contact surfaces (handheld harvesting tools, harvest containers, harvesting equipment, transportation equipment, post-harvest equipment, storage containers) and gloves. Questions pertaining to management of cleaning and sanitizing of food contact and non-food contact surfaces included questions

about: i) the frequency of cleaning and sanitizing; ii) availability of standard operating procedures (SOPs); iii) clean-breaks; iv) roles and positions responsible for cleaning and sanitizing activities; v) availability of records related to cleaning and sanitizing; and vi) types of sanitizers used. Information related to verification of cleaning and sanitizing activities included questions about environmental monitoring programs (EMPs) and types of tests performed as part of EMP. One question focused on the major barriers for improving cleaning and sanitizing in the facility, with a list of responses provided to participants as well as an optional text entry. Lastly, questions related to educational opportunities and resources focused on: i) preferred length of training events for cleaning and sanitizing and EMP workshops; ii) resources for employee training; iii) resources for management/owners; and iv) language preferences for resources.

The questionnaire contained no double-barreled questions and provided a thorough list of response alternatives for each question. The questionnaire was reviewed by an expert panel of food safety specialists and Extension educators and revised for clarity and flow. Survey participants had the option to skip any of the questions. The study was determined exempt from the need for approval by the Institutional Review Board at Oregon State University.

Data analysis

Data were collected via Qualtrics survey software, and the resulting scores were exported to Excel and JMP (v. 15) for data analysis. Survey respondents were excluded from consideration if they responded to less than 22% of the survey. After removing excluded respondents, a total of 162 surveys were analyzed. The majority of respondents (n = 116) provided answers to 87–100% of the survey questions, followed by three respondents that completed 50–74% survey questions, and 43 respondents that completed 22–37% of the questions. The included respondent surveys were analyzed via quantitative, qualitative, and descriptive analyses.

RESULTS AND DISCUSSION

Respondent demographics and produce operation diversity

Survey respondents that disclosed their position title (n = 119) represented a cross-section of roles and responsibilities within the produce industry *(Table 1)*. Approximately one-third of respondents were in food safety management positions. Farmers and/or owners were also a common occupation (28% respondents). Remaining respondents held various positions, with most having a managerial or higher organizational role (including presidents). Few responded with occupations not directly associated with produce operations, including two educators, a retired chemist, and an executive chef. Respondents with positions within this "other" category *(Table 1)*, mostly self-omitted responses not relevant to their position. The majority of survey respondents (66%) indicated that they were familiar with their operation's goals and policies of cleaning and sanitation and more than 20% of respondents are part of the sanitation crew and/or directly supervise their sanitation crew *(Table 1)*.

Respondents (n = 135) represented produce operation in 18 states, with >75% being on the west coast *(Table 2)*. The majority of respondents represented primary production farms with size ranging from 0.5 to 120,000 acres; however, there was also substantial representation from secondary activities farms, packinghouses, and processors *(Table 2)*. Most operations (88%) had a single physical location. The majority of operations (55%) meet the PSR definition of a large business (>$500,000 in annual produce sales), while the remaining respondents were split equally across the small ($250,000-$500,000), very small, ($25,000-$250,000) and excluded (<$25,000) business categories. Operations produced and/or handled a diverse array of agricultural products including fruits and/or vegetables/herbs, with 11% of operations indicating only business activities related to food or feed products not subject to the PSR *(Table 2)*.

Surface materials and cleaning and sanitizing practices in produce operations

Seventy-four respondents described the tools, containers, and equipment used in their operation. The majority of operations reported that they use harvest containers (50/74; 68%), post-harvest equipment (42/74; 57%), and transportation equipment (40/74; 54%). Less than half of respondents reported the use of handheld harvest tools (34/74; 46%) and harvest equipment (15/74; 20%). When it comes to materials used for food contact surfaces, typically, in food processing facilities food contact surfaces are composed of smooth and nonporous materials to ensure sanitary conditions during food production and allow for effective cleaning and sanitation (e.g., stainless steel, plastic) *(8, 19)*. This same standardization of equipment and surface materials does not exist for the fresh produce industry. Equipment and materials used on farms are often highly specialized to specific crops and/or activities and equipment and materials may be used for single crops or many crops. These tools and equipment are often designed and/or built by the farm to support farming activities, not necessarily with consideration to hygienic management and food safety. While there have been many studies on the efficacy of sanitizers on "standard" food contact surface materials *(7, 14, 16)*, there is limited information on the effectiveness of cleaning and sanitizing practices for more complex surfaces found in produce operations (e.g., wood, rubber, canvas). From our survey data, plastic was the most common produce contact material reported across all surface categories, followed by stainless steel *(Fig. 1A)*. The use of wood and cardboard surfaces was also commonly reported (12–43% of respondents depending on surface category), while a small

