CHAPTER EIGHT

Food Safety from Production to the Farmers Market

Why is Food Safety Important?

Food safety is an important issue at farmers markets. Customers expect the food and products they purchase to be grown and handled so that they will be safe to consume. Vendors have a responsibility to grow and handle food using good food safety practices.

The Centers for Disease Control and Prevention (CDC) estimates that each year roughly one in six Americans contract a foodborne illness. The illnesses have varying results (1):

- 48 million people get sick
- 128,000 are hospitalized from foodborne illness
- 3,000 die from food borne illness

Fresh produce providers should be aware of the statistics relating directly to produce. From 1998 to 2008, 25% of the deaths and 46% of the illnesses each year from foodborne disease were attributed to contaminated produce. Leafy greens alone accounted for 22% of all foodborne illnesses (2).

These statistics substantiate the importance of food safety. In order to produce and sell safe foods, growers must strive to understand and implement the best food handling practices at each stage of production, processing, and marketing.

Stages for Contamination and Prevention

This chapter provides basic food safety information to vendors and market managers selling produce and other food products at farmers markets. Each step of food production presents unique opportunities for contamination. Therefore, this chapter includes best practices for prevention of foodborne illnesses at each step of production:

- Health, hygiene, and hand washing

- Growing and on-farm production (field, greenhouse, and more)
- Harvesting and storage
- Cleaning or washing product
- Packaging, transportation, and storage
- Food safety at the market

For more information on food safety practices for growers refer to the SDSU Food Safety Practices for Growers in the resources section following this chapter.

Health, Hygiene and Hand Washing

Health

Health, hygiene, and hand washing apply to all stages of production, processing, and marketing. Food handlers can easily contaminate fresh produce with disease-causing microorganisms. Many of these organisms have the capability to survive on fresh fruits and vegetables for an extended time, from several days to weeks. Once the organism is established on fresh produce, it is very hard to remove. If a vendor or employee is sick, they should not handle food, food products, utensils, containers, and other types of food contact surfaces. The following symptoms are indicative of a foodborne illness and necessary precautions should be followed to not contaminate produce:

- Diarrhea, fever, vomiting, jaundice, or sore throat with fever
- A cut containing pus, such as a boil or infected wound that is draining and located on the hands, arms, wrists, or a body part that is not covered.
- If the employee has been diagnosed with a foodborne illness or lives with someone that has been diagnosed with a foodborne illness.

The manager will make the decision to send the employee home or restrict the jobs that the sick individual performs that day.

Open wounds can harbor disease-causing microorganisms. If the wounds cannot be covered adequately with a bandage or glove, the field worker should not be handling fruits and vegetables or food contact surfaces, such as containers. Duties that do not involve contact with or close proximity to foods and food contact surfaces are recommended (3).

Hygiene

Good personal hygiene should also be practiced. Be certain to change out of any clothing worn in animal production areas before working with produce. Farming and growing produce can cause workers to become dirty, and it is important to clean up before attending the market and selling produce.

Hand Washing

Hand washing is an important part of food safety. Vendors should wash their hands in the following situations.

Table 8.1: Hand Washing Situations

Before	After
• Harvesting, picking, packing, transporting, bagging, displaying or otherwise handling fresh produce • Putting on single-use gloves • Preparing foods on-site • Presenting a cooking demonstration • Preparing food samples • Handling ready-to-eat products	• Touching and feeding animals • Going to the bathroom • Coughing or sneezing • Eating or drinking • Handling dirty tools or equipment • Handling money

Glove Use at Farmers Markets

Many people assume that wearing disposable, single-use gloves prevents contamination. However, gloves can transfer harmful microorganisms to produce just as easily as bare hands. Correct use of gloves maintains the safety of harvested fruits and vegetables. Be sure to wash your hands and bandage cuts before putting on gloves and when changing to a fresh pair. Then, wash your hands after removing gloves. Never wash and reuse single-use gloves. Food handlers should change their gloves in the following situations:

- If the gloves become torn
- Before beginning a new task
- If a task is interrupted. For example, by answering the telephone, gathering supplies, assisting with the cash register, handling money, or emptying trash
- After two hours of continual use
- If the gloves are contaminated. For example, sneezing
- When the food being handled changes from raw to cooked or ready-to-eat
- When leaving the food preparation and serving area

There are many situations and times when a grower or produce handler should wash their hands. However, while working in the fields or at the farmers market, growers may find that there is no sink or running water available. Hand sanitizers and moist towelettes do not replace the need for hand washing. These products are not effective in removing bacteria when debris such as food particles or dirt are on hands. Hand sanitizers should not be used in place of good hand washing. To overcome the lack of hand washing facilities consider building a temporary hand washing station.

Building a Hand Washing Station

Farmers markets or individual vendors can build their own, simple hand washing station when one is not available. A hand washing station should be easily accessible for all food handlers on site. For more information on building a hand washing station for use at a farmers market, food stand or in the field refer to SDSU Extension publication Temporary Hand Washing Stations at Farmers Market, Food Stands, and in the Field in the resources section following this chapter.

