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# **Post Harvest Handling: Processing, Storage, & Distribution**

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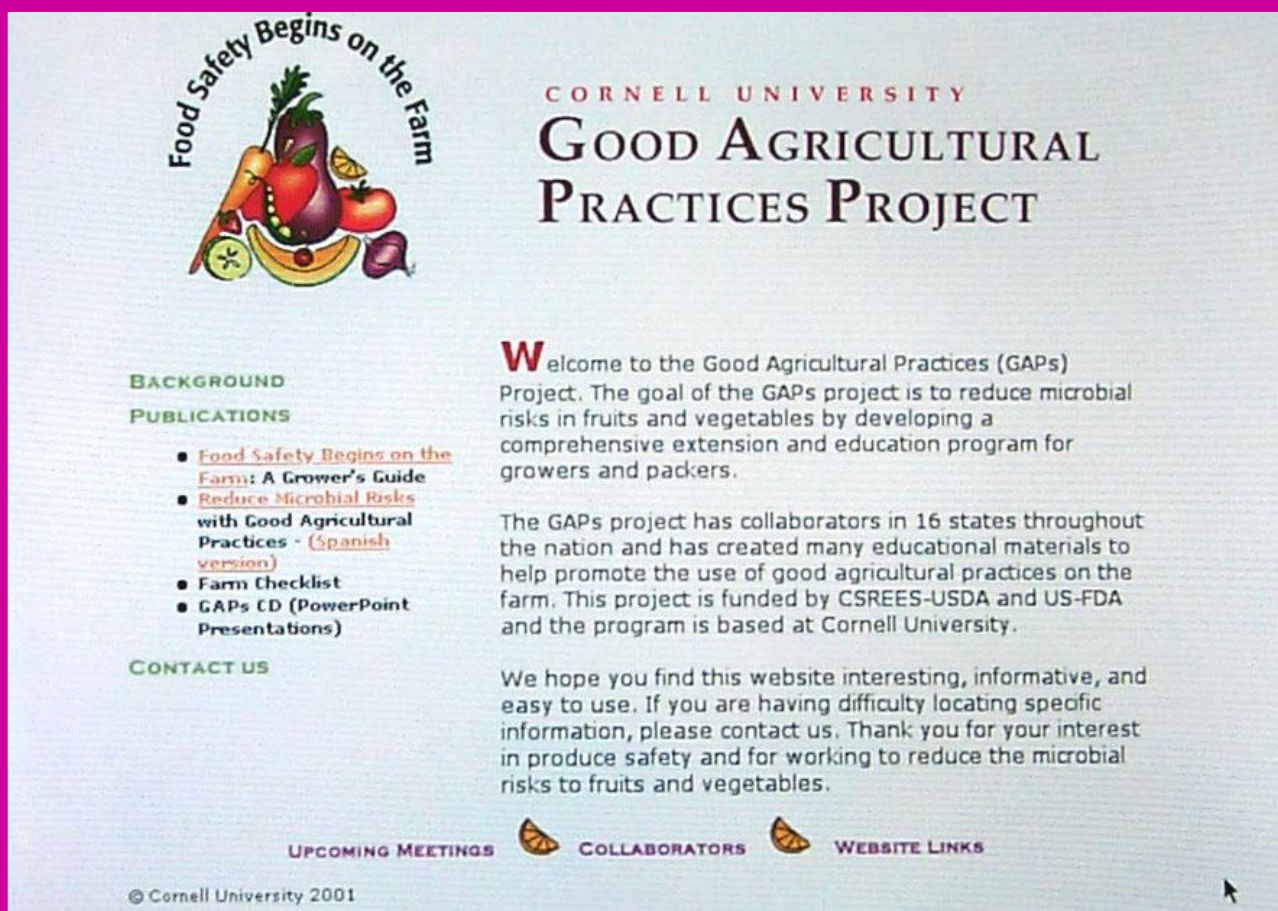


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# Sources of Information



**Food Safety Begins on the Farm**

CORNELL UNIVERSITY  
**GOOD AGRICULTURAL PRACTICES PROJECT**

**BACKGROUND PUBLICATIONS**



- [Food Safety Begins on the Farm: A Grower's Guide](#)
- [Reduce Microbial Risks with Good Agricultural Practices - \(Spanish version\)](#)
- [Farm Checklist](#)
- [GAPs CD \(PowerPoint Presentations\)](#)

**CONTACT US**

**W**elcome to the Good Agricultural Practices (GAPs) Project. The goal of the GAPs project is to reduce microbial risks in fruits and vegetables by developing a comprehensive extension and education program for growers and packers.