TABLE 1. Demographic information of individual survey respondents (n = 162). The number of respondents answering each question is shown after the subheading (in bold). Each participant may have selected multiple answers to some questions and participants may have not answered every question. Percent of participants was calculated using the frequency of the response and number of respondents answering that particular question

Demographic information – Respondents	Frequency of selected answer	% of participants
Respondent occupation/job position (n = 119)		
Food safety & QA coordinator/manager/director	41	34
Farmer/owner	33	28
Manager/supervisor	15	13
Operations manager/general manager/director/president	12	10
Educator	2	2
Other[a]	16	13
Respondent job duties (n = 153)		
Familiar with the company goals and policies of cleaning/sanitizing	101	66
More than one step above the direct supervision of the sanitation crew	55	36
Directly supervise in-house sanitation crew	47	31
Part of the sanitation crew or have responsibility for work station	42	27
Contract and oversee an external sanitation service	13	9
Other[b]	25	16

[a]Other occupations included: apprentice melittologist, bee innovator/producer, compliance coordinator, compliance specialist, employee health and safety coordinator, executive chef, produce safety rule inspector, purchaser, retired chemist, retired commercial food processor, safety compliance coordinator, salesperson, self-employed baker, technical fellow, and transportation manager.

[b]Other job duties included: approval of SOPs and chemicals; deep cleaning, daily cleaning, hourly cleaning and sanitizing between each customer; design of specific sanitation programs for a number of facilities and farms; inspector; only worker at farm if not trimming; primary person in charge of all aspects of sanitization from cleaning and sanitizing stalls, coops and animals to harvesting eggs and produce and cleaning those products harvested; training people on this topic; sanitizing innovator.

number of facilities (n = 14) reported using canvas, typically during harvesting activities (e.g., handheld harvesting tools [n = 6], harvesting containers [n = 6], harvesting equipment [n = 1], post-harvest equipment [n = 3], storage containers [n = 2]). Foam was disclosed as a produce contact surface in post-harvest equipment at seven operations. Other produce contact materials reported included metals other than stainless steel (n = 3), concrete (n = 2), glass (n = 2), brushes (n = 2), nylon belts (n = 1), and mesh netting (n = 1).

When asked about who performs cleaning and sanitizing activities in the operation, 146 respondents provided answers, some of which had more than one category selected. The majority of produce operations (57%) reported that they rely on employees with other job responsibilities to also perform cleaning and sanitation duties, whereas 28% had a dedicated crew whose primary job duties were cleaning and sanitation, and 5% said that they utilize contract workers or their customer's cleaning crew. The remainder of operations (16%) relied on the owners, family members, or volunteers to perform cleaning and sanitation activities.

The majority of operations (60–81%) indicated that they cleaned and sanitized produce contact surfaces across most surface categories, with the exception of transportation equipment, for which only 35% respondents reported cleaning and sanitizing those surfaces *(Fig. 1B)*. Most operations indicated the use of more than one class of sanitizers, with bleach (63%), quaternary ammonium compounds (51%), and peracetic acid (41%) commonly reported *(Fig. 1C)*. Less commonly used are chlorine dioxide, silver compounds, and hydrogen peroxide, with each reported by one operation. Rinsing only and cleaning only were common responses (7–15%) across most surface categories *(Fig. 1B)*. The most common surface categories for which no hygiene management of produce contact

