

# Good Agricultural Practices

---

## Reduce Risks of Microbial Contamination During Production



# The Produce 'Outbreak' Chain Reaction

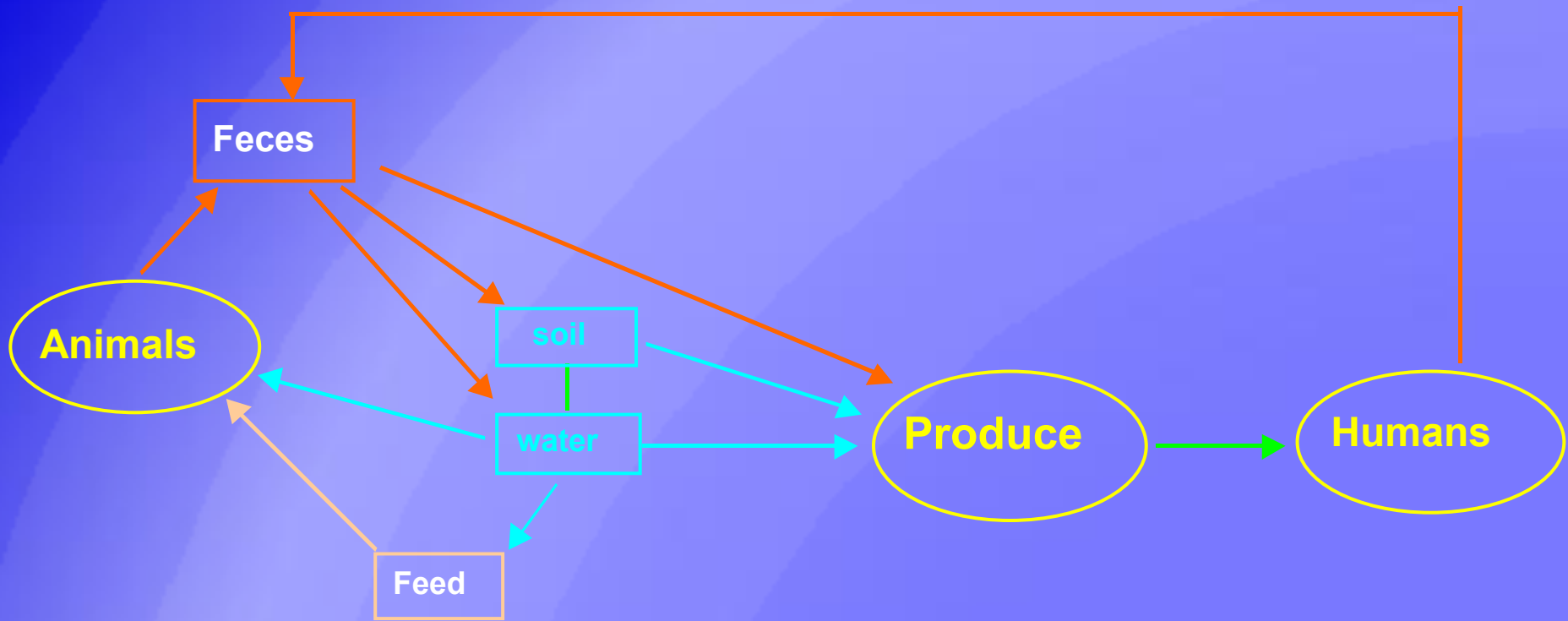
---

- Consumers become ill.
- Consumers lose confidence in safety of food.
- People eat less produce, decreasing sales.
- Works against “5-A-Day” nutrition programs.
- Leads to unwanted legislation or regulation.

