Practices mostly commonly changed as a result of participating in a PPS workshop.

- Handling / cleaning of harvest containers (90%)
- Employee training in produce safety (80%)
- Expanded produce safety plan (75%)
- Installed hand washing station (60%)
- Improved record keeping (55%)
- Switched to triple rinsing (40%)
“Why a workshop on food safety?”
Salmonella

Campylobacter

Norovirus / Norwalk-like virus

E. coli 0157
Salmonella
Campylobacter
Norovirus / Norwalk-like virus
E. coli 0157
Thinking like a microbe.

- Moisture
- pH
- Nutrients
- Temperature
  - $40^\circ - 141^\circ = \text{happy microbes}$
  - *Listeria* is an exception
- Time

*Listeria* in tissue. Photo courtesy of CDC.
Growth of *Salmonella* at various temperatures

Minimize chance of contamination by pathogen

Minimize Growth Rate of all bacteria—COLD!

Slide data courtesy of Penn. State University
Annual Burden of Foodborne Illness in the US: CDC Estimates

- 3,000 Deaths
- 128,000 Hospitalizations
- 48 Million Foodborne Illness (1 in 6 Americans)
“Why is food safety suddenly such a big deal?”
Outbreaks: Then & Now

• Then
  – Local outbreaks
  – Gross contamination
  – Mostly animal products

• Now
  – Multi-state outbreaks
  – Enhanced recognition
  – Additional food vehicles recognized
Why Produce-Related Food Borne Illnesses Increasing?

Number of Produce-Associated Outbreaks

- More people eating raw produce: 24% increase in produce consumption 1970-1997
- More virulent pathogens: E. coli 0157:H7

Source: Wesley Kline, PhD Rutgers Cooperative Extension of Cumberland County, 2009
The 2006 E. coli outbreak in Natural Selection Foods’ bagged spinach commodity chain

26 states with confirmed cases of E. coli O157:H7 from spinach

Natural Selection Foods (partnership of Earthbound Farm, Tanium & Arbe, and Mission Ranch) San Juan Batista, CA

North Processing Plant

South Processing Plant

Dole

Acquisition from Pride of San Juan April 1, 2006

Natural Selection backs out of acquisition, September, 2006 Pride of San Juan sells plant to Church Brothers, January, 2007

Shift A, August 15, 2006 E. coli O157:H7

Shift A, August 15, 2006 E. coli O157:H7

Recalled bagged spinach brands

Recalled brands with spinach ingredients

Graphics: Philip H. Howard
Michigan State University
Trends in public health

• Changing Microbes
  – Microbes mix and mutate
  – Low numbers of microbes needed to cause disease

• Changing demographics
  – Aging population
  – More people with compromised immune systems
“If someone got sick from food from my farm I would know it.”
Yes and no....

Yes...
- You probably have a relationship with many of the people who eat your food, or at least they know where to find you!

No...
- Most people blame the meal they consumed immediately prior to getting sick
  - Only the case with toxins and environmental contaminants
  - Typically takes days to weeks for illness to develop
- Many cases of foodborne illness go unrecognized
Necessary steps for outbreak recognition

1. Eat contaminated food
2. Develop illness
3. Seek medical attention
4. Laboratory test ordered
5. Laboratory test isolates a pathogen
6. Outbreak
“Food safety is only a concern for big agriculture”
Yes and no...

Yes...
- Products are co-mingled and processed (such as ready-to-eat) increasing the potential for cross contamination
- Longer storage and transportation increase the opportunity for improper handling
- Outbreaks usually large

No...
- Basic on-farm good agricultural practices apply to all farms regardless of size
Everyone from Farm to Fork is Responsible for Food Safety

For produce eaten fresh, there is no microbe-killing (heat) step. (i.e., no opportunity for corrective action).

Field (Plant, Grow, Harvest) → Processing (Wash, Pack) → Transport → Retail → Preparation

Points Most Susceptible to Contamination
Everyone from Farm to Fork is Responsible for Food Safety

For produce eaten fresh, there is no microbe-killing (heat) step. (i.e., no opportunity for corrective action).

Points Most Susceptible to Contamination
We’re here to help you with your food safety plan!
5 Routes of Microbial Contamination

- Agricultural water
- Biological soil amendments of animal origin
- Worker health and hygiene
- Equipment, tools, buildings and sanitation
- Domesticated and wild animals
It’s all about poop!