TABLE 2. Demographic information of survey respondents' operations (n = 162). The number of respondents answering each question is shown after the subheading (in bold). Each participant may have selected multiple answers to some questions and participants may have not answered every question. Percent of participants was calculated using the frequency of the response and number of respondents answering that particular question

Demographic information – Operations	Frequency of selected answer	% of participants
Operation type (n = 153)		
Primary production farm[a]	88	58
Secondary activities farm[b]	47	31
Packinghouse, re-packer that does not meet the 'secondary activities farm' definition	33	22
Processing[c]	31	20
Other[d]	22	14
Single and multi-location operations (n = 135)		
Operations with one location	119	88
Operations with multiple locations[e]	16	12
State where operation is located (n = 135)		
Oregon	95	70
California	20	15
Washington	19	14
Michigan	8	6
Florida	5	4
New York, Ohio, Texas (3 responses each)	9	7
Arizona, Illinois, Pennsylvania (2 responses each)	6	4
Alaska, Idaho, Georgia, Hawaii, Nevada, North Dakota, South Carolina (1 response each)	7	5
Nationwide	1	1
Operation size (Annual Produce Sales) (n = 145)		
Less than $25,000	21	14
Very small business: $25,000-$250,000	22	15
Small business: $250,000-$500,000	22	15
Large business: More than $500,000	80	55
Types of produce grown/handled (n = 116)		
Fruits only	47	41
Vegetables/herbs only	21	18
Fruits and vegetables/herbs	17	15
Fruits and/or vegetables/herbs and other farm products[f]	18	16
Other farm products only (no fruits or vegetables)[f]	13	11

[a]Main activities include growing of crops, or mixed farm operation, including domesticated animal production.

[b]Main activities include packing, cooling services, and/or holding raw agricultural commodities.

[c]Main activities include processing of FSMA-covered agricultural commodities for human consumption.

[d]"Other" responses included warehousing and distribution, innovation honeybee production, food safety consultation firm, shipper, dry powder packing for retail and holding of raw ingredients on site.

[e]Four multi-location operations were also cross-state operations.

[f]Other farm products included baked goods, beef, bees and bee-related commodities, coffee, eggs, flower seed, grapes, grass, hay, hemp, honey, hops, lavender buds, livestock, marijuana nuts, wheat, wine grape and jams.

