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Cornell University

Module 6: Postharvest Handling & Sanitation

Learning Objectives

- Identify potential routes of contamination associated with harvest and postharvest activities
- Identify practices that reduce risks
- Identify the steps involved in cleaning and sanitizing food contact surfaces
- Define key parts of a pest control program
- Describe key practices for transporting fresh produce that will reduce contamination risks
- List key practices that need to be monitored during postharvest activities
- Describe corrective actions that reduce risks
- Identify key records to document practices

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Keeping Things Clean

- Continue produce safety practices by keeping things clean during harvest and postharvest handling
- Consider everything that touches or impacts produce
  - Packing and picking containers
  - Packing equipment
  - Hands and clothing
  - Postharvest water
  - Buildings (i.e., coolers, storage areas)
  - Transport vehicles

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Sanitation Practices

- **Basic Concepts**
  - Using basic good housekeeping practices
  - Providing facilities and training workers so practices are implemented properly
  - Eliminating pests and debris
  - Minimizing standing water
- **Cleaning and Sanitizing**
  - Use a 4 step cleaning and sanitizing process when possible for equipment and tools such as harvest containers, packing tables, and packing lines

Worker Training for Harvest and Postharvest Practices

- Workers must never harvest covered produce contaminated with feces
- Workers must never harvest or distribute dropped covered produce
- Worker health and hygiene practices should include:
  - Wearing clean clothing and footwear
  - Following glove, hairnet, and jewelry policies
  - Using worker break areas, handwashing stations, and restrooms

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Not All Packing Areas Are The Same

Open

Open to the environment, may or may not be covered

Closed

Has doors and windows, with some ability to control entry into the building

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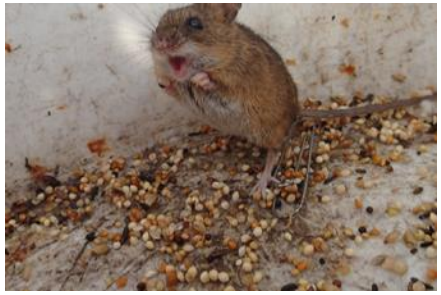
Reduce Risks in All Packing Areas

Proper hygiene facilities & break areas for workers

Keep it clean

Pest management



Avoid standing water

Keep it organized

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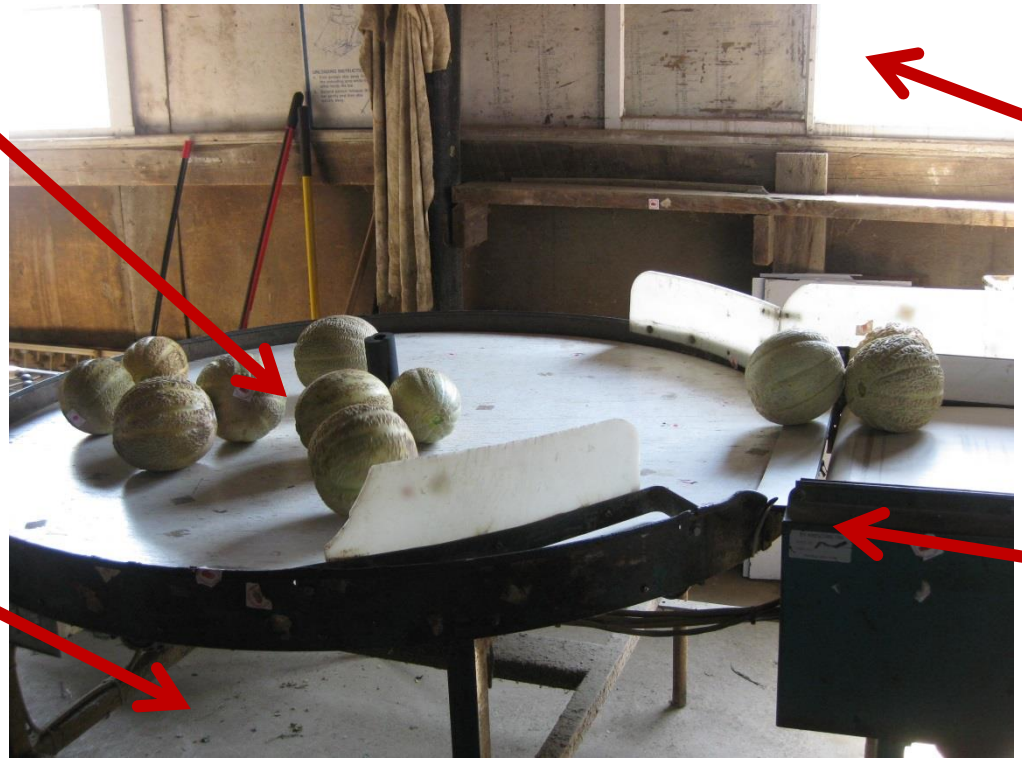
Assessing Risks in Packing Areas

- Map the flow of produce from the field through the packing area into storage and out to transportation
- Identify areas where produce may directly contact surfaces and equipment (Zone 1)
- Identify other areas that may introduce food safety risks such as equipment surfaces adjacent to food contact surfaces, floor drains, or adjacent land uses (Zones 2, 3, and 4)

Zones in the Packinghouse

Help prioritize cleaning and sanitation efforts by designating areas or ‘zones’ within the packing area.

Zone 1
(direct food contact surface)



Zone 4
(outside)

Zone 3
(floor)

Zone 2
(outside surface of washer)

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Zone 1: Direct Food Contact Surfaces

- Biggest concern because if contaminated, could result in cross-contamination of the produce
- Includes harvest/storage bins, workers' hands, conveyors, belts, brushes, rollers, sorting tables, racks, and utensils
- Initial efforts should be focused on Zone 1 since it has the most immediate impact on safety

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The Other Zones: 2, 3, & 4

- These areas are important because they may contribute to contamination of Zone 1
- These areas are best managed by established cleaning schedules to make sure areas adjacent to or outside of Zone 1 do not introduce contamination

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Zone 2

- Surfaces and areas in close proximity to the produce and food contact surfaces
- Not direct food contact surfaces
- Includes internal and external parts of washing or processing equipment such as sidewalls, housing, or framework

Zone 3

- Areas inside of the packinghouse
- Includes trash cans, cull bins, floors, drains, forklifts, phones, foot traffic areas, and catwalks or storage areas above packing areas
- May contribute to spreading contamination due to proximity to food contact surfaces and produce

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Zone 4

- Areas outside of or adjacent to the packing area
- Includes loading docks, warehouses, manure or compost piles, and livestock operations
- May provide opportunities for contamination to enter the packing area

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Name that Zone

SUPPLEMENTAL MATERIAL

Version: 12-7-17

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Develop Sanitation Practices That Reduce Your Risks

- Implement practices that reduce the risks identified through your risk assessment
- Practices may include:
  - Implementing or reinforcing worker training
  - Establishing pest control programs
  - Cleaning and sanitizing food contact surfaces
  - Converting to equipment that can be easily cleaned and sanitized
  - Cleaning and maintaining coolers
  - Cleaning transportation vehicles

Cleaning vs. Sanitizing

What is the difference and why does it matter?

