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Assessing On-Farm Produce Safety Risks: Post-Harvest Handling Stage

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Overview

As consumption of fresh fruits and vegetables in the United States has increased, so have foodborne disease outbreaks and recalls associated with fresh produce (Callejón 2015; Painter 2013). In addition to compliance with regulations such as the Food Safety Modernization Act (FSMA) Produce Safety Rule, the marketplace has become stiffer in terms of on-farm produce safety requirements. Growers selling to larger buyer channels and institutions are often required to obtain Good Agricultural Practices (GAP) food safety certification. While growers selling through direct market channels including farmers markets and roadside stands do not typically need certification, they may have on-farm produce safety standards to achieve. Regardless of the market outlet channel and/or size of the farm, the potential for produce contamination exists. Thus, understanding on-farm produce safety risks is essential for all farms who grow, harvest, pack, hold and/or ship fruits and vegetables. Identifying risks at the post-harvest handling stage is the sixth step to developing and implementing best practices to reduce those risks and reduce potential produce contamination. This publication is the sixth in a series of seven factsheet publications to assist you in creating a food safety program (Figure 1).

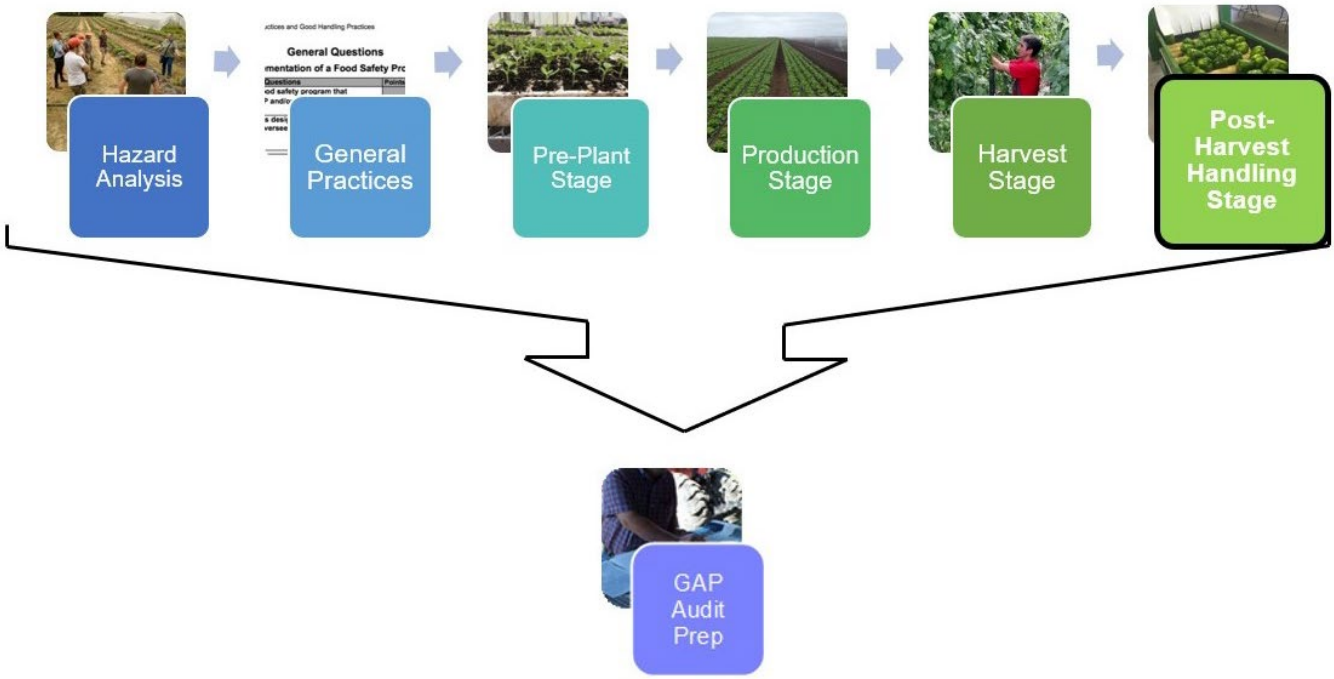

Figure 1. This series is designed to provide produce operators with the knowledge and tools to develop and implement Good Agricultural Practices (GAP). The final publication provides guidance for tying all the pieces together in preparation for a third-party food safety audit.

Post-Harvest Infrastructure

Buyer requirements tend to dictate the way the final product needs to be handled and packaged. Yet, apart from these considerations, specific handling steps will differ depending on crop types and best handling guidelines, as well as your unique post-harvest infrastructure. Overall post-harvest infrastructure includes both fixed, permanent facilities and moveable vehicles, equipment, tools, and consumables (Figure 2).

