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Assessing On-Farm Produce Safety Risks: Production 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 that may be associated on your farm during the production stage is the fourth step to developing and implementing best practices to reduce those risks and reduce potential produce contamination. This publication is the fourth in a series of seven factsheet publications to assist you in creating a food safety program (Figure 1).

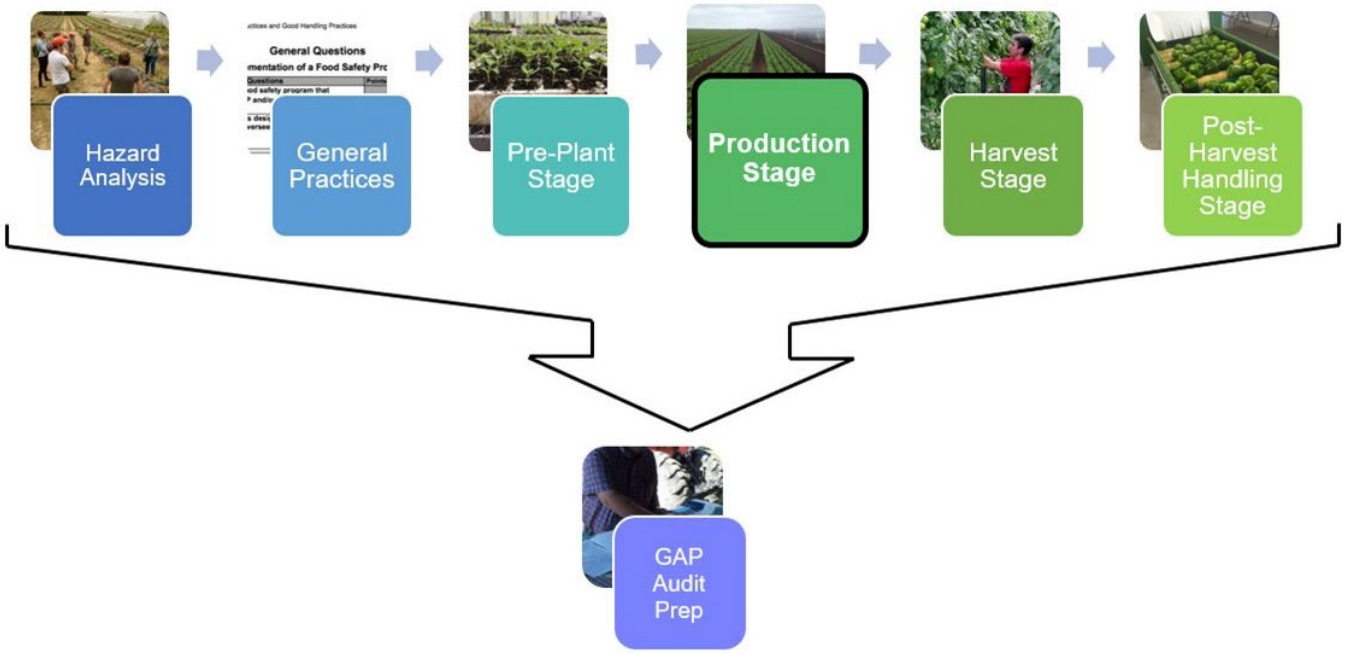

Figure 1. This series is designed to provide produce operators with the knowledge and tools to develop and implement Good Agricultural Practices (GAP). The final publication provides guidance for tying all the pieces together in preparation for a third-party food safety audit.

Production Stage

It is important to identify the primary routes of contamination during the production stage which include biological, chemical, and physical hazards. Identifying these potential routes of contamination will allow you to implement practices that reduce risk, or the likelihood of contamination events. Consider how each of the factors in the image below relate to different crop characteristics in order to assess associated contamination risks (Bardsley et al. 2021b) (Figure 2). In subsequent sections, we will explore each of these factors in greater depth.