- **Cleaning:** Physical removal of dirt (soil) from surfaces which can include the use of clean water and detergent
- **Sanitizing:** Treatment of a cleaned surface to reduce or eliminate microorganisms

Important point: You cannot sanitize a dirty surface.

Cleaning always comes first!

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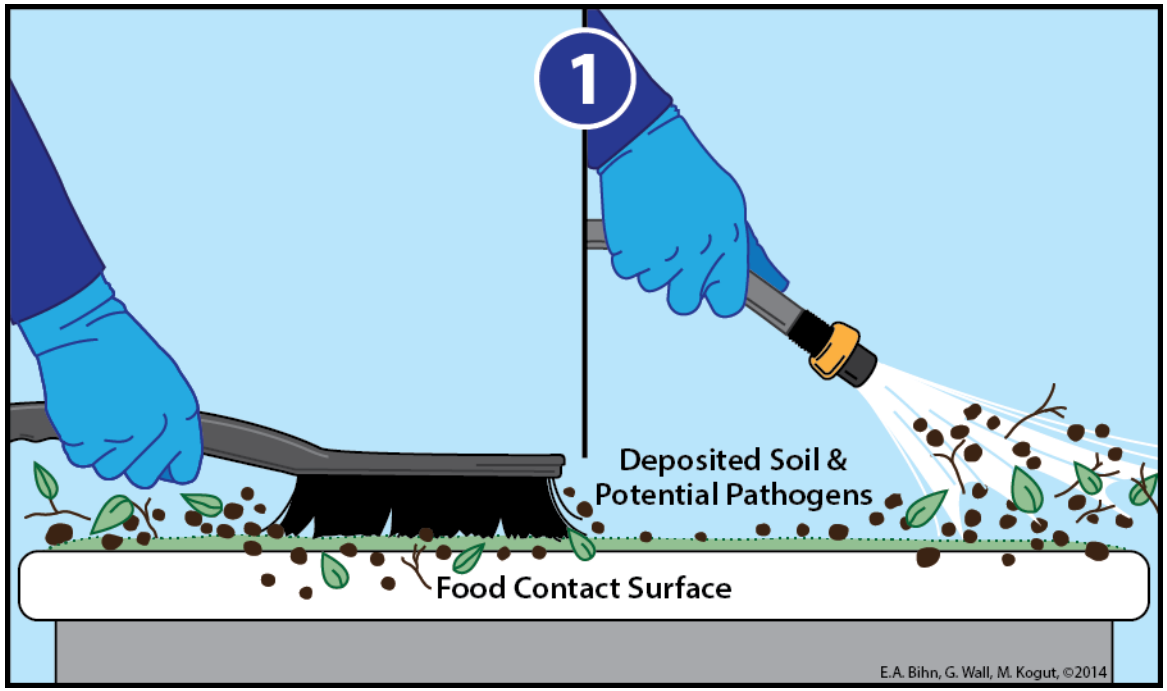
Cleaning & Sanitizing Food Contact Surfaces

- **Step 1:** Remove any obvious dirt and debris from the food contact surface.



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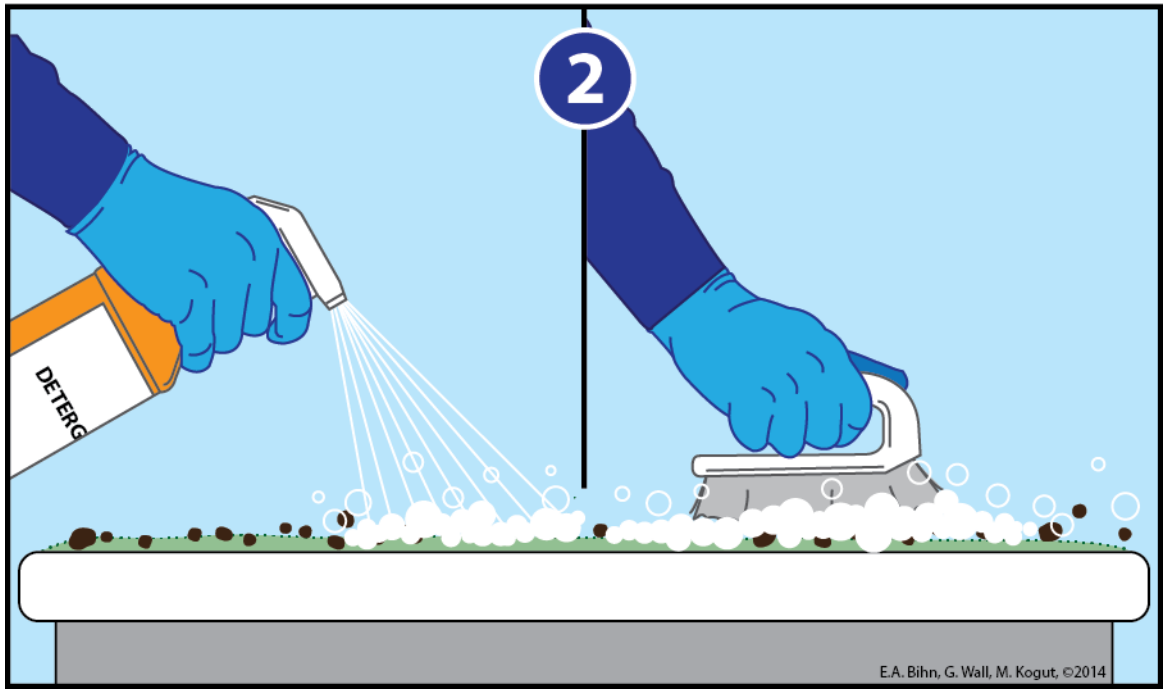
Cleaning & Sanitizing Food Contact Surfaces

- **Step 2:** Apply an appropriate detergent and scrub the surfaces.