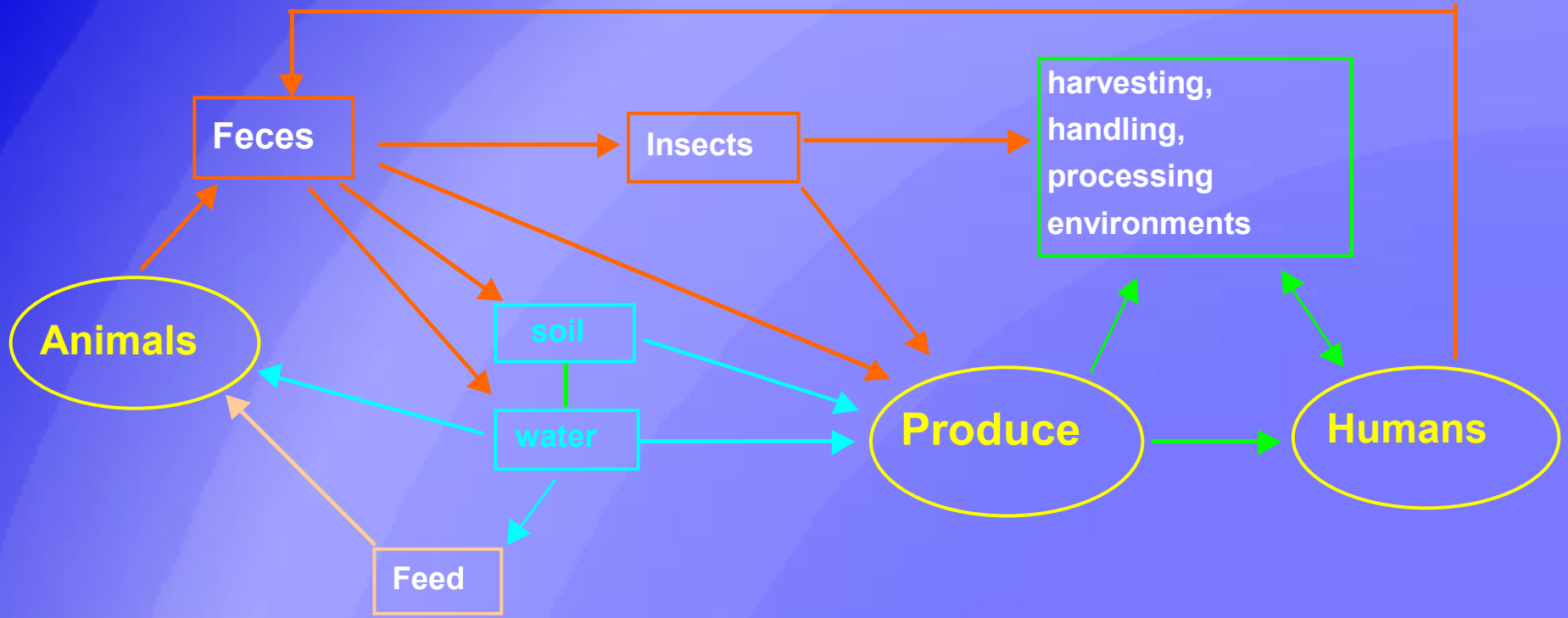




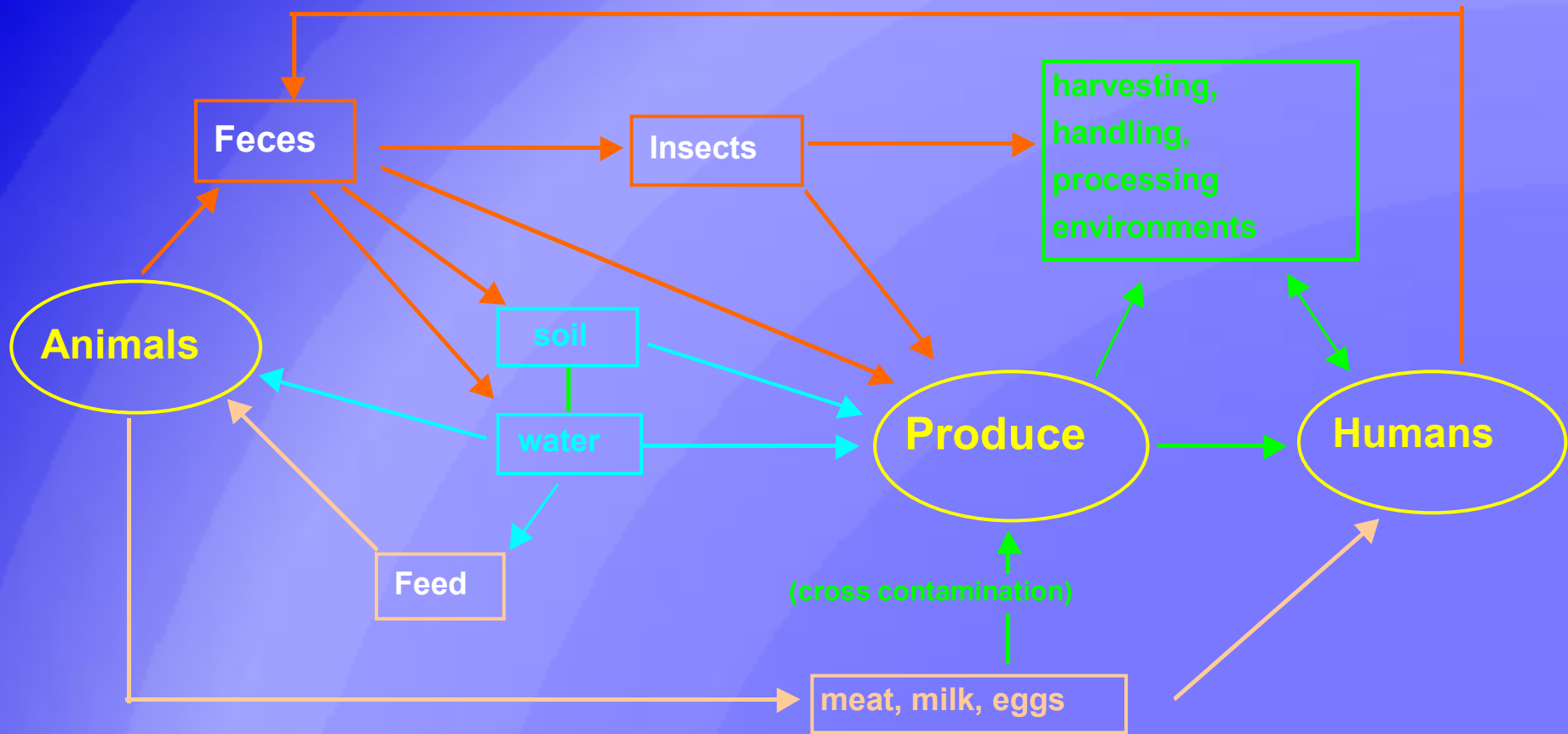
Modified from Beuchat, 1996



Modified from Beuchat, 1996



Modified from Beuchat, 1996



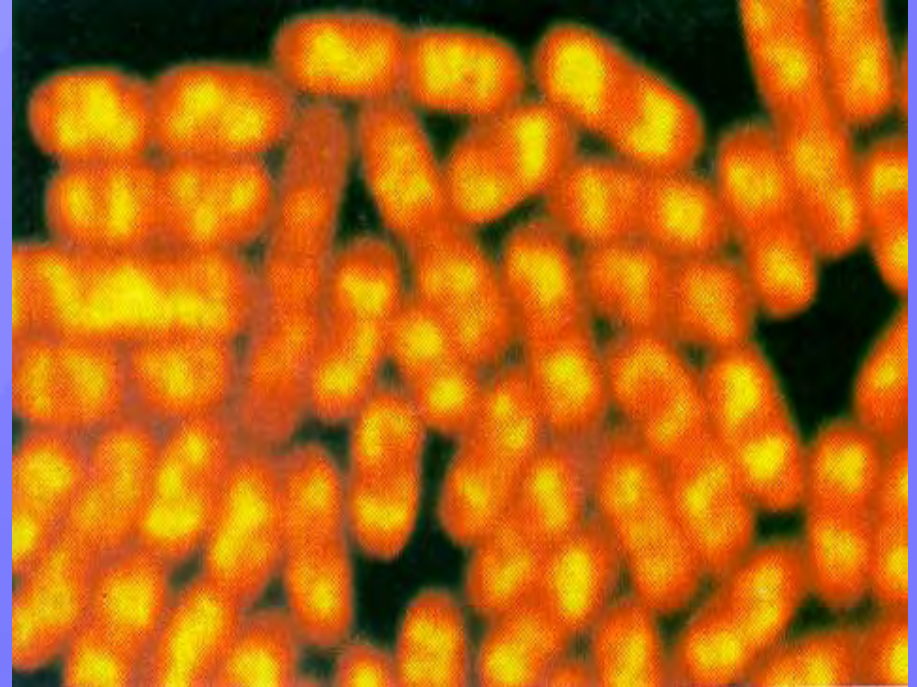
Modified from Beuchat, 1996

# Naturally Occurring Bacteria

---



*E. coli*



*Salmonella*



# Good Agricultural Practices Can Reduce Food Safety Risks

---

- **Good Agricultural Practices (GAPs) for food safety include Best Management Practices (BMPs) to protect the environment.**
- **These same practices that reduce losses of soil and nutrients can reduce risk of microbial contamination of produce.**
- **Keeping records of production practices allows regular updates of plans.**

