

# **Food Safety for Small Vegetable Farmers**

Publications Contributing to the Success of Virginia Small Vegetable Farmers through the Lens  
of Food Safety Practices

Frank Scott Long

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Dr. Laura K. Strawn, Department of Food Science and Technology  
Dr. H. Lester Schonberger, Department of Food Science and Technology  
Dr. Renee R. Boyer, Food Science and Technology

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### Publications Contributing to the Success of Virginia Small Vegetable Farmers through the Lens of Food Safety Practices

#### **Abstract**

Limited educational food safety publications are available for small vegetable farmers and extension personnel seeking information on the exemptions from FSMA regulations and the Produce Safety Rule, along with voluntary practices and food safety practices. Research was conducted to construct three educational publications focused on the Best Management Practices and Good Agricultural Practices, vegetable washing stations, handwashing stations, and sanitizing practices. These educational publications are for distribution within the Virginia Cooperative Extension System and for use by Cooperative Extension Agents, Specialists, and growers who need to educate themselves or others on the basics of on-farm food safety needs and practices. This report serves (1) small and beginning vegetable farmers in the realm of food safety, (2) provide Virginia ANR Extension agents with publications to help them explain the intricacies of vegetable food safety on the farm, and (3) help with educating Virginia stakeholders to the intricacies of on-farm vegetable food safety practices.

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## **Introduction**

### *Background and Setting*

The eastern coast of the contiguous state of Virginia is made up of three peninsulas. Separated by the York River and the Rappahannock River, the aptly named Middle Peninsula is located between both rivers. The counties of Middlesex, Mathews, and Gloucester are on the southernmost end of this peninsula. These three counties play host to a sizable population of small vegetable farmers. All these small vegetable growers vary in experience, consumer base, and markets. Virginia Cooperative Extension (VCE) is a state agency that specializes in bringing resources, programming, and education from Virginia's land-grant universities, Virginia Tech, and Virginia State University to the citizens of Virginia. Established in 1914, VCE operates 107-unit offices across the state, within counties. Unit offices are primarily made up of Agriculture and Natural Resources (ANR) agents, 4-H and Positive Youth Development (4-H) agents, and Family and Consumer Sciences (FCS) agents. These three agent denominations conduct educational programming for stakeholders with their representative Virginia counties. This educational programming is critical for spreading information from the university to stakeholders. Many stakeholders express their educational needs to agents, through program evaluations, on-site visits to farms, office consultations, situational analysis reports for counties, or by different in-direct media contact (phone, email, direct social media messaging). From these contact outlets, agents can gather relevant data to understand county residents' questions and needs for certain topics.

The Food and Drug Administration (FDA) implemented new regulatory oversight to enforce compliance with food safety practices as allowed through the Food Safety Modernization Act (FSMA). FSMA allows the FDA to strengthen the food system of the United States by

enforcing comprehensive controls to prevent illnesses and outbreaks rather than react to outbreaks after they occur. These controls oversee human food facilities and animal feed facilities, produce safety standards, transportation, and intentional adulteration standards. FSMA reinforces our public health system by strengthening our food system. The FSMA regulations dictate a mandated inspection frequency, as well as new tools that will be put in place such as mandatory recalls, record access, product tracing, and third-party laboratory testing. FSMA regulations charge the FDA to construct an “integrated national food safety system.” For the FDA to maintain control and set some national food safety standards for an integrated system, there were seven rules put forth to establish a framework. These rules included: Sanitary Transportation of Human and Animal Food, Focused Mitigation Strategies to Protect Food Against Intentional Adulteration, Produce Safety Rule (PSR), Preventative Controls for Human Food Rule, Preventative Controls for Animal Food Rule, A Foreign Supplier Verification Program for Importers of Food for Humans and Animals, and an Accredited Third-Party Certification Rule. All production of food falls under one of these seven rules of the FSMA. Each of the different rules aims to develop a safer, more robust food safety system. This report focuses on FSMA’s PSR and its exemptions for small farmers.

The PSR sets a series of science-based standards for the safe growing, harvesting, packing, and holding of produce grown for human consumption. Like other FSMA rules, the PSR aims to be proactive rather than reactive by focusing on high-risk practices and identification of hazards within individual operations. The PSR applies to most produce in its natural, raw, and unprocessed state (see Appendix D). The Rule does not apply to processed products, produce grown for personal use or on-farm consumption, produce that is "rarely consumed raw", food grains, and farms that make less than \$25,000 in all produce sales; in a

three-year average (see Appendix E). There is another exemption that farms may fall under if the farm meets both the following requirements: farms that make less than \$500,000 in all food sales; in a 3-year average and at least 50.1% of all food sales are direct to qualified end users. A qualified end-user is either a consumer or a restaurant/retail food establishment in the same state/Indian reservation or within 275 miles of where the produce was grown. This requirement must also be met historically for the previous three years of the farm's operations. VCE has an in-depth publication for farmers adhering to the PSR and an overview of the rule itself<sup>2</sup>.

With many laws, regulations, and guidelines, it is easy for small farmers to become discouraged while trying to grow vegetable produce for their consumers. Food Safety is an integral part of any farm and should be a core value of any farm.

Small vegetable farms are increasing due to expanding business and the total population expanding with new residents relocating to the area. This creates a need for Extension to lead the way in assisting them in building their new business opportunity. Among the economics and other barriers to industry entry, food safety should be at the forefront of business planning.