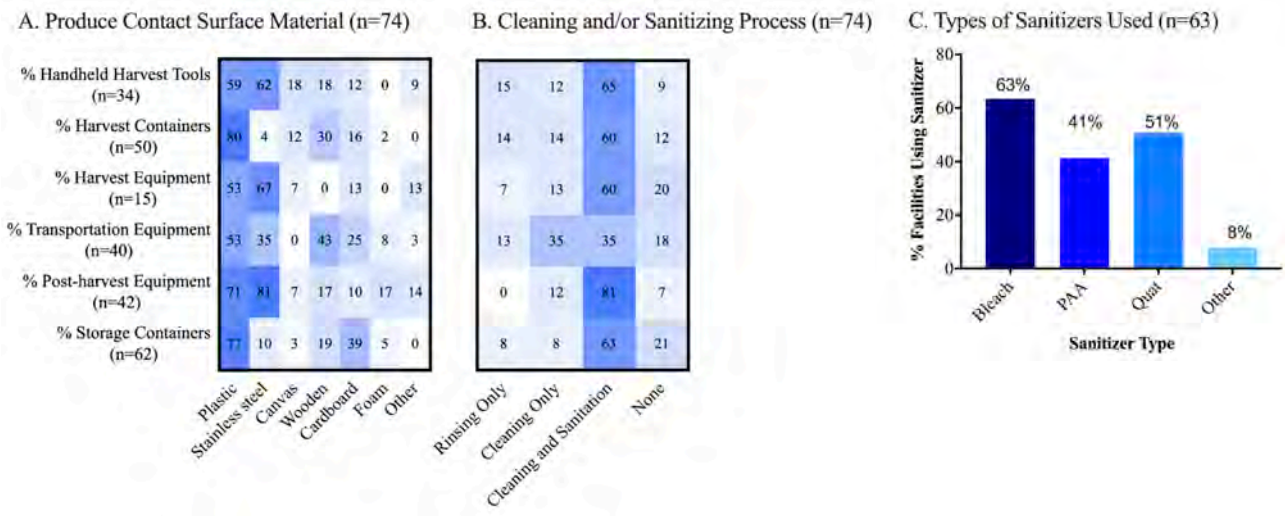

Figure 1. Percentage of facilities with specific A) surface materials, B) cleaning and/or sanitizing processes, C) types of sanitizers reported. Surfaces and activities are separated by six categories of produce contact surfaces found in fresh produce operations: handheld harvest tools, harvest containers, harvest equipment, transportation equipment, post-harvest equipment, and storage containers. The number of total respondents that provided answers for questions in the panel topic are shown in parentheses after the panel heading. The number of respondents for each produce contact surface in each panel are shown in parentheses at the bottom of each table. Surface materials in the "Other" category include metals other than stainless steel, glass, concrete, brushes, mesh netting, and nylon.

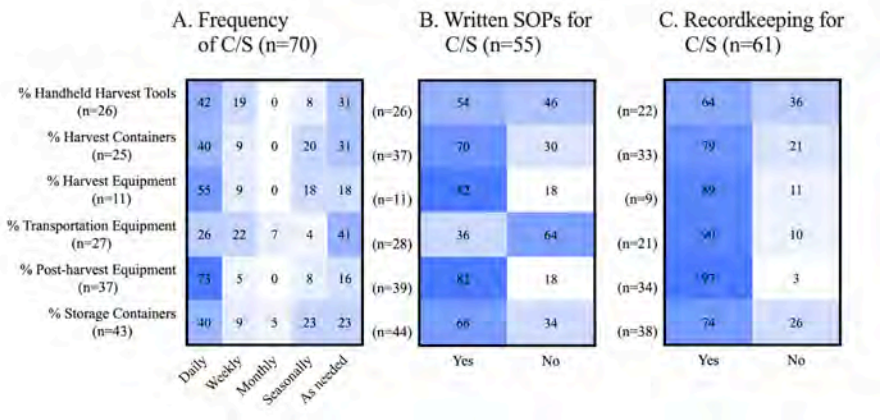

Figure 2. Percentage of facilities with specific A) cleaning/sanitizing frequencies, B) written standard operating procedures for cleaning and/or sanitizing and C) record keeping for cleaning and/or sanitizing by facilities that utilize each type of produce contact surface category. Surfaces and activities are separated by six categories of produce contact surfaces found in fresh produce operations: handheld harvest tools, harvest containers, harvest equipment, transportation equipment, post-harvest equipment, and storage containers. The number of total respondents that provided answers for questions in the panel topic are shown in parentheses after the panel heading. The number of respondents for each produce contact surface in each panel are shown in parentheses at the y-axis.

surfaces was reported included storage containers (13/62; 21%), harvest equipment (3/15; 20%) and transportation equipment (7/40; 18%).

A large number of respondents (16–41% across surface categories) indicated that their cleaning and/or sanitation processes were performed "as needed" *(Fig. 2A)*. This was particularly evident for transportation equipment (41%); however, this unscheduled approach was also not uncommon for hygienic management of handheld harvest tools (31%), harvest containers (31%), and storage containers (23%). Of the operations that had a scheduled approach for their cleaning and/or sanitation processes (69–84% across surface categories), most facilities cleaned surfaces on a daily basis *(Fig. 2A)*. Weekly cleaning/sanitizing frequency was common for transportation equipment (22%) and handheld harvest tools (19%), whereas seasonal cleaning/sanitizing was common for storage containers (23%), harvest containers (20%), and harvest equipment (18%).