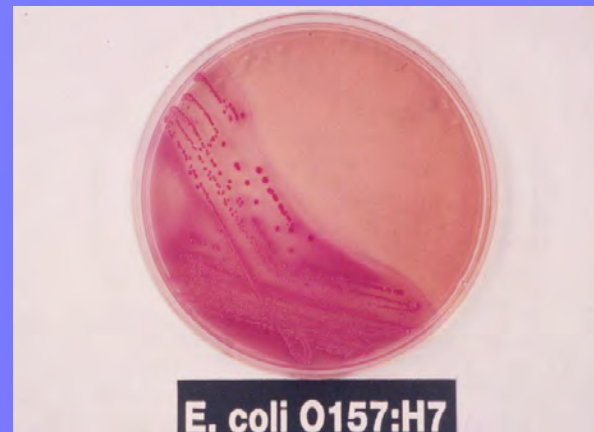
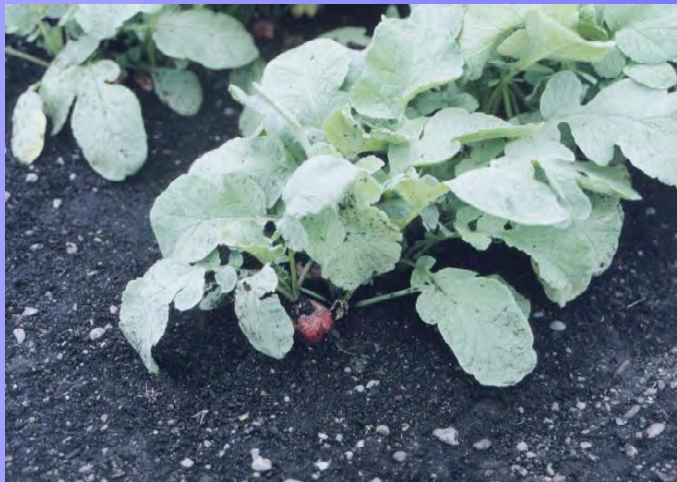




# Reduce Plant Diseases

---

- Many bacteria behave the same in the environment.
  - *E. coli* / *Salmonella* vs. Bacterial Leaf Spot / decay
- Many BMPs that decrease plant pathogens also decrease human pathogens.



# Reduce Post Harvest Loss

---

- Post-harvest management practices that reduce loss to spoilage or shrinkage will reduce risks.
- These include sorting, quick cooling, chlorinated wash water, and good refrigerated storage and shipping.



# Review Field Management Practices to Reduce Risks

---

- **Manure**
- **Crop Selection and Management**
- **Water quality**
- **On-Farm Planning and Documentation**



# Manure = Fecal Matter = Microbes

---

- Human or animal: **DO EVERYTHING** you can to keep manure off produce.
- Preventing contamination is the goal.



# All Manure Can Carry Pathogens

---

- **Livestock**
  - cattle, swine, poultry, horse, & sheep
- **Dog and Cat**
- **Bird**
- **Rodent**
- **Deer**
- **Fly or other insect**
- **Human**



# *E. coli* 0157:H7 Sources

---

- Water
- Manure of young or transitioning livestock (feed or housing)
  - 5% of post wean heifers shed *E. coli* 0157:H7
  - 2% calves
  - 1% adults cows
- Manure of other animals



# *E. coli* 0157:H7 Has a Seasonal Pattern

---

- Most prolific under warm humid conditions.
- Frequently traced back to moist animal feed and water troughs.



# *E.coli* and Other Bacteria are Vulnerable to Competition

---

- In soils, *E. coli* O157:H7 levels decrease over time due to natural conditions.
- Incorporation reduces physical transmission risk (splash) and increases competition.
- High temperature, aerobic composting of manure reduces levels quickly.





# Plan Herd Health and Manure Management

---

- Use environmentally sound manure treatments, applications, and disposal.
- Work with veterinarians to create biosecurity plans.
  - feeding programs
  - animal isolation



# On-Farm Manure Handling

---

- **Manure**
  - Store for 6 months prior to field application.
  - Compost manure correctly.
- **Slurry storage systems and waiting periods**
  - Wait 60 days in summer and 90 days in winter prior to spreading.
  - Consider satellite storage or special management for slurry destined for vegetable ground.