### *Statement of the Problem*

Agriculture is Virginia's largest private industry, providing an economic impact of \$82.3 billion (about \$250 per person in the US) annually and more than 381,800 jobs for Virginians<sup>16</sup>. Many of Virginia's agricultural commodities rank in the top ten for sales when compared with all other states within the United States. This demonstrates the impact that Virginia's agriculture has not only within the Commonwealth but across the country. Therefore, it is important to maintain food safety across all farms. Whether starting a new vegetable farm or expanding a current one, food safety should remain a core value for every farm. Vegetable farmers across Virginia need to be made aware of current voluntary Good Agriculture Practices (GAP), safe

handling of vegetables, and sanitation practices. This is especially true in Virginia's Middle Peninsula. Small vegetable farms are increasing due to expanding business and the total population expanding with new residents relocating to the area. Among the already existing small vegetable farms, new ones have begun to spring up creating a need for Extension to lead the way in assisting them in building their new business opportunity. Among the economics and other barriers to industry entry, food safety should be at the forefront of business planning. If clean vegetables cannot be grown by these farms, then the businesses could be at a higher risk of failing due to consumer bias towards their products.

What all the Middle Peninsula's small vegetable farmers have in common is the exemptions from the Food Safety Modernization Act's (FSMA) Produce Safety Rule (PSR), along with a lack of knowledge about these exemptions and other food safety topics. Even though these small farmers are exempt, it should not excuse them from overlooking the realm of food safety and its practices. There has been an expressed interest in the lower Middle Peninsula for more current VCE food safety publications for small vegetable farmers. These specific growers are looking for information on growing produce that is cleaner and safer.

### *Purpose of the Project*

The project's objective is to publicize three VCE fact sheets relating to food safety for small vegetable farmers, along with initiating an educational food safety programming process provided by VCE. It will help provide timely food safety information to both VCE ANR agents and vegetable farmers promptly. These three fact sheets can serve as a starting point for food safety educational programming held in counties across the state.

### *Project Objectives*

1. Create and publish a series of publications on relevant food safety topics regarding new, beginning, and current small vegetable farmers.
2. Improve small vegetable growers and farm owners' understanding of the regulations, exemptions, practices (voluntary and regulatory), and vegetable cleaning practices to educate them for maintaining their produce's safety for their consumers.

### *Definition of Terms*

1. *Exemption*- disqualified from or free from the regulations imposed by the Produce Safety Rule.
2. *Food Safety Modernization Act (FSMA)* - federal legislation, a law passed by Congress and signed in 2011. FSMA is the first major overhaul of note in the United States since 1938 and lays down the framework for authorities to prevent contamination rather than respond to a foodborne outbreak or disease.
3. *Good Agricultural Practices (GAP)* – A United States Department of Agriculture (USDA) program; a set of voluntary farm management practices for the production of fresh fruits and vegetables. When correctly used and put in place GAPs are intended to minimize the risk of microbial food safety hazards.
4. *Best Management Practices (BMP)* – A Virginia Department of Conservation Resources program that poses site-specific voluntary, agricultural, and economically feasible practices that are applied by farmers while accounting for environmental and public health impacts.
5. *Produce Safety Rule (PSR)* – The rule is a collection of science-based standards for the growing, packing, harvesting, and storing practices of produce grown for human

consumption. The final rule is a collection of the original proposed rule and all the revisions, amendments, and modifications to form a final collection of standards for the science-based practices of growing food for human intake.

6. *Virginia Cooperative Extension (VCE)* – A network of educational outreach that provides the Commonwealth of Virginia’s residents with resources in the areas of agriculture and natural resources, family and consumer sciences, community viability, and 4-H youth development. Since 1914 and the Smith-Lever Act, Virginia Tech and Virginia State University have served as sources for the educational information provided by VCE.

### *Review of Literature*

Even though American consumers participate in one of the safest food markets in the world, outbreaks of foodborne illnesses associated with fresh produce can still happen. Educating small vegetable farmers about BMPs and GAPs would be efficient in preventing and limiting the risk of contamination from vegetables, along with the prevention of potential recalls. From 1970 – 1997, the total U.S. annual consumption per capita of vegetables and fruits rose 24%, from 577 pounds to 718 pounds<sup>13</sup>. This shows an increasing demand for fruits and vegetables among consumers in the country. However, there has been a decline in per capita production according to USDA’s 2023 study of vegetable availability per capita decreasing 3% across the country<sup>5</sup>. The need for more U.S. vegetable farmers is crucial as consumers begin to seek more fruits and vegetables. According to the 2022 USDA Ag. Census, 55% of the farmers on the lower Middle Peninsula sell directly to the consumer<sup>16</sup>. This is a clear indication of the relationship between small farmers and their consumers and how food safety needs to become a part of the grower’s culture on the lower Middle Peninsula. This includes VCE playing an integral part in starting the

educational process of assisting these new and beginning farmers, especially regarding food safety.

## **Project Overview**

### *Targeted Population & Participating Audiences*

This project was to create these three fact sheets to meet the educational needs of the small vegetable farmers located on the lower Middle Peninsula, along with those throughout Virginia.