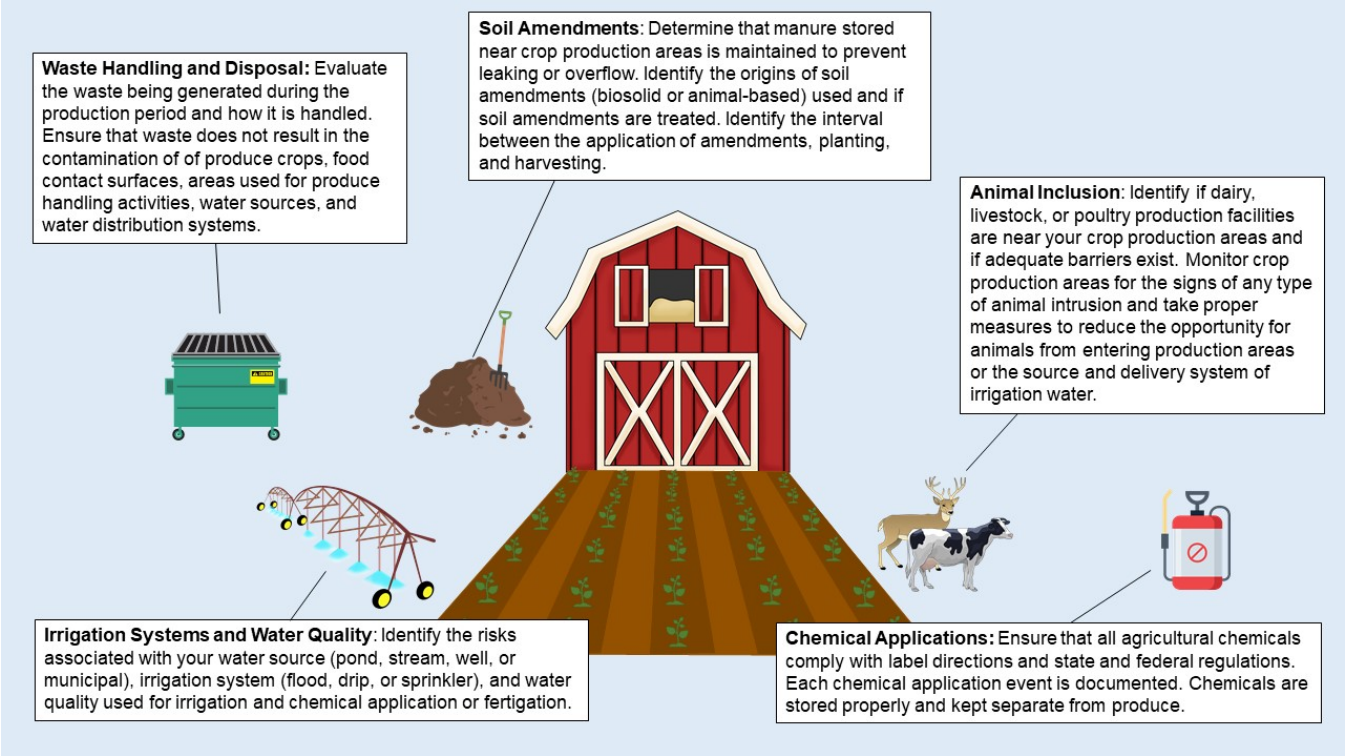

Figure 2. Irrigation and water quality, waste handling and disposal, the use of soil amendments, animal inclusion, and chemical applications are all essential factors to consider when assessing risk during production.

Soil Amendments

Some important factors to consider initially are the kinds of amendments you use in production fields and whether or not they contain any materials of animal origin (e.g., untreated manure, composted manure, animal by-products). In low-spray or organic production situations where organic practices are followed, animal-based soil amendments are typically used to build soil health and obtain plant fertility. Animal-based soil amendments include raw manure, composted manure, compost teas, bloodmeal, bone meal, fish emulsion, shellfish waste, and other non-fecal animal by-products (Produce Safety Alliance 2019a). A good way to categorize animal-based amendments is whether or not they have undergone a treatment process to adequately reduce microorganisms of public health significance to meet microbial standards (Produce Safety Alliance 2019b).

Untreated Animal-based Amendments

Untreated animal-based amendments can take various forms: raw manure from livestock production areas, “aged” or “stacked” manure, untreated liquid manure and slurries, untreated manure compost teas, agricultural teas with supplemental microbial nutrients (e.g. molasses, yeast), or any soil amendment mixed with raw manure. All of these cases do not involve a controlled, scientifically-validated treatment process which means they can be a source of human pathogens when used in the production of fresh produce. Therefore, it is vital that these types of amendments are handled, applied, and stored according to GAP to prevent cross-contamination. Any workers handling and applying untreated amendments must be trained in special worker hygiene practices related to use of clothing, boots, gloves, etc., as well as procedures related to machinery, equipment, and tools used to move, haul,

and apply the untreated materials. It is especially important that tractors, front end loaders, application implements, and tools used in handling untreated amendments are cleaned and sanitized prior being used for other farm tasks, since this equipment can be a source of cross-contamination (Figure 3).