Proper Hand Washing Steps:

1. Wet hands with warm water from spigot
2. Apply soap and rub for 15 seconds
3. Rinse hands using water from spigot to remove all soap
4. Dry with a paper towel

Safe Food Handling: Growing and On-Farm Production

Growers producing local foods are responsible for the products they offer for sale. Using Good Agricultural Practices (GAPs) while the crops are growing in the field includes precautions such as the proper use of manure and water sources. Additional components of a safe food-handling plan include restricting access by pets or wild animals, and cleaning equipment before use.

Water Source and Flooding Considerations

Clean water is crucial to safe food production. Once contaminated water is applied to a field, *E. coli* and other harmful bacteria can persist for over six months in the soil and on

plants. Whatever the water source, remember to add a back flow preventer to irrigation hookups.

Surface Water Considerations

Surface water can become contaminated by farm animals, wildlife, run-off during storms, flooding, leaking, or overflowing septic systems and manure piles. Therefore, surface water should only be used as a last resort, and it should be tested at planting, peak use, and prior to harvest. Minimize the contact of surface water with the edible portion of plants by using a drip, furrow, or low volume spray technique. A drip irrigation system is mostly preferred with a subsurface application. Overhead spray methods are at most risk for causing contamination.

Municipal Water Considerations

Municipal water is considered the safest water source since it is potable (safe to drink) and adheres to strict chemical and microbiological standards. The South Dakota Drinking Water Program, part of the Department of Environmental and Natural Resources (DENR), develops and enforces the South Dakota Drinking Water regulations that apply to public water systems in the state. Additionally, chlorine and fluoride from municipal sources are at concentrations low enough not to interfere with plant growth.

Drinking water contaminants, compliance reports, and violation history of public water sources across South Dakota can be viewed at the DENR's drinking water webpage. Additionally, a DENR Proof of Safety may be furnished through a water bill or by request. To contact the DENR Drinking Water program visit their website at https://denr.sd.gov/des/dw/dwhome.aspx or call (605) 773-3754.

Well Water Considerations

If well water is being used, have it tested at the beginning of the season before the first irrigation application, and every three months thereafter. The test of choice is for *E. coli* specifically, rather than for generic coliform bacteria counts. Wells can become contaminated by flooding or heavy rains, or if located close to a cesspool, septic system, livestock agricultural site, manure storage area or drainage field. Properly maintaining a well includes conducting wellhead inspections to check the condition of the well covering, casing and cap to be sure it is in good condition. There should not be any cracks or entry points for potential contaminants. In addition to regularly scheduled testing, wells need to be tested if at greater risk of contamination, for example, after a flood or unusually heavy rains. Note any changes that occur in the water quality such as cloudiness or grit. These may indicate surface water is contaminating the well. If you notice these changes, have the water tested again.

Flooding Considerations

Flooding of production fields is particularly hazardous. Flood water may deposit contaminants such as chemicals and pathogenic microorganisms onto both the soil and plants. Because of the wide variety of possible contaminants and their erratic occurrence, testing is generally not a viable option. One needs to assume that contamination may have occurred and manage the affected area accordingly. It should be noted that pooled water, which is the simple accumulation of water within a field following a rainfall, is not considered flooding. The FDA has developed specific guidelines for fields affected by flooding. Additionally, Ohio State University provided a fact sheet based on this FDA

guidance. Visit SDSU Extension and search "Food Safety from Production to the Farmers Market" to access these resources.

Safe Food Handling: Harvesting and Storage

Harvest Records

Keep harvest records by recording the following information: what type and quantity of produce was harvested; field location; who harvested which produce; and the date of harvest. These records can be valuable for recording the productivity of the fields throughout the season as well as tracking of produce that may be implicated in a foodborne illness. A tracking system for marking containers of harvested produce with a code that contains this information can also prove helpful if a problem develops. For more information, visit the Cornell website at, http://www.gaps.cornell.edu and search for "traceability".

Best Practices for Use of Produce Containers

When harvesting, growers should pay special attention to preventing contamination, avoiding contact with soil, and selecting proper container types. Cleaning and sanitizing equipment is also an important part of harvesting and storing produce. For more information on produce containers refer to the SDSU Extension publication Best Practices for Use of Produce Containers in the resources section following this chapter.

Managing Produce Quality

Produce with damaged surfaces (cracks, cuts, rots, bruises, etc.) should be culled, because these injured areas can serve as entry points for harmful microorganisms. These microorganisms can then be transferred from the damaged produce to high quality produce. To reduce cross-contamination it is best to pick the blemished produce in a separate harvest operation. These culled produce items should not be piled within the field, because this can attract insects and animals that carry harmful microorganisms, a situation that has been implicated in the incidence of deadly disease outbreaks. Instead, dispose of culled produce in a location that is not near the growing, processing, or storage areas.