### *Methodology*

As a VCE ANR agent for the past 4 and a half years, I have been able to collect stakeholder needs and dictate direct and indirect contacts from stakeholders. This included farmer conversations and on-site visits to determine this set of questions. These questions describe the needs of the small vegetable farmer on the Lower Middle Peninsula. These questions were then used to help with a discussion about potential publication topics with VCE Food Safety specialists as well as researching other extension publications for the discussed topics. Small vegetable farmers have asked the VCE Middlesex unit the following questions:

1. What food safety regulations apply to me?
2. What practices should I be aware of in case of a food safety audit?
3. Will I need to clean harvested products while it is on the farm?
4. If they sell at farmer's markets, do I need to do something specific?
5. What are Good Agricultural Practices and Best Management Practices?
6. Where do I build a proper vegetable washing station?

These are just some of the questions that have been answered directly by the ANR agent on the lower Middle Peninsula, defining some of the needs of the small farmer. These small vegetable farmers struggle to understand what government regulations apply to them and are worried about a government representative coming to conduct a food safety audit of their farm. They have a fear of getting products "recalled" due to selling at farmer's markets and need some

programming specifically on food safety practices and requirements as a small farm. With these questions in mind, research into other states' extension institutions' food safety publications was performed. Finding the starting point and sourcing the information congruently with VCE's and Virginia Tech's publication standards was the most difficult part of the project. Working with Virginia Tech's Department of Food Science and Technology faculty and VCE food safety specialists determined which topics needed to be addressed first, based on the VCE publication database and the questions posed by the Middle Peninsula small vegetable growers. The three fact sheets are titled:

1. "Best Management Practices and Good Agriculture Practices for Small Vegetable Farms" (see Appendix A)
2. "Wash Stations and Vegetable Cleaning for the Small Vegetable Farmers" (See Appendix B)
3. "Sanitizers for Vegetables in Harvest/Post-Harvest Water for Small Farmers" (See Appendix C)

These topics were determined as the timeliest topics to start the process. Reviewing other state extension publications gave an idea of what portions of the topics needed to be delved into more than others.

The fact sheet, "Best Management Practices and Good Agriculture Practices for Small Vegetable Farms" was determined as significant because farmers need to consider the voluntary practices that Good Agriculture Practices (GAPs) and Best Management Practices (BMPs) can offer a new and existing small vegetable farm. This fact sheet covers how the two voluntary programs compare. BMPs deal with the farm site itself. It covers practices about soil conservation, water management, pest control, energy use, environmental impacts, and soil nutrient management<sup>5</sup>. GAPs refer more to farming practices such as harvesting operations, facility management, sanitation, and record-keeping<sup>12, 15</sup>. Defining the two practice sets was the first step in detailing how these topics can assist small farmers, especially if their operations

grow large enough to require following government food safety regulations. Creating a visual diagram comparing the two allows for quick access and understanding (See Appendix A).

“Wash Stations and Vegetable Cleaning for the Small Vegetable Farmers” discusses topics to consider when building a wash station, hand-washing station, and proper vegetable cleaning practices for small farmers. Setting up a wash station has many specifications to consider from harvest to post-harvest operation workflow, how many wash stations are needed, the considerations of building a station versus buying one, and practices for cleaning vegetables properly<sup>1, 6, 10</sup>. The fact sheet also addresses post-harvest water testing and the importance of consistent testing practices to ensure clean water<sup>14</sup>. This fact sheet is another example of the amount of information provided potentially becoming lengthy and complex.

“Sanitizers for Vegetables in Harvest/Post-Harvest Water for Small Farmers” considers the type of chemical sanitizers for vegetables when washing them<sup>3</sup>. The fact sheet breaks down the sanitizer’s makeup, how sanitizers might react to different metals, and water and sanitizer testing, in addition to providing the chemical analysis in definable terms<sup>7, 9</sup>. This fact sheet will apply to small farmers seeking to limit contamination and provide safer and less risk-averse vegetables to their consumers, whether by using a sanitizer or water testing practices<sup>11, 12</sup>.

## **Summary of Outcomes, Discussion, & Recommendations**

### *Program Outcomes*

Once the fact sheets are published, VCE agents and specialists can use them to educate farmers and share them with the public. More food safety publications are to come as VCE continues to identify the needs of stakeholders and contacts and updates the publications catalog. Views and download data should become available to see how often these publications are used.

This will help determine the impact of the published documents and allow VCE to determine new food safety publication topics. Agents will continue to work with specialists to publish more timely food safety periodicals for small vegetable farmers, along with assisting Virginia State University's (VSU) Small Farm Outreach Program (SFOP) with aiding new and growing farms in the realm of food safety for vegetables and hydroponic farming. There are many more food safety topics to cover. Dividing up publications to convey information effectively is crucial. Publications should discuss topics quickly and efficiently without compromising the information that needs to be conveyed. In-person or virtual programming, however, we should take the time to explore and analyze the information presented. Ample time needs to be given to help establish the proper practices and techniques for these topics. Food safety remains one topic that may not change often, but there are plenty of sub-categories that are specific and will need to be combed through. Breaking up and streamlining the information is the path that needs to be taken when publishing, but in-person or virtual programming needs to take the time to convey and practice all aspects of the topic.