Figure 3. Types of untreated animal-based amendments (left to right): stacked raw manure from livestock production area; fresh manure application using a manure spreader; and liquid manure application into the soil using manure injection equipment. (First image © Lewis Clarke – CC BY-SA/2.0; Other images © MN Pollution Control Agency – CC-BY-NC/2.0

Another key consideration is when and how the untreated amendments will be applied. To avoid runoff, untreated materials should not be applied when the soil is saturated, frozen, or snow-covered. The standard GAP practice is to follow the National Organic Program (NOP) guidelines which require that "uncomposted animal manures be applied at least 90 days prior to harvest for crops whose edible portions do not come in contact with the soil and at least 120 days prior to harvest of crops whose edible portions do come in contact with the soil" (USDA 2018). In some cases, amendments are applied into the soil in the fall followed with a cover crop since surface application to bare, fallow ground is best avoided. If materials are applied closer to the growing season, carefully select the application method based on whether the amendments will be surface applied or incorporated. Surface applications will be more prone to runoff as compared to mechanically incorporated or injected applications.

Workers applying materials using manure spreaders/vehicles should be aware of the contamination potential when using travel lanes next to crop fields. Workers should make sure to measure and calibrate manure spreader spray swaths to avoid off-site movement of aerosols, liquid, slurry, and manure solids into actively growing production fields. This awareness is especially important when untreated manure is applied to cropping areas that are adjacent to actively growing produce crops. In this case, it is recommended to incorporate an adequate buffer zone between the active growing area and the adjacent fields to minimize potential cross-contamination from any runoff (Baumgartner and Lowell 2016). The size of the buffer depends on the crops being grown and specific audit standards/requirements, which can be ambiguous and may vary depending on the certifying agency. If possible, it is best to avoid this situation altogether by applying untreated amendments prior to the actively growing crop production cycle.

Treated Animal-based Amendments

In contrast to untreated animal-based amendments, treated amendments are those materials of animal origin that have undergone a controlled biological decomposition (composting) process for a designated period of time at a specific temperature followed by a curing stage (Rittenhouse 2015) (Figure 4). If you use treated amendments either made on the farm or purchased, you will need documentation specifying the composting process followed. Any composting process needs to achieve a desirable minimum temperature for an adequate amount of time to properly reduce pathogens. If you make compost on-farm, compost windrows/areas should be located to prevent contamination of production areas and irrigation sources. The composting process typically requires turning or incorporating air as the materials are decomposing. Machinery used to turn and move the composted manure should follow similar practices as those outlined above for untreated animal-based amendments. You must keep records documenting the composting process which include the types of compost materials used as well as daily monitoring logs indicating temperatures, moisture content, and turnings. If treated amendments are purchased, you should obtain documentation from your supplier (i.e. a certificate of analysis or COA) to show what

ingredients make up the soil amendment, the composting procedure used, and verification that the finished compost meets microbial standards.

Figure 4. Treated animal-based amendments (left to right): compost during initial stages of decomposition; windrows being mechanically turned; and two compost thermometers inserted in a compost windrow to monitor compost temperature. (First two photos by Amber Vallotton, Virginia Cooperative Extension; last photo by Michelle Danyluk, University of Florida)

Storage of Animal-Based Amendments

Regardless of whether soil amendments of animal origin are treated or untreated, they should be physically contained, covered, and protected to prevent cross-contamination. If you have both treated and untreated amendments, store them separately from each other to avoid the potential for co-mingling. Amendments should not be stored without some cover from the weather, and storage containment areas should be separate from all production areas, packing areas, and water sources. It is recommended to create a buffer zone around these areas, and to consider the potential for any soil amendment runoff and/or leaching (Baumgartner and Lowell 2016).

Animal Activity

Wildlife, livestock, and other domesticated animals can be a source of biological contamination of fresh produce. Assess the various risks that animals pose on your farm's production, harvest, and packing areas (Figure 5). A good way to conduct an initial animal assessment is to consider the production fields and all adjacent areas, including physical structures, land features (like bodies of water and roads), and other agricultural use sites (Produce Safety Alliance 2019c). Here we focus on the production stage, but the following principles also apply to pre-plant, harvest, and post-harvest stages (Bardsley et al. 2021c; Vallotton et al. 2021b, c).