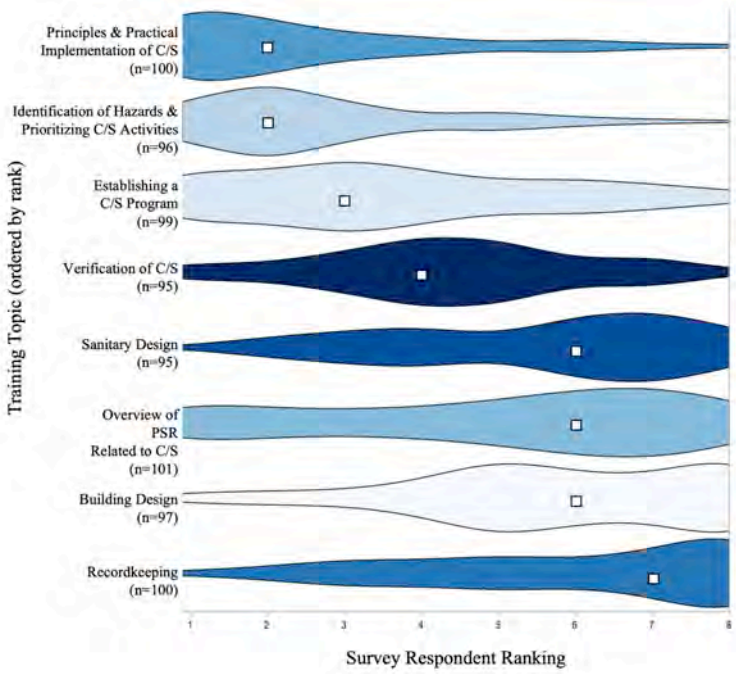

Figure 3. Survey respondents ranked preference of training topics related to cleaning and sanitizing in produce operations. Respondents ranked provided topics from 1 to 8 with 1 being the most preferred. The median rank, indicated by the white square, was used to order the topics as presented in the figure.

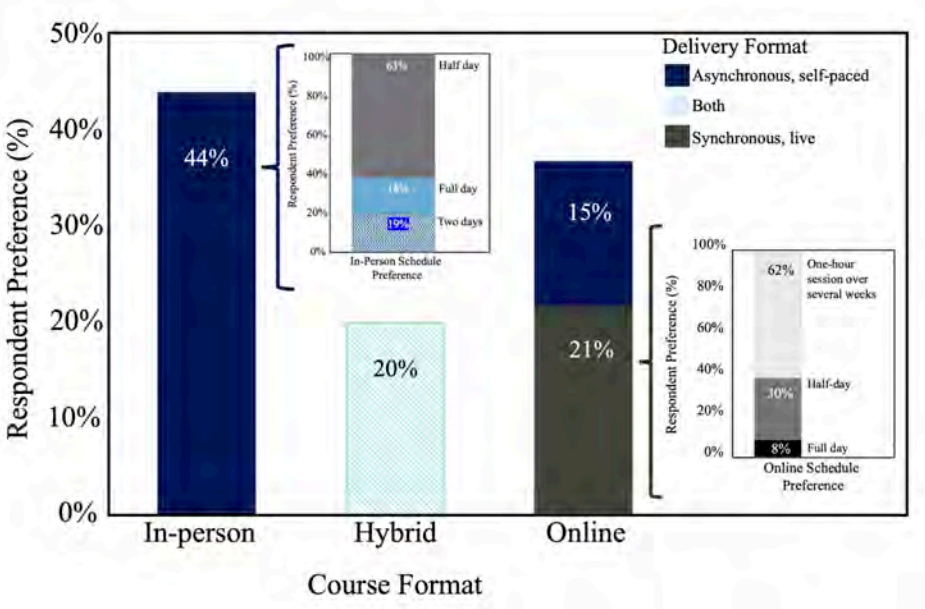

Figure 4. Survey respondent preferences for mode of training delivery for workshops related to cleaning and sanitizing in produce environments. Respondents preferring in-person delivery of information and those preferring online delivery were both separately stratified into desired length of delivery. Hybrid course delivery included pre-requisite asynchronous online sessions paired with in-person interactive session(s).

While written procedures for cleaning and/or sanitizing programs are not strictly required by the PSR, they are considered a good agricultural practice and encouraged in the PSR draft guidance *(22)*. The majority of operations that completed the survey reported having written procedures for cleaning and sanitizing of harvest equipment (82%), post-harvest equipment (82%), harvest containers (70%), storage containers (66%), and handheld harvest tools (54%) (Fig. 2B). Written procedures were less common for transportation equipment (36%).