### *Implications and Recommendations*

Publishing these three fact sheets will increase food safety education and programming for counties involved with small vegetable grower stakeholders. Better vegetable cleaning, farmer and worker hygiene, and farm practices can be established by equipping the farmers with this information. These publications will allow for faster dissemination of information to the stakeholders. The topics provide foundational themes when tackling food safety on both existing and new small vegetable farms. The fact sheets will allow easier accessibility to those who may need them since the information is written concisely. In the future, the fact sheets will be used to conduct programs that will gather evaluation data on the program and the information itself,

which will determine if a review of them is needed to update the material. In addition to these publications, VCE agents, VCE specialists, and Virginia Tech faculty can begin to draft more publications to combat the lack of food safety education, not only for small farmers but for other food safety topics relative to the industry.

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## Appendix A



# Best Management Practices and Good Agriculture Practices for Small Vegetable Farms

*Authored by Frank Long, Graduate Student/VCE Agriculture and Natural Resources Agent, Middlesex County; Laura Strawn, Associate Professor and Extension Food Safety Specialist, Department of Food Science and Technology, Virginia Tech; Lester Schonberger, Associate Extension Specialist, Department of Food Science and Technology, Virginia Tech; Renee Boyer, Professor and Extension Specialist, Department of Food Science and Technology, Virginia Tech;*

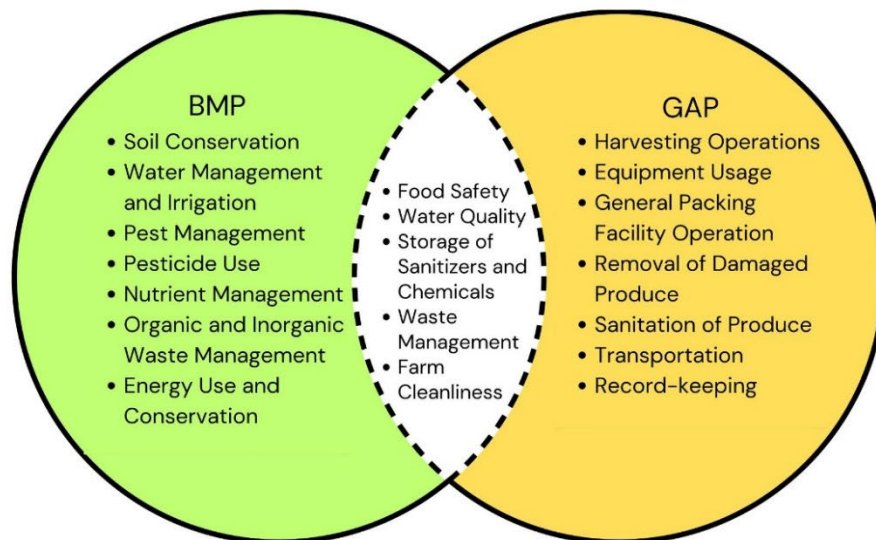


Figure 1. Comparing Vegetable Best Management Practices (BMPs) and Good Agricultural Practices (GAPs)

### Introduction

Small and beginning farmers, especially small vegetable farmers, can be daunted by the number of tasks needed to be completed before the start of the growing season. Farmers know certain inputs can cause future problems that can contaminate produce. Incorporating Best Management Practices (BMPs) and Good Agricultural Practices (GAPs) can help with the planning process for the upcoming season.

With different acronyms and comparisons between these two voluntary programs, having to sift through an overwhelming amount of information can discourage farmers from implementing some of these practices. This publication is meant to help small vegetable farmers distinguish between the programs and help them implement these practices. Farmers could also reach out to their local Extension

office to have a conversation about how to incorporate these practices on their farms.

## Best Management Practices

Best Management Practices (BMPs) are a voluntary set of practices intended to minimize undesirable effects of vegetable production on the local environment and water resources. BMPs are those farm initiatives that promote the efficient use of resources, safety for consumers and farm workers, and financial practicality of farms (UMass, 2013). They are the practices that can help build a stronger foundation for the produce on the farm. BMP considerations for vegetable production can include:

- Soil conservation
- Water management and irrigation
- Pest management
- Pesticide use and storage
- Nutrient management
- Organic and inorganic waste management
- Energy use and conservation
- Food safety from microbial contamination

BMPs can be classified as source, structural, cultural, or managerial controls. Source controls include limiting or removing particular pesticide or nutrient sources. Structural controls are physical measures designed to prevent water and sediment movement, such as erosion, along with fencing to keep out deer and other vertebrate pests. Cultural controls are cropping and tillage practices that minimize pest problems and maximize nutrient use efficiency through soil conservation and crop rotations. Managerial controls are strategies and tools adopted by farmers that consider both

environmental and economic impacts for the farm (UMass Extension, 2013). BMPs are site-specific so it is difficult to create a general checklist of BMPs since each farm and environment is different. However, by using these controls and practices, producers can begin to create a better farm while growing healthier produce.