Local and national surveys indicate that produce quality is the number one reason customers come to a farmers market. This is yet another reason why defective produce should be culled and disposed of, not sold. Undamaged lower quality produce, such as misshapen items, should at the very least be separated and sold separately. However, marketing lower quality produce can have a negative influence on the customers' perception of your produce. They may decide that all the produce at your market is inferior. Rather than market your lower quality produce a better option may be using the produce in a processed product or donating it to the local food bank.

Cleaning or Washing Produce

Cleaning

After harvest, excess field dirt and plant debris can often be removed from many types of produce by gentle scrubbing with a dry brush. Be sure to clean the brushes frequently and use a tarp or container to catch the dirt so it does not contaminate the processing area. It is recommended to use this method of dry brushing when possible, rather than washing, before packing or marketing fresh fruits and vegetables. However, very muddy

produce or produce that cannot withstand brushing may require washing with water.

Understanding Contamination From Water

Washing with water must be done carefully, as it has the potential to lower the quality of the produce and cause contamination. Although washing with water is typically a good food safety practice by the consumer just prior to consumption, when preparing produce for sale it can increase the risk of contamination. Water can infiltrate to the inside of the fruit or vegetable through the following process: When produce is placed in a container of water that is at a different temperature than the produce, this situation is called a temperature differential. If the water is colder than the produce, it causes the air in the cells of the fruit to contract. This contraction draws water into the fruit or vegetable through pores, channels, or bruises. The water drawn into the produce may be contaminated, thus causing the produce to become internally contaminated.

In some instances, washing produce may be required. Growers often look to various methods of washing fresh produces before selling it to customers. There are several questions to consider:

- What is the possibility that the produce was contaminated?
- Should this specific produce be washed and how should it be washed?
- What is the water source - is it a public treated and tested source or a private well that requires sampling sent to a state health lab for testing?
- What temperature should the water be?
- Should I use a sanitizing solution?

The following procedures provide tips and best management practices for washing specific produce items without causing contamination or lowering the quality or appearance of the produce (6).

Tomatoes

If tomatoes appear clean, they usually do not need to be washed. However, if you choose to wash the tomatoes, the overall quality of the water is critical for both safety and quality of the tomatoes. The grower must be in control of the water source and its applications or usage throughout the entire process. Water temperature should be at a minimum of 10° F above the temperature of the fresh or pulp of the tomatoes. Water that is too cold will infiltrate the skin of the tomatoes as described in the preceding section. Water temperatures of 131 to 136°F have been shown to reduce the rate of contamination of tomatoes by major post-harvest disease pathogens (7).

Melons & Cantaloupe

Melons have several qualities that make them more susceptible to contamination than other fruits and vegetables including:

- Warm weather growing conditions are favorable for the growth of human pathogens such as E. coli, Salmonella, and Listeria.
- Direct contact with the soil and heavy rains may increase the risk for contamination.
- Netted rinds provide a good area for human pathogens to survive, and the removal of pathogens is more difficult than with smooth surfaced produce.
- When harvested, scarring occurs around the stem. This can serve as a route for infiltration of pathogens.

- Watermelons and less mature cantaloupe are sensitive to injury when chilled, therefore increasing the likelihood of storing at ambient temperatures that encourage the growth of microorganisms.
- Melons are heavy and difficult to handle which contributes to more damage.

All of these reasons contribute to the fact that melons have repeatedly been associated with foodborne illnesses (8).

In order to prevent contamination, follow these procedures:

1. Follow all recommended food safety field practices. Drip irrigation is recommended. Watch for field incursions by wild or domestic animals, and do not harvest any melons within five feet of any animal droppings. Flagging contaminated areas is recommended to help harvesters avoid them. Train all field staff in food safety hazards and procedures, including handwashing.
2. Clean all containers, shipping, and storage surfaces. Do not transport in an unwashed truck bed. Clean padding can be used to reduce bruising and abrasions.
3. If necessary, clean with soft dry brushes. Provide customers with safe handling and preparations instructions for cantaloupe.

Leafy Greens

To maintain quality, leafy greens must be sprayed with a light mist when harvested to reduce the loss of water. This must be an approved and potable water source and the method used for spraying must not introduce additional contaminants. When possible, harvest early in the morning as the produce will be cooler and better hydrated.

When greens and other crops are harvested, they need to be cooled quickly to maintain quality and safety. Consider the following precautions to minimize the contamination of leafy greens and other produce:

- If submerging the produce, or using a recirculating water system for spraying, the water should be no more than 10° F colder than the produce, this can allow for infiltration of water into the plant. This is of special concern if using the following unsafe practices: washing with water that may be contaminated with pathogens. Even potable water may become contaminated from the produce if the produce is submerged in the water rather than simply sprayed.
- Avoid cross-contamination from other types of produce by dedicating containers to be used only for leafy greens. Washing in a container that is used to wash and cool other produce.

