The safety of fresh fruits and vegetables for direct consumption is an important issue for both consumers and producers. During the past few decades, consumption of fresh produce has increased substantially as people have learned more about the health benefits of a diet rich in fresh fruits and vegetables. Along with this increased consumption of fresh produce there has been an increase in food borne disease outbreaks associated with fresh produce. Both consumers and producers suffer adversely when fresh produce related outbreaks occur. Consumers suffer serious health risks and the produce industry suffers from a loss in consumer confidence and trust and the resultant loss of sales. Aside from the tragic losses in human productivity and potential caused by illness and even death, an outbreak can result in the loss of millions of dollars from lost sales and lawsuits.

Farm-to-School programs need to be proactive concerning food safety. This section provides the important simple steps that any produce grower, school kitchen or school garden should follow to ensure a safe locally grown fruit and vegetable supply to our students.

Good Agricultural Practices (GAPs) are an important concept for producers of fresh fruits and vegetables to understand in order to assure the microbial safety of produce that is grown in their operation. GAPs involve many things, but suffice it to say they are practices used during planting, production, harvest and after harvest to guard the safety of fresh produce.

One point to understand is there is not a one-size-fits-all plan for food safety. GAPs must be uniquely tailored to crops and management practices for each farm. Basically, we should focus on reducing the risk of contaminating fresh produce. It is not possible at this time to completely eliminate food safety risks; in fact the Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables states “current technologies cannot eliminate all potential food safety hazards associated with fresh produce that will be eaten raw.”

Times when producers should be vigilant to reduce and control food safety risks include prior to planting, during the planting stage, during production, and during and after harvest. Before planting, growers should complete a grower risk assessment. Cornell University has a great publication to help with this, titled “Food Safety Begins on the Farm – A Grower Self Assessment of Food Safety Risks.” This publication is available online at http://www.gaps.cornell.edu/index.html. The document includes 24 sections that provide GAPs and checklists for everything from worker hygiene to petting zoos. Working through the assessment will help producers in developing a food safety plan for their operation.

Good Manufacturing Practices (GMPs) take over where GAPs leave off. GMPs cover issues such as sanitary design of the packing shed itself and any produce-handling equipment or produce contact surfaces, packing shed pest control, packing shed sanitation, worker health and hygiene monitoring, and temperature control for produce that requires refrigeration. Sanitizing washes or dips, which rely on chlorine or other sanitizers to kill harmful microbes, also may be part of a GMP program. The overall goal of a GMP program is to minimize and control the risks of contamination that occur after harvest and during packing, and includes many of the same principles that are applied as part of a GAPs program.

It is important to note that an on-farm packing shed is not normally considered a food processing facility. This means that an on-farm packing shed is generally exempt from state and federal licensing and inspection requirements that apply specifically to food processing facilities. However, there are certain produce-handling operations that would commonly be called a packing shed that could be regarded as a food processing facility by state and federal authorities. Specifically, any process that alters the natural state of a raw agricultural product may be construed as food processing. Generally this would include operations such as peeling, shelling, cutting and sometimes re-packaging harvested produce into retail packs. Be aware these sorts of activities will likely change the regulatory status of an on-farm produce handling facility.

The worksheets mentioned in this section can be found at www.okfarmtoscool.com/resources/fts-distro-foodsafetymanual.
Step 1: Address Pre-Plant Issues

- **Site Selection.** Prevention should begin with proper field selection. Property surrounding the site should be checked to determine the chance contaminants can enter the field from dust, runoff or animals. See site selection worksheet.

- **Water.** Water for irrigation should be tested annually or more often for fecal coliforms (2.2 fecal coliforms per 100 ml is the EPA limit for non-potable uses). Overhead irrigation water should be treated if fecal coliforms exceed the limit mentioned above. See worksheet for irrigation and spray water.

- **Land history.** History of site use including past crops, applications of pesticides or other chemicals, animal waste applications, etc. This should indicate if the soil has potential for causing crop contamination or has potential for crop damage from previous land use. See site selection worksheet.