The GAPs project has collaborators in 16 states throughout the nation and has created many educational materials to help promote the use of good agricultural practices on the farm. This project is funded by CSREES-USDA and US-FDA and the program is based at Cornell University.

We hope you find this website interesting, informative, and easy to use. If you are having difficulty locating specific information, please contact us. Thank you for your interest in produce safety and for working to reduce the microbial risks to fruits and vegetables.

**UPCOMING MEETINGS**  **COLLABORATORS**  **WEBSITE LINKS**

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<http://www.gaps.cornell.edu>



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# Sources of Information



## POSTHARVEST TECHNOLOGY

Research and Information Center



### Goals:

- Improving the quality and value of horticultural crops available to the consumer
- Reducing postharvest losses and improving marketing efficiency
- Solving particular problems in handling fruits, vegetables, and ornamentals to maintain their quality and safety

### Postharvest Technology Research and Information Center

- [About the Center](#)
- [Endowment Fund](#)
- [Short Courses and Workshops](#)
- [Announcements and Meetings](#) NEW [SEARCH!](#) NEW
- [Center Publications](#) - list and order form

### Online UC Postharvest Information

- [Produce Facts](#)
- [Physiological Disorder Fact Sheets](#)
- [Properties and Recommended Conditions for Storage of Fresh Fruits and Vegetables](#)
- [Additional Information](#)

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<http://postharvest.ucdavis.edu>



# On Farm Food Safety: Areas of Concern

- ✓ **Production: (GAPs)**
  - ✓ Water quality & safety
  - ✓ Manure handling & application
  - ✓ Wildlife & Pets
- ✓ **Harvest:**
  - ✓ Worker sanitation
- **Post-harvest Handling:**
  - Cleaning
  - Packing & Processing
  - Storage
  - Transportation
  - Distribution



# Post Harvest Handling

- **Post-harvest management practices that reduce product loss to spoilage or shrinkage will reduce microbial risks.**
- **These include:**
  - Cleaning the product
  - Sorting
  - Packaging
  - Quick cooling
  - Good refrigerated storage
  - Good transportation & distribution





# Post Harvest Handling

- **Also includes Good Manufacturing Practices (GMPs):**
  - **Packing facility sanitation**
    - Building
    - Equipment
    - Storage
  - **Water quality**
  - **Worker hygiene**