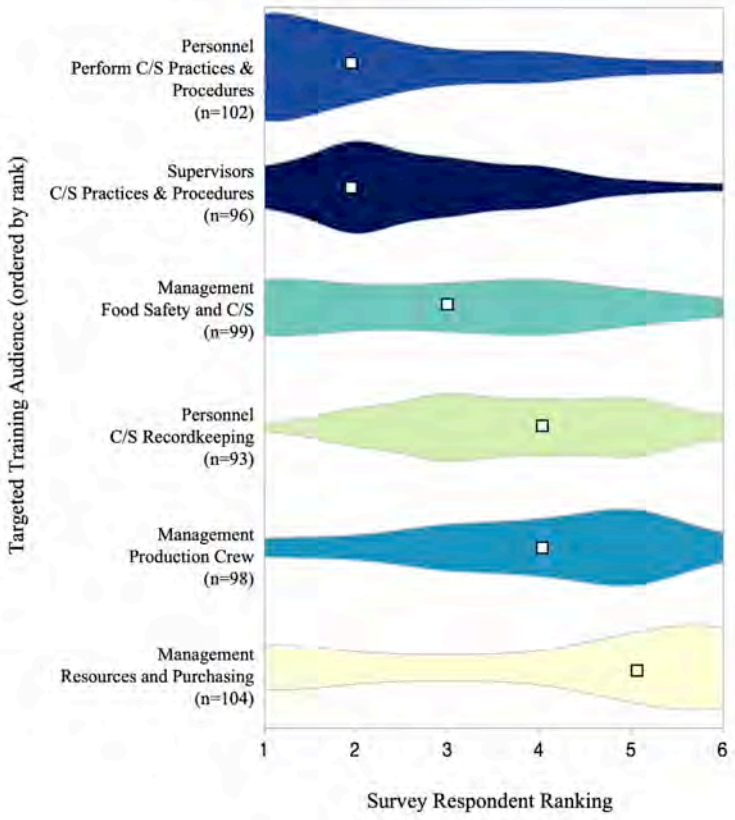

Figure 5. Survey respondents ranked priority for target audience of future trainings on cleaning and sanitizing topics in fresh produce operations. Respondents ranking provided personnel categories from 1 to 6 with 1 being the highest priority. The median rank, indicated by the white square, was used to order the topics as presented in the figure.

Recordkeeping related to cleaning and sanitation of tools across equipment categories was reported by most operations in the survey, particularly for harvest equipment (89%), transportation equipment (90%), and post-harvest equipment (97%) *(Fig. 2C)*. Documentation of cleaning/sanitation was lower for handheld harvest tools (64%) and harvest and storage containers (79% and 74%, respectively). From previous interactions with farms during PSA training discussions (personal communications) and findings from On-Farm Readiness Reviews *(12)*, recordkeeping related to cleaning and sanitation of personal equipment or high quantity items, such as harvest and storage containers, is among the top challenges for the farms. Often this is due to challenges with creating records that fit the structure of their operation without being overly burdensome.

While environmental monitoring programs (EMPs) are a requirement for registered food facilities that are subject to the Preventive Controls for Human Foods Rule *(19)* when a food safety plan identifies an environmental pathogen as a hazard requiring a sanitation preventive control, these programs are not required for farms or fresh produce operations subject to the PSR other than sprouts, regardless of potential environmental hazards. However, they are highly recommended as they can be useful to support food safety and food quality goals *(10, 15)*. Most produce operations (59%) surveyed stated that they have an EMP to monitor the efficacy of their cleaning and sanitation. Of the 38 operations with EMPs, 71% reported testing for indicator organisms, 63% test for pathogenic organisms, and 68% use ATP testing. While testing for pathogens (e.g., *Listeria monocytogenes*, *Salmonella* spp.) or indicators (e.g., *Listeria* spp.) is often included in EMPs, these programs can be cost prohibitive for farms and facilities that are already facing budget restrictions to support their farm and food safety plans. ATP has been shown as a time- and cost-effective option for verifying sanitation procedures in facilities with high hygienic standards (e.g., food processing facilities, hospitals) *(2, 11, 13, 17)*; however, further studies are needed to validate the effectiveness of these ATP-based tests under conditions and on surfaces commonly found in fresh produce environments.