Figure 5. All animals, both wild and domestic, should be restricted from all production areas in order to avoid product contamination. Control measures should be implemented in order to exclude animals from entering into production areas whenever possible. (From left to right: © Carla Rolfe – CC-BY-NC/2.0; Amber Vallotton, Virginia Cooperative Extension; last two photos CC0)

Wildlife

When identifying risks related to wildlife, use knowledge of your farm to think about where animal activity is likely to occur (or where your farm has had past issues with wildlife). Wildlife need places for shelter, water,

food, and rearing and protecting their young from predators. Wildlife also have activity patterns such as being active during the day versus being active during the night. If you have forested or wooded areas surrounding your produce fields, these areas may provide ideal habitat and protective cover for deer and birds, while the produce fields may provide a source of food. Ponds used for irrigation purposes and their adjacent areas might be appealing dwelling or nesting spots for waterfowl year-round. Other situations to recognize as problematic are outdoor cull piles, trash receptacles, and unkempt areas around structures and facilities which attract rodents and other wildlife. Understanding some of these characteristics can be very helpful not only for identifying potential wildlife risks but also for developing strategies to reduce their presence (Dolbeer et al. 1994; Baumgartner et al. 2019).

Not only should you consider where wildlife activity *might* occur, but you should also observe where and how frequent activity *is occurring*. Physical evidence of wildlife presence include tracks, feces, trampled/damaged vegetation and crops, chewed drip lines, underground tunnels, and rummaged storage areas. Familiarizing yourself as well as field workers and farm employees with the appearance of wildlife tracks, tunneling, and scat/feces is important as you implement a monitoring/scouting protocol. Your initial animal assessment should include observations and notes to determine any "hot spots" along with ideas of specific control strategies to target observed wildlife presence and to minimize contamination.

Logs should document areas where wildlife is observed (type, number, patterns/persistence). Include any evidence of wildlife pathways, migratory fowl, and rodents in fields and storage spaces such as trampling, damaged produce, droppings. Make note of any physical gaps/cracks/openings in structures, doors, and windows that pose a means for entry by wildlife. A regular monitoring program will help to pinpoint new or recurring problem areas of wildlife presence and demonstrate the efficacy of your prevention and control strategies. Monitoring can be included as a regular part of your spray program in order to ensure it gets done.

Wildlife control measures primarily focus on deterrence and exclusion. Deterrents include physical predator decoys, scarecrows, noise machines (e.g., sonic devices, canons), bird repellant tape, live traps, and nuisance kill permits. Usually these measures have limited effectiveness, thus it is best to use multiple approaches or rotate your control measures. Exclusion includes fencing, netting, and actual enclosed structures (Figure 6). There are pros and cons for all of these measures in terms of cost, effectiveness, and feasibility. Compare the options and find what works best for your situation. In some cases, it may be more practical to shift high density wildlife areas to other uses rather than spending a lot of effort and money on exclusion options. Before the use of any wildlife control measures — especially the use of traps, baits, poisons, chemical repellants, and hunting permits — consult any pertinent local, state, and federal regulatory bodies to ensure that the measures are in line with legal guidelines (Virginia Department of Wildlife Services 2021; USDA 2020). Make sure you are well informed since some species are protected and there are also definite regulations concerning trapping, baiting, and hunting. In some cases, it is advisable to work with a state or federal wildlife specialist to assist with the process.

Figure 6. Various types of deterrents and exclusion methods. Left to right: plastic fencing for areas where fields may be rotated annually; rodent trap in greenhouse; bird netting placed on ceiling to prevent roosting on rafters; a decoy bird of prey. (Amber Vallotton, Virginia Cooperative Extension; last photo CC0)

Corrective actions should be included in your contingency plan and should be taken to remedy any ineffective control measures should you find damaged crops or feces in the field. Some examples of contingencies include marking off no harvest zones, whether you will leave feces or remove them, how you will move and dispose of them, and how you will discard any affected produce. Monitoring and corrective action logs should be kept as part of your ongoing food safety program (Bihn et al. 2014).

Livestock

As discussed in the "Assessing On-Farm Produce Safety Risks: Pre-Plant Stage" factsheet (Bardsley et al. 2021b), it is important to determine risks that are posed by livestock adjacent to food production fields. It is not uncommon for farms to have diversified operations of food crops and livestock. Livestock operations can range from small free-range style operations to large, concentrated feedlots or confinement barns. Each situation presents its own set of risks that are important to identify in your animal activity assessment.

Farms raising small livestock can provide a ready supply of manure for soil fertility. To avoid cross contamination from fresh manure, it is important that any free ranging livestock do not have access to production fields for at least 120 days prior to harvesting. It is also important to consider exclusion practices like fencing livestock out of production fields and finding strategies to reduce runoff into fields and water sources. For larger free-ranging livestock on pastures, similar considerations also apply. Animal Feeding Operations (farms where animals are kept and raised in confined situations) are highly regulated and must meet exacting standards for manure and wastewater discharge (U.S. EPA 2021). Nonetheless, it is important to consider contamination from any runoff from feeding and loafing areas, manure management systems, slurry tanks, manure front end loaders, tractors, as well as these areas attracting nuisance birds, rodents, and flies. It is vital that any vehicular (e.g. tractors, loaders, trucks, manure spreaders, cattle trailers) movement to and from these areas are closely monitored to avoid cross contamination into produce fields, packinghouses, and storage areas. Dust emission controls, vegetative buffers, or other mitigation strategies should be implemented around poultry houses to reduce airborne dust from ventilated poultry houses (Guo et al. 2019). Finally, employees involved in both livestock and food production roles should be properly trained on the importance of clean clothing, boots, shoes, etc. to avoid cross-contamination.