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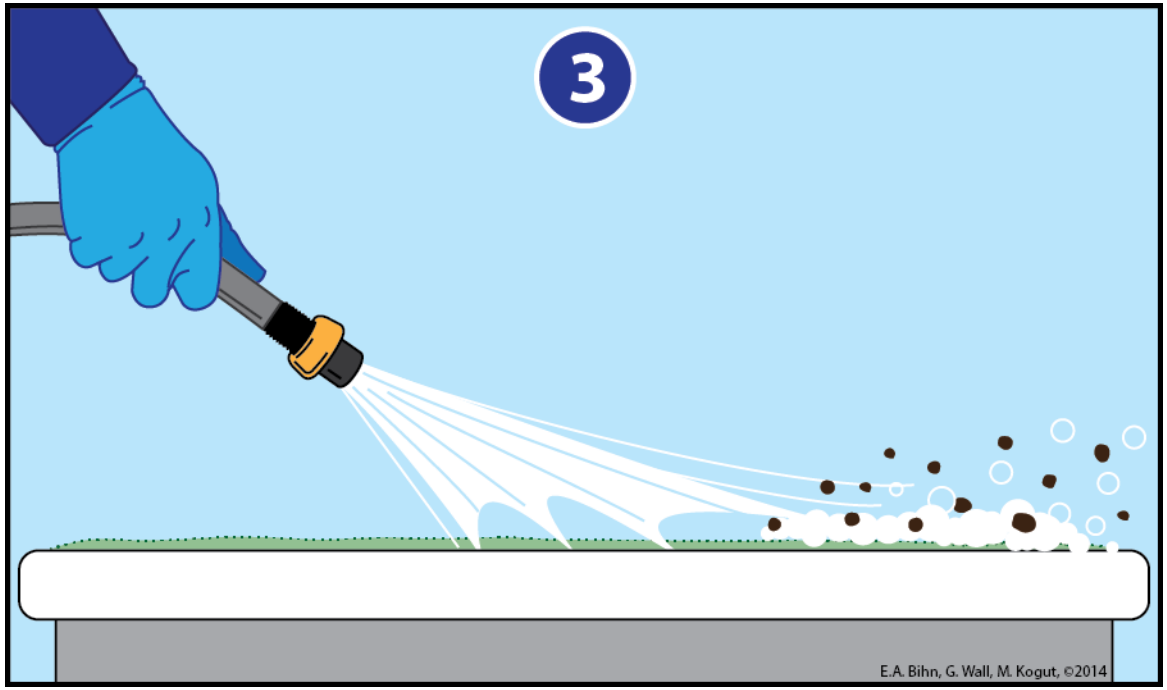
Cleaning & Sanitizing Food Contact Surfaces

- **Step 3:** Rinse the surface with clean water, making sure to remove all the detergent and soil.



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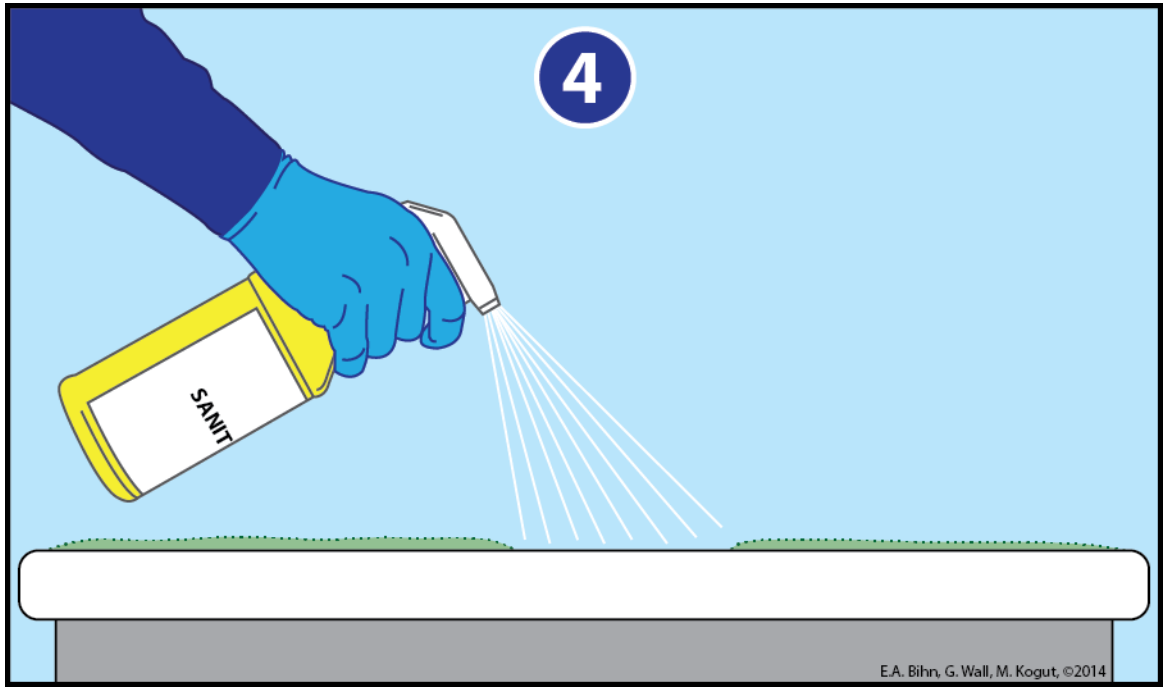
Cleaning & Sanitizing Food Contact Surfaces

- **Step 4:** Apply a sanitizer approved for use on food contact surfaces. Rinsing may be necessary. Let the surface air dry.



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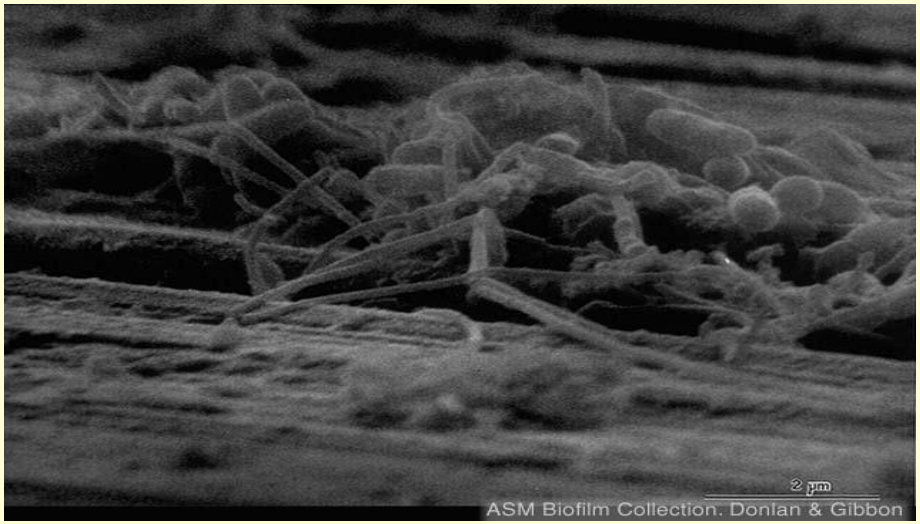
Areas of Concern for Cleaning and Sanitation