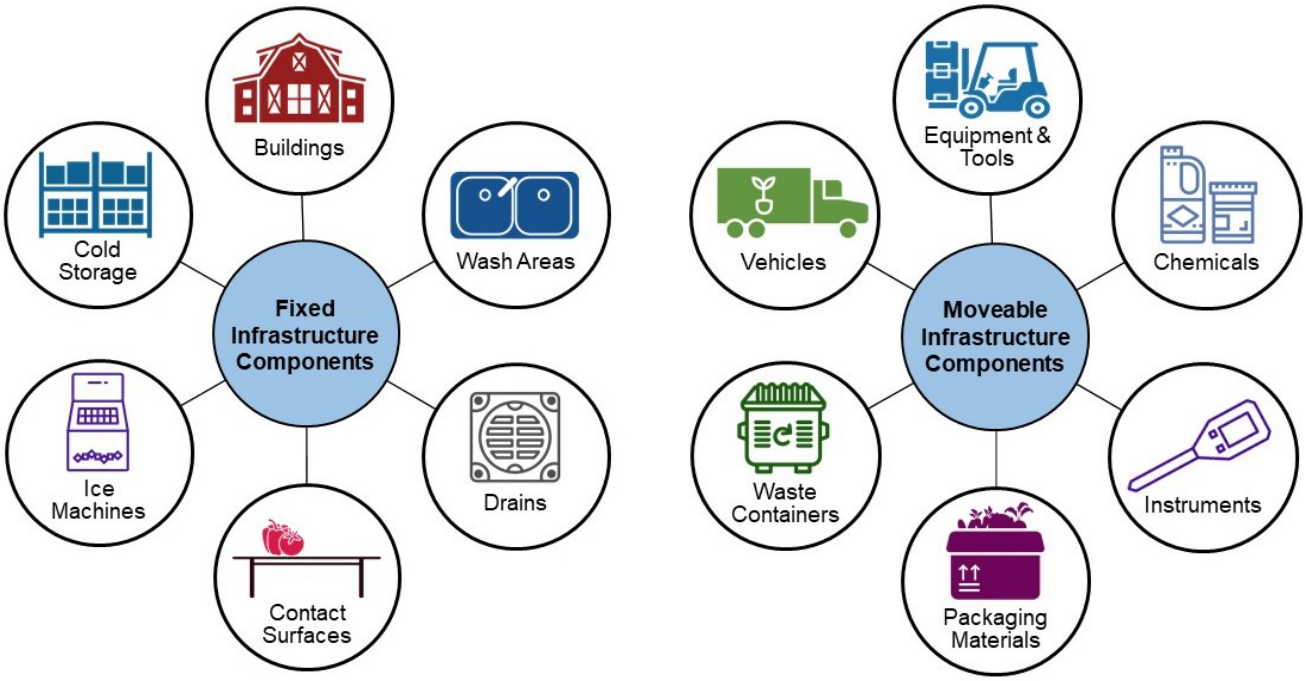

Figure 2. Post-Harvest Infrastructure includes both fixed, permanent facilities and moveable vehicles, equipment, tools, and consumables.

Fixed Infrastructure Components

There can be a wide array of buildings, ranging from open pole barn structures to fully enclosed elaborate packinghouses. Wash areas may be free-standing single- or three-wash sinks to single-pass spray bar wash lines, to complicated dump tanks with automated conveyor wash systems. Plumbing may be retrofitted in existing buildings, or else attention given to proper hygienic design. Food contact surfaces are diverse and include folding tables, Formica® or stainless-steel countertops, and industrialized-grade packing set-ups. When ice is used, it might be purchased or made on site. Cold storage areas range from insulated ice-chest type coolers to stand-up refrigerators to walk-in room coolers and even large storage areas.

Since permanent facilities necessitate an investment of money, some farms will try to retrofit what already exists and purchase only what is needed for a working post-harvest system. In this scenario, fixed infrastructure is often developed in stages and as available capital allows. A primary consideration when retrofitting any older equipment (e.g., packing lines, food contact surfaces, old cooling equipment) is making sure a hazard analysis is performed to minimize risks. Retrofitted packing lines must be inspected for damaged foam rollers, carpet padding (which should be removed and discarded), exposed bolts, chains, and belts, sharp metal edges on housing, chipped paint, grading table surfaces, and overall suitability and functionality. Sometimes it is not feasible to retrofit old equipment because of physical hazards, so it is best to consider other options until a better packing line system can be purchased.

In cases where a new packing area is being constructed, it is a perfect time to purposely design the overall product flow and selection of fixtures with the intention of reducing food safety risks. Attention to the water source and plumbing of the structure, especially washing systems and drains, is critical. Take care to minimize standing water

on floors near sinks, packing lines, and cooling areas. Counter surfaces should be made of non-porous material that is easily cleaned and sanitized. Corner joints should not have nooks or gaps where microbes and dirt can get trapped. Air conditioning units and condensers in cold storage areas should be easy to clean and have some means to catch any dripping condensate.

Whether old or new, the design of a facility greatly affects food safety (Callahan and Chamberlin 2019). All structures should be constructed in a manner that allows them to be properly cleaned and sanitized and does not harbor any contaminants or pests. Walls, floors, and ceilings should be maintained and free of any visible cracks. Proper and adequate lighting must be provided in all areas of the facilities; however, any lights above product wash, pack, and storage areas should be shielded with covers or protective sleeves so that produce cannot be contaminated with glass shards or broken plastic. Any catwalks above areas where product is washed and packaged or held should also have safeguards in place to prevent cross-contamination.