Domestic Animals

Farms with working animals as well as pets need to have established practices in place. If your farm uses draft horses, it is important to minimize animal presence in production areas when produce crops are present. There should be protocols in place for employees working with the horses, along with policies regarding animal and manure handling (Produce Safety Alliance 2019c). Pets should always be restricted from accessing all production, packinghouse, and storage areas since they can carry and transmit human pathogens. Additionally, if visitors frequent your farm because you offer agritourism, you-pick situations, or an on-farm market stand, you should have "no pets" signage posted. Any instances of animal intrusion should be documented along with the corrective actions taken.

Agricultural Water

Agricultural water used in the production, harvest, and post-harvest handling of fresh produce can carry and distribute human pathogens. Additionally, water distribution systems used on the farm and in packing areas can become contaminated when pipes, backflow devices, or other parts of the distribution system are not in good condition and functioning properly. It is critical to assess the risks associated with water and water systems to minimize produce contamination.

Creating a Water Distribution System Map

You should identify and map all agricultural water sources and water distribution systems used for farm activities. While post-harvest water will be covered in "Assessing On-Farm Food Safety Risks: Post-Harvest Handling Stage" (Vallotton et al. 2021b), be sure to show how the water distribution system ties into post-harvest operations.

To create your map or drawing you can start with a base map such as one obtained from Google Earth to denote the orientation of crop fields, and then mark the location of any structures, water sources, and other relevant features.

- For agricultural water, label each source using the following three main types: municipal water, ground water (wells, springs), and surface water (streams, ponds, reservoirs).
- For municipal sources, you can simply use an incoming arrow to show where your water system connects to the municipal source.

Depending on the size and complexity of your water system, you might want to sketch the general layout of the system with separate illustrations depicting how water feeds in and out of production and packing areas. As you do this task, it may be helpful to take photographs of the farm water system showing the location of permanent fixtures (wells, pumps, backflow prevention devices, treatment equipment, valves, returns, and other above ground features) and the flow of the water system (including holding systems, delivery lines, water captured for re-use, and irrigation sprinkler and application devices). Make sure to also include any mobile systems like transfer tanks or water trucks that are used to move water used for spraying or irrigating from field to field.). Photos can provide a lot of detail, but even if you do not use photos you should try to include these various features in your sketches (Figure 7).