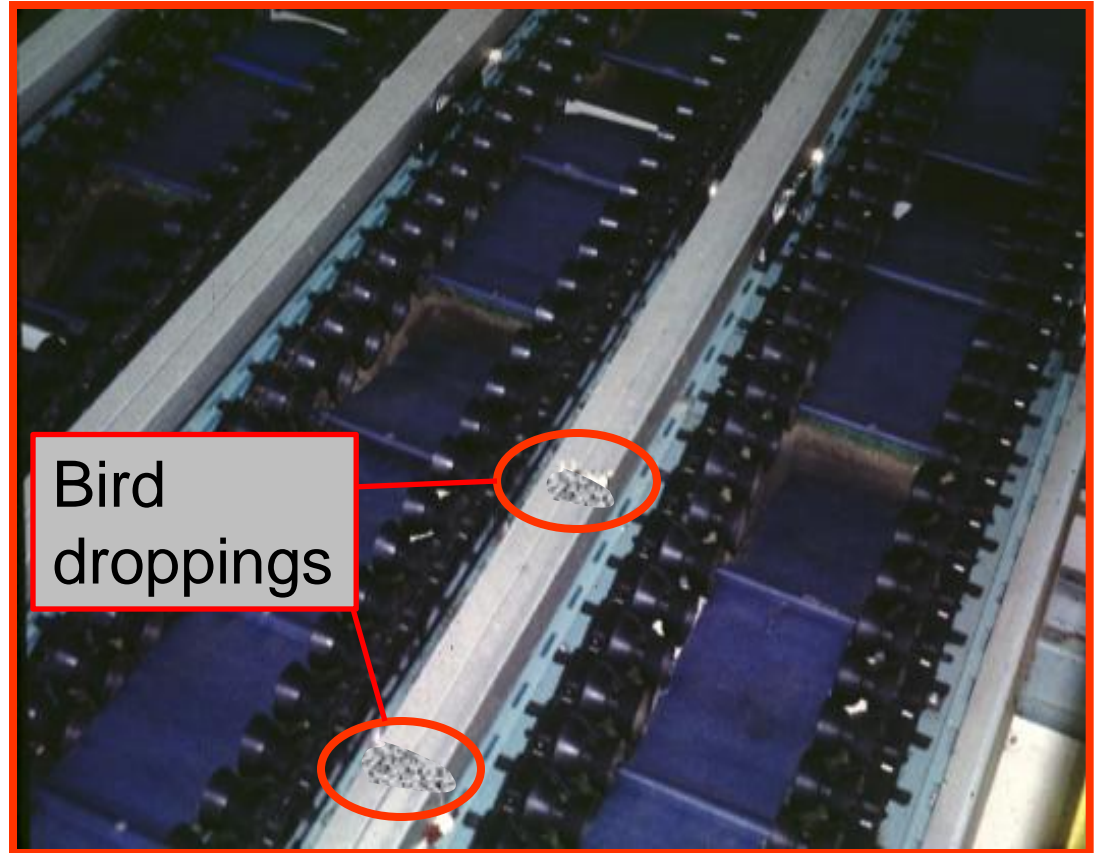
# Packing House Sanitation

- Proper sorting and culling of product.
- Maintaining detectable free chlorine in wash waters.
- Enforcing good worker hygiene.
- Cleaning and sanitizing equipment.



# Packing House Sanitation

- Excluding all animals from Packing House, especially insects, birds and rodents.





# Packing Facility



- Should be arranged so that product moves to a cleaner area during each step of processing.
- Good sanitation & housekeeping should be practiced in the area – **SOPs** (**S**tandard **O**perating **P**rocedures).
- Cleaning supplies should be stored in a separate area.
- Rest rooms should not open directly into processing and packaging areas.

# Packing Facility

- Should have adequate lighting and shielded to protect product if breakage occurs.
- Processing equipment **food contact surfaces** should be cleaned & sanitized and done as frequently as necessary.
- Use only food grade machinery lubricants.
- Exposed overhead piping & ducts should be minimized and kept clean.





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# Packing Facility

- Work tables/product preparation surfaces – food contact surfaces:
  - Smooth surfaces allow easy cleaning.
    - Rough surfaces harbor dirt and microorganisms.
  - Important to clean and sanitize AS NEEDED.
    - Wash, Rinse, and Sanitize with approved food contact agents.
- Store packing containers away from contamination sources.
- Close doors at night.







Stainless steel surfaces are easy to clean & sanitize.

# Packaging materials should be stored to prevent contamination



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# Test Water Frequently

## First requirement for GAPs Certification.

- **At least once a year:**
  - Municipal water
  - Well water
- **Test surface water for quality assurance.**
  - 3 times during season in temperate climates.
    - at planting (high flow)
    - at peak use (low flow)
    - at harvest
- **Maintain good records of results.**



# Worker Hygiene

- Workers should follow good hygienic practices to protect against contamination of the product.
- Workers should receive training in proper food handling techniques, food protection basics, personal hygiene and sanitary practices.



# Worker Hygiene

- **Wear clean outer garments.**
  - Change clothing or don aprons if coming from the field.
- **Maintain personal cleanliness.**
- **Wash hands thoroughly:**
  - Before starting work.
  - After each absence from work station.
  - At any time when hands become soiled.

# Worker Hygiene

## Hand washing:

- **Are adequate supplies available?**
  - Hand soap and cleaning detergent
  - Disposable towels
  - Clean water
- **Are supplies used properly?**
  - Hands washed after using the bathroom.
  - After harvesting or work in field.
  - After eating or drinking or smoking.







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# Worker Hygiene

- Remove all unsecured jewelry and other objects.
- No eating, chewing or smoking in packing areas.
- Gloves must be intact, clean and sanitary.
- Wear hairnets and beard covers.
- A worker with a health problem that could contaminate food or food equipment shall be excluded from working with food.