- **Wildlife and domestic animals.** Animals have serious potential for contaminating the crop with feces. Scout the field for game trails and adjacent areas for the potential of harboring wildlife or domestic animals that could enter the field. If concern exists, you will need to develop a plan to reduce these risks. See site selection worksheet.

- **Crop selection.** Different crops vary in their potential for being contaminated. Root and leafy crops have a much greater potential for contamination than crops that flower and fruit (i.e. tomato, tree fruits, brambles, snapbeans), grain or forage crops.

- **Other potential risks.** These might include contamination by pets, workers, visitors, field machinery, etc.

Step 2: Address Production Issues

- **Irrigation / spray water.** Water is the most likely way of spreading contamination to fresh produce. During production, pay special attention to monitoring irrigation water safety and using only potable water for crop sprays. Water supplies should be tested at least annually and more often if well sites have experienced flooding or are uncapped. See worksheet for irrigation and spray water.

  Irrigating using drip or furrow irrigation is less likely to spread contamination to produce than overhead or flood irrigation.

- **Field worker hygiene.** Field worker hygiene is an important part of keeping fresh produce safe during production. Provide not only convenient clean restroom and hand-washing facilities, but also training to ensure workers understand the importance of personal hygiene for keeping fresh produce safe to eat. Worker training materials and videos are available at the National GAPs training website (http://www.gaps.cornell.edu/educationalmaterials.html). See worksheet on worker training.

- **Fertilizer use.** Fertilizers vary in their potential to harbor microbial contaminates. Synthetic fertilizers have low potential for contamination while un-composted and improperly composted manure has a high potential. Sidedressing during the growing season should use only well composted manure or synthetic fertilizers. See worksheet on fertilizer, compost and manure application.

- **Wildlife control.** Controlling access to the field will reduce the risk of contamination from people, livestock and wildlife. Exclude livestock, including pets and poultry, from the field with fencing or other means. Develop and implement a plan to manage wildlife access through appropriate methods. Workers and visitors access to the field should be controlled to limit access when wet field conditions exist. See worksheets on wildlife control.

Step 3: Address Harvest Issues

- **Harvest worker hygiene.** Worker and U-Pick customer health and hygiene is a key component of the overall program to guard the safety of fresh produce during harvest. Workers will need to be trained in their responsibilities, and well-maintained facilities will need to be provided to allow them to carry these out. U-Pick customers will need convenient well maintained restroom facilities and signage to encourage them to follow good sanitary practices. See worksheets for worker training and field and packing shed restroom cleaning.

- **Harvest equipment cleaning.** Harvest equipment must be maintained in a clean and sanitary condition. Pressure wash, rinse, and sanitize all harvest bins, harvest aids, and machinery daily. Cover washed and sanitized bins to prevent recontamination by wildlife. Maintain harvest equipment to minimize abrasion and wounding of fresh produce. See worksheets for worker training, field harvest/processing/packing/cleaning and the field and packing shed restroom cleaning and service log.

- **Avoid damaging produce.** Wounds or other damage provides an entry point for harmful microorganisms into fresh produce. And once inside, these microorganisms cannot be removed or killed by washing or sanitizing agents. Therefore, is it very important to
avoid damaging produce before or after harvest. Be aware of equipment or contact surfaces that may cut, bruise, or compress produce. Minimize operations that transfer produce from one container to another. Also, beware of damage to produce that may occur during harvest from improper use of equipment, untrimmed fingernails and so on. Remove damaged produce from packaging area to a cull pile.

- **Holding / transport equipment cleaning.** Transportation and holding equipment including bins, trailers, trucks, etc. should be checked on a daily basis and maintained in a clean and sanitary condition. Follow a checklist for inspection of vehicles that will be carrying fresh produce. See worksheets for truck checklist and processing, packing line, facility cleaning.