- Animal & human
  - Soil
  - Water
  - Contact surfaces
  - Hands
Cultivation: Contamination Sources

- **Soil**
  - Amendments (manure)
  - Prior contamination
  - Weather conditions (flooding)
- **Water**
  - Irrigation, applications
- **Animals**
  - Wildlife or domestic
- **Humans**
  - Workers and visitors
Land History: Any contamination?

- Prior use of land
  - Agricultural
  - Non-agricultural (e.g. dump site)

- Potential contaminants
  - Persistent chemicals
  - Carcass & manure
Cultivation: Soil Amendments

**Best Practices**

- Locate animals, manure and manure-based compost downslope or in a depression
- Use berms & buffer strips to protect crops from run-off
- Manure-based compost should heat to at least 131°F for at least 3 days
Cultivation: Soil Amendments

Best Practices

• Monitor composting process, temperature and turning

• Allow 120 days between application of raw manure or presence of livestock and harvest

• Watch out for recontamination!
Cultivation: Flooding

Best Practices

• Know areas on farm prone to flooding
• Plant lower risk crops in areas prone to flooding
  – e.g. corn, not lettuce
  – Inedible cash crops
• Construct berms and other physical barriers between water source and crop land
Cultivation: Water

Best Practices

• Keep livestock away from irrigation water sources

• Know your water quality:
  – Regular Water testing
    – Water quality should be appropriate for use
Water, water, everywhere…..

- Used for multiple on-farm purposes
  - Quality must match use
- Common source of microbial contamination
  - Promotes growth
  - Cross contamination
- Necessary for on-farm hygiene
  - Produce and people!
Taking a Water Sample

• Follow lab instructions (amount, timing, etc)

• Sample on low flow day (surface water)
  – Under conditions in which you would normally irrigate
  – Not after heavy rain

• Sampling
  – Potable water: tap
  – Surface water: pump valve or from body of water
## Water Testing: Frequency

<table>
<thead>
<tr>
<th>Type of Water Source</th>
<th>Testing Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal / Public</td>
<td>Not required</td>
</tr>
<tr>
<td>Well Water (drilled, dug, driven point wells)</td>
<td>1 time/yr</td>
</tr>
<tr>
<td></td>
<td>Beginning of season</td>
</tr>
<tr>
<td>Surface (ponds, rivers, streams, lakes, springs)</td>
<td>At least 3 times per year**</td>
</tr>
<tr>
<td></td>
<td>• Start of the season</td>
</tr>
<tr>
<td></td>
<td>• At peak use</td>
</tr>
<tr>
<td></td>
<td>• Prior to harvest</td>
</tr>
</tbody>
</table>
## Water Testing: Interpreting Results

<table>
<thead>
<tr>
<th>Water Use</th>
<th>Tests</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-harvest: Irrigation, frost protection, chemical or fertilizer application</td>
<td>E. coli</td>
<td>235 CFU / 100 ml *</td>
</tr>
<tr>
<td>Potable water for drinking, hand washing, crop washing &amp; rinsing, and post-harvest applications</td>
<td>Total coliform</td>
<td>0 CFU / 100 ml</td>
</tr>
<tr>
<td></td>
<td>E. coli</td>
<td>0 CFU / 100 ml</td>
</tr>
<tr>
<td></td>
<td>Nitrate</td>
<td>10 mg/L (NO$_3$-N)</td>
</tr>
</tbody>
</table>

*Above 235 CFU / 100ml, consider the following steps:
- Repeat testing
- Modify practices (call Extension to consult)
Cultivation: Irrigation

**Best Practice**
- Drip Irrigation

**Not as safe**
- Overhead spray
Modifying Practices Based on Water Tests

- Alter irrigation methods
  - Drip or drip under plastic
  - Trench Furrow
  - Overhead
    - Consider type of crop
      - Lettuce vs. corn
    - Maximize drying time between irrigation and harvest
Cultivation: Wildlife and Domestic Animals

Best Practices

• Cover or fence crops
• Use deterrents
  – Owl eyes, pie pans, etc
• Hunting & traps
• Avoid harvesting produce near animal feces
• Restrict domestic animals from fields (including U-pick) and production areas
Cultivation: Minimizing Animal Contamination and Crop Damage
E. Coli 0157:H7 in Strawberries

- Distributed to roadside stands and farmers markets
- Outbreak: 15 ill, 7 hospitalized, 1 death
- Environmental samples found E. coli identical to outbreak strain
- Deer suspected as source of contamination
Harvest: Keep it Clean!