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# Sorting & Cleaning



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# Sorting

**Objective:** To remove product or portions of product that may detract or pose a risk for shortened shelf life and/or contamination by a microbial organism.

- Contaminated product
- Senescing product
- Insect damaged product
- Product with a broken skin
- Product that is out of grade



**Nobody wants damaged or aging product**



# Cleaning the Product

**Objective: Provide customers with product that is attractive and clean with minimal risk of microbial contamination.**

- **Wipe/brush? Wash? Sanitize? Do nothing?**
  - Ideally, washing, rinsing & sanitizing provides the greatest reduction of potential microbial contamination.
- **Have to consider the crop:**
  - How dirty the product is coming from the field?
  - Ability to remove excess moisture.
  - Tenderness & perishability of the product.

# **Focus on Cleaning & Sanitizing**

- **Cleaning means free of any visible soil & other materials.**
  - May involve the use of soap/detergent and water.
  - Adequate rinsing so no residue is present.
  - Using water of potable quality.
- **Sanitizing is next step.**
  - Reduction of pathogens to non-harmful levels.

# **Cleaning & Sanitizing the Product**

- **Is Rinsing Enough?**
  - Customers demanding - convenience of ready to eat (RTE) products.
  - Allows only partial removal of microorganisms.
  - Can spread microbial contamination without water renewal.
- **Use of potable water – test and change as needed.**
- **Sanitizers – many options**

**Effectiveness of each varies with the food tested**





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# Bacteria can enter the stem scar when improper handling or wash water management is practiced.



Fruit pulp must be  $< 10^{\circ}\text{F}$  warmer than  
water temperature to prevent infiltration.



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# Sanitizing Agents

- Typical sanitizers include chlorine, iodine, hydrogen peroxide, quaternary ammonium compounds (Quats), and some organic acids.
- Be sure sanitizers are approved for food contact.
- Use correct concentrations for food contact.
- Test that correct concentrations are reached and maintained - test strips.
- Discard and change as needed.
- Avoid *re-contamination* of sanitized items – with hands or contact with other items.

# Sanitizing Agents for Fresh Produce

- **Sodium hypochlorite** \* – *aka Bleach*  
(6%, @ 100 - 200 ppm)
- **Hydrogen peroxide** \* ( $\text{H}_2\text{O}_2$ , 3%)
- **Tsunami™** \* (peroxy-acetic acid, 80 ppm)
- **PRO-SAN® LC** (1%)
- Acidified sodium chlorite (**Sanova™**)
- **Ozone** \* (*requires a generator*)
- **Acetic acid** \* (*from an organic source*)

\* Approved by the USDA National Organic Program



# Over-the-Counter Sanitizers

## Chlorine Bleach:

1. Can be used for sanitizing Product and Food Contact Surfaces.
2. Important to **measure accurately to avoid toxicity.**
3. Effectiveness decreases with time and dirtiness of the water.
4. Use **test strips** to ensure proper concentration.
  - a. Document in a log book.
    - i. Time of testing and result.
    - ii. When water & sanitizer was changed.
5. Note: **Don't use scented/oxidized chlorine bleach.**

# Chlorine Bleach Use

## Sanitizing the Product:

- Up to 200 PPM.
  - 2 Tablespoons per gallon in warm water (75 - 120°F)
- Most effective if used after any soil is removed.
- Change the solution as needed.

## Sanitizing Food Contact Surfaces:

- 50 – 100 PPM (1/2 to 1 Tablespoon/gal.)
  - Packing table & other contact surfaces
    - Last step in cleaning; do not wipe off.
  - Harvest & other reusable containers.
  - Gloves (washable)

# Resources for Information

## ISU Publications:

Available at: <https://www.extension.iastate.edu/store/>

- **PM 1853 Local Food Connections:**
  - A. From Farms to Schools
  - B. From Farms to Restaurants
  - C. Food Service Considerations
- **PM 1974 On Farm Food Safety:**
  - A. Guide to Good Agricultural Practices (GAPs)
  - B. Guide to Food Handling
  - C. Guide to Cleaning and Sanitizing

**UC Davis web site:** <http://postharvest.ucdavis.edu>



# Packaging Containers

- Containers must be food grade quality.
- Must protect integrity of the product.
- Disposable containers should not be re-used.