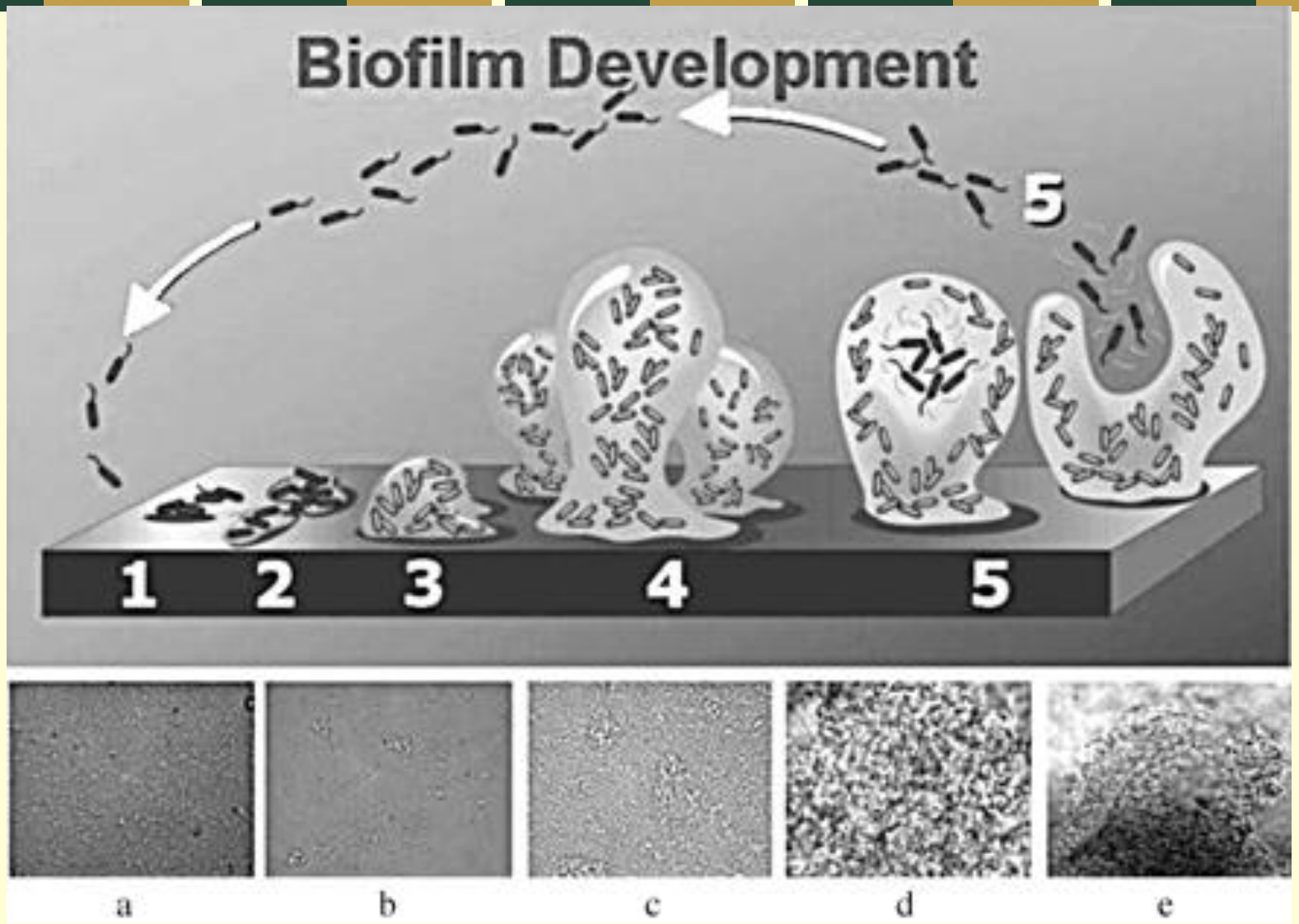
- Two problematic areas:
  - Biofilms
  - Harborage sites



From Penn State

Biofilms

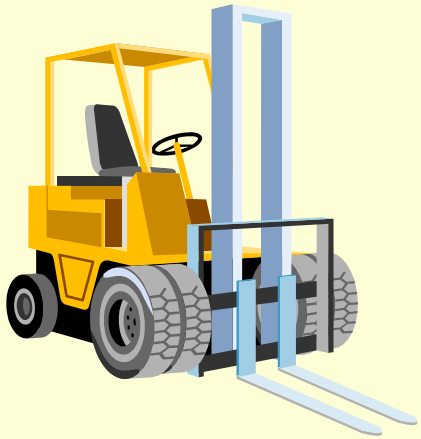
- A bacterial film that is attached to a surface and protects the microorganism. The mass of cells become large enough to entrap organic and inorganic “debris” . The biofilm is a biologically active matrix in association with a solid surface – like stainless steel. Concept of biological attachment.
- Biofilms make sanitizers less effective
- Biofilms can occur on any surface such as metal, flooring material, fabric, rubber and wood – especially is porous or “pitted”.
- Problems with areas that are infrequently or inadequately cleaned – “pieces can break off” and enter food contact surfaces and food without you knowing.



(Stoodley et al., 2002)

Harborage sites

- Areas in or near food contact surfaces that provide location for pathogens (specifically Listeria monocytogenes) to survive, multiply and, eventually, contaminate food.
  - Hard to clean/sanitize. Overlooked. Hard to get to.
  - Provides food, water, ideal temperatures
  - Hollow rollers, boots/shoes, forklifts, cracked walls or ceilings, equipment such as conveyors, bins, blenders, slicers etc.



Sanitizers

- Many different sanitizers
  - How do you choose?
  - No fragrances!!
- Equipment
- Produce
- Two discussed here
  - Chlorine
  - Peroxyacetic acid
  - Others

Chorine as a Sanitizer – an example

- Check labels for use
  - "Bleach" w/EPA register number is a designated sanitizer, germicidal
  - Use food sanitizer
  - Follow label directions
- Caustic, corrosive
- Room temperature, not too cold
- Effectiveness lost with time – check w/ test strips
- Water pH 6.0-7.5, Neutral area
  - Check pH of water
- Inexpensive

Peroxyacetic Acid (PAA)

- Peroxyacetic Acid (PAA) – comes under many names: Sanidate, Tsunami and Vigorox
  - Hydrogen peroxide + acetic acid
  - 100-200 ppm for equipment
  - 24-80 ppm for washing produce depending on product
    - Wash water and cross-contamination
    - 60 ppm recommended for submersion
  - Sanitizing food contact surfaces
- Key Attributes
  - Works at low temperatures
  - Not corrosive, long shelf-life, effective
  - Check label for concentration and EPA registration
  - More expensive

Suslow, Hadad PSA - resources

Cleaning and Sanitizing

- https://www.youtube.com/watch?v=WBynfFM0fVo

Best Case Scenario: Sanitary Design of Equipment

- Food contact surfaces should be:
  - Non-toxic, non-absorbent
  - Durable, able to withstand corrosion
  - Able to be easily cleaned and sanitized