## Good Agricultural Practices

If BMPs are for creating the best possible land, Good Agricultural Practices (GAPs) are the tools to use for growing healthy and safe produce. GAPs consist of voluntary practices that prevent risks in the field, greenhouse, irrigation waters, from workers, and crop production practices GAPs include:

- Harvesting operations
- Equipment usage
- General packing facility operation
- Removal of damaged produce
- Sanitation of produce
- Transportation
- Record-keeping

These practices are designed to minimize the contamination of vegetable produce with microbial pathogens in every step from production to food preparation (Rangarajan, 2000). The goal is contamination prevention because once contaminated the removal of pathogens from produce is very difficult (Rangarajan, 2000). This is why prevention is strongly favored over treatments to eliminate contamination. Recordkeeping of prevention programs and food safety awareness training for workers are key components of a GAPs program. There are GAP checklists available for producers that will provide a starting point since these practices do not vary from farm to farm.



Figure 2. Image of vegetables getting cleaned in a washing sink (University of Vermont Extension).

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## Appendix B



# Wash Stations and Vegetable Cleaning for the Small Vegetable Farmers

*Authored by Frank Long, Graduate Student/VCE Agriculture and Natural Resources Agent, Middlesex County; Laura Strawn, Associate Professor and Extension Food Safety Specialist, Department of Food Science and Technology, Virginia Tech; Lester Schonberger, Associate Extension Specialist, Department of Food Science and Technology, Virginia Tech; Renee Boyer, Professor and Extension Specialist, Department of Food Science and Technology, Virginia Tech*

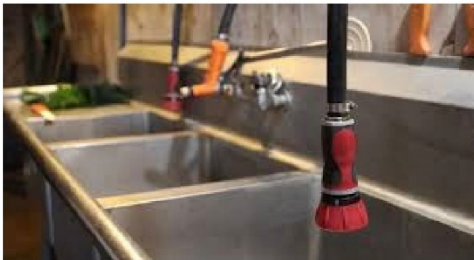


Figure 1: Stainless steel vegetable wash station (provided by the UVM Ag Engineering)

- Helps to meet Good Agricultural Practices (GAPs) set by the United States Department of Agriculture (USDA) Food Safety and Modernization Act (FSMA)
- Helps with record-keeping and maintaining a standard operating procedure (SOP) for cleaning/sanitizing properly each time.
- Can help to organize the workflow from harvest to packaging.

## Introduction

Wash stations are an important part of any vegetable farm, but they can also be a focal point for cross-contamination if not properly built, handled, or cleaned regularly. Knowing the correct way to design, implement, and build a wash station can alleviate many potential future problems. This publication covers the importance, components, scale, and principles to consider before setting up a station for small farmers along with vegetable cleaning techniques to best clean vegetables before storing or packaging.

## Importance of wash stations

The significance of a well-placed and well-maintained wash station cannot be understated for vegetable production. Here are reasons to consider creating a wash station:

- Raises the quality of the vegetables by having a clean, safe product.
- Removal of dirt and contaminants from harvested vegetables to improve their value.

## Setting up a wash station

These components will help to start planning a better wash station and work area.

1. Wash stations come in various sizes and shapes based on the scale of the operation. Whether it is outside or inside, the washing station can be set up for success. Follow these steps to find a suitable space for you.
2. Determine the water source for cleaning. Water should be potable (drinkable). If the water source is non-municipal, water testing is not needed but the water bill should be kept with your record-keeping documents. Non-municipal sources (groundwater, personal wells) should be tested three times a year; at the beginning of harvest, during harvest, and after harvest. Surface water (irrigation ponds, lakes, rivers, or ditches) should not be used to clean vegetables. Having the wash station close to the water source can save on plumbing costs, hoses and pipes, and help to ensure proper water pressure.
3. Be sure to use clean water. Test your water's pH and turbidity levels regularly to ensure that it is pathogen-free or below the recommended organism indicator thresholds. Know how to add

sanitizer to the wash water for disinfecting. Think about temperature regulation, depending on the vegetable, more on this topic later in this publication.

4. Be sure the space identified has proper drainage, is non-slip, and washable. Proper drainage means that water cannot become stagnant or sit on the floor. Establishing the wash station on concrete with floor drains or on a very small angle, allowing wash water to flow away is the best way. This will help prevent pooling water from creating any contamination, help avoid slippery floors, and will be easy to clean. If concrete is unavailable, look for a spot where water can easily leave the wash site or when plumbing drains can be installed.
5. Use stainless steel materials for sinks, tables, and cleaning tools. This material will be easier to clean, disinfect, and is non-absorbent. If stainless steel is unavailable, there are other options. However, when looking do not choose wood, anything that is absorbent, or could rust.
6. Have proper lighting in the work area. Use light fixtures that do not contain glass, or if you have to use glass make sure it is shielded or otherwise shatter-resistant. If working inside, do not place fixtures directly above the wash station. Dirt, dust, glass, or other debris may descend on the products.
7. Table height and movability can be a consideration if the station needs to be moved due to workflow and comfortability.
8. Mark a clear entrance, an area for harvested vegetables, the washing area, and the air-drying space for the station. Create a specific workflow for dirty produce to enter and will not cross or contact with the clean produce.
9. Having a standard operating procedure (SOP) in place and training employees to follow it can ensure vegetables are cleaned properly.
10. Handwashing station before and after washing vegetables.
11. Clean and sanitize all containers and surfaces used for transporting vegetables before and after use. When not in use cover the station and containers to prevent contamination.