Moveable Infrastructure Components

Moveable infrastructure includes equipment such as forklifts, front end loaders, draining racks, movable sorting tables, Dosatron® injectors, and scales; knives, long-handled tools for gently pushing produce on wash lines, and brooms, mops, and scrubbers; consumables like cleaning and sanitation supplies, pH strips, food grade lubricants, clamshells, cardboard boxes and liners; instruments like thermometers, pH meters, temperature and humidity loggers; waste receptacles, larger bins, and dumpster services; and vehicles for transport such as pick-up trucks, vans, refrigerated vehicles, and contracted truck lines. Like fixed facilities, equipment, tools, vehicles, and the food contact surfaces of any movable sorting tables should be in good working condition. Equipment and tools should be labeled or easily identified for their specific use. Cleaners, sanitizers, and other agricultural chemicals used in the post-harvest environment must be stored in such a way as to prevent cross-contamination.

Steps in the Post-Harvest Handling Stage

While there is overlap and similarities with principles discussed for the harvest stage, the post-harvest handling stage consists of five general steps (Figure 3) (Strawn, Chapman, and Guitierrez-Rodriguez 2017; Slama and Diley 2013). Regardless of the simplicity or complexity of the overall infrastructure on a farm, there must be policies, protocols, and practices to mitigate any potential food safety risks, and records to document activities and overall compliance. When thinking about post-harvest handling, it is also important to consider food quality issues. In fact, harvest and post-harvest handling are critical since how and what is done at these stages have a huge bearing on the overall quality and shelf life of the produce.

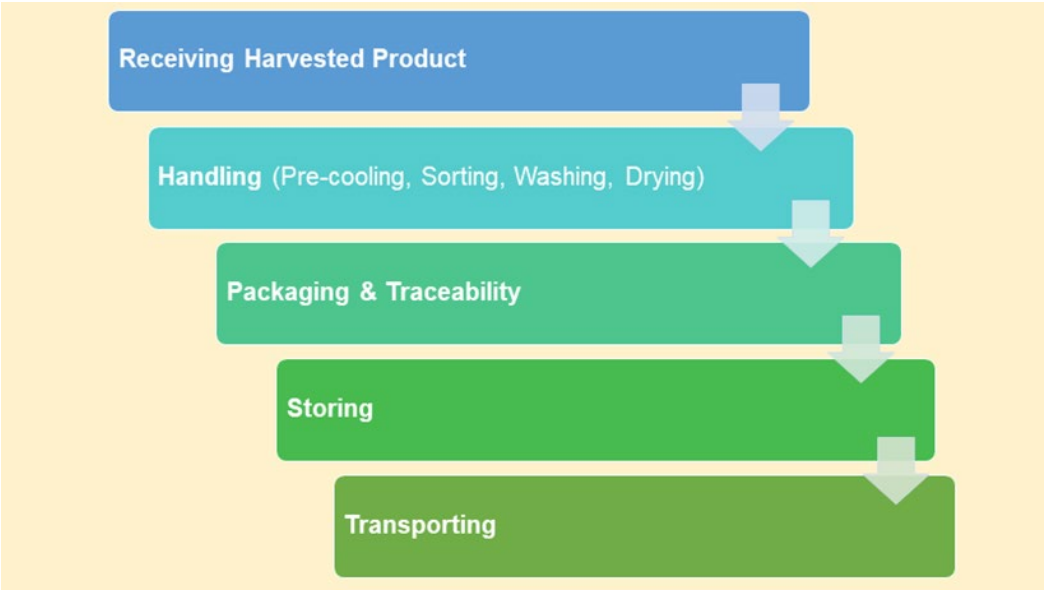

Figure 3. The five general steps of the post-harvest handling stage.

Receiving Harvested Product

The first step is receiving harvested produce from production fields or protected culture areas. Unlike field-packed product that is packed and directly transported off farm (Vallotton et al. 2021b), the produce is either picked into harvest bins/containers or into packaging in the production areas and subsequently brought to a post-harvest handling area for further steps. There may also be cases where growers are a part of a farmer cooperative association in which produce is grown on individual farms and then transported to a common facility where the produce is packaged, labeled with new traceback codes, stored, and transported to a wholesaler or other buyer. Any product coming from production areas needs to be identified with a field traceback code (Vallotton et al. 2021b), since that information is needed during the packaging and traceability step.

Handling

The second step can involve pre-cooling, sorting, washing, and drying. As mentioned previously, the way crops are handled is closely linked to crop type, so it is important to have a good understanding of each crop to optimize quality while also meeting food safety standards. The sequence of handling steps may not be linear as described here — in fact, some of these steps may not be done at all depending on the type of crop and your operation. Nonetheless, it is vital to be familiar with and understand the factors that can impact food quality and freshness. While spoilage organisms are not the same as microbes causing foodborne illness, they cause significant economic loss (DuPont 2015).

