

Introduction to Produce Safety

for Hydroponic & Aquaponic Growers

NECAFS

The Northeast Center to
Advance Food Safety





The Food Safety Modernization Act's Produce Safety Rule (FSMA PSR) sets mandatory standards for growing, harvesting, packing, and holding produce for human consumption.

Farms that are covered by the FSMA PSR will be held to certain standards designed to reduce the presence of foodborne illness causing organisms that can contaminate produce. This factsheet outlines the requirements for covered farms and uses the word "must" when the practice is required by the FSMA PSR.

For farms that may not be subject to the FSMA PSR, it is important to consider the implementation of these practices to ensure your produce is safe.

Introduction

Produce safety is meant to reduce and prevent contamination of produce with harmful human pathogens, such as bacteria, viruses, and parasites. This is done by controlling known risks. Other factors to be aware of include physical and chemical contamination, but this guide will focus on human pathogens.

Hydroponic and aquaponic production are unique, from a produce safety perspective, because of the way **water** is used, the specific constructed production **systems** in use, and how **people** are involved in the systems. Aquaponic systems have added produce safety considerations related to the inclusion of **fish**.



Water

Hydroponic systems use stored and/or recirculating nutrient rich water in greater volumes than other forms of production, which presents unique produce safety circumstances. This "nutrient solution" is "production water" with nutrients added to it. For the purposes of this document, these terms mean the same thing.



NUTRIENT RICH

Water delivered to the plants is full of nutrients, since this is the source of food needed for plant growth and crop production. Since human pathogens also depend on water and food to survive and reproduce, there is a chance that this water can be contaminated with them.



ABUNDANCE

Water is central to plant growth in hydroponic production. This is true of other production systems, of course, but in hydroponic systems the potential for contact between production water and the edible portion of the crop is greater.



CIRCULATION

In most hydroponic systems, the nutrient solution is also circulated. This means that contamination in one place can quickly spread to other places and, perhaps, throughout the entire system.

Systems

Hydroponic production depends on constructed systems which introduce unique food contact surfaces in the growing environment.



FOOD CONTACT SURFACES

Because hydroponic production doesn't involve soil, other growing media and structural surfaces such as rafts and troughs are used. The media and support surfaces can become "food contact surfaces" due to the way plants grow and how the surfaces are handled. This requires special attention to these surfaces relative to cleaning and sanitizing. The abundance of

nutrient rich water and its circulation also leads to connectivity between different parts of the system. For example, any surface that the recirculated water contacts should be treated as a food contact surface if the water later has the potential to contact any harvested food, or other food contact surface. The nutrient solution connects all these surfaces.



MOVEMENT

Product movement is unique in hydroponic operations as well. Sometimes rafts and troughs are moved prior to harvest. Other times, the primary movement is at harvest time. Regardless of the timing, it is important to take care when moving parts of the production system to prevent water dripping and contacting food contact surfaces or the harvested portion of the crop. Common examples to consider are:

1. lifting a raft for harvesting in such a way that it does not drip production water over produce, other rafts, or other food contact surfaces, and
2. lifting rafts out of the water in a way that prevents edges or corners from dipping into the production water, which can lead to contact between production water and produce or food contact surfaces.



CLEANING AND SANITIZING

Given the considerations above, it becomes clear that cleaning and sanitizing surfaces that contact food and water is critical for control of human pathogens (and plant pathogens). Unfortunately, many of these surfaces are not well designed for cleaning and sanitizing. So, there is a need

to carefully document appropriate standard operating procedures (SOPs), provide appropriate cleaning and sanitizing tools and supplies, and think about continuous improvement through the application of [hygienic design principles](#).





People

Due to continuous and high levels of production, hydroponic operations tend to involve significant human contact during the plant growth period. Growing surfaces are moved, water is managed, and harvest involves movement of product and surfaces by people.



PROCEDURES AND PRACTICES

Hydroponic production tends to involve significant human interaction during the period of plant growth and in other ways that can result in contamination. Moving germinated plants to production surfaces, moving production surfaces through the production system, managing water supply, water treatment, and harvest occurring in or near the production area all tend

to lead to human interaction with the system. Even cleaning and sanitizing of surfaces that contact food and water, when not done properly, can present risk. These activities should be carefully planned and described so that each person completes them without introducing the risk of contaminating the system with human pathogens.