### Handwashing stations

It is important to complete handwashing before and after cleaning or handling vegetables. Handwashing will consistently lower the chance for contamination the more it is completed. Building a handwashing

station is not difficult. Consider these actions when building and placing a handwashing station:

- Handwashing technique consists of wetting hands with drinkable water. Scrubbing for 20 seconds, cleaning under fingernails, between fingers, thumbs, top of the hands, and down to the wrists. Rinse and let hands drip water downward, with fingers down towards the ground. This step will stop possible contaminated water dripping back onto the wrists. Dry off with cloth towel or dry paper towels. Used cloth towels and paper towels should placed into a trash receptacle or a separate container. Cloth towels should only be used once.
- Placement of all handwashing stations should be convenient for workers, near all toilets, in packing sheds, and produce handling areas. OSHA requires one handwashing station for every twenty employees, however the more placed the better opportunity to complete handwashing.
- Components should consist of a clean enclosed container to hold potable (drinkable) water with a spigot that can be turned on and off (not a push button) to allow for a continuous stream of water. Either liquid soap or a bar of soap and it does not have to be antibacterial. Containers for catching used water and an enclosed receptacle for used hand-drying materials.
- Handwashing stations can either be stationary or transported. For example, stations can be placed with the same components on the back of a vehicle or on a trailer for transport to the field.



Figure 2: An example of a handwashing station. (Provided by UMN Extension)

## Cleaning the vegetables

There are different ways to clean vegetables, so it is important to correctly identify the best cleaning option. Vegetables can be cleaned by submersion or spraying and brushing.

Submersion is the method of filling the wash station with clean water and allowing the vegetables to sit in the clean water, while you clean the vegetables. The temperature of the water is important because the water may begin to infiltrate the leaves and absorb the dirty water internally. Temperature regulating and constantly changing the water will help to lessen potential contamination when it comes to submersion washing. Sanitizing the water with this method will help to kill microorganisms and bacteria on the leaves. Avoid letting the vegetables soak too long. Rinse vegetables off after submersion. Submersion will work for the following vegetables: lettuce, spinach, microgreens, kale, collard greens, cabbage, turnip greens, peppers, cucumbers, squash, and zucchini.

The spraying and brushing methods can work for vegetables with harder exteriors. Rinsing underwater while brushing the exterior of the vegetables will help to diminish the number of microorganisms on vegetables that may be peeled or cut. Removing dirt and brushing will help to dislodge any contaminants. Always clean and sanitize the brush between each use. Wipe cleaned vegetables dry with a disposable paper towel to remove any excess moisture after washing before storing or packaging. This method can be applied to cucumbers, yellow squash, zucchini, carrots, turnips, beets, yams, potatoes, green beans, and onions.



Figure 3: Farmer cleaning kale at wash station. (Provided by UVM Ag Engineering)

## Conclusion

While no single washing method is 100% effective for removing all contamination and organisms, establishing a washing program for vegetables can significantly reduce any potential hazards. A knowledge of safe washing practices and an understanding of the needs for a well-established wash station will help set up vegetable growers for success. Food safety is a critical need for our food systems and all farmers should consider their part in growing clean vegetables.

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[food/testing-well-water-fruit-and-vegetable-production](#)

## Appendix C



# Sanitizers for Vegetables in Harvest/Post-Harvest Water for Small Farmers

*Authored by Frank Long, Graduate Student/VCE Agriculture and Natural Resources Agent, Middlesex County; Laura Strawn, Associate Professor and Extension Food Safety Specialist, Department of Food Science and Technology, Virginia Tech; Lester Schonberger, Associate Extension Specialist, Department of Food Science and Technology, Virginia Tech; Renee Boyer, Professor and Extension Specialist, Department of Food Science and Technology, Virginia Tech;*



Figure 1: Image of cleaned cucumbers on a grading line.

## Harvest/Post-Harvest Water

The Food and Drug Administration's (FDA) Produce Safety Rule (PSR) defines agriculture water as "water intended to, or likely to, contact the harvestable portion of covered produce or food-contact surfaces" (FDA, 2023). Furthermore, the PSR divides agricultural water into pre-harvest water and water used in production activities (harvest/post-harvest). For example, cleaning water for grading lines, wash tanks, spray lines, or any other water used for cleaning purposes is harvest/post-harvest. Harvest/Post-harvest water must meet two conditions before it can be used.

The water must be "safe and of adequate sanitary quality for its intended use"

Must meet the performance standard of zero detectable generic *Escherichia coli* (*E. coli*) per 100 mL water.

It is important to maintain your post-harvest water to comply with the PSR. There are several ways to maintain post-harvest water including adding clean water to the dump tank (overflow) or emptying and refilling the dump tank when the water gets too cloudy or dirty due to high turbidity. Additionally, chemical sanitizers can be added to the post-harvest water to help reduce the number of microorganisms and produce a cleaner product. This publication will focus on commercially available sanitizers that have chlorine, peracetic acid, or hydrogen peroxide formulations for use in produce production.

## Sanitizer Use Factors

Adding sanitizers to post-harvest water is an important risk management strategy since sanitizers can reduce microorganisms' levels in production water and prevent any cross-contamination between produce. However, there are factors you need to consider to strengthen your sanitizer's capability. These factors include:

- Incoming water characteristics (pH level and mineral content).
- Water temperature.

- Amount of total dissolved solids in the water (soil, dirt, other debris).
- Contact time of the sanitizer with the produce.
- Surface texture of the produce being washed.