Pre-Cooling

One important factor during and immediately following harvest is removing field heat from crops (i.e., pre-cooling) and maintaining them at the correct temperature and storage conditions (DuPont 2015). Although harvested, the crop is still alive and continues to respire. Cooling the crop reduces respiration, increases product quality and freshness, extends storage life, and inhibits post-harvest spoilage diseases (Callahan and Chamberlin 2018). The success of pre-cooling depends on the time interval between harvest and pre-cooling, and the initial temperature of the crop before pre-cooling. Some methods for pre-cooling include ice cooling in storage containers, boxes, or coolers; forced air cooling in which cool air is moved through and around the product in a cold storage area; hydro-cooling by spraying or immersing crops in water; and room cooling in a refrigerated area (Figure 4). While not all crops require pre-cooling (e.g., radish, cabbage), and some crops are even susceptible to chilling injury when exposed to cold temperatures (e.g., beans, sweet potatoes, basil, eggplant, okra), there are many crops where it is critical to pre-cool (e.g., berries, peppers, tomatoes, cucumbers, beans, melons, spinach) to maintain quality (DuPont 2015; Hajdu 2021; Boyette, Wilson, and Estes 1989).

Figure 4. Some methods used for pre-cooling. From left to right: edible flowers harvested into clamshells and placed on ice in portable cooler; broccoli with forced air cooling and misting; sweet corn moving on a conveyor through a conventional hydrocooling system; and a small pre-cooling chamber. (Amber Vallotton, Virginia Cooperative Extension, except for second from right by Southwest Farmers Market)

Sorting, Washing, and Drying

Sorting includes inspecting produce for any foreign material, dirt, and debris, and culling poor quality, blemished, or damaged produce. It also includes grading for size and other characteristics. This step may occur without any wash steps, or simultaneously with the washing and/or drying process (Figure 5). When produce is packaged directly during the harvest process, sorting out poor quality produce typically occurs then. Washing and drying depends on the crop. With some crops, water should not be used since it will degrade produce quality and lead to secondary post-harvest spoilage. In contrast, for other crops, water is a necessary means for cleaning, and helps to maintain freshness and moisture content. Where dirt is not a key factor, a dry roller brush packing line system may be a better choice since it can still remove slight dirt without introducing water into the system. Using the best option for the crop(s) you will be handling ultimately depends on the kind of infrastructure you have available. If new or retrofitted equipment is not feasible because of cost constraints, consider lower-cost options that do not necessitate a big capital investment (Callahan and Chamberlin 2019; Chamberlin and Callahan 2019a,b).

Figure 5. Potatoes running through a packing line system. From left to right: potatoes moving on a conveyer roller after they have been washed under a single-pass spray bar, where they are then sorted by hand to remove poor quality potatoes, and then passed over grading sizer holes to separate out smaller potatoes, then conveyed up a belt where the potatoes are air dried with large fans, and then moved through a chute (not shown) where they are bagged with an automated bagging system. (Amber Vallotton, Virginia Cooperative Extension)

Post-Harvest Water

In any wash system where water is used, you should conduct an initial assessment of the washing process to pinpoint all potential risks. It is important to consider the crop(s) being washed, the type of wash system(s), the water quality, and the type of sanitizer or antimicrobial (Bihn et al. 2014a; Produce Safety Alliance 2019a). Water (including ice) that comes into direct contact with the harvested crop or on food contact surfaces, must meet the microbial water standards for drinking (potable) water (USDA 2021, p 66). The EPA drinking water standard is set at zero total coliforms and zero detectable generic *E. coli* (EPA 2021). Post-harvest water must be tested annually to make sure it meets this standard. For water that does not meet the standard, it is important to inspect the water system, take any corrective actions (e.g., water treatment) to remediate, and re-test the water. Water test results and any documentation of corrective actions should be kept with your other food safety records.

Because water can become contaminated by produce that contacts it, adding a sanitizer to the water is critical (Bihn et al. 2014a). This is especially true when produce is submerged into a batch or bulk wash water sink, dump tank, or trough. Yet even with single-pass spray bar systems, using a sanitizer is important. Sanitizers and washing products must be EPA-approved food grade products. Label rates, usage, handling, storage, and disposal directions must always be followed (Produce Safety Alliance 2020). When monitoring the wash process, you should document type of sanitizer used, concentrations in the wash water, water pH, water temperature, produce pulp temperature (if relevant), and turbidity (Suslow 1997).

Measuring sanitizer concentrations and water pH are essential. This is especially true when using chlorine-based sanitizers since concentration of the sanitizer, pH, and organic matter have a direct impact on the availability of free chlorine (Ritenour et al. 2020). Water pH can be determined using pH test strips, colorimetric kits, oxidation reduction potential (ORP) meters, and pH meters (Figure 6). Organic matter and debris interfere with sanitizer activity since the more dissolved and suspended solids that are in the water (e.g., turbidity), the longer it takes a

sanitizer to kill microbes (Wszelaki and Critzer 2018). One low-cost method to monitor turbidity is a modified Secchi disk, which indicates when it is time to change out the wash water. In cases where recirculated water is used, the water should be filtered to remove organic matter and debris on a prescribed scheduled basis (Produce Safety Alliance 2019a).

