

Harvest and Postharvest Handling

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

Harvest and postharvest handling practices in hydroponic and aquaponic operations are generally similar to those used in field agriculture. A key difference is that in these operations production water (water used in the growing of a crop) can be in close proximity to the crop during harvesting. Postharvest water (water that contacts produce or food contact surfaces during or after harvest) may or may not be used in these operations since they are soilless and often produce is not washed. The objective of this factsheet is to focus on practices that reduce the risk for cross-contamination between water, tools and equipment, and people during harvest and postharvest activities.

The key points covered in this factsheet include:

- Production water may cross-contaminate produce, tools, or hands in a number of ways. Harvest layout should be planned to reduce cross-contamination.
- If crops are washed and/or cooled using water, then the water must meet postharvest water quality standards.
- Harvested crops with roots attached need to be packaged in containers that provide proper space to reduce potential for production water contacting the crop.



Whether harvesting by hand or robot, growers must manage postharvest food contact surfaces to prevent contamination.




PRODUCE SAFETY CONSIDERATIONS DURING HARVEST




Growers' adoption of produce safety practices – through either human interactions or system design – will be driven by the specific operation. Most hydroponic and aquaponic operations utilize recirculating production water that can serve as a vector for cross-contamination during harvest. Harvesting protocols should be designed to minimize contact of production water with the harvestable portion of the crop. Production water may come into contact with the harvestable portion of the crop during harvest in a number of ways. This includes but is not limited to: dipping, splashing, dripping, or when hands or harvest tools get wet with production water. For example:

- Dipping may occur if a raft is lifted from one end or corner and the opposite end tips into the water, thereby dipping the plants on the lower end into production water.
- Splashing may occur when rafts are moved too quickly, as they can collide and cause splashing.
- Dripping may occur if crops are pulled directly out of a production tray with wet roots intact, or full production trays are lifted and carried over top of production areas underneath. Both cause nutrient solution to drip from the roots onto other crops.

Water, biofilm, or algae may also get on a harvester's hands or their tools when, for example, lifting rafts and then removing roots. Growers should design a harvest process with the goal of minimizing the opportunity for cross-contamination. To start, they should intentionally think about the best location of produce, tools, equipment, and people during harvest. 

RECOMMENDED HARVEST PRACTICES

These best management practices will minimize risk and guide compliance with the FSMA PSR.

- The first line of defense is good personal hygiene. Harvesters must wash their hands before beginning harvest and before putting on gloves. If harvesters wear gloves, then proper use to maintain clean, intact, and sanitary gloves must be followed. Gloves must also be appropriately managed after use to prevent contamination.
- Have the harvest process in mind when designing, expanding, or reimagining the growing system.
- When developing standard operating procedures and day-to-day harvesting protocols, plan the approach to minimize dipping, splashing, and dripping.
- When cutting crops at their base, do not cut into solid substrate such as peat moss or rockwool, to avoid contaminating the harvesting knife or the produce. 
- If an operation is harvesting crops that come into contact with production water, then the water must meet more stringent postharvest water quality standards. Ideally, harvest practices would prevent the harvested crop from coming into contact with production water.
- If an operation's production water quality is unknown or found to be of unsanitary quality:
 - The harvestable portion of the crops should not touch production water or the crop roots (ex. do not package with roots intact).
 - If any production water incidentally contacts the harvestable portion of the crop through dipping, splashing or dripping immediately before or during harvest, do not harvest those plants.
 - Workers should not touch production water or crop roots with their hands or gloves or harvest tools during harvest. If this occurs, any crops touched with wet hands, gloves or tools should not be harvested. Before continuing, hands should be washed and tools should be cleaned and sanitized.
- Take care to handle crops carefully during and after harvest, as damaged plant tissue creates an entry point for bacterial pathogens.
- Harvest containers should be on a raised surface, and never placed on the floor or ground.
- Act as if the floor is lava. If produce drops on the ground before, during or after harvest, discard it.

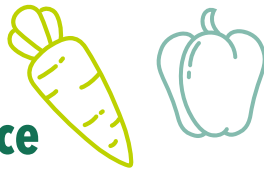
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Growers may wash produce for a number of reasons, including buyer or audit requirements, but the produce safety rule does not require produce to be washed.

Postharvest Handling: Washing and Cooling Produce



Generally, postharvest handling (washing, cooling, packing, and storing) of produce at hydroponic and aquaponic operations will be similar to that for field crops. Although, since these systems are soilless, it is less common to see produce being washed. However, some growers may choose to wash produce or do so because of buyer requirements. Additionally, growers may be cooling their produce with a process that involves water (e.g., hydrocooling and icing).

Washing and cooling produce are not required by the FSMA PSR. However, the FSMA PSR does outline requirements for the quality of water that contacts

produce or food contact surfaces during or after harvest. This includes water for making ice and handwashing. This water, known as “postharvest water,” must have no detectable generic *E. coli* per 100 mL sample. The concentration of *E. coli* in a water source can be determined by referring to municipal water testing results or by taking samples from ground and surface sources and sending them to a water testing lab. 

Growers using postharvest water must also employ water management strategies to reduce cross-contamination risk. These often include single pass water or using sanitizers, which must be used according to the EPA label.



RECOMMENDED POSTHARVEST WATER USE PRACTICES

These best management practices will minimize risk and guide compliance with the FSMA PSR.