Major barriers and needs for improving cleaning and sanitation

Survey respondents (n = 65) indicated that the most common barrier (57%) for improving cleaning and sanitation practices was high employee turnover/seasonal workforce.

Other commonly selected barriers were insufficient time to clean (29%), difficulty in deciding which products to use (23%), lacking confidence in whether procedures were working (22%), and insufficient time to train employees (20%). Four operations (6%) indicated cost as a barrier to improving cleaning and sanitation practices. Only two operations (3%) said that a lack of management support was a barrier with most respondents (75%) indicating that they did not need additional resources to share with management or ownership.

Most operations (56%) indicated a need for additional resources for employee training related to cleaning and sanitizing, especially in languages other than English and/or visual aids to support understanding across the diverse workforce. Nearly all operations (98%) requested that materials be available in Spanish. Other languages requested were French Creole (n = 3), Vietnamese (n = 2), Tagalog (n = 1), and Arabic (n = 1). This is consistent with the findings from the 2019-2020 National Agricultural Workers Survey (NAWS), which found that Spanish was the language most common and comfortable to use amongst farm workers (62%) *(20)*. According to the NAWS survey, a substantial percentage of farm workers cannot speak (29%) or read (40%) English *(20)*. Similarly, data from our survey indicated that efforts and resources are needed for learning materials in relevant languages to support food safety practices in fresh produce operations. Respondents in our survey also indicated a need for templates of records and SOPs, and suggested the development of "how-to" videos as a useful format for new resources.

Preferences for educational opportunities topics and formats

The ranking of eight suggested cleaning and sanitation topics for workshops by survey respondents is provided in *Fig. 3*. The proposed topics with the highest level of interest were i) principles and practical implementation of cleaning and sanitizing and ii) identification of hazards and prioritizing cleaning and sanitizing activities with approximately 60% of participants placing these as their top rankings. In contrast, a topic focused on recordkeeping received the lowest ranking, while establishing a cleaning and sanitation program and verification of cleaning and sanitation programs were of medium priority.

In-person workshop was the most preferred delivery method (44%) *(Fig. 4)*, while online format was preferred by 36% of respondents. Within online options, synchronous, live (21%) was more preferred than asynchronous, self-paced (15%). A hybrid course structure (portions online and portions in-person) was preferred by 20% of respondents.

In terms of who would mostly benefit from future cleaning and sanitizing training opportunities, personnel directly performing cleaning and sanitation were ranked as the highest priority audience with those who supervise cleaning and sanitation practices as a close second *(Fig. 5)*. The survey respondents also indicated personnel who manage food safety practices overall, including cleaning and sanitation procedures, as higher priority. Personnel and management with less-direct responsibilities for cleaning and sanitation activities (e.g., cleaning/sanitizing recordkeeping and production crew management) were of lower priority. Overall, management of resources and purchasing were the lowest priority audience for future cleaning/sanitation trainings; however, responses followed a bimodal distribution with over 20% of respondents ranking this personnel category as the highest priority for cleaning/sanitation training *(Fig. 5)*.

CONCLUSIONS

Surveying stakeholders in the fresh produce industry identified key information about existing practices, barriers, and training and resources needed to improve cleaning and sanitation. This survey allowed for an estimation of the prevalence of specific materials as food contact surfaces, the relative use of classes of sanitizers, and the frequency of cleaning and/or sanitizing different surfaces. The survey clarified that the majority of employees who are responsible for cleaning and sanitizing in fresh produce operations have other job responsibilities. Large portions of the fresh produce workforce are not fluent in English and resources in other languages are needed. Training materials and opportunities must be designed with these realities in mind. The optimal format, according to the majority of respondents, is a half day, in-person workshop targeted towards the personnel who are directly responsible for the cleaning and sanitizing activities at their respective facility. Collectively, these data helped guide a virtual cleaning and sanitizing workshop for produce industry led by the members of the Center for Food Safety and Applied Nutrition of the U.S. Food and Drug Administration, and Extension and Associations supporting produce industry in 2021. In addition, we are currently developing an in-person workshop for regional trainings in the Pacific Northwest.

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