Figure 6. Wash water that has been dosed with chlorine is being sampled from single-pass spray bar nozzles to determine chlorine concentration and pH. (Amber Vallotton, Virginia Cooperative Extension)

Water temperature and produce pulp temperature are important when washing a crop that is susceptible to the infiltration of human pathogens (e.g., tomatoes, apples, melons) and with produce that is wounded, bruised, and punctured. Infiltration can result when the difference between wash water temperature and the warmer produce pulp temperature is at or more than 10°F, which causes the wash water to be drawn into the produce. Best practices to reduce infiltration risk include removing field heat by pre-cooling, using water that meets drinking water standards, adding an approved sanitizer, and reducing contact time with submerged produce (Estrada et al. 2019).

Packaging and Traceability

There is overlap between the handling steps and the next main step of packaging and labeling the produce with traceability codes. Like field harvest packaging discussed previously (Vallotton 2021b), there are many types of packaging materials. Here we will focus on materials where product is packaged in a packing area. Choices for packaging will depend on where the product is going (e.g., specific market), how the buyer wants to receive the product, as well as the best ways to pack, store, and transport the specific produce to reduce food safety hazards and maintain quality. All packaging materials should be new, single-use products except in cases where you have a buyer that wants produce in reusable plastic bins that are returned and cleaned/sanitized (Figure 7). Materials include cardboard boxes, outside trays, flats, shipper cartons, pulp tills, plastic clamshells, crispers, soaker pads, insert trays, liners, Ziploc® reclosable seal storage bags, wire crates, and more (Glacier Valley 2021). Materials should always be stored off the floor to reduce the risk of contamination from pests and separated from any chemicals and physical hazards. Where warranted, packaging should be covered (e.g., in areas more open to the environment and susceptible to windblown dirt and other contaminants).

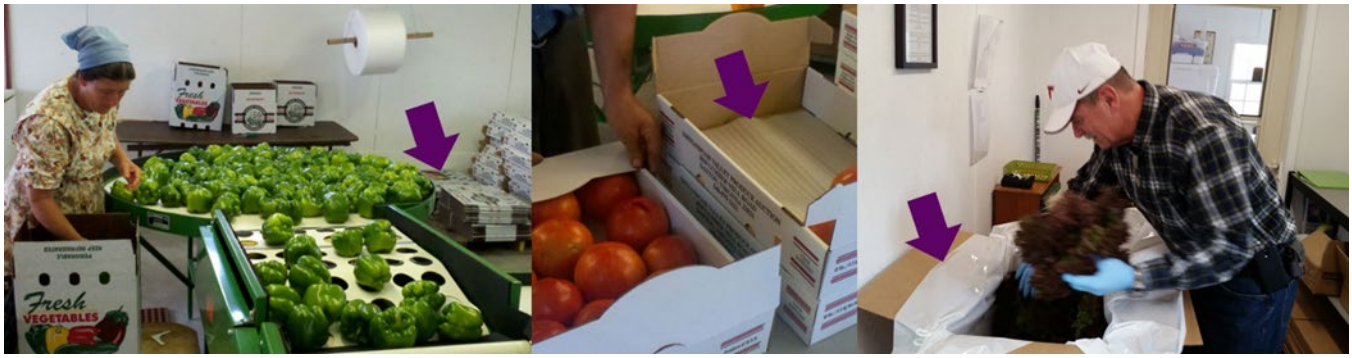

Figure 7. Packaging examples showing new cardboard boxes, cushion pads, and plastic lining (left to right). Green peppers being packed into wax boxes after being washed, with new boxes stored off the ground on a clean pallet, along with assembled boxes on a table close to packing area; dry-brushed tomatoes packed into padded, pre-assembled boxes; harvested greenhouse lettuce being placed into plastic-lined cardboard boxes. (Amber Vallotton, Virginia Cooperative Extension)

As mentioned in Vallotton et al. 2021b, packaged produce must be labeled to facilitate traceability back to the farm once the produce is sold. Once you have a system, it is important that product labels contain the full traceability code (lot number) and farm name, since a numeric number used alone is meaningless if it cannot be linked back to a specific farm (Figure 8). The labels are affixed to each unit of product. A unit can be an individual clamshell, a box or bin with loose product, a box containing a certain quantity of clamshells, a shrink-wrapped pallet with a certain number of boxes, etc. — this again depends on the market. Make sure the lot code is also designated on any invoices when produce is sold since this will provide documentation of buyers and lots sold. If you pack into reusable containers, make sure old labels have been removed and new labels are accurate.

Figure 8. Traceability crop codes and package label examples (left to right). Traceback crop code sheet used in packing area for labeling boxes; 'template' label showing the farm name and traceability code (harvest date, crop code, field number, and/or plot number); numeric traceability code with farm name; and pre-printed cardboard box with check boxes of contents along with lot number at bottom. (Amber Vallotton, Cameron Bardsley, Virginia Cooperative Extension)

To test your system, a traceability exercise (e.g., mock recall) should be performed annually. A buyer is contacted and asked about a randomly selected lot number or series of lot numbers you have previously sold to them. The buyer should be asked how much of the lot remains in their possession and how much has been sold. The request and buyer's response and farm production information pertaining to the selected lot numbers is documented in your food safety plan. The buyer must provide a written and signed notice of the completion of the trace exercise. When requesting a mock recall, emphasize that it is a 'mock exercise' and not a true recall!