# Salmonella survives for long periods under conditions common on the livestock farm

Pasture and soil ---- 200 days

Garden soil ---- 251 days

Liquid manure --- 27 days ( S. Dublin), ---  
286 days ( S. Anatum)

Slurry - 84 to 250 days

Infected feces stored in cans -  
159 days ( S. Dublin)



New York State Cattle  
Assurance Program



# Compost Manure Properly

---

- **Manage piles to have active, uniform composting.**
  - High temperatures, good moisture, proper aeration, and mixing.
  - Weed seeds killed means good composting conditions were achieved.
- **Exclude animals from compost area to prevent recontamination.**



# Composting Research

- Larneyet al. (2003) reported that more than 99.9% of *E. coli* was eliminated in the first 7 days of windrow composting with temperatures ranging from 33.5 to 41.5 °C (92 to 107°F).
- Johannessenet al. (2005) demonstrated that composting animal manure for 40 days during which a temperature of >60 °C (140 °F) is maintained for at least 5 days is effective at removing *E. coli*.



# Recommendations for Composting

- Carbon source and aeration method don't seem to make a difference, but composting in windrows is more effective than in enclosed vessels.
- Be sure to compost in such a way that the compost reaches 130-140°F for two 5-day cycles.

Dr. Jessica Davis, Colorado State University



# Manure Application

---

- Do not assume any manure is 'clean'.
- Incorporate, Incorporate, Incorporate
- Absolutely NO SIDEDRESSING with fresh manure.
- Know manure source and handling.



# Time manure applications WISELY

---

- Following recommendations to minimize negative environmental impacts.
  - Timing of manure spreading now regulated in Maine and Vermont.
- In the fall, apply to cover crop.
- In the spring, incorporate two weeks prior to planting.





# Target manure applications WISELY

---

- If applying manure in spring, target agronomic crops (grain) or new perennial plantings (apple or strawberry).
  - Crops not targeted for direct human consumption
  - Delayed harvest reduces risk (perennials)



# Observe Pre-Harvest Intervals for Manure

---

If applying manure in spring to fruit and vegetable fields, wait 120 days to harvest.

- Not all pathogens die at the same rate



# Keep Records of Manure and Compost Use

---

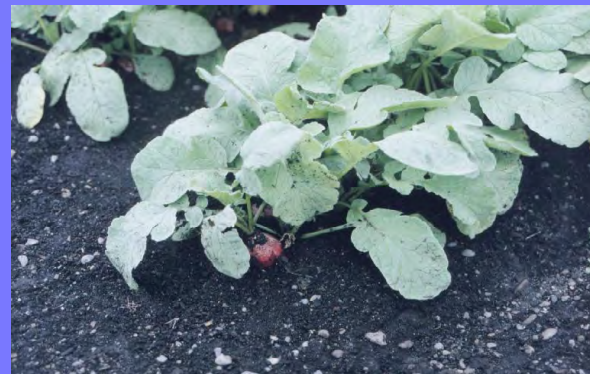
- Know your source of manure or compost.
- Know the methods used to produce compost or the manure storage time.
- Keep records of application rates, timing, and fields receiving manure or compost.



# Crops for Manured Fields

---

- Avoid root/low growing crops (lettuce, beets) in season manure is applied.
- Avoid crops consumed fresh or those where leaves are eaten by humans.
- Apply manure to ground where perennials are being planted.



# Crop Management

---

- Use trellis/staking where appropriate, such as tomatoes.
- Use plastic mulch and drip irrigation to reduce leaf wetting.
- Use organic mulches to reduce splash.



# Exclude Animals

---

- Keep wildlife out of production areas as much as possible.
- Manage rodents and birds in packing houses and storage areas.
- No weeder geese in fields prior to harvest.
- No dogs or other pets in the field.



# Water Carries Pathogens

---

- *E. coli* 0157:H7 viewed primarily as a water-borne pathogen.
  - Many outbreaks associated with recreational water.
- *Salmonella*, *Giardia* and *Cyclospora* outbreaks on produce caused by contaminated water.



# Water Management



- Select water source based upon agricultural use.
- Clean water quality is most important when in direct contact with edible portion of crop close to or at harvest.