- Equipment should be designed and installed to facilitate cleaning and sanitizing
  - Easy access to equipment and adjacent spaces
  - Able to remove or access brushes, rollers, and nozzles for cleaning and sanitizing

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Best Case Is Not Always Possible

- **Many farms have old or wooden equipment that is not easy to clean or sanitize. All hope is not lost!**
  - Most things can be cleaned, even old equipment!
  - Keep equipment clean (sanitize when necessary)
  - Establish cleaning schedules that reduce contamination risks and prevent biofilm formation
  - Air dry wooden surfaces after washing
  - Equipment and tools that cannot be maintained or cleaned properly may need to be discarded
  - Be sure <u>new</u> equipment and buildings are designed to be easily cleaned and sanitized

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Retrofitting Equipment

- Make sure changes or modifications to equipment will not result in an increased risk of contamination
- Use materials that can be cleaned and sanitized
  - No carpet or materials that cannot be cleaned or do not dry
- Consider consulting technical assistance resources or a sanitation expert if using the equipment for a new purpose or for which it was not designed
- When possible, invest in the right equipment rather than modifying equipment

Post-manufacturing welds are not easy to clean and may become a source of contamination

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Reduce Risks BEFORE Entering the Packing Area

- Clean harvest bins before using them
- Develop practices to minimize harvest bin contact with the soil and remove soil before entering the packing and storage areas
- This reduces:
  - Risk of contamination entering packing and storage areas
  - Organic load in wash water
  - The frequency of which wash water needs to be changed
  - Risks when stacking produce bins on top of each other

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Packing Area Maintenance

- Regularly inspect and maintain equipment to avoid:
  - Cracked hoses, torn rubber door seals
  - Standing water
  - Dirty conveyor belts, brushes, and rusty equipment
  - Condensation: Especially from walls, ceilings, cooling equipment, and pipes over packing lines and in storage areas
- All workers must be trained so they know how to identify and reduce risks

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Packing Containers

- Only new, single-use containers or cleaned, reusable containers should be used to pack produce
- Packing containers and materials should be stored in a covered area, off the floor, to reduce the risk of contamination from pests, windblown dirt, and other contaminants

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Excluding and Discouraging Pests

- Inspect all walls, doors, windows
  - Repair holes and seal any cracks between floors or walls
  - Make sure door seals are in place to prevent pest entry
- Deter birds from roosting in rafters with nets or spikes
- Keep doors and windows closed as much as possible
- Cut grass around packing area
- Remove cull piles and garbage everyday, and as needed throughout the day
- Keep produce covered when possible

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Pest Management

- Traps can help monitor and reduce pest activity
  - Identify all trap locations on a map
  - Place traps along walls of packing or storage operations
  - Check traps regularly and keep records
  - Do Not use bait inside the packing area

- Store pallets of produce at least 12”from walls to aid in visual inspection and trap monitoring
- Train all workers to report any pest problems they see
- Be sure your pest control program is controlling the pests you have!

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Food safety News. Walpuck. 2/11/2016

Cold Storage Areas

- Inspect regularly to ensure the area is clean and the cooling equipment is functioning properly
  - No condensation or dripping on produce
  - Door and window seals are intact
  - Cooler temperatures are monitored and recorded at the beginning of each day
- A cleaning and pest management program should be established for all storage areas
- Cooling is not required, but if used, do it **properly!**

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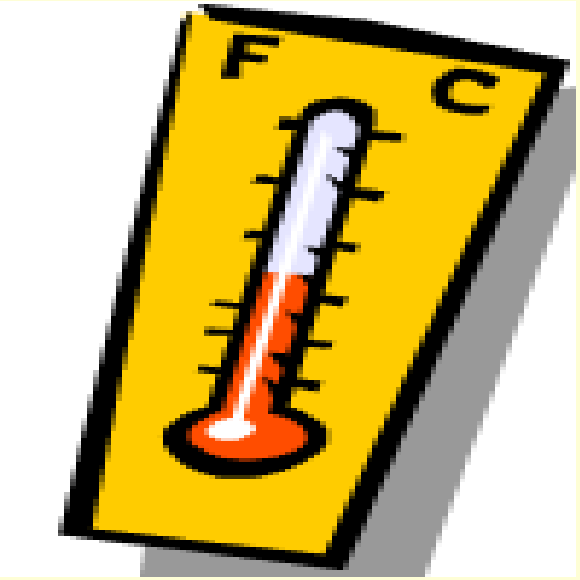
When to Control Temperature

- Important at many steps in the process
  - Cooling produce
  - Washing
  - Packing
  - **Cold storage**
  - Transport
  - Point of sale



Storage and Temperature Control

- Maintains produce quality
- Minimizes pathogen growth
- Quality deterioration can impact microbial proliferation and growth

Goal of Proper Storage

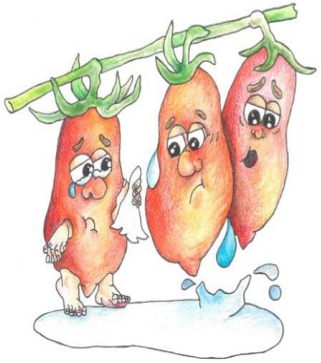
- Slow down intrinsic biological activity in fruits and vegetables without chilling injury
- Slow microbial growth – spoilage, pathogen
- Reduce transpiration or water losses
- Helps against disease and insect infestation
- Storage can be:
  - short term, immediate sale/retail
  - mid term, not glutting market, weeks
  - long term, harvested earlier, sold continuously over the year

Fresh Produce…


IS ALIVE


BREATHES


RELEASES HEAT


LOSES MOISTURE


CAN GET SICK

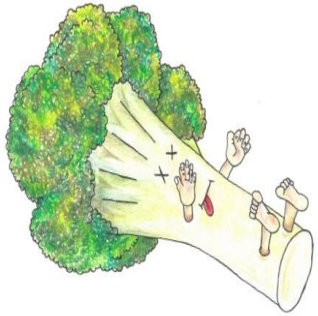
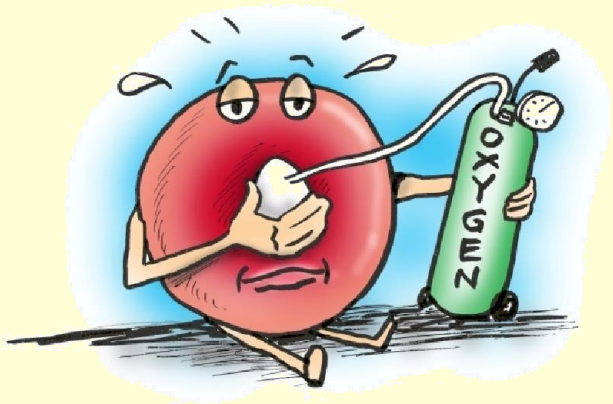