Storing

Once produce is packaged and labeled, the next step is storing it under optimal conditions until it is transported. Handling during storage is critical for both food safety and maintaining quality. All crops require specific optimal conditions in terms of temperature and relative humidity (DuPont 2015). Since these conditions vary for each type of vegetable or fruit, be familiar with the storage requirements. At the start of the season and regularly throughout, inspect the cooling equipment and door and window seals to make sure they are functioning properly, cleaned, and maintained (Callahan 2017). During main use periods, monitor and record cooler temperatures daily, and have a contingency plan if there is a power outage or cooler break-down. Thermometers and other gauges should be regularly calibrated (Callahan 2017). For walk-in and larger coolers with plastic vinyl strip curtains at doorways, make sure the curtains are cleaned and do not pose a risk of cross-contamination, especially when product is moved in and out of the cooler. Condensate from coolers should be captured in drip pans to avoid dripping on to packaged produce, open bulk bins, and puddling on the floor (DuPont and LaBorde 2015). Packaged product should be stored off the floor on pallets or shelves. If produce is iced in waxed cardboard boxes, do not stack above other boxes to avoid dripping and cross-contamination risks. Produce coolers should not be used to store meat and other non-produce or non-food items, with signage posted to communicate this policy. Consider these principles within the context of your unique situation as you develop your food safety plan (Figure 9).

Figure 9. Produce storage from left to right: digital temperature display and posted rules on the outside door of a cooler; plastic vinyl curtain (arrow) at the entry of a large cooler area; packed vented produce stacked off the ground on a plastic pallet; and signage posted on outside of small walk-in cooler door. (Amber Vallotton, Virginia Cooperative Extension)

Transporting

The final step is transporting the finished produce. Equipment used for moving fresh produce such as pallet jacks, carts, trolleys, and forklifts should be regularly inspected and serviced so they do not have excessive dirt, rust, or debris. Care should be taken with any belts, chains, and moving parts. Make sure any movement in and out of the packing facility does not pose a risk of cross-contamination. Farm vehicles that serve multi-purposes must be inspected, cleaned, sanitized, and maintained prior to use for transporting finished product (Figure 10). If the vehicle is an open truck, produce should be covered so contamination does not occur while being transported. If refrigerated vehicles are used, whether from the farm, the buyer, or a contracted service, they must always be inspected prior to using. They should be checked to make sure they are clean and free of any odors, that doors seal properly, and that the cooling system is working and will not drip onto product. Loggers used to monitor and record temperatures should be inspected. Before loading, the produce and refrigerated vehicles should be pre-cooled, since the loading process will increase the temperature inside the cooler. Document the transfer of all produce, using your traceability codes on invoicing/shipping records and other record sheets (DuPont and LaBorde 2015; Bihn et al. 2014c).

Figure 10. Examples of transport vehicles from left to right: chest freezers containing lettuce being placed into a small, refrigerated trailer equipped with a CoolBot™ device; boxed broccoli stacked on pallets inside a refrigerated truck; melons in bulk bins that have been transported to nearby produce auction using a fully covered trailer with roll down sides to protect from contamination. (Amber Vallotton, Virginia Cooperative Extension, except for center photo by Justin Light)

Post-Harvest Food Safety Plan Written Standards

As we have discussed previously, the flow of produce through the various post-harvest processes should be designed to minimize contamination hazards at all steps. As a part of your food safety plan, you should develop a program with written standards (e.g., policies, operating procedures, corrective actions, record keeping logs) that address the entire post-harvest handling process and related infrastructure. The standards should include maintenance, cleaning, and sanitation of the facility buildings, equipment, tools, food contact surfaces (direct and

indirect), washing and cold storage areas, allergen and pest/animal control, vehicles, and waste management (Figure 11).