You should use several washings after harvesting leafy greens and other crops. Start with water that is slightly cooler (less than 10° F) than the produce and progressively use colder water in subsequent washings. This will help cool the leafy greens and safely maintain quality. Studies at the University of Vermont have found that using three consecutive rinsing (with fresh water each time) or a single rinse with sanitizer drastically reduced the amount of E. coli remaining on lettuce leaves.

Another option is to use a pass-thru system, where the greens are spread on clean mesh trays that allow quick drainage and are sprayed with fresh clean water rather than submerging the produce in a water bath. It may be necessary to stir or turn the greens several times so that all surfaces are cleaned.

Immediately after cooling with water, place leafy greens in a refrigerator to maintain a temperature of 32 to 36° F. The refrigeration unit must be kept clean. Do not store leafy

greens in a closed container with other fruits or vegetables that produce ethylene gas, such as apples, tomatoes, bananas, mangos, onions, and pears. Ethylene gas can cause browning and an off taste in lettuce and other greens.

High humidity (90 to 95%) needs to be maintained to minimize wilting. Avoid direct contact with standing water, which can serve as a source of cross-contamination. Clean, moist (not soggy) paper towels can provide sufficient moisture if coolers are not equipped with humidifiers.

At the market, use tongs or disposable gloves when bagging leafy greens for customers. Avoid setups that allow a customer's hand to touch raw produce.

Scallions or Green Onions

Bunching is usually done in the field with the outer leaves stripped off and the roots clipped. Always used cleaned and sanitized knives and other equipment. Filled boxes should be moved to the processing shed within two or three hours of being harvested. The scallions are run through a washing and cooling process that uses 33 to 35° F chlorinated water bath or spray. The wash water should contain 75 to 100 ppm free chlorine (1 ½ teaspoon 5.35% Chlorine Bleach to 1 gallon of water) to reduce postharvest decay (9). For more information, visit the University of Nebraska website at, http://digitalcommons.unl.edu/ and search for "Growing Scallions (Green Onions) for Market Gardeners".

Packaging, Transportation & Storage

All packaging materials should be made of food contact grade materials. Products that are not food grade may contain toxic compounds that could leach out of the packaging materials and into the produce. Empty packages such as boxes and plastic bags should be stored in an enclosed area to protect from insects, rodents, dust, dirt, and other potential sources of contamination. This will protect against losing valuable materials and preserve the integrity and safety of the packaging materials.

Use of safe handling practices when transporting from farm to market. SDSU photo by Terry Molengraaf.

Whenever transporting produce from the field or to the market, ensure that the vehicle is clean and sanitary. If you use a general-purpose farm pickup for transporting fresh produce, thoroughly wash, rinse, and sanitize the bed each trip. This is especially important if live animals or objects of dubious sanitation have been transported previously. During transportation, packaging, and at the market provide shade for the produce with a clean plastic tarp or other cover to reduce heat buildup and sun scalding.

A variety of facility designs are available for cold storage, ranging from commercial walk-in coolers to farm-adapted designs, or even refrigerated truck trailers. Remember that most coolers are designed to keep cool produce cool, not take off the "field heat" from the produce. Forced-air designs help remove "field heat", but there must be good air circulation to avoid hot spots that can lead to product deterioration. When possible, harvest early in the day when the produce is still relatively cool.

Remember that crops differ in their tolerance to cold temperatures; for example, cucumbers and peppers can be damaged by temperatures under 45° to 50° F. For more information on produce containers and produce storage see the resources section following this chapter.

Food Safety at the Market

Displaying Food and Produce Safely

Displaying food and produce safely requires attention to reducing the risk of contamination. Place produce on clean, sanitized tables or stands rather than the ground. If necessary, some large or heavy items, such as pumpkins, can be placed on a clean plastic tarp or in a clean food storage container on the ground. Produce that will be eaten uncooked should not be placed at ground level. Displaying food in plastic tubs is a good way to maintain food safety and is also good for your business.

Safety displaying food to reduce risk of contamination. SDSU Photo by Terry Molengraaf.

Food Safety for Produce

Always watch over your stall; prevent contact with produce and other foods by customers, including small children and pets. Keep produce in the shade if possible. If the area does not have shade, consider setting up a tent or canopy to prevent the produce from heating up and dropping in quality.

Food Safety for Baked Goods

Before arriving at the market, individually wrap baked goods such as bread or cookies. If the items will be sold in a group, consider placing them on a paper plate and wrapping the plate with cellophane. This will help protect the baked goods and prevent contamination. For more information on the regulatory aspects of offering food samples in South Dakota see Chapter 9.