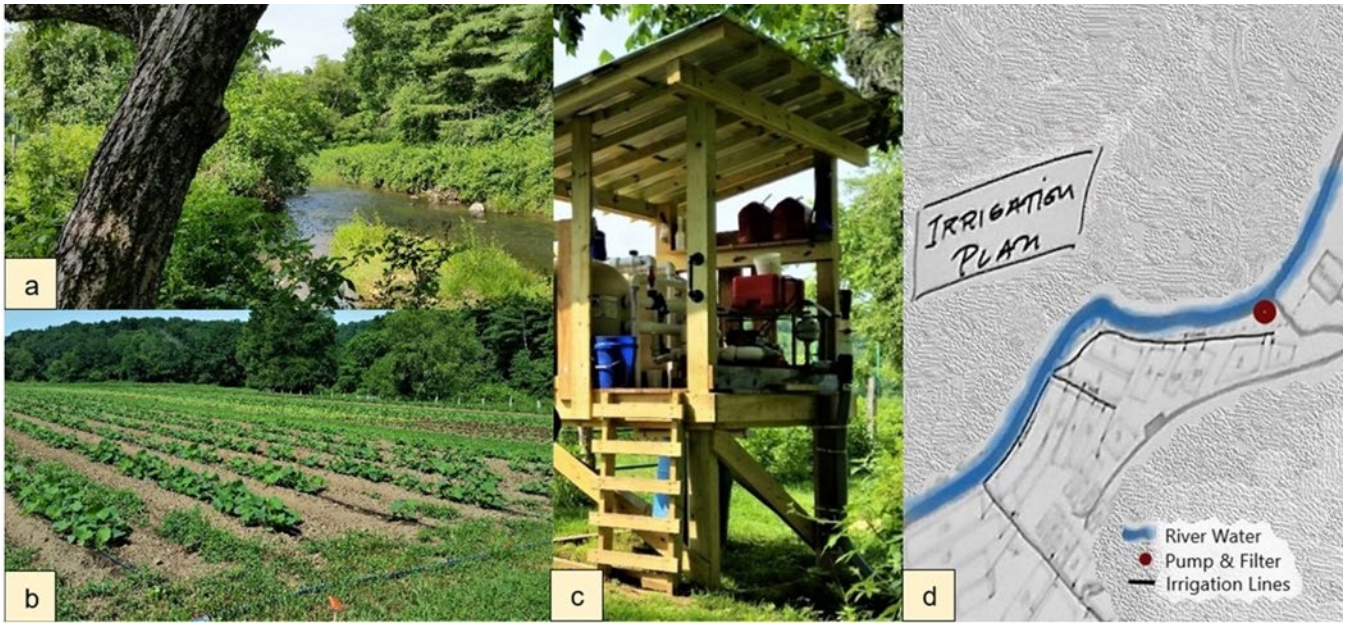

Figure 7. Using photos to create an irrigation plan. (a) River water source; (b) Production fields with irrigation feeder and drip lines; (c) Pump, filter, and treatment system; and (d) Completed irrigation plan sketch. (Amber Vallotton, Virginia Cooperative Extension)

Water Sources

Once you have completed your map or drawings, consider the different water sources and list the specific uses for each source. Your water source may have production uses (e.g. irrigation, spray applications, fertigation, frost protection, handwashing, drinking water), harvest uses (e.g. cleaning/sanitizing tools, bins, equipment, crushed ice, hydro-cooling), and postharvest uses (e.g. cleaning/sanitizing packing lines, and wash water, misting for postharvest storage, ice). Generally, untreated surface water should not be used for harvest and postharvest uses. However, there may be certain instances, i.e., potatoes, where a pre-wash step with surface water is allowable when followed immediately with a sanitizer on a wash line. Post-harvest water will be discussed more in Vallotton et al. 2021b. It is always important to understand your crop and potential food safety risks. In this context, use the irrigation maps/drawings and water use list to develop your water management plan. This plan should detail your policies and practices for frequency of water source testing, application methods, water treatment methods (if used), as well as water system inspections, maintenance, and repair.

Testing Water Sources

All groundwater and surface water sources should be sampled and analyzed to quantify generic *Escherichia coli* (*E. coli*). If you are using municipal water, you can request a copy of your municipality's water tests pertaining to the specific growing time period of interest. Standard criteria for generic *E. coli* differs depending on the end use of the water. Frequency of testing depends on the water source, specific audit guidelines, buyer requirements, and Produce Safety Rule water testing requirements, so make sure to verify with the certifying body and market buyer (Table 1) (Produce Safety Alliance 2019d; Strawn et al. 2019). It is important to document your sampling method(s) and include copies of each source's water analysis and lab accreditation as part of your records.

Table 1. GAP Audit Water Testing Criteria

Water Use	**Water Source**			**Testing Method**	**Standard (CFU/ MPN generic *E. coli* per 100 mL)**	**Testing Frequency** (Minimum times/ year)		
	Ground	**Surface**	**Municipal**			**Ground**	**Surface**	**Mun**
Irrigation	✓	✓	✓	a	≤126	1	3	0
Frost Protection	✓	✓	✓	a	≤126	1	3	0
Spray Application	✓	✓	✓	a	≤126	1	3	0
Pre-Harvest Washing of Bins, Tools, Utensils	✓		✓	a	0	1		0
Post-Harvest Washing and Handling	✓		✓	a	0	1		0
Handwashing	✓		✓	a	0	1		0
Drinking Water*	✓		✓	a	0	1		0

Source: Table criteria, except for testing frequency, is based on the Produce Safety Alliance Grower Curriculum (Produce Safety Alliance, 2019d).
Note: Table note "a" applies only to cells with "a" and denotes a quantitative testing method like IDEXX Colilert-18 and Quanti-Tray/2000 or other similar method should be used.

Corrective Action

You should develop corrective actions to implement should results from any water source test outside of GAP Water Testing Criteria (Table 1) metrics. A good first step is checking water sources for signs of contamination by wildlife or other issues, followed by inspecting the water system to make sure it is intact and functioning properly. Ensure no lines are broken, damaged, and that there are no issues with septic systems or waste water overflows. Remember, there may also be other reasons for higher *E. coli* values, such as sampling error, sample cross contamination, or sampling too soon after a severe weather event. If a particular problem is determined, it should be fixed, and then the water re-tested to make sure the problem is resolved. If after re-testing the problem still persists, you may need to consider other options, such as implementing new treatment systems. However, since treatment systems can be costly, it is wise to establish a baseline set of *E. coli* values for each water source and know what is "normal" and what represents "outlier" values. If a treatment system is used, any chemicals used to treat the water must be EPA registered and labeled for its intended use. Non-chemical treatments (filter units, UV light units) may be used if they adequately reduce microbial risks. In both cases, the treated water source should be re-tested after treatment to ensure the treatment is effective (Produce Safety Alliance 2019d).