PRODUCE SAFETY TRAINING AND AWARENESS

There are three types of trainings that growers need to be aware of and provide to relevant personnel on the farm including 1) worker health and hygiene, 2) role specific produce safety training, 3) visitor awareness. Worker health and hygiene and role specific produce safety training must be provided to people who

touch produce or food contact surfaces, which may include visitors, volunteers and other farm personnel. Visitors who do not touch produce or food contact surfaces must be made aware of the farm's produce safety policy.




Summary

This guide is meant to provide an introductory overview of key produce safety considerations for hydroponic growers. The table below provides specific items to discuss with your team and to act on as you develop a produce safety culture and plan. More specific resources are available at go.uvm.edu/ponics.

FOR MORE RESOURCES
PLEASE VISIT:



go.uvm.edu/ponics

Nutrient Solution/Production Water

Produce Safety Factor	What You Can Do About It	Resources
<p data-bbox="126 327 386 457">Nutrient Solution / Production Water Quality</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Track water quality parameters over time <input type="checkbox"/> Filter and/or treat nutrient solution <input type="checkbox"/> Maintain farm hygiene / biosecurity <p data-bbox="513 478 1182 814"><i>Note: Resources for aquaponics or terrestrial aquaculture are often adaptable to hydroponic and/or aquaponic operations. For example, the Daily Water Quality Log for aquaponics can be adapted for hydroponics by removing the column headers that aren't relevant and adding in parameters that are.</i></p>	<ul style="list-style-type: none"> - Controlled Environment Agriculture Water Circularity Guide - Water Treatment in Aquaponics - Daily Water Quality Log Template - Biosecurity in Aquaculture, Part 1: An Overview
<p data-bbox="126 898 418 1029">Nutrient Solution / Production Water Contact with Produce</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Prevent contact through system design and crop choice. If contact occurs, nutrient solution is <i>agricultural water</i> and must be maintained according to the FSMA Produce Safety Rule. If contact occurs during or after harvest, maintain water quality according to the more stringent requirements for <i>postharvest agricultural water</i> in the FSMA Produce Safety Rule. 	<ul style="list-style-type: none"> - National Water Testing Lab Map
<p data-bbox="126 1449 386 1621">Nutrient Solution / Production Water Contact with Food Contact Surfaces</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Prevent contact where possible. To mitigate, clean and sanitize the affected surfaces before using again. 	<ul style="list-style-type: none"> - Cleaning and Sanitizing for Hydroponic and Aquaponic Operations


Cleaning and Sanitizing

Q READ THIS GUIDE: [CLEANING AND SANITIZING FOR HYDROPONIC AND AQUAPONIC OPERATIONS](#)

Produce Safety Factor	What You Can Do About It	Resources
<p>Cleaning</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Effectively clean surfaces prior to sanitizing. <hr/> <ul style="list-style-type: none"> <input type="checkbox"/> Establish and follow a cleaning schedule and use standard operating procedures (SOPs) to ensure cleaning happens as needed. <input type="checkbox"/> Prevent cleaning activities from contaminating produce. For example, avoid using a pressure washer to remove algae from the production area floor while in production. <input type="checkbox"/> Include buildings, transport equipment, trash, litter, and waste in a cleaning plan. <input type="checkbox"/> Keep production and packing areas tidy to increase efficiency and reduce the risk of a pest infestation. <hr/> <ul style="list-style-type: none"> <input type="checkbox"/> Use the right tool for the job and consider color coding tools for specific tasks to prevent cross-contamination. 	<ul style="list-style-type: none"> - Cleaning and Sanitizing Food Contact Surfaces - PSA Factsheet: Cleaning vs Sanitizing <hr/> <ul style="list-style-type: none"> - What are SOPs? - Standard Operating Procedures <hr/> <ul style="list-style-type: none"> - Cleaning Tools for Produce Farms
<p>Choosing a Sanitizer</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Streamline operations by using one product approved for all uses, being clear about different application procedures with labeling, training, and SOPs; or, <input type="checkbox"/> Intentionally choose specific products for different uses and clearly communicate this approach with staff through training, labeling, and SOPs. <hr/> <ul style="list-style-type: none"> <input type="checkbox"/> Determine appropriate dose of sanitizer for the intended use. <hr/> <ul style="list-style-type: none"> <input type="checkbox"/> Take care when measuring and dispensing sanitizers. 	<ul style="list-style-type: none"> - Introduction to Selecting an EPA-Labeled Sanitizer - Labeled Sanitizers for Produce <hr/> <ul style="list-style-type: none"> - Sanitizer Dose Calculator <hr/> <ul style="list-style-type: none"> - Safely Dispensing Sanitizers

Cleaning and Sanitizing (continued)