CAN EVEN DIE

Illustration by Virginia Jaquish.
More info: USDA Handbook 66 – go.uvm.edu/respiratorymetabolism

THE UNIVERSITY OF VERMONT EXTENSION

Post-harvest changes in fruits and vegetables

- Still alive – respiration continues
  - improper storage → undesirable changes

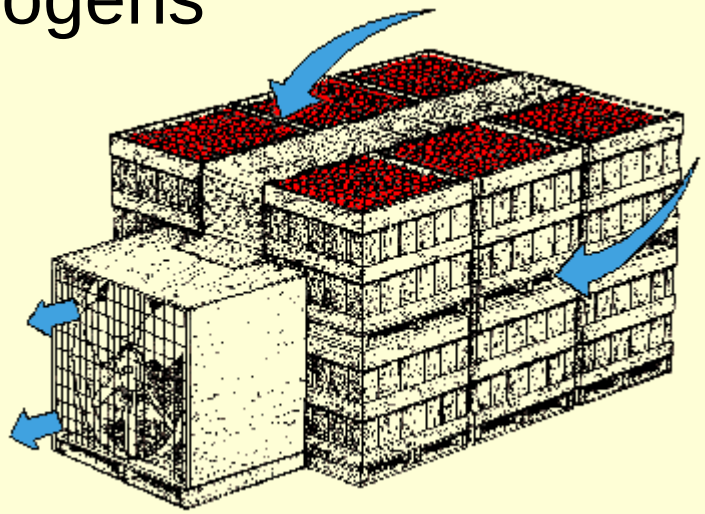


Cold Storage/Cooling

- Metabolic activity produces heat
  - Produce stores and absorbs heat
  - Limit production of heat
- Slows metabolic activity:
  - slows produce respiration and transpiration
  - slows heat production
  - slows inherent breakdown through enzyme activity
  - slows ethylene production – ripening

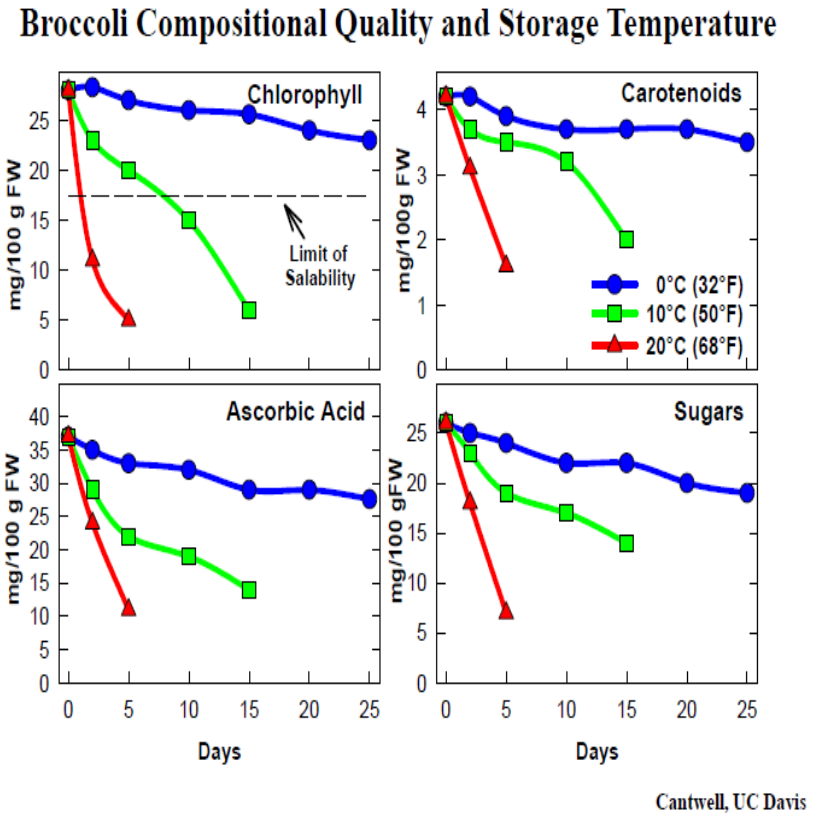
Cold Storage/Cooling

- Slow water loss and wilting
- Slows sprouting
- Slows/stops growth of spoilage/decay microorganisms
- Slows/stops growth of pathogens



Respiratory Metabolism

- Slowing the reaction down maintains harvest quality.
- Reduced temperature decreases rate of respiratory metabolism.
- Controlled Atmosphere (CA) storage limits oxygen available for reaction.



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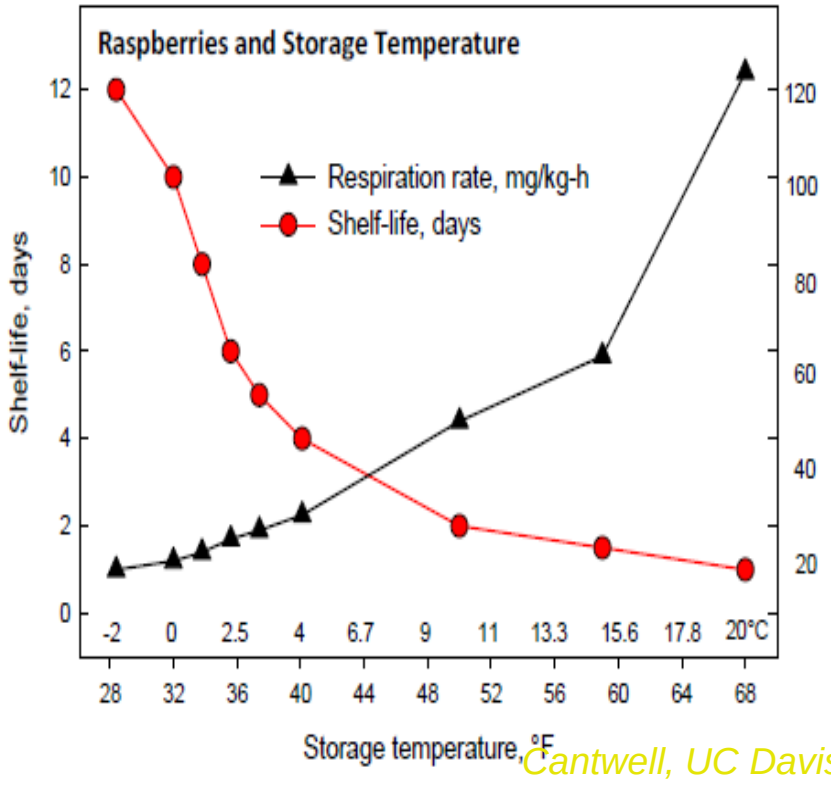

Cantwell, UC Davis

More info: USDA Handbook 66 – go.uvm.edu/respiratorymetabolism

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Temperature Control

- Refrigeration/temperature control
  - Insulation, air circulation
    - air passage between containers optimum
    - space between containers
    - fans
  - Calibrated thermometer
  - Proper temperature
- Capacity to cool – do not exceed
  - Heat from fans, lights, personnel (in and out)
  - Respiration from fruits and vegetables

Relative Humidity (RH) Important

- Amount of water in the air at a given temperature
- Relatively high RH, 90-95% best (crop ~ 100%) – prevent drying of produce

- Below, get moisture loss
  - wilting, shrivel, browning, softening (limp)
- High, more rapid growth of microorganisms
  - spoilage/decay
  - pathogen growth

As you think about storing these vegetables …

…What would you worry about?