It is also important to know the state of your post-harvest water because it can dictate your decision for which sanitizer to use.

## Chlorine

Chlorine is commercially available and is an over-the-counter product ready to purchase (make sure to check the label for the listing as a food sanitizer). It is inexpensive, and effective when properly used, however, it is corrosive to equipment such as stainless steel and aluminum and is pH dependent. Additionally, it degrades in sunlight and heat, making proper storage of it paramount. Two forms of chlorine can be purchased for mixing with clean post-harvest washing water. The first form is calcium hypochlorite ( $\text{CaCl}_2\text{O}_2$ ) which comes in the form of a tablet or powder. The second form is sodium hypochlorite ( $\text{NaOCl}$ ) which is a liquid, commonly called bleach. When either of these compounds are dissolved in water they form hypochlorous acid, which can kill the target microorganisms on the surface of the produce. Both of these products are commonly used by small to medium growers. When it comes to produce and using chlorine sanitizers, the preferred method is to prepare a chlorine mixture concentration of 100-150 ppm of free chlorine with clean post-harvest water at a pH between 6.0 and 7.5. The pH matters because if it is outside the recommended range, it will be less effective due to a change in the charge of the chlorine molecules. Attach the dump tank to the grading line's cleaning sprayer spraying over a continuous belt of harvested produce. Make sure to remove all physical and organic materials with the produce beforehand since this will diminish the concentration of the free chlorine in the solution. 1-2 minutes of contact

with the produce is recommended, followed by a clean rinse.

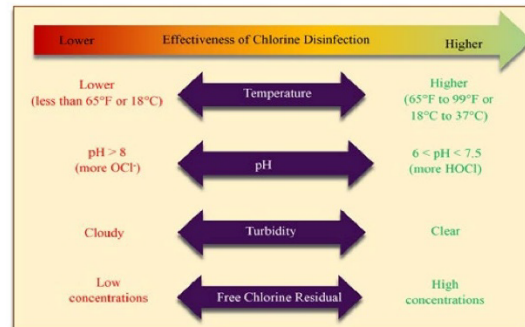


Figure 2. Factors that influence chlorine efficacy in post-harvest water. Graphed provided by University of Arizona Cooperative Extension.

## Peracetic Acid

Peracetic acid (PAA) is a mixture of hydrogen peroxide and acetic acid. The advantages of PAA are that it is noncorrosive to postharvest equipment, effective at varying pH levels, and not as sensitive to organic matter as chlorine. The disadvantages are that PAA is more expensive than chlorine and loses its sanitizing effectiveness and corrode certain metals, such as copper, brass, galvanized iron, and plain steel. You can mix a solution for submersion clean at a concentration of 60 ppm. The submersion technique is used by having a wash bin and two rinse tanks. Make sure to remove as much excess soil or organic matter with a hose before adding the produce to the wash bin that has the sanitizer solution. Once added, the produce must be left in the solution for at least 1 minute. Afterward, move the produce to the next two rinse buckets to remove any residual sanitizer. Allow the produce to drip dry and continue the process again, testing your water's pH, turbidity, and temperature before adding new clean rinse water and new PAA solution as needed.

## Hydrogen Peroxide

Hydrogen Peroxide, also called hydrogen dioxide, can be used as a sanitizer for fruits and vegetables in either a liquid or gaseous form. An

advantage of hydrogen peroxide is that it is “generally recognized as safe” (GRAS) by the FDA and Environmental Protection Agency (EPA) and is environmentally friendly due to its ability to break down water and oxygen molecules. However, hydrogen peroxide is affected by the organic load in the post-harvest water (but not by pH level). In recent years operations have adopted a method of combining hydrogen peroxide and peracetic acid (PAA) when sanitizing post-harvest water. It is recommended that no more than 59 ppm of a sanitizer mixture of hydrogen peroxide and peracetic acid (PAA) is applied to fresh produce that is not RAC (raw agriculture commodities). This can be used on other produce as well, but not for all produce. Be sure to check before using this sanitizer for certain produce, such as cucumbers.

## Monitoring Post-Harvest Water

When it comes to monitoring your post-harvest water for effectiveness, it is paramount to remember that the quality of the water changes over time. Consistent testing is key to preserving the quality of the washing water. To start, make sure your bulk/batch water tank as well as the water in it are clean by conducting an *E. coli* test to make sure it meets the PSR standard for clean water. Check pH levels with pH strips, turbidity levels with a turbidity meter, and remove any organic materials (leaves, rocks, and other field debris) you may find in the batch/bulk tank. The next step is to check the water’s temperature to make sure it is appropriate for the produce and sanitizer’s temperature recommendations to avoid infiltration. Infiltration is when the outer layer of the produce becomes compromised and lets potential contamination enter the inside of the produce. Additionally, be sure to routinely clean and sanitize any bins, tanks, sprayers, and other washing line equipment routinely to stop cross-contamination. Lastly, be sure to keep records of cleanings to make sure that proper monitoring and cleaning are continually completed.

Virginia Cooperative Extension

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## Appendix D

### § 112.1 What food is covered by this part?

(a) Unless it is excluded from this part under § 112.2, food that is produce within the meaning of this part and that is a raw agricultural commodity (RAC) is covered by this part. This includes a produce RAC that is grown domestically and a produce RAC that will be imported or offered for import in any State or territory of the United States, the District of Columbia, or the Commonwealth of Puerto Rico.