Agricultural Chemicals

In the USDA HGAP audits, the term "agricultural chemicals" refers to a broad range of inputs, including pesticides, fertilizers, detergents, sanitizing agents, waxes, lubricants, fuel, etc.. This term is used for production, harvest, and post-harvest stages. In conventional field production scenarios, it is common to use inorganic chemical (synthetic) fertilizers to promote crop growth. Agricultural chemicals and plant protection products pose a risk of contaminating produce and food contact surfaces, and must be handled, applied, stored, and disposed of

properly (Ornamental Production Texas A&M 2020). Applicators should always be adequately trained, and it is important to always follow the label instructions during mixing, application, and cleaning of application equipment (Puckett et al. 2018). Bulk containers or bags of fertilizers and other plant nutrients should always be stored in such a way as to maintain product quality and to avoid any spillage, leakage, and the potential for cross-contaminating plant materials and/or harvested and packed product. When possible, it is a good idea to physically separate the chemicals; loose bags of dry chemicals should be placed in lidded, labeled secondary containers. It is

A part of your food safety plan needs to address agricultural chemical use. You should consider and create an inventory of the various products you use for pre-planting, production, and post-harvest activities, including fertilizers, pesticides, plant protection products, cleaning chemicals, equipment lubricants, fuels, sanitizers, and waxes. Using this list, product label instructions, and Safety Data Sheets (SDS), you can then develop an agricultural chemical use policy with specific handling protocols focusing on worker applicator training, mixing, clean-up, disposal, storage, spills, and recordkeeping (Figure 8).

Figure 8. The main focus areas to target in developing an agricultural chemical use policy and protocols include an agricultural chemical list, worker applicator training, chemical storage, application basics, clean-up, disposal of chemicals, recordkeeping, and corrective actions logs when needed.

Waste Handling and Disposal

All farm operations generate production, harvest, and postharvest waste, along with other waste items such as trash from toilet and handwashing facilities. It is important to determine and assess all waste streams and manage them appropriately in order to prevent contamination of produce crops, food contact surfaces, areas used for produce handling activities, water sources, and water distribution systems. A good way to do this is to use your flow chart or map developed as part of your overall sketch of your operation (see Bardsley et al. 2021a). Once you identify all the waste materials, you will need to develop written standards and measures that address cross-contamination by the waste, making sure waste is disposed of according to local, state, and federal regulations.

Make sure to consider:

- Production waste like plant trimmings, diseased plants, unusable potting mix, trays, plastics, and other plant-related wastes from fields and greenhouse production areas
- Harvest and postharvest waste like culls, produce waste, cardboard, and any litter or trash generated
- Locating trash receptacles at each indoor toilet and/or portable sanitation unit and handwashing stations, at designated eating and break areas, in any indoor production areas, and in packing areas and other facilities
- Emptying waste into temporary waste containers and cull bins at the end of each day or sooner when full to avoid attracting rodents and pests
- Locating outdoor trash receptacles and dumpsters away from food handling, packing, and storage areas
- Providing waste containers with lids and maintaining adjacent areas to minimize contamination by litter, waste culls, debris, and harborage of rodents and other animals
- Avoiding placement of any receptacles where there is a tendency for standing water to occur
- Properly handling and disposing of bodily fluid waste like blood and first aid supplies used for cleaning up injuries
- Handling broken glass and metal shards so employees and sanitation workers are not put at risk
- Keeping records of waste handling and disposal

On-Farm Produce Safety Production 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.

Field Preparation

- ☐ For field preparation, take into consideration all inputs, equipment, tools, and machinery used.
- ☐ Research and develop written protocols and log sheets for all related field preparation and production tasks.