What is common about these vegetables and what is different?

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Common Storage Zones





	Carrot/ Cabbage	Onion/ Garlic	Potato	Sweet Potato	Squash
Storage Zone	Cold Humid	Cold Dry	Cool Humid	Warm Humid	Warm Dry
Temp	32 – 34 °F	32 °F	40 °F	57 °F	50 °F
RH	98 – 100 %	65 – 70 %	99 – 100 %	90 %	50-70 %
Duration	7 – 9	6 – 9	Up to 12	3 – 6	1-3

More info: USDA Handbook 66 – go.uvm.edu/handbook66

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Refrigeration:
Parameters to Control/Monitor

- Air circulation important
  - removal of heat away from product
- Proper refrigerator capacity and air velocity (movement)
- Proper RH
  - more water in the air at warmer temperatures then colder
  - as temperature goes up, water holding up
- Avoid drying
  - uniform air flow to remove respiration heat, proper RH

Ice and Ice Slurries

- If ice or ice slurries are used for postharvest cooling, it must be made from water that is free of detectable generic *E. coli*/100 mL water
- Equipment used to make and distribute ice should be cleaned and sanitized on a regular schedule
- Ice should be stored in clean containers
- Do not stack boxes containing iced produce above other boxes to avoid dripping and cross-contamination risks

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Transportation Considerations

- Many different types of vehicles are used to transport fresh produce
  - Open trucks, closed trucks, vans, wagons
- Some farms may use vehicles for many farming purposes and for personal use
  - Vehicles must be cleaned before hauling produce
  - A clean liner may be used as a barrier if adequate to prevent contamination

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Inspecting Vehicles

- All vehicles used to transport produce should be inspected prior to loading to make sure they are clean and free from physical debris and off odors
- If hiring transportation, make cleaning, sanitizing, and documentation a part of your contract requirements
- If refrigeration is required, the inspection should include making sure the refrigeration units are functioning properly and at the proper temperature prior to loading

Control at Farmers Markets

- All food should be stored off the floor or ground – pallet is 4 inches and acceptable. 6 inches usually optimal.
- Keep produce shaded with a canopy, umbrella or constructed stand
- Use a spray bottle of potable water to keep produce moist and prove some evaporative cooling
- Display produce on clean ice
- Store extra produce in coolers and maintain temperatures at or below 41F.
- If possible have one individual handle the money to reduce the chance of cross contamination

From Wes Kline, Rutgers University- NJ Ag Station

Are Microbial Risks the Only Ones?

- Most of the contamination of fresh produce is caused by microorganisms
  - e.g., *E. coli* O157:H7, *Salmonella*, *Listeria monocytogenes*
- BUT, there are two other types of contamination issues to consider
  - Chemical risks
  - Physical risks

Chemical Food Safety Risks

- Chemical hazards include pesticides, detergents, sanitizers, and other chemicals used on the farm
- To reduce chemical food safety risks:
  - Keep chemicals locked and stored in an area away from produce packing and storage areas
  - Train workers and develop detailed SOPs for them to follow
  - Keep SDS on site in case of an emergency
  - Use only food grade lubricants, oils, and chemicals according to their labeled use
  - Use non-reactive materials that will not leach into produce

Physical Food Safety Risks

- Physical risks include wood, metal, glass, plastic or other foreign objects that can end up in the produce
- To reduce physical food safety risks:
  - Screen or cover overhead light bulbs or replace with shatterproof fixtures
  - Inspect bearings and other moving equipment to make sure they are in good working condition and not introducing metal parts or pieces into the fresh produce
  - Cover packing materials and produce containers to reduce the risk of physical hazards entering

Corrective Actions

- If a food safety risk is identified in the produce packing, storage, or transportation vehicles:
  - Immediately assess the situation
  - Has produce been affected?
    Can it still be sold or does it need to be thrown away?
  - Determine the cause of the problem
  - What needs to be done to correct it?
  - Adjust practices to address risks, keep records, and monitor to make sure the corrective actions have fixed the problem

Examples of When Corrective Actions Should be Considered

- Pest infestation
- Contamination of the packing line by blood when a worker cuts their finger on a sharp metal edge
- Drain backs up into the produce handling area
- Other situations that pose an immediate contamination risk to produce

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Recordkeeping

- As always, records are critical to ensuring the job gets done and is completed properly
- Recordkeeping for postharvest handling and sanitation must include:
  - Cleaning and sanitizing of tools, equipment, and containers
- Additional records may include:
  - Pest management
  - Building maintenance and monitoring
  - Worker training on sanitation SOPs
  - Packing area and cold storage cleaning and monitoring
  - Vehicle cleaning and inspections prior to loading

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Summary

- All packing areas, regardless of age or design, must have sanitation practices that minimize contamination risks
- Identify all of the food contact surfaces as produce moves through the packing and storage areas—focus on keeping these surfaces clean as a first priority
- Cleaning and sanitizing are not the same thing
- You cannot sanitize a dirty surface
- Food safety practices such as cleaning, general maintenance and housekeeping, and pest control need to be in place to reduce risks

Post Harvest Considerations: Summary

- Worker hygiene first line of food safety
- Clean harvest storage facilities and containers/bins prior to use
- Ideally, pick when produce dry
- Use harvesting and packing equipment appropriately and as clean and practical
- Store harvest containers so they are protected from rain, water splash and pests. Cleaned and air dried prior to reuse
- Use new boxes for shipping – previously used boxes could be source of contamination
- Cover bins from field to packing/shipping