# Storage

**Objective: Extend the shelf life of the product.**

- Slow down product respiration rate.
  - Lower the temperature.
- Minimize moisture loss from the product.
  - Increase the humidity in the storage room.
  - Increase the humidity around the product.
- Reduce the risk of microbial growth.
  - Lower temperature below 41° F.



# Cooling the Product

- Wet product can allow rapid bacterial growth if not cooled.
- Proper storage temperature is dependent upon the vegetable or fruit.
- Critical temperatures are:
  - Below 41° F to minimize bacterial growth.
  - Bacterial grow most rapidly from 70 - 135° F.





# Cooling & Postharvest Quality

- To prolong the shelf life of a product, it is important to cooling it down to slow respiration.
- The importance and optimum storage temperature varies with:
  - The respiration rate of the product.
  - Whether the product is chilling sensitive.
- Refer to the UC Davis Postharvest Technology website <http://postharvest.ucdavis.edu> under “Produce Facts” for each crop.

# Cooling

**Principle of Half Cooling Time** for standard coolers with moderate air circulation:

- In cooling a product from its initial temperature to the desired storage room temperature.
  - If it take X hours to cool the product temperature to  $\frac{1}{2}$  the storage room temperature, then it will take:
    - 2X hours to cool it to  $\frac{3}{4}$  the storage room temp.
    - 3X hours to cool it to  $\frac{7}{8}$  the storage room temp.
    - 4X hours to cool it to  $\frac{15}{16}$  the storage room temp.

# Steps to Aid in Cooling

- Harvest in the morning when it is cool.
- Keep the product out of direct sunlight.
- Move the product to the processing facility as soon as possible.
- Use water rinses in postharvest handling.
- Move product into a cooler as soon as possible after processing.
- Procedures to increase the rate of cooling:
  - Forced air cooling (within the storage room).
  - Hydro cooling
  - Icing



# Chilling Sensitive Crops

- Several crops can suffer chilling injury when stored below 41 to 55° F.
- Some chilling sensitive crops require curing to harden the skin before storing.
- Refer to the UC Davis Postharvest Technology website <http://postharvest.ucdavis.edu> under “Produce Facts” for each crop.

# Chilling Sensitive Crops

Crop	Chilling Injury Temp. (F)	Crop	Chilling Injury Temp. (F)
Basil	< 50	Potato, early, Table	< 45
Cucumber	< 50	Potato, early, Frying	< 50
Eggplant	< 50	Pumpkins *	< 55
Green beans	< 41	Squash, summer	< 41
Okra	< 45	Squash, winter *	< 55
Peppers	< 45	Sweet Potato **	< 55
		Tomato	< 50

\* May require curing. \*\* Require curing.

<http://postharvest.ucdavis.edu>



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# Storage Area



- Separated from the processing area.
- Maintain clean using good housekeeping practices.
- Storage racks should be away from walls to allow cleaning and air circulation.
- Practice a “First-In”, “First-Out” system for inventory control.

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# Storage Area



- No products, packaging materials, ingredients should be stored on the floor.
- Maintain a rodent control program.
- Maintain appropriate temperature and humidity.
  - Monitor
  - Maintain a record.

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# Storage Area

- Walls, floor and ceiling should be constructed so that they can be kept clean and in good repair.



# Transportation of Product

- Ownership of product until transferred.
- Take precautions to minimize risk of microbial contamination during transit.
- Attention to:
  - Food contact surfaces.
  - Time and temperature abuse.
  - Product integrity – potential or opportunity for unintentional or intentional contamination.
  - Other uses of the vehicle.



# Distribution / Display





# What they don't want!



# Distribution / Display



Avoid exposure to direct sunlight.



Product should not be displayed on the ground.





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# Distribution / Display



Risk of contamination from birds and small mammals.

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# **Zero-Risk / Pathogen Free is “Mission Impossible”**

- **BUT** Action Steps can **REDUCE** the Risk.
- People want and need fruits and vegetables for many reasons – taste and health.
- Consumer education is also needed.
- Producers need to show that best practices are being used.
- Show with Policies and Documentation.