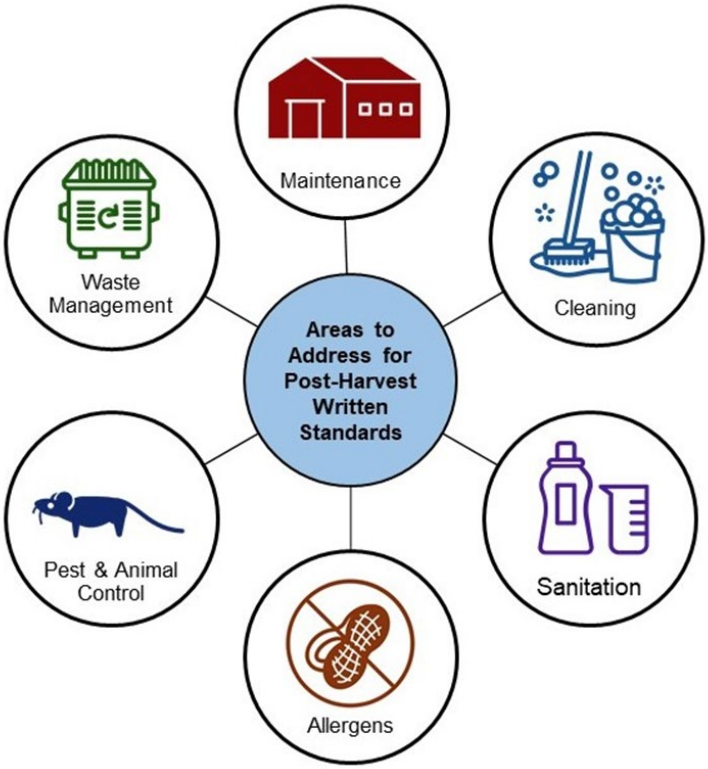

Figure 11. Areas to address for written standards relating to post-harvest handling.

Maintenance, Cleaning and Sanitation

Maintenance, cleaning, and sanitation go hand in hand, and are involved in all the post-harvest handling steps previously discussed (Figure 4). Pathogenic organisms can survive in the post-harvest environment, especially in packing areas, on equipment and surfaces, and on what is brought into the packing facility when best practices are not followed in the field and packing area (Bihn et al. 2014b; Produce Safety Alliance 2019b). Predetermined, documented, and effective cleaning procedures should be in place. Facilities and equipment should be cleaned and maintained on a scheduled basis (e.g., beginning of each season, before each use or packing line run) and recorded on log sheets.

During the season, instruments used to measure temperature, pH, antimicrobial levels (chlorine, peroxyacetic acid), or other important measurements that ensure product safety need to be calibrated on a scheduled basis so that they are reading the correct measurements. Proper sanitizers and cleaning agents must be approved for food contact surfaces and mixed according to product instructions (Produce Safety Alliance 2020). Cleaning equipment and tools need to be clean, in good repair, and stored properly away from product handling areas. Drains should be checked to ensure water is draining and that buildup and standing water does not occur (Callahan and Chamberlin 2020). Pallet jacks, forklifts, trolleys, and carts should be maintained and cleaned as needed. As warranted, infrastructure repairs can be done during the season, making sure to assess any changes to equipment and to avoid introducing any new risks.

A great time to conduct an overall inspection of the post-harvest infrastructure is during long down-times. During the inspection create a list for any repairs you note for plumbing, drains, and climate-controlled spaces, such as freezers, coolers, refrigerators, and refrigerated vehicles. Cooler curtains should be replaced if broken, ripped, or moldy. Repairs and/or re-lubrication of food processing and packaging equipment should be made at this time.

Allergens

If you process or store any of the “Big Eight” food allergens in your packinghouse or designated break area, you will need to develop an allergen program. The allergens include milk, eggs, fish, crustacean shellfish, tree nuts, peanuts, wheat, and soybeans (Villalba and Boyer 2018). An allergen risk assessment conducted by the operation will determine if there are needed procedures to address identification and segregation of allergens during storage and handling.

Pest & Animal Control and Waste Management

Assess post-harvest areas to determine if there are any pest "hot spots". You should then monitor the area and implement control strategies and preventive measures to minimize contamination from any pests and animal activities (Internet Center for Wildlife Damage Management 2021). Workers should be trained to recognize and monitor evidence of pests and animal intrusion/damage in post-harvest handling areas. Take note of any signs of intrusion in storage spaces such as droppings, chewing of materials, etc., and the structures, doors, and windows for physical gaps, cracks, and openings that pose a means for entry by animals. Consult pertinent local, state, and federal regulatory bodies before any animal control measures are taken (e.g., trapping rules and bird measures). Preventative measures include regular mowing around all packing areas/facilities, using live rodent traps (never poison bait stations), keeping all boxes on pallets at least one foot from the wall to minimize rodent hiding spaces, keeping structures in a good state of repair, and using deterrents (screechers, bird netting, or bird spikes to prevent nesting) when warranted. You should record all observations and control strategies on a log sheet in your food safety plan.

To avoid contamination, properly manage all post-harvest trash and waste. Keep garbage cans and dumpsters closed and locate them away from entrances. Maintain areas around garbage receptacles so they do not attract pests. Keep facility grounds free of litter, debris, piles of broken pallets, and standing water to discourage breeding, harboring, and feeding of pests. Store any equipment kept outside away from the building perimeter.

Summary of Post-Harvest Handling Steps

In this factsheet we have covered a lot of information related to the post-harvest stage. As you consider this stage, keep in mind the following main points:

- How you handle the produce at the harvest and post-harvest stages directly impacts produce quality as it moves from your farm to the next step in the value chain.
- Know and understand buyer and specific market requirements and expectations.
- Use your post-harvest process assessment to pinpoint areas of risk and implement GAP to address during each step.
- Recognize that the overall infrastructure has a large influence on your produce handling, especially since food safety and quality go hand in hand.
- Remember that methods for handling your produce is integrally tied to the crop type, so know each crop well and manage optimal conditions to maintain the quality for each crop.
- Develop a program with policies, operating procedures, corrective actions, and record keeping logs that address the entire post-harvest infrastructure.
- Improvements at this stage often are costly, so make incremental changes that have the greatest impact on safety and quality, while still working toward achieving your larger overall food safety program goals.