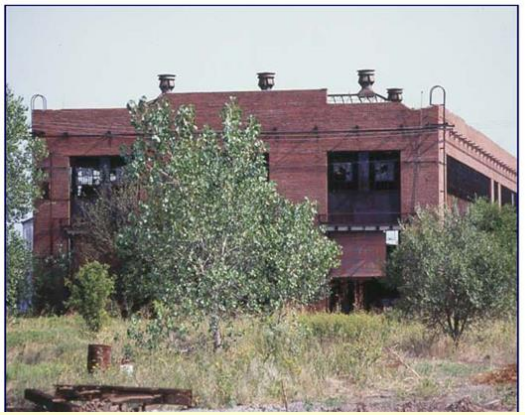
Packing House Considerations: Summary

- Check roof/walls for water entry
  - Water should drain away
- Avoid standing water
- Regular cleaning/sanitizing
- Glass fixtures covered, shatterproof
- Pest control program – remove unused equipment, weeds outside packing area. Hiding places.
- Remove bird's nests

Thanks to Penn State, 2012, Wes Kline, Rutgers

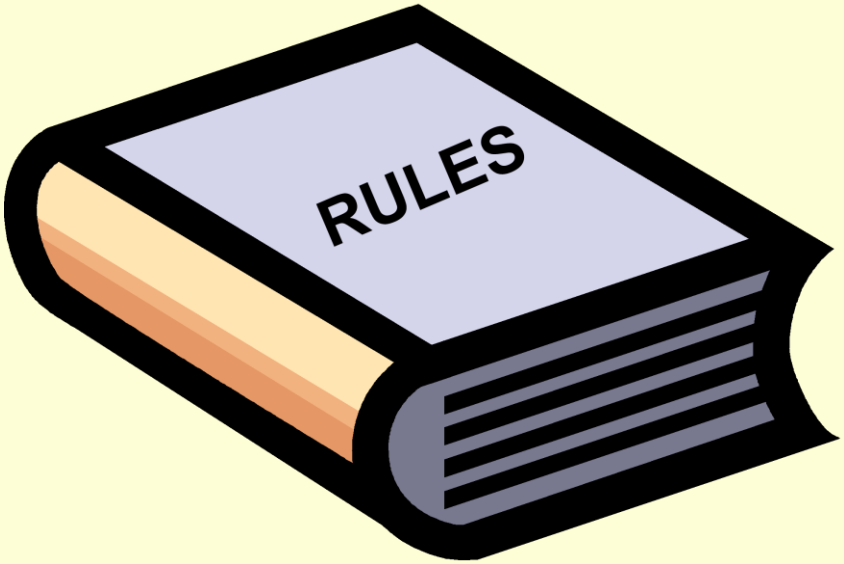
Packing Considerations: Summary

- Remove waste/garbage often, keep covered
- Remove weeds and used equipment
  - Hiding places for pests
  - Perch site for birds
- Store bins, packages on pallets – not on floor
- Keep hazardous chemicals secure
- Potable water
- Place to eat



Thanks to Penn State, 2012

Standard Operating Procedures



Standard Operating Procedures

- SOPs guide cleaning and sanitation practices and help ensure they are done correctly
- SOPs could be developed for:
  - Monitoring for pests
  - Preparing cleaning and sanitizing solutions
  - Cleaning and sanitizing produce washing lines
  - Cleaning and monitoring cold storage areas
  - Inspecting trucks prior to loading fresh produce
  - Cleaning vehicles used to transport fresh produce

Standard Operating Procedures: SOPs

- Set of **written** instructions/procedures for routine activities
- A guide for tasks and how to accomplish
  - Step by step procedures
- Unique to farm
- Consistent approach
  - checklists for self-audit
- Content clearly worded and understandable
  - necessary information

Written Operational Procedures

- Standard Operating Procedures – SOPs
- Sanitation Standard Operating Procedures – (SSOPs)
- **Incorporate in overall food safety plan**
- Written so task can be preformed – what are you doing and when, detailed to do the job
- Can be used for training
- Documents actual procedures you are following
- Records

Written Operational Procedures

- What would it include:
  - Who is involved
  - What needs to be done
  - Operational limits
    - Sanitizer levels
    - Cooler temperatures
    - Evidence of wild animals in field
    - Training topics
    - Water testing – generic E.coli
  - Corrective measures if something goes wrong

Developing SOPs – Other Examples

- Use of agricultural chemicals and storage
- Water testing schedule
- Thermometer calibration
- Cooler temperature monitoring
- Traceback/recall procedures
- Produce washing procedures
- Employee training
- Receiving produce from another farm
- Washing bins
- Waste disposal

Writing Standard Operating Procedures

https://www.youtube.com/watch?v=24QxF0H3l-s

Packing facility…Policies and procedures

Pest control – example

- Have a written **pest control program**, including a map of locations of traps, repairs
- Document with a pest control **log** - inspections, actions taken, applications of pesticides, location of traps, emptying of traps, etc. and /or service reports if contracted to a Pest Control Business
- Do not let pets in your packing facility

Developing SSOPs - Examples

- Maintenance of
  - Handwashing facilities
  - Toilet facilities
- Cleaning/sanitation of
  - Food contact surfaces
    - conveyors/belts
    - tables
    - cooling units
    - boxes/totes
    - wash/dump tanks

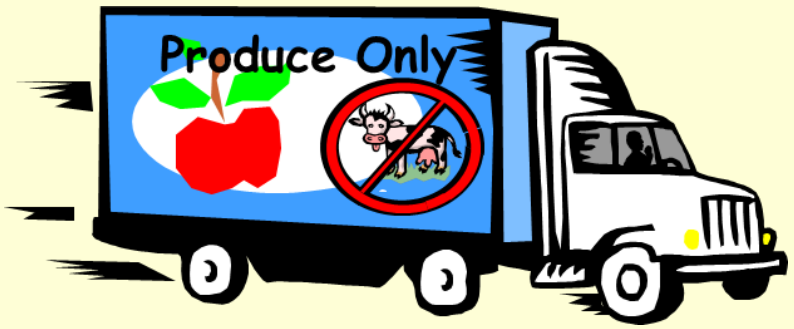
Developing SSOPs - Examples

- Employee hygienic practices and sick policy
- Cleaning
  - Floors, walls
  - Harvest equipment
- Use and cleaning tools
- Waste/trash disposal

Transportation - Example

Specifications and procedures for:

- Temperature control if needed
  - Document
- Inspection and cleanliness of trucks
  - Prior to loading - record
  - Are trucks used for a variety of products?
    - Eggs?
- Loading and unloading procedures to prevent damage and/or contamination of product



Standard Operating Procedures- Washing Greens

https://www.youtube.com/watch?v=NTu_Q_kpRgM

Developing Standard Operating Procedures

UMass Website

https://ag.umass.edu/resources/food-safety/for-farmers/sanitation

SOPs – Writing, Cleaning Greens, Clean/Sanitize

https://www.youtube.com/watch?v=24QxF0H3l-s

https://www.youtube.com/watch?v=NTu_Q_kpRgM

https://www.youtube.com/watch?v=WBynfFM0fVo