Good Agricultural Practices (GAP) for Fresh Fruit and Vegetable Growers
Storage and Temperature Control

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

- **Principle Goals:**
  - Control transpiration (water loss)
  - Respiration
  - Disease/insect infestation
  - Preservation
  - Microbial growth
Storage Life

- Storage life impacted by:
  - Harvest maturity
  - Disease control
  - Controlled or modified atmosphere
  - Chemical treatments
  - Irradiation
  - Proper refrigeration – focus
Goal of Proper Storage

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

- Still alive – respiration continues
  - improper storage ➔ undesirable changes
    - Sprouting: potatoes, onions, garlic
    - Decay, shriveling, limpness due to increase in humidity: celery
    - Greening: exposure to light, glycoalkaloids in potatoes
    - Toughening: prolonged storage at high temperature – green beans, sweet corn
Cold Storage/Cooling

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

- Slow water loss and wilting
- Slows/stops growth of spoilage/decay microorganisms
- Slows/stops growth of pathogens
Proper Temperature Control Important

- Proper temperature – delay may mean decrease in marketability
- Correct temperature
  - below optimum – freezing, chilling injury
    - may not be apparent right away
    - sensitive crops: tomatoes, basil, green beans, eggplant
  - above optimum – storage life decreases
  - wide temperature fluctuations – weight and water loss
  - microbial control- spoilage, food safety
Temperature Control Important

- Refrigeration/temperature control
  - Insulation, air circulation
    - air passage between containers optimum – as well vented as possible.
    - space between containers
    - fans
  - Calibrated thermometer
  - Proper temperature
- Important at many steps in the process, not just storage
When to Control Temperature

- Cooling produce
- Washing
- Packing
- Cold storage
- Transport
- Point of sale
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
Refrigeration: Capacity to Cool

- Capacity of refrigerator influenced by:
  - Heat from floor, walls and ceilings
  - Respiration from fruits and vegetables
  - Heat
    - light
    - fans
    - personnel in and out
  - Do not exceed capacity
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 than colder
  - as temperature goes up, water holding up
- Avoid drying
  - uniform air flow to remove respiration heat, proper RH
Post-harvest Handling: Storage/Washing

- Temperature of wash water can impact safety of some fruits and vegetables
  - tomatoes
  - peppers
  - apples
- Water much colder than produce may cause pathogens to be absorbed through the stem or blossom end
- Wash water should not be more than 10°F degrees colder than the produce.
  - Still being studied.
  - Key: Minimize cold differential
In the Packing House Summary: What You Can Do?

- Cool produce quickly when needed
- Use ice made from potable water
- Cut produce MUST be refrigerated
- Avoid cooling water bath or wash temperatures that are much cooler than produce pulp temperature.
Refrigeration/Coolers Summary: What You Can Do?

- Monitor water temperatures
- Check refrigeration storage temperatures
- Don’t overload cooling capacity
- Monitor cooler and produce temperatures
- Use and monitor transport truck temperature
- Keep Records
Control at Farmers Markets

- All food should be stored at least six inches off the floor or ground
- Keep produce shaded with a canopy, umbrella or constructed stand
- Use a spray bottle of potable water to keep produce moist and provide 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
Guidance

- Guidance: USDA Handbook #66
  - recommendations for storage temperature, relative humidity
- [www.ba.ars.usda.gov/hb66/contents.html](http://www.ba.ars.usda.gov/hb66/contents.html)
Resources Used

- United Fresh, 2016. Fruit and Vegetable Storage. PowerPoint
- Suslow et. al. 2003. Production practices as risk factors in microbial safety in fresh and fresh-cut produce. Comp. Reviews in Food Sci. and Safety. (2)38-77. Supplement
- Gast and Flores. Precooling Produce. 1991. CE, Kansas State