(b) For the purpose of this part and subject to the exemptions and qualified exemptions therein, covered produce includes all of the following:

(1) Fruits and vegetables such as almonds, apples, apricots, apriums, Artichokes-globe-type, Asian pears, avocados, babacos, bananas, Belgian endive, blackberries, blueberries, boysenberries, brazil nuts, broad beans, broccoli, Brussels sprouts, burdock, cabbages, Chinese cabbages (Bok Choy, mustard, and Napa), cantaloupes, carambolas, carrots, cauliflower, celeriac, celery, chayote fruit, cherries (sweet), chestnuts, chicory (roots and tops), citrus (such as clementine, grapefruit, lemons, limes, mandarin, oranges, tangerines, tangors, and unqi fruit), cowpea beans, cress-garden, cucumbers, curly endive, currants, dandelion leaves, fennel-Florence, garlic, genip, gooseberries, grapes, green beans, guavas, herbs (such as basil, chives, cilantro, oregano, and parsley), honeydew, huckleberries, Jerusalem artichokes, kale, kiwifruit, kohlrabi, kumquats, leek, lettuce, lychees, macadamia nuts, mangos, other melons (such as Canary, Crenshaw and Persian), mulberries, mushrooms, mustard greens, nectarines, onions, papayas, parsnips, passion fruit, peaches, pears, peas, peas-pigeon, peppers (such as bell and hot), pine nuts, pineapples, plantains, plums, plumcots, quince, radishes, raspberries, rhubarb, rutabagas, scallions, shallots, snow peas, soursop, spinach, sprouts (such as alfalfa and mung bean), strawberries, summer squash (such as patty pan, yellow and zucchini), sweetsop, Swiss chard, taro, tomatoes, turmeric, turnips (roots and tops), walnuts, watercress, watermelons, and yams; and

(2) Mixes of intact fruits and vegetables (such as fruit baskets).

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## Appendix E

### §112.2 What produce is not covered by this part?

(a) The following produce is not covered by this part:

(1) Produce that is rarely consumed raw, specifically the produce on the following exhaustive list: Asparagus; beans, black; beans, great Northern; beans, kidney; beans, lima; beans, navy; beans, pinto; beets, garden (roots and tops); beets, sugar; cashews; cherries, sour; chickpeas; cocoa beans; coffee beans; collards; corn, sweet; cranberries; dates; dill (seeds and weed); eggplants; figs; ginger; hazelnuts; horseradish; lentils; okra; peanuts; pecans; peppermint; potatoes; pumpkins; squash, winter; sweet potatoes; and water chestnuts.

(2) Produce that is produced by an individual for personal consumption or produced for consumption on the farm or another farm under the same management; and

(3) Produce that is not a raw agricultural commodity.

(b) Produce is eligible for exemption from the requirements of this part (except as noted in paragraphs (b)(1), (2), and (3) of this section) under the following conditions:

(1) The produce receives commercial processing that adequately reduces the presence of microorganisms of public health significance. Examples of commercial processing that adequately reduces the presence of microorganisms of public health significance are processing in accordance with the requirements of part 113, 114, or 120 of this chapter, treating with a validated process to eliminate spore-forming microorganisms (such as processing to produce tomato paste or shelf-stable tomatoes), and processing such as refining, distilling, or otherwise manufacturing/processing produce into products such as sugar, oil, spirits, wine, beer or similar products; and

(2) You must disclose in documents accompanying the produce, in accordance with the practice of the trade, that the food is “not processed to adequately reduce the presence of microorganisms of public health significance;” and

(3) You must either:

(i) Annually obtain written assurance, subject to the requirements of paragraph (b)(6) of this section, from the customer that performs the commercial processing described in paragraph (b)(1) of this section that the customer has established and is following procedures (identified in the written assurance) that adequately reduce the presence of microorganisms of public health significance; or

(ii) Annually obtain written assurance, subject to the requirements of paragraph (b)(6) of this section, from your customer that an entity in the distribution chain subsequent to the customer will perform commercial processing described in paragraph (b)(1) of this section and that the customer:

(A) Will disclose in documents accompanying the food, in accordance with the practice of the trade, that the food is “not processed to adequately reduce the presence of microorganisms of public health significance”; and

(B) Will only sell to another entity that agrees, in writing, it will either:

(1) Follow procedures (identified in a written assurance) that adequately reduce the presence of microorganisms of public health significance; or

(2) Obtain a similar written assurance from its customer that the produce will receive commercial processing described in paragraph (b)(1) of this section, and that there will be disclosure in documents accompanying the food, in accordance with the practice of the trade, that the food is “not processed to adequately reduce the presence of microorganisms of public health significance”; and

(4) You must establish and maintain documentation of your compliance with applicable requirements in paragraphs (b)(2) and (3) in accordance with the requirements of subpart O of this part, including:

(i) Documents containing disclosures required under paragraph (b)(2) of this section; and

(ii) Annual written assurances obtained from customers required under paragraph (b)(3) of this section; and

(5) The requirements of this subpart and subpart Q of this part apply to such produce; and

(6) An entity that provides a written assurance under § 112.2(b)(3)(i) or (ii) must act consistently with the assurance and document its actions taken to satisfy the written assurance.

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