Food Safety for Fresh and Frozen Meats

Most meat is sold as frozen food products at farmers markets. They should be maintained as a solid frozen product at a temperature of 20°F or colder. If you are selling frozen meat products, encourage your customers to bring a cooler and ice to the market. Suggest that they make your booth their last stop of the day, reminding them to move their meat products to a freezer as soon as possible. In the late summer, meat will stay frozen 1½ to 2 hours in a cooler if it is completely frozen and wrapped. Offer to hold the customers' purchases in your cold storage until they are ready to leave the farmers market. If meat products are being sold fresh, they should be held at a refrigerated temperature of under 40 °F.

It can be difficult to display both fresh and frozen meat products because customers often want to see the product. It is challenging to display meat products while keeping them at the proper fresh or frozen temperature. To overcome this challenge, consider investing in high-quality product photos and displays. This will help keep the products safe. Always place the meat in a clean plastic bag with handles, so that it does not contaminate other produce that the customer may have purchased. For more information on the regulatory aspects of selling fresh and frozen meat in South Dakota see Chapter 9.

Food Safety when Offering Food Samples

Giving out samples can be an effective tool for introducing customers to new produce or food items and can help increase sales. However, from a food safety standpoint, there are issues to consider. For more information on the regulatory aspects of offering food samples in South Dakota see Chapter 9.

Food Safety when Preparing or Serving Meals that Require Temperature Controls

Cleanliness, cooking, cooling and not contaminating are critical items to consider when preparing and serving foods that need to be temperature controlled. Vendors preparing or serving foods that require temperature controls must adhere to the South Dakota Food Code regulations which are explained in Chapter 9. SDSU Extension provides information and self-studies on quantity cooking and serving safe food. For more information visit the Healthy Families Food Safety section on extension.sdstate.edu and search for "FoodSafe".

Food Safety when Donating Produce

Vendors may have unsold produce at the end of a selling day. Handling this produce can be a challenge, because the fresh, high-quality products may not hold over until the next market day. Consider coordination with a local food bank so vendors can donate unsold produce while it is still in good condition. Be sure all who handle the produce follow recommended food safety practices, including washing their hands and using suitable containers that are clean and intended for food.

Vendors as Food Safety Educators

While working at the farmers market, growers can serve as food safety educators. The SDSU Extension website provides up-to- date research-based information and resources for preparing safe and healthy foods to share with customers. For example, the Pick It! Try It! Like It! materials developed by SDSU Extension provide fact sheets, recipe cards and videos for over 40 fruits and vegetables commonly grown in South Dakota. Contact an Extension Food Safety specialist to access these materials. Growers can provide tips and education to customers who purchase their products. After all, food safety does not end with the grower. After the sale is made, the consumer now has the responsibility to prepare and maintain a safe product.

Through implementation of recommended safe food handling guidelines and following their food safety plan, farmers market growers and markets should feel secure that they are using "best practices" for a safe food supply.

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Best Practices for Use of Produce Containers

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Equipment and containers used by growers to harvest and market produce need to be kept clean. This requires diligence in care and maintenance to prevent foodborne illness and keep high quality products.

Photo taken by Rhoda Burrows, SDSU Extension Horticulture State Specialist

Prevent Contamination

Equipment and containers used for harvesting, transporting, and displaying produce can pose a risk for contamination of food if not properly cleaned, sanitized, and maintained. The following conditions can expose equipment and containers to food contamination:

- not cleaning and sanitizing before and after use
- allowing animals and birds in the area where equipment and containers are stored
- using a pickup bed or cart used to haul nonfood items or animals
- allowing contact with waste water, or water that is not tested for safety
- workers handling containers or equipment in a manner that would increase the risk of contamination
- storing in an area that is unprotected

Avoid Contact with Soil

While harvesting, produce should be placed in clean and sanitary field containers, rather than on the ground. Field containers should be cleaned and sanitized on a regular basis, as well as be free of contaminants such as mud, industrial lubricants, metal fasteners or splinters. To reduce pathogens spread by shoes, do not allow workers to stand in field bins during harvest.

Types of Containers

Plastic field bins and totes are preferred to wooden containers since plastic surfaces are easier to clean and sanitize. Wooden containers or field totes are almost impossible to sanitize since they have a porous surface. Wood or metal fasteners such as nails may accidentally be introduced into produce. Before reusing cardboard field bins, they should be visually inspected for cleanliness, and lined with a clean plastic bag that is intended for food to prevent the risk of cross contamination. Trash bags often contain chemicals that can leach into food; therefore, do not use as a food container during harvesting, transporting, or marketing.

Cleaning and Sanitizing Equipment

All food contact surfaces (sorting bins, tables, tools, utensils, display baskets) should be cleaned and sanitized before and after use. Pressure wash, rinse, and sanitize all crop containers, tools and packing house surfaces prior to each day's harvest. Sanitizers should be used on surfaces only after thorough cleaning with abrasion to remove organic materials such as dirt or plant materials. The two sanitizers most commonly used contain chlorine (bleach) or quaternary ammonium (quats) compounds. Refer to Table 1: Sanitizer Characteristics to compare bleach and quats sanitizers. Cleaning agents and sanitizers are in the physical states of compressed gas, powders, or concentrated liquids; therefore extreme care is required when handling.