Q READ THIS GUIDE: [CLEANING AND SANITIZING FOR HYDROPONIC AND AQUAPONIC OPERATIONS](#)

Produce Safety Factor	What You Can Do About It	Resources
<p>Sanitizing</p> 	<ul style="list-style-type: none"> <li data-bbox="509 447 1101 638">☐ Identify the 4 zones: Food contact surfaces (Zone 1) and adjacent surfaces that could indirectly contaminate produce (Zone 2) are areas that should be prioritized for cleaning and sanitizing. <li data-bbox="509 972 1101 1045">☐ Regularly inspect, maintain, clean, and, when possible, sanitize Zone 1 (food contact) surfaces. <li data-bbox="509 1161 1122 1318">☐ Establish a cleaning and sanitizing schedule tailored to your operation, making sure to prevent re-contamination of sanitized surfaces through other cleaning activities. <li data-bbox="509 1413 1073 1570">☐ Use water of adequate and sanitary quality for diluting and applying sanitizers (must meet FSMA PSR requirements for postharvest agricultural water). 	<ul style="list-style-type: none"> <li data-bbox="1179 447 1458 653">- Packinghouse Environmental Monitoring Programs: Identifying Packinghouse Zones <li data-bbox="1179 699 1479 856"><i>Note: Resources for packing houses are often adaptable to hydroponic and aquaponic operations.</i> <li data-bbox="1179 972 1357 1045">- How to Clean and Sanitize <li data-bbox="1179 1161 1385 1192">- What are SOPs? <li data-bbox="1179 1224 1430 1297">- Standard Operating Procedures <li data-bbox="1179 1413 1479 1528">- Requirements for Harvest and Postharvest Agricultural Water




Harvest and Postharvest Handling

Q READ THIS GUIDE: [HARVEST AND POSTHARVEST HANDLING FOR HYDROPONIC AND AQUAPONIC OPERATIONS](#)

Produce Safety Factor	What You Can Do About It	Resources
<p>Harvest</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Lay out the harvest process to reduce the potential for cross-contamination of produce, tools, and hands through production water. <input type="checkbox"/> When harvesting and packing crops with roots attached, consider steps to reduce the opportunity for cross-contamination between water and produce, such as using containers to keep roots separate. If water and crops come into contact, production water must contain no detectable generic <i>E. coli</i> in a 100 mL sample. 	<ul style="list-style-type: none"> - Planning an Efficient and Safe Wash/Pack Area <p><i>Note: Resources for packing houses, like this one, are often adaptable to hydroponic and aquaponic operations.</i></p> <ul style="list-style-type: none"> - National Water Testing Lab Map
<p>Washing Produce</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Consider whether washing your produce is necessary for product quality. Most postharvest washing is done to remove soil and debris from the field, and in many HP/AP operations this is not a significant issue. Also, washing of harvested produce is not required by the FSMA PSR but can be a part of certain market requirements. <input type="checkbox"/> Use sanitizer when washing produce to prevent cross-contamination. <input type="checkbox"/> Manage and maintain wash water quality to ensure the effectiveness of the sanitizer. 	<ul style="list-style-type: none"> - Using Sanitizers in Wash Water Part 1: Reasons for Washing Fresh Produce - Introduction to Selecting an EPA-Labeled Sanitizer - Labeled Sanitizers for Produce - Labeled Sanitizers for Produce: Video Tutorial - Using Sanitizers in Wash Water Part 3: Correct Use of Sanitizers - Requirements for Harvest and Postharvest Agricultural Water
<p>Storage</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Clean and sanitize storage areas before use and on a regular schedule to prevent contamination of the produce. <input type="checkbox"/> Prevent condensation from dripping on to harvested produce. 	<ul style="list-style-type: none"> - Farm Cooler Checklist - Managing Condensation in Coolers


Personal Health and Hygiene

Q READ THIS GUIDE: [PERSONAL HEALTH AND HYGIENE FOR HYDROPONIC AND AQUAPONIC OPERATIONS](#)