- If choosing to wash produce, growers must follow the FSMA PSR postharvest water requirements.
- If using a sanitizer, the product must be labeled for the use and the label must be followed.
- Used production water may be a source of cross-contamination and should not be used for postharvest activities. Similarly, used postharvest water should not be used for production activities.
- Design harvest practices to avoid cutting soilless substrate along with crop. If substrate is introduced to wash water, growers should understand that it may be a source of cross-contamination and impact sanitizer efficacy. The water change schedule should be managed through regular water quality monitoring.
- Some growers “live harvest” their plants with the roots intact. There is potential for pathogens spreading from wet roots to the harvestable portion of the crop within the packaging during storage and shipment. Microbial water quality testing can help a grower to assess this risk.



Packing



Depending on the size and complexity of the operation, a grower should consider the various points in their packing operation to determine where contamination may occur. The following examples are all potential sources of contamination:

- harvest bins or other materials coming in from the production area;
- packing tools and materials;
- food contact surfaces on packing lines;
- equipment;
- vehicles such as a forklift; and
- people.

Worker health and hygiene are critical to maintaining produce safety during postharvest. Growers should also understand the importance of maintaining clean and tidy facilities – and properly sanitizing food contact surfaces – in preventing produce contamination.


After the crops are harvested, they may be packed into single-use packaging for retail or transported to a pack room. If the operation is highly mechanized, produce transport may be on a mechanical conveyor belt. Smaller operations may carry produce in harvest totes. Providing details on where the crop was grown,

who harvested it, and on what day makes the product traceable. This is especially important if a foodborne illness outbreak is traced back to an operation.

Immediately following harvest, the quality of fresh produce begins to decline, which can increase the risk of foodborne pathogen growth. Maintaining a cold chain appropriate to the crop from harvest to consumption will ensure the longest shelf life possible and reduce produce safety risk. Therefore, transport vehicles and packing areas should maintain optimal temperature and humidity conditions, whenever possible.

RECOMMENDED PACKING PRACTICES

Operations must store packing materials properly to prevent contamination from pests and other hazards. Harvesting and packaging materials should be stored in an enclosed area and separate from chemicals, including nutrient salts and fish feed.


Operations should be aware of whether or not they are performing any activities that fall within the FSMA definition of a facility. Operations are likely not a facility if they are only mixing produce without any additional processing. For example, mixing different intact herbs and leafy greens in a package for sale to consumers is not considered processing. However, if operations are processing (e.g., slicing or cutting whole leaves into smaller pieces) or packing and holding produce off-farm, it may qualify as a facility and need to register with the Food and Drug Administration. Facilities must comply with the FSMA Preventive Controls for Human Food Rule. 



“Live harvesting” crops in a hydroponic or aquaponic system can introduce risk since the harvestable portion of the crop may come into contact with the water on the roots. If packing with roots attached, be sure to use packaging containers designed to keep the roots separate from the harvestable portion of the crop, as seen in these two examples.





Cold storage can help slow the growth of harmful bacteria on produce. However, storage areas and refrigerators can also become sources of contamination when surfaces are not regularly cleaned and sanitized, if animal intrusion occurs, or if condensation drips on produce. Storage areas and distribution vehicles must be cleaned and sanitized as needed, and temperature and humidity should be maintained according to the specific crop being stored. Condensation should be prevented where possible, but if it happens it should be managed to prevent contact with produce. 

Harvest and Postharvest Handling Takeaways



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Hydroponic and aquaponic growers should practice careful harvesting and postharvest handling to minimize any contact of crops, tools, or hands with production water. Growers should adopt practices to minimize dipping, splashing, and dripping of production water onto produce and food contact surfaces. Growers should follow similar packing and storage protocol for harvested crops as in field agriculture.



Additional Resources

Some of the resource links provided here may be general in nature and can be adapted to hydroponic and aquaponic operations. These links do not represent an exhaustive list of content on this topic and are intended as a starting point to guide the user toward finding additional relevant resources.

Do I Operate a Farm or a Facility?

<https://sustainableagriculture.net/fsma/learn-about-the-issues/do-i-operate-a-facility>

Farm Cooler Checklist: <http://go.uvm.edu/coolercleaning>

Food Safety for Wash/Pack Facilities

on the Farm: <https://www.youtube.com/playlist?list=PLMxaHBxUI9qYUupJw4B5k4RURKUrxn5J>

FSMA Requirements for Additional Traceability Records for Certain Foods:

<https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-requirements-additional-traceability-records-certain-foods>

Keeping Produce Fresh: Best Practices for Producers:

<https://extension.psu.edu/keeping-produce-fresh-best-practices-for-producers>

Labeled Sanitizers for Produce Tool:

<https://foodsafetyclearinghouse.org/resources/labeled-sanitizers-produce-tool>

Managing Condensation in Coolers:

<http://go.uvm.edu/humidity>

National Water Testing Lab Map:

<http://go.uvm.edu/waterlabmap>

Planning an Efficient and Safe Wash/Pack Area:

<http://go.uvm.edu/phplanning>

Proper Postharvest Cooling and Handling Methods:

<https://content.ces.ncsu.edu/proper-postharvest-cooling-and-handling-methods>

Small-scale Aquaponic Food Production. Appendix 1 (pg. 169) for growing and harvesting guidelines for 12 common aquaponic plants:

<http://www.fao.org/3/i4021e/i4021e.pdf>