Table 1: Sanitizer Characteristics:

Characteristics	Bleach	Quats
Common uses	All food contact surfaces	Food and Non-food contact surfaces, porous materials, drains and walls
Concentration	25-200 ppm	as per manufacturer's directions
Effectiveness in killing germs	Highly effective	Variable – depending on microorganism; more effective than chlorine on yeasts, molds and Listeria; less effective on Salmonella and E.coli
Speed	Fastest	Moderate
Stability over time	Good	Excellent
Temperature	55-120° F	55-120° F
Effectiveness in hard water	Effective in hard water	Less effective in hard water
Corrosion	Causes light to moderate corrosion on metals	None

To Effectively Clean and Sanitize Containers and Equipment, use the following protocol:

1. Remove all visible debris (organic matter such as dirt, plant materials, and insects) and other possible contaminants using a pressure spray and an all-purpose soap or detergent if needed.

2. Rinse thoroughly – soap and organic matter bind with the sanitizing solution, decreasing its effectiveness in killing germs.

3. Apply a sanitizer with a clean cloth or spray using the dilutions on Table 2 or the label directions from another type of sanitizer.

4. Test the sanitizer solution using test strips. Test strips are available at many restaurant supply companies, hardware or pool and spa stores.

Use of steam to clean equipment should be avoided since steam may actually cake organic materials and form a biofilm, which renders equipment almost impossible to sanitize. Steam may also aerosolize bacteria and actually spread contamination throughout the packing house facility. A biofilm is a matrix that is formed by microorganisms allowing them to attach and survive for an extended time on a surface. Once formed, biofilms are very difficult to remove.

Table 2: Chlorine Sanitizing Dilutions

Concentration (ppm*)	Chlorine (5.25%)	Water (gallons)	Use	Note
100 ppm	1.5teaspoons	1	Table tops, dishes, utensils	To effectively sanitize, water must maintain a temperature between 55° F and 125° F
200 ppm	1tablespoon	1	Table tops, dishes, utensils	
400 ppm	2 tablespoons	1	Produce storage containers	

Packaging Materials

All packaging materials should be made of food contact grade materials to assure that toxic compounds in the packaging materials do not leach out of the package and into the produce. Empty boxes and plastic bags should be stored in an enclosed storage area to protect from insects, rodents, dust, dirt, and other potential sources of contamination.

Reference:

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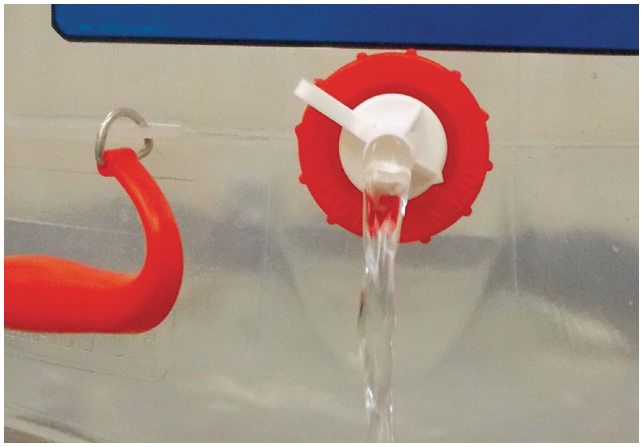
Temporary Hand Washing Stations at Farmers Market, Food Stands, in the Field

Joan Hegerfeld-Baker, Ph.D., former SDSU Extension Food Safety Specialist

The ability to wash hands by food handlers at a temporary food stand, farmers market and out in the field harvesting produce is critical for prevention of foodborne illness. The challenge of proper hand washing for food handlers at these locations can be met by the use of a temporary hand washing station.

A temporary hand washing station consists of the following:

- A beverage container with a tap or spigot for the storage of warm water. The spigot must be capable of turning on with hands-free operation. Push button spigots requiring constant finger presser are not approved. The container size is dependent upon the situation.
- The container or bucket placed directly under the tap or spigot to catch wastewater.
- Hand soap in a pump dispenser
- Paper towels
- Garbage receptacle
- A sign* posted reminding workers when to wash their hands as well as the hand washing steps.
- Water (potable) must be obtained from an approved source. Examples of approved sources: public water systems that have met the drinking water standards in South Dakota or private wells that have been tested for safety by the South Dakota Department of Health or other approved lab.



Hands-free spigot

Spigot – Not Hands-free operation – **unacceptable**

Example of a Temporary Hand Washing Station

The hand washing station should be easily accessible for all food handlers.

Water Container Cleaning and Sanitizing Procedure

Household bleach is an acceptable sanitizer when used in concentration of one tablespoon chlorine bleach for two gallons water. Use the following steps to clean and sanitize the water container:

1. Wash with warm water and soap
2. Rinse with clear water
3. Sanitize by rinsing container with chlorine bleach solution (1 Tablespoon/2 gallons water) for 10 seconds. If using a different sanitizer, it must be approved for food contact surfaces and follow label directions.
4. Air-dry or fill with warm water for immediate use.