- **Fresh produce cleaning.** Safe produce handling should include removing soil from produce as it may be a source of contamination. Clean equipment and produce before it enters the packing shed. Consider using a sanitizing agent as part of the cleaning process. Damaged or diseased produce should be culled in the field to avoid contamination. Note culled produce should be transported to a remote cull pile as soon as possible in order to avoid attracting pests or creating a reservoir for both human and plant pathogens.

**Step 4: Post harvest issues to address**

- **Packing shed cleaning.** The packing shed should receive a general cleanup to remove dirt, debris, and culled produce at least once a day. Produce-handling equipment and any surface coming in contact with produce should be cleaned and sanitized daily. Bathrooms, sinks, waste receptacles and floor drains also should be cleaned and sanitized daily, or more often if needed. Frequent inspections of the facility should be performed throughout the day to ensure sanitary conditions are maintained. Cold rooms should be cleaned and sanitized once a month or as operations allow. Rodent and insect traps and other pest control aids should be inspected and renewed as necessary – generally at least once a month. See worksheets on field, packing shed restroom cleaning and service, processing packing line facility cleaning, and pest / rodent control.

  Note high-pressure hoses are not recommended for general cleaning when produce is being packed because high-pressure water sprays can spread harmful microorganisms over fairly long distances.

  A 200 PPM chlorine solution (1 tbsp household bleach / gallon water) makes an effective sanitizing solution when applied with a contact time of at least two minutes. Prior cleaning is important to ensure that the sanitizer is effective. Note surfaces sanitized with 200 PPM or stronger chlorine should be rinsed with clean water or allowed to air dry before coming into contact with produce.

- **Cooling or wash water sanitation.** Water used for cooling or washing must be clean and potable (drinkable). If water is being sanitized by adding chlorine, then the strength of the chlorine solution must be checked at least daily, more often if required, or whenever a fresh tank of water is prepared. See Washing / Cooling / Sanitizing Water Treatment worksheet.

- **Cooling water temperatures.** If a water tank is being used to hydrocool fresh produce ensure the cooling water is no more than 10°F cooler than the incoming produce to minimize the risk that produce will imbibe water during cooling.

- **Strength of sanitizing washes.** Table 1 gives basic recommendations for chlorine-based sanitizing solutions that can be used to help ensure the safety of fresh produce. If a sanitizing wash is appropriate, the strength of the chlorine solution should be monitored at least once a day, more often if required or whenever a fresh tank of solution is prepared. Be aware of the strength of the chlorine will dissipate over time, and the more soil is present on the produce, the more quickly the strength of a chlorine-based sanitizing solution will be lost. See Washing / Cooling / Sanitizing Water Treatment worksheet.

- **Proper storage of packed produce.** Hold and store produce away from possible hazards, e.g. cleaning agents, pesticides, etc. Hold and store produce off the floor, away from walls and in such a way as to avoid damage. If the produce is stored in a cold room, be sure to monitor and record temperatures. See cooler temperature worksheet.

- **Transportation of packed produce.** Trucks used to transport produce should be cleaned and sanitized prior to loading. If trucks are not used exclusively to transport produce, then be aware of what other items may have been previously transported and clean accordingly. If refrigerated transportation is being employed, consider using temperature monitoring systems to help ensure proper refrigeration temperatures are being maintained during shipping. See truck checklist worksheet.

**Step 5: Address important record keeping issues**

- Create and maintain records for all employee trainings (see worker training log).
- Create and maintain records of facility cleaning and sanitizing (see processing, packing line, facility cleaning and field, packing shed restroom cleaning and service worksheets).
• Create and maintain records of produce sanitizing, if applicable (see washing / cooling / sanitizing water treatment worksheet).
• Develop a traceback system for your farm that will allow you to trace produce to the field it was harvested from, including harvest date (see produce tracing and recall traceback worksheets).
• Consider developing a HACCP-like program for your farm (Hazard Analysis Critical Control Points). This system will identify where contamination problems are likely to occur (Critical Control Points) and will provide ways to address these potential hazards.
• Records of all produce leaving your farm should be maintained to assist you in traceback and in any other problems that may occur. Remember if you don’t record it, you didn’t do it (see produce tracing worksheet).