Best Practices

• Keep harvest containers off the ground

• Avoid stacking soiled harvest containers on top of clean containers & produce
Harvest: Keep it cool!

Best Practices

• Harvest early
• Cover outdoor wash/pack areas for shade
• Cool to remove field heat, then *keep* cool
Harvest: Containers & Equipment

Best Practices

• Clean and/or sanitize harvest containers regularly
• Stack and store containers in covered area
• Maintain container of bleach solution to sterilize hand tools
Post-harvest: Washing

Best Practices

• Use potable water only for washing
• Change water often
• Double or triple rinse greens
• Add sanitizer*
  – Monitor pH & disinfectant levels
  – Adjust as needed

Reduced Microbial Load = longer shelf life + safer produce
Post-harvest: Surfaces

Best Practices

• Non-porous surfaces
• Screens and/or mesh
• Regular schedules for cleaning and sanitizing work surfaces and equipment
• Well-drained, cleanable floors
Post-harvest: Storage

Best Practices

• Store produce at optimal temperature for product
  – Monitor temp daily
• Avoid condensate
  – Dripping coolers
  – Avoid wet over dry goods
• Minimize time between harvest and sale (72 hrs)
  – First in, first out policy
• Wash cooler walls & floor regularly or as needed
Post-harvest: Pests Control

Best Practices

• Maintain a pest control program in processing and storage area
  – Keep grounds around food storage areas mowed & free of debris
  – Empty trash often
  – Locate compost away from stored produce
  – Remember to check the traps!
Old Barn Considerations
Transporting Produce

Best Practices

• Clean or sanitize transport vehicles especially after transporting:
  – Livestock
  – Meat
  – Manure or compost
  – Chemicals

• Cover produce during transport
Listeria in Cantaloupe

• Outbreak
  – 146 ill, 29 deaths, 1 miscarriage from 28 states

• Environmental Assessment
  – Listeria found on fruit, processing line, packing area and cold storage
Listeria in Cantaloupe (cont.)

• Introduction
  – Field, truck, used equipment

• Spread
  – Pooled water on floor near equipment and walkways
  – Facility and equipment not easily cleaned

• Growth
  – No pre-cooling step before cold storage \( \rightarrow \) condensation
Traceability: One step forward, one step back

Step 1. Map all production fields or greenhouses, and assign numbers to identify specific growing areas.

Step 2. Using a labeling gun, mark all produce packages with the date and location of harvest.

Tomatoes
L & J Farms
1 Bumpy Rd, Honolulu 96822
808-000-0000
Grown in Hawai'i, USA

TOTAL NET WT 16 oz (1 lb)

031100-2

L & J Farms
1 Bumpy Road
Honolulu, HI 96822
Phone: (808-000-0000)
Fax: [000-000-0000]

INVOICE
DATE: 3/12/2000
INVOICE #: 123456

ITEM # | DESCRIPTION       | QTY | UNIT PRICE | TOTAL  
-------|-------------------|-----|------------|--------
P1     | Papaya (031100.1) | 15  | 1.24       | 18.00  
T2     | Tomatoes (031100.2)| 200 | 0.35       | 70.00  

Step 3. Put the harvest date and location ID, on each invoice.
Tracking Produce

Best Practices

• Label containers for wholesale buyers
  – Farm name
  – Farm address / phone
  – Date of harvest / sale
  – Lot / field number

• Use of invoices combined with harvest log
  – Ability to trace lot / box of produce to harvest date and field

Label gun for pack codes

Pre-printed labels with farm name, address & phone
Recordkeeping for Produce Safety

Best Practices

• Water Tests
• Dates of raw manure application or livestock rotations
• Compost
  – Temp, turning
• Cleaning schedules
• Cooler temp monitoring
• Harvest / packing logs
• Wholesale invoices
Employee training
Humans hands are always a potential source of contamination.
Hepatitis A in Green Onions

• 2003 outbreak in PA
  – 601 patients
  – 124 hospitalizations
  – 3 deaths
  – 13/69 workers ill

• Grown in Mexico
  – Nucleic acid sequence identical and similar to Hepatitis A among travelers to Mexico
Worker Health and Hygiene

- Accessible toilet and hand-washing facilities
  - In field or accessible by vehicle

- First aid
  - Multiple accessible first-aid kits
  - Gloves over bandages
Worker Health and Hygiene

- Encourage proper hand washing
  - Running water
    - Cold is ok
  - Soap
    - Liquid or bar
    - Antimicrobial soap not necessary
  - Single use paper towels
  - Signs

Printable poster available at:
http://www.uvm.edu/~susagctr/?Page=gapresources.html
Worker Health and Hygiene

Sneeze in progress showing a plume of salivary droplets – yuck!