Hand washing signage should include the following:

Proper hand washing steps:

1. Wet hands with warm water from spigot
2. Apply soap and rub for 15 seconds
3. Rinse hands using water from spigot to remove all soap
4. Dry with paper towel

When to wash hands:

Before	After
Harvesting, picking, packing, transporting, bagging, displaying or otherwise handling fresh produce	Touching animals
Putting on single use gloves	Going to the bathroom
Preparing foods on-site	Coughing or sneezing
Presenting a cooking demonstration	Eating or drinking
Preparing samples	Handling dirty tools or equipment
Handling ready-to-eat products	Handling money

*Hand washing posters can be printed from following websites:

- South Dakota Department of Health Food and Lodging Website: http://doh.sd.gov/food/ Click on Fact Sheets for Food Service Establishments
- Centers for Disease control has several hand washing fact sheets to choose from, based on the situation: http://www.cdc.gov/handwashing/

Cleaning Produce

- Do not wash produce unless necessary – washing increases possibility of cross-contamination
- All water used for washing should be potable (drinkable)
- When possible, use a pass-through rinse to avoid cross-contamination
- If produce is washed in a tank, use appropriate levels of sanitizer* and change water frequently
- Avoid tank water temperatures that are more than 10°F cooler than the produce temperature

* See references for more information on materials and rates for specific crops

More Information:

Available at extension.sdstate.edu

- Best Practices for Use of Produce Containers
- Storage of Fresh Vegetables
- Vegetables and Herbs (includes post-harvest and food safety links)

Other Sources:

- Food Safety Modernization Act http://www.fda.gov/Food/GuidanceRegulation/FSMA/default.htm
- Good Agricultural Practices http://www.extension.umn.edu/rsdp/community-and-local-food/good-agricultural-practices/

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Food Safety Practices for Growers

SOUTH DAKOTA STATE UNIVERSITY EXTENSION

Fresh produce is vulnerable to contamination by harmful microbes, as shown by outbreaks of Salmonella or Listeria or other pathogens on tomatoes, leafy greens, melons, etc. You can reduce the risk of your produce carrying harmful microbes by using safe production "Good Agricultural Practices" and post-harvest practices that are outlined in this brochure.

Each producer should evaluate their operation for possible entry points of contamination – from planting thru selling it at the market. Keep in mind that pathogens can survive for several months in contaminated soil, plants, or water.

Consider each of the following factors:

Water source

- Surface water, such as ponds, lakes or creeks, has a high risk of contamination via wildlife or upstream livestock use. Avoid use of surface water for overhead irrigation, or for drip irrigation of low-growing crops such as salad greens. It is relatively safe for subsurface drip irrigation, as long as there is no ponding or flooding.
- Well water should be tested at least at the beginning of each growing season, more often if well integrity or recharge area is in doubt.
- City or rural water systems supply potable (drinkable) water that is routinely tested to ensure its safety.

Only potable water should be used for post-harvest washing, cooling, icing, or other processing.

Manure

Fecal matter is by far the most common source of harmful microbes.

- Aging manure for at least 180 days at temperatures above freezing before application will help limit pathogens present in the manure, and decrease salt levels in the manure. New food safety rules stipulate that any raw manure should be applied not less than 9 months before harvest date. Keep records of all manure application rates, source, and dates.
- Avoid producing fresh vegetables in areas that have a history of heavy wildlife use, unless fencing can exclude access.
- Avoid using fields next to or downhill from livestock grazing/feeding areas.
- When possible, exclude domestic pets as well as wild animals especially from sensitive crops such as salad greens or green onions, as well as from packing, processing or storage areas.
- Watch for animal droppings in the field. Mark any that are found and do not harvest produce from their immediate vicinity.
- Do not place manure piles near production fields or processing areas.
- Keep produce off the ground at the market.

Keep in mind that insects, birds, and other animals can carry contaminants from a waste pile or livestock area to clean fresh produce.

- Any vehicle used to transport animals should be thoroughly disinfected before hauling produce and/or a barrier such as a clean tarp placed to isolate the surface from produce containers.

People: Farmers are Food Handlers!

Follow food handler guidelines when harvesting or working with produce.

- Field workers should always wash their hands before entering the field.
- Don't wear clothes or shoes soiled from working with animals into produce fields or handling areas.
- Don't allow anyone to work in the field or processing area if they are sick.
- When handling produce, wash hands frequently and make sure your workers do too!
- At the market, change gloves between handling money and handling produce.