### Table 1: Strength of chlorine sanitizing wash recommended for various types of produce.

<table>
<thead>
<tr>
<th>Type of Produce</th>
<th>Recommended PPM Chlorine</th>
<th>Bleach/gallon of water¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples, pears, squash, cucumbers</td>
<td>65 ppm</td>
<td>1 tsp/gal</td>
</tr>
<tr>
<td>Leafy greens, peaches, peppers, tomatoes, asparagus, broccoli, carrots</td>
<td>130 ppm</td>
<td>2 tsp/gal</td>
</tr>
<tr>
<td>Melons, citrus, root crops</td>
<td>400 ppm²</td>
<td>2 tbsp/gal</td>
</tr>
<tr>
<td>Berries (strawberries, blueberries, blackberries, raspberries, etc.)</td>
<td>No washing</td>
<td>N/A</td>
</tr>
</tbody>
</table>

¹ Bleach/gallon of water based on using household bleach containing no fragrances or thickeners with a base concentration of 5.25% sodium hypochlorite.
² Sanitizing wash should be followed by a potable water rinse.

### Table 2: Common types of sanitizers and their characteristics.

<table>
<thead>
<tr>
<th>Sanitizer</th>
<th>Chlorine-based</th>
<th>Quaternary ammonia “Quats”</th>
<th>Iodophors “Iodine-based”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses</td>
<td>Produce wash water, equipment and facilities</td>
<td>Hands, facilities, food contact-surface, &amp; equipment</td>
<td>Facilities, food contact-surfaces &amp; equipment</td>
</tr>
<tr>
<td>Recommended Concentrations</td>
<td><em>&lt;200 ppm without rinsing&lt;br&gt;</em>&lt;2,000 ppm with potable H2O rinse</td>
<td>*&lt;200 ppm without rinsing&lt;br&gt;*200-500 ppm with potable H2O rinse</td>
<td><em>12.5-25 ppm without rinsing&lt;br&gt;</em>&gt;25 ppm with potable H2O rinse</td>
</tr>
<tr>
<td>Contact Time Required</td>
<td>1 to 5 minutes at 200 ppm</td>
<td>&gt;1 minute</td>
<td>&gt;1 minute</td>
</tr>
<tr>
<td>Advantages</td>
<td>• Inexpensive&lt;br&gt;• Available&lt;br&gt;• Wide range of effectiveness</td>
<td>• Non-corrosive&lt;br&gt;• Relatively non-irritating</td>
<td>• Effective at: low concentration wide pH range hard water&lt;br&gt;• Non-irritating&lt;br&gt;• Good penetration&lt;br&gt;• Prevents biofilm formation&lt;br&gt;• Good residual</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>• Corrosive&lt;br&gt;• Irritating fumes&lt;br&gt;• Rapid loss of effectiveness</td>
<td>• Good residual activity/stability&lt;br&gt;• Less effective than others for control of E. coli</td>
<td>• Expensive&lt;br&gt;• May stain&lt;br&gt;• Not a cleaner</td>
</tr>
</tbody>
</table>

The following worksheets, as found on www.okfarmtoschool.com/resources/fts-distro-foodsafetymanual are intended to serve as templates pertaining to documentation and record keeping occurring within a typical fresh produce food safety program.

Site Selection Review
Irrigation Spray Water Treatment Log
Worker Training Log
Fertilizer / Compost / Manure Applications Log
Wildlife Control Log
Field / Packing Shed Restroom Cleaning and Service Log
Field Harvest / Processing / Packing Cleaning Log
Truck Checklist
Processing / Packing Line / Facility Cleaning Log
Pest / Rodent Control Log
Washing / Cooling / Sanitizing Water Treatment Log
Cooler Temperature Log & Calibration of Your Thermometer Information
Produce Tracing Log
Recall / Traceback log
Illness / Injury Reporting Log
First Aid Kit Monitoring Log
Visitor Log

These worksheets were adapted from documents developed by Cornell University Department of Food Science.