Worker Health

• Establish sick policy
• Find non-food contact work if:
  – Gastrointestinal symptoms: nausea, vomiting, diarrhea
  – Jaundice (yellowing of eyes and skin)
  – Fever
  – Respiratory symptoms if unable to contain secretions

Photo courtesy of CDC.
Visitors (CSAs, U-Picks)

- Request no dogs in production or packing areas
- Post informational signs as needed
- Encourage visitors to wash hands after touching livestock and before handling produce
Want more info?
## Extension Cost Tool

<table>
<thead>
<tr>
<th>Capital Cost</th>
<th>Annual Cost</th>
<th>First Year Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>$1,550</td>
<td>$980</td>
</tr>
<tr>
<td>Part 1</td>
<td>$500</td>
<td>$46</td>
</tr>
<tr>
<td>Part 2</td>
<td>$500</td>
<td>$174</td>
</tr>
<tr>
<td>RECORDS</td>
<td>$1,440</td>
<td><strong>estimate for maintaining records: .3hr/day x 240 days x $20/hr</strong></td>
</tr>
<tr>
<td>TOTAL</td>
<td>$2,560</td>
<td>$2,642</td>
</tr>
</tbody>
</table>

### General Section

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Documentati</th>
<th>Needed Purchases</th>
<th>Labor need</th>
<th>Up-Front</th>
<th>Annual Lab</th>
<th>Annual Mat</th>
<th>Annual Total</th>
<th>First Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART 2</td>
<td>Field Harvest and Packing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Pre-Harvest Assessment/A</td>
<td>Y</td>
<td>NA</td>
<td>.17 HR/WK X 32WKS X $21/ci</td>
<td>$109</td>
<td>$109</td>
<td>$109</td>
<td>$109</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Field Sanitation Units Comp</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Toilet available</td>
<td>N</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Filed Sanitation units placed</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Response plan for Sanitation</td>
<td>SOP</td>
<td>DONE</td>
<td></td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Harvest containers cleaned</td>
<td>Y–ALREADY</td>
<td>SANITIZER–PERIOD</td>
<td>3 X 1 HOURS</td>
<td>$500</td>
<td>$30</td>
<td>$30</td>
<td>$530</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Hand harvest tools (knives)</td>
<td>Y</td>
<td>NA</td>
<td>.08 HR/WK X 40WKS X $1/ci</td>
<td>$35</td>
<td>$35</td>
<td>$35</td>
<td>$35</td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>Damaged containers fixed</td>
<td>N</td>
<td>???</td>
<td>???</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>Harvesting equipment in good condition</td>
<td>N</td>
<td>Already doing it</td>
<td>???</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>Glass on Field Equipment</td>
<td>N</td>
<td>???</td>
<td>???</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.11</td>
<td>Plan for glass breaking in field</td>
<td>SOP</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.12</td>
<td>Plan for various field containers</td>
<td>SOP</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.13</td>
<td>Remove dangers/toxic items</td>
<td>SOP</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.14</td>
<td>Produce container policy</td>
<td>SOP</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.15</td>
<td>Post-harvest water is micro</td>
<td>RECORD</td>
<td>NA–DO NOT REUSE</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.16</td>
<td>Remove excess dirt/mud from</td>
<td>N</td>
<td>NA</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.17</td>
<td>Transportation Equipment</td>
<td>Y</td>
<td>NA</td>
<td>ALREADY DOING IT</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.18</td>
<td>Cover produce during transport</td>
<td>SOP</td>
<td>ALREADY DOING IT</td>
<td>NA</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.19</td>
<td>New/clean field pack container</td>
<td>Y</td>
<td>INCLUDED ABOVE</td>
<td>INCLUDED ABOVE</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.20</td>
<td>Field pack containers well-served</td>
<td>N</td>
<td>INCLUDED ABOVE</td>
<td>INCLUDED ABOVE</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>2.21</td>
<td>Product ID for traceability</td>
<td>Y</td>
<td>HARVEST MAP–INCLUDED ABOVE</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td></td>
</tr>
</tbody>
</table>
That’s it folks!