Fertilizers and Soil Amendments

- ☐ For each crop being grown, determine the specific type of fertilizer and/or soil amendments you will be applying.
- ☐ Make sure all employees who will be applying fertilizers and soil amendments are properly trained in handling practices.
- ☐ If you will be using bulk fertilizers and plant protective chemicals, how will they be labeled and stored to prevent contamination?
- ☐ Define a plan for mixing, applying, and disposing of fertilizers and other chemicals, as well as procedures for usage and cleaning of personal protective equipment and spray equipment.
- ☐ If animal-based soil amendments will be used, will you be using treated or untreated materials?
- ☐ Will you be making your own compost or compost teas, or purchasing materials?
- ☐ If compost is generated on farm, determine your process, such as materials you will incorporate, frequency of turning, temperatures needed for proper composting, how you will monitor, and curing times.
- ☐ Develop a working log to document the composting process.
- ☐ If you purchase compost, determine a supplier and make sure the manufacturer can provide a certificate of analysis, process verification, and vendor information.
- ☐ Develop a soil amendment log to document what types, when, how, and at what rates amendments are applied. Include equipment calibration and cleaning/sanitation of machinery and tools used.

Wildlife Activity

- ☐ Perform a thorough written assessment of your observations and notes to determine “hot spots” of wildlife activity.
- ☐ Make sure to look at each production area and adjacent areas to determine any potential animal-related risks, including overhead power lines or building rafters.
- ☐ Consider what deterrence and exclusion measures you need to take and the pros and cons of each measure, then create a wildlife control and monitoring/scouting plan.
- ☐ Include rodent deterrence and monitoring measures in your wildlife control plan.
- ☐ Develop cleaning and maintenance protocols for adjacent outside spaces around structures to reduce rodent habitat and refuge areas.

Livestock

- ☐ Consider livestock production areas; identify and target risks through specific food safety protocols related to manure runoff, dust emission, cross-contamination, and employee training.

Domesticated Animals

- ☐ Establish protocols for domesticated animals in fields and indoor production/packing areas.

- Develop appropriate employee training for all animal-related controls and documentation.

Agricultural Water

- Identify and map all agricultural water sources and water distribution systems used for farm activities.
- On your water distribution map, label all water sources along with pumps, backflow devices, connecting lines, and their layout in field production and/or protected culture areas. Label each feature (or create a legend).
- For each production area, create a written list of what the water will be used for (irrigation, spray applications, frost protection), how the water will be applied (drip, overhead spray, other), and when it will be applied (timing).

Water Management Plan

- Create a water management plan using your map/diagram and list.
- Create a schedule for sampling and testing the production water at each source. Find a state-certified water testing laboratory and know their handling and holding procedures.
- Develop a summary of water test results for all water sources, making sure to include dates sampled and a copy of test reports.
- If chemical or non-chemical water treatment systems are used to improve water quality, make sure to include label information in your plan, and report analyses for any treated water samples in your testing schedule to ensure the treatments are effective.
- Develop logs for water system inspections, maintenance, and any corrective actions needed.
- Include any employee training required for performing duties related to water management in your water management plan.

Agricultural Chemicals

- Create an inventory of agricultural chemical products you use for pre-planting, production, and post-harvest activities (fertilizers, pesticides, plant protection products, cleaning chemicals, equipment lubricants, fuels, sanitizers, and waxes).
- Develop an agricultural chemical use policy with specific handling protocols including applicator training, chemical storage, application basics, clean-up, disposal of chemicals, recordkeeping, and corrective actions logs when needed.

Waste Management

- Use your flow chart or farm map to consider trash and waste streams.
- Create a waste management plan and respective logs for all aspects of the operation, including waste handling and disposal.

Protected Culture Systems

While we did not discuss protected culture systems in this factsheet, all the areas covered above apply to some extent. Consider the following questions within the context of your protected culture system. For more information on greenhouse food safety, please see Vallotton, Strawn, and Latimer (2017), and Vallotton, Vu, and Wyatt (2017).

- Think through the possible sources of contamination for crops being grown in protected culture systems such as high tunnels and greenhouses.
- What growing system is being used? In-ground or raised beds? Hydroponic bag culture, Bato bucket, NFT, raft system, vertical tower, ebb and flow? Aquaponics? Growing unit/container?
- What growing substrate is used for starting transplants and actual growing channels?
- Note the various features of the growing system and evaluate specific risks posed such as the condition of

channels, rafts, pots, benches; cleaning and sanitizing between rotations; water quality, application, recycling issues; or cross-contamination by fish (for aquaponic systems).

- Consider how bulk nutrients, acids, and other chemicals will be stored and labeled to prevent accidents and contamination.
- Consider preventive steps to avoid overhead light breakage such as installing sleeves or protective covers to light fixtures.
- What control measures will be used for your pest management control program (i.e., rodents, flies)?
- How do you plan to exclude pets or stray animals?
- What policies and procedures are needed to address culls, “spent” growing substrate, and other waste generated?

_____
Name

_____
Signature

_____
Date

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