Equipment

Dirty equipment has been the source of foodborne illness. Make sure yours isn't:

- Use containers that are either single use or can be cleaned and then sanitized between each use.
- Never place bruised or damaged produce in the same container as good produce; cross-contamination is likely.
- Clean and sanitize all packing and loading surfaces before and after use, and every four hours with continued use.
- Don't overfill harvest bins (bruising can result and be an entry point for disease)
- Never re-use grocery bags for produce sales.
- Don't store cleaned bins in an area where birds or other animals can contaminate them.
- Don't allow water to stand in processing or storage areas.

South Dakota State University Extension

Storage of Fresh Vegetables

Rhoda Burrows, Professor & SDSU Extension Horticulture Specialist

The storage life of various types of vegetables can be extended by several days or even months, depending on the type, by keeping them at recommended temperature and humidity levels.

Storage places can be cellars, garages, outdoor banks, pits, or mounds. If cellars can be kept cold enough, they are usually better for prolonged storage. Areas in some basements will also remain cool enough (40 to 50°F) during the winter for storing many vegetables.

Temperature, humidity, and ventilation are important factors in vegetable storage. Different kinds of vegetables require different storage conditions; some need very cool temperatures, while others, such as tomatoes or squash, will be damaged by prolonged exposure to temperatures under 50°F. Table 1 gives storage requirements for some commonly stored vegetables.

Handle carefully to avoid bruising. Be sure all vegetables to be stored are free of disease, and periodically check stored produce to remove any rotted ones before the rot can spread to nearby produce

Most vegetables, except potatoes, cabbage, and cauliflower, will store longer and remain in better condition if placed in perforated polyethylene bags.

- Cabbage will store better if the entire plant is harvested and the roots placed in moist sand.
- Carrots, broccoli and cauliflower, cucumbers, lettuce, and acorn squash are sensitive to ethylene, which may be given off from apples and other fruit, so store them separately from fruit to avoid off-tastes and color.
- Green tomatoes that have reached full size and begun to lighten from dark to light green (known as “breaker” stage) are mature enough that they will continue ripening after harvest. Place them stem-down, with no more than two layers deep, on a padded surface. Storage at 55°F will adversely affect the taste of any tomato that is not fully ripe; no tomato, ripe or unripe, should be exposed to temperatures under 50F.
- Store potatoes in complete darkness to avoid tuber greening.

For help in selecting a preservation method, visit the SDSU Extension Food Safety and Preservation webpage or call AnswerLine at 1-888-393-6336 (in South Dakota). Additional harvest and storage information can be found in the USDA Handbook 66: Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks, http://www.ba.ars.usda.gov/hb66/contents.html.

Table 1. Storage Requirements for Fresh Vegetables

Crop	Cool & Humid	Cool & Dry	Humid	Warm & Humid	Warm & Dry	Storage Life
Temp.:	32-40°F	32-40°F	45°F	50-60°F	55-60°F	
Humidity:	95-98%	65%	95%	90%	65%	
Asparagus	X	-	-	-	-	2-3 wks.
Basil	-	-	-	X	-	1 wk.
Beans (dry)	-	X	-	-	-	1+ yrs.
Beans (green)	-	-	X	-	-	8-12 days
Beans (lima)	shelled-37-40°	-	un-shelled	-	-	1 wk.
Beets	X	-	-	-	-	4-10 mo.*
Broccoli	X	-	-	-	-	2-3 wks.
Cabbage	X	-	-	-	-	1-6 mo.
Carrots	X	-	-	-	-	5-6 mos.
Cauliflower	X	-	-	-	-	2-3 wks.
Cucumbers	-	-	-	X	-	1-2 wks.
Eggplants	-	-	-	X	-	1-2 wks.
Honeydew melons	-	-	X	-	-	3 wks.
Lettuce & other greens	X	-	-	-	-	1-2 wks.
Muskmelon (Cantaloupe)	X	-	-	-	-	10-14 days
Onions (bulb)	-	X	-	-	-	6-9 mos.
Onions (green)	X	-	-	-	-	7-10 days
Parsnips	X	-	-	-	-	4-6 mos.
Peas	X	-	-	-	-	1-2 wks.
Peppers	-	-	X	-	-	2-3 wks.
Potatoes	-	-	X	-	-	2-9 mos.**
Pumpkins	-	-	-	-	X	2-3 mos.
Radishes	X	-	-	-	-	3-4 wks.
Rutabagas	X	-	-	-	-	4-6 mos.
Squash (summer)	-	-	X	-	-	1-2 wks.
Squash (winter)	-	-	-	-	X	2-3 mos.
Sweet Corn	X	-	-	-	-	4-7 days
Sweet potatoes	-	-	-	X	-	6-9 mos.***
Tomatoes	-	-	-	X	-	2-14 days
Turnips	X	-	-	-	-	4-5 mos.
Watermelon	-	-	-	X	-	2-3 wks.

* 10-14 days if green tops are left on
** longer storage times require curing at 60-68 degrees for 1-2 wks., with gradual lowering of temperature thereafter
***Need to be cured at 82-86 degrees for 4-7 days, prior to storage