On-Farm Produce Safety
Post-Harvest Handling Stage Checklist

Use the list of items below as a guide to tasks to be completed and questions to be addressed as a part of your on-farm food safety program. Once each item is completed, check off that item. For items that do not apply to your operation, write N/A next to the item.

Post-Harvest Infrastructure

- ☐ Create a basic sketch of the overall infrastructure used for all your post-harvest handling activities. Make sure to show all buildings, along with water sources, wash areas, drains, packing surfaces, cold storage facilities, loading areas, restrooms, storage areas for chemicals, packaging materials, equipment, and tools. Make sure to also show outdoor storage and waste areas, as well as vehicle parking areas.
- ☐ Perform a thorough assessment to determine 'hotspots' needing attention for your overall infrastructure.
- ☐ Note the type of packing facility (pole barn vs. enclosed), building construction, and state of repair.
- ☐ What is the source of water for the facility? Has it been tested? What were the results?
- ☐ What plumbing fixtures are available, such as wash sinks, lines for wash lines, restrooms?
- ☐ If wash systems are used, are they newer or retrofitted? What is the condition of rollers, nozzles, flaps, and other food contact surfaces? Have surfaces been painted and are they chipping? Are belts, chains, and moving parts exposed? Are screws and other metal parts rusty?
- ☐ Are floors easily cleaned, sloped to properly drain, scored to prevent cracking, and skid-resistant?
- ☐ Are packing and other food-contact surfaces made of materials that can be cleaned and sanitized? Are there crevices where dirt and water can hide?
- ☐ Are walls and ceilings able to be cleaned? Are they free of visible cracks and gaps?
- ☐ Is there adequate lighting in the facility? Are light fixtures protected to prevent glass shattering over product?
- ☐ Are coolers properly functioning? Does condensate have a catch tray to avoid dripping? Are cooler storage areas constructed to allow proper drainage?
- ☐ Once you complete the assessment, develop a timeline for addressing any issues.
- ☐ On the sketch, draw arrows to show the flow of product as it is received and moves through the various steps of post-harvest handling. Use the flow diagram to consider the next several points.

Receiving Harvested Product

- ☐ Develop a protocol for product receiving areas to avoid potential for cross-contamination from external sources.
- ☐ Make sure to consider tracking the product to the packaging and traceability stage.

Handling

- ☐ For each crop being grown, determine how field heat will be removed and the optimal conditions during the pre-cooling stage. Make sure to develop a written procedure detailing the various steps.
- ☐ If you will be using a post-harvest wash system, you should assess the washing process to help identify all potential risks.
- ☐ Use the assessment to develop a written procedure and related log sheets. Make sure to include crops being washed, type of wash systems, water quality standards, type of sanitizers being used, label instructions, ways the wash process will be monitored, and any corrective actions that will be taken if problems arise.
- ☐ If no wash water is used, detail how produce will be sorted prior to packaging.

Packaging and Traceability

- ☐ Consider potential risks, practices, and protocols for this step.
- ☐ If produce is not washed prior to repacking, make sure to develop a system for how harvest totes and bins will be handled to make sure they don't dirty floors and surfaces.
- ☐ If produce is washed before being packed, what types of packaging will be used? Where will packaging be stored to prevent contamination from rodents, dirt, and other possible risks?
- ☐ Consider how produce will be labeled to provide traceability. Determine traceback codes, how labels will be generated, the unit sizes for all crops, and a working invoicing system.
- ☐ Consider the timing of your annual mock recall and any records you need to document it.

Storing

- ☐ Consider your overall cold storage system and related risks.
- ☐ If produce is put on ice to cool, is the ice machine clean and maintained? Is the water used to make the ice from a potable source?
- ☐ Are cooling units maintained, cleaned, and sanitized? Are non-produce items stored in other refrigerators or coolers to avoid cross-contamination?
- ☐ How will storage facility temperatures be monitored? How will thermometers be calibrated? Make sure to determine how records will be kept.
- ☐ Develop protocols for the storage step.

Transporting

- ☐ Consider how packaged produce will be moved into transport vehicles.
- ☐ Are transport vehicles kept clean and maintained between uses?
- ☐ How will temperature controls be maintained and monitored during transport?
- ☐ Develop all related protocols for the transport step.

Post-Harvest Infrastructure Program

- ☐ Maintenance, cleaning, and sanitation go hand in hand. Develop a schedule to clean and maintain facilities and equipment on a regular basis.
- ☐ Conduct an allergen assessment and, if warranted, develop an allergen program.
- ☐ Determine if there are any pest/animal "hot spots" in the packing area and on facility grounds.
- ☐ Develop a pest monitoring and control program, making sure to incorporate preventive measures.
- ☐ Develop protocols to manage all wastes to discourage pests.

_____ _____

Name Signature

_____

Date

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