Produce Safety Factor	What You Can Do About It	Resources
<p>Washing Hands</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Create an SOP that describes when and how workers must wash their hands. <input type="checkbox"/> Train personnel and check compliance with hand washing procedures regularly. <input type="checkbox"/> Post instructional signs at handwashing sinks, in languages that personnel can understand. <input type="checkbox"/> Harvest is a key moment for potential cross-contamination through hands. If one person is doing multiple steps in the harvest, they must wash their hands before handling the produce. For plant health and biosecurity, it's a good idea to wash hands before and after touching system components, e.g., foam rafts, as well. 	<ul style="list-style-type: none"> - Handwashing SOP Template - Essentials of Food Safety for Farmworkers, Part 3: Everyday Practices to Prevent Foodborne Illness - Compliance Guide for Growers - Worker Training - Printable Signage
<p>Visitors and Volunteers</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Visitors or volunteers who interact with the system, especially edible or harvestable portions of produce, must be fully trained in the farm's food safety procedures as if they were a regular employee doing the same job. <input type="checkbox"/> Visitors who don't touch the production system must be made aware of the farm's food safety policy. 	<ul style="list-style-type: none"> - Essentials of Food Safety for Farmworkers, Part 3: Everyday Practices to Prevent Foodborne Illness - Compliance Guide for Growers - Worker Training - Printable Signage - Produce Safety Rule: Required Training for Covered Farms - Food Safety Modernization Act: Visitors
<p>Sick Personnel</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Train workers in health and hygiene practices and do not let sick personnel handle produce or touch food contact surfaces. <input type="checkbox"/> Provide paid sick leave for workers with gastrointestinal illness, or provide alternative work assignments that do not involve handling produce or food contact surfaces, to limit the chance that produce becomes contaminated. 	<ul style="list-style-type: none"> - Starting a Produce Safety Worker Training Program on Your Farm - Compliance Guide for Growers - Worker Training - Essentials of Food Safety for Farmworkers

Wildlife and Domesticated Animals

Q READ THIS GUIDE: [WILDLIFE AND DOMESTICATED ANIMALS IN HYDROPONIC AND AQUAPONIC OPERATIONS](#)

Produce Safety Factor	What You Can Do About It	Resources
<p>Pest Animals</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Conduct and log regular scouting for animal damage to crops and other signs of intrusion, including feces. <input type="checkbox"/> Conduct preharvest crop assessments to look for evidence of potential animal contamination in open-air and partially-enclosed operations. <input type="checkbox"/> Exclude pest animals in fully-enclosed (indoor) operations. <input type="checkbox"/> Place rodent bait boxes, when used, on the exterior, not interior, of structures. <input type="checkbox"/> Keep a mowed buffer around a greenhouse or building to reduce animal and insect pest pressure. 	<ul style="list-style-type: none"> - Food Safety Modernization Act: Pest Management - Wildlife & Animal Management Decision Tree - Hydroponics - Pest Control Strategies - Rats (and other rodents)

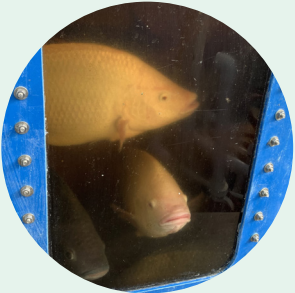
Audits

Produce Safety Factor	What You Can Do About It	Resources
<p>Audits</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Plan out audits over time based on market and operational requirements. 	<ul style="list-style-type: none"> - What is a GAP Audit? Do I need one on my farm?

Fish: Aquaponic-Specific Considerations

In addition to water, systems, and people, as described above, aquaponic operators must also consider the potential produce safety impacts of fish. In an aquaponic operation, the production of fish and produce are connected through recirculating water. Practices that promote a healthy aquatic and handling environment for fish also tend to promote produce safety.

Q READ THIS GUIDE: [FISH HEALTH AND HANDLING FOR HYDROPONIC AND AQUAPONIC OPERATIONS](#)

Produce Safety Factor	What You Can Do About It	Resources
<p>Aquaponics: Fish Care for Produce Safety</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Support healthy fish to reduce produce safety risk. 	<ul style="list-style-type: none"> - Aquaponics Produce Manual
	<ul style="list-style-type: none"> <input type="checkbox"/> Design the fish unit to actively manage solid waste so that it doesn't accumulate in system components. 	<ul style="list-style-type: none"> - Aquaponics Produce Manual - Solids Filtration
	<ul style="list-style-type: none"> <input type="checkbox"/> Start with fish that have been quarantined and a system that has been thoroughly cleaned and sanitized. 	<ul style="list-style-type: none"> - Biosecurity in Aquaculture, Part 1: An Overview
	<ul style="list-style-type: none"> <input type="checkbox"/> Establish standard operating procedures (SOPs), especially around hygiene and biosecurity, to ensure that human-system interaction does not become an opportunity for cross-contamination between the outside environment, the system, and produce. 	
	<ul style="list-style-type: none"> <input type="checkbox"/> Track water quality parameters as a component of routine fish health assessment. 	<ul style="list-style-type: none"> - Aquaponics Produce Manual - Water Quality