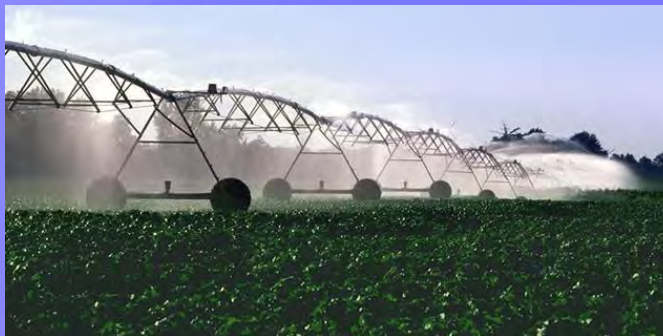




# Water Management

---

- Choose application method and treatment to reduce risk
  - Drip has a lower risk than overhead irrigation
  - Chlorinate dump tanks and wash water
- Keep records of water tests



# Know Water Source Quality

---

- **Best source (lowest risk) is drinking water, such as municipal.**
- **Ground water is less likely to have microbial contaminants than surface water.**
- **Surface water quality and pathogen levels are affected by watershed activities and season.**



# Surface Water Contamination Sources

---

- Livestock
- Sewage treatment facilities
- Wildlife



# Well Water Contamination Sources

---

- Poorly maintained wells or pumps
- Livestock in active well recharge area



# Irrigation Water Environmental BMPs

---

- Drip irrigation maximizes water use efficiency (WUE) and keeps leaves dry.
  - WUE is yield per volume water added as irrigation
- If applying overhead, apply early in morning to conserve water.
  - Speeds leaf drying time
  - Reduce crop diseases



# Irrigation Water Microbial BMPs

---

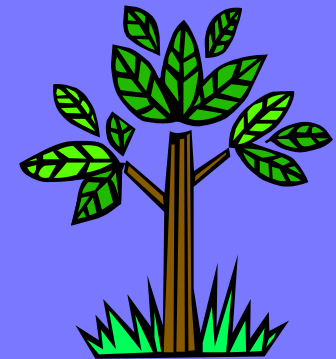
- Drip Irrigation has lowest risk
- Overhead irrigation
  - Source determines risk
  - Apply to minimize leaf drying time
  - Longer periods between overhead irrigation and harvest lowers risk



# Spray Water Quality

---

- Use potable (drinking) water for pesticide sprays.
- When potable water is not available, test water quality and keep records.
- Low water volumes reduce risk.



# Water Testing

---

- Research relating to field irrigation water quality and risks is still needed.
  - Fecal coliform count  $<$  than 100 per 100 mls is one recommendation
  - Survival on produce surfaces is variable
- Fecal coliform as an indicator of water quality only partially useful.
  - Not always correlated to pathogens
  - Does suggest general contamination





# Common Questions

## Enumeration of Irrigation Water Test

For Idaho - 576 *E. coli* organisms/100 ml of sample or less

A policy statement should be included in your SOP outlining the step(s) that will be taken if *E. coli* levels exceed this threshold

# Water Testing Frequency

---

- Annually with municipal water
- Quarterly with groundwater
- Test surface water for quality assurance
  - 3 times during season in temperate climates
    - at planting (high flow)
    - at peak use (low flow)
    - at harvest
  - Quarterly in more southern climates
- Maintain good records of results



# What Can You Do?

---

- Learn about the risks.
- Develop a plan.
- Document your actions.
- Strive to reduce risks.



---

# On Farm Food Safety Plan: Where to Begin?

---



# Farm Food Safety Plan Describes:

---

- Manure storage and handling
- Animal exclusion (domestic & wild)
- Irrigation and drainage management
- Equipment sanitation
- Harvest and post harvest handling
- Employee training program
- Restroom & hand washing facilities
- Crisis management strategy



# Start with What You Know !

---

- Assess your operation, pre-plant through post-harvest handling.
- Identify areas that you know are high risk or areas of concern.
- Consider farming practice modifications that will reduce the risks AND are economically feasible.
- Document your progress.



# Be Active and Be Ready

---

- Make changes to practices as needed.
- Keep good records of all production practices, especially manure use and water tests.
- Teach employees the importance of prevention strategies.
- Work with upstream neighbors and local watershed committees on management goals
- Update your plan regularly.



# Good Agricultural Practices for Managing Food Safety Risks Continue to Evolve

---

As new research becomes available, recommended practices may change.





# GAP Audit and Marketing

- Direct marketing (eg. Farmers' Markets)
  - Not required yet
  - Customer/Consumer request
  - Discussion continues
  - All should have a farm/food safety program in place regardless of audit
  - Have working knowledge of GAP requirements
  - Look over GAP audit- improvements to farm program
  - Advantage: Market to customers you are GAP certified?





# Strawberries and OR Farmers' Market

- “E. coli O157:H7 attributed to Oregon strawberries sold at farmers markets and roadside stands. At least 15 illnesses and one death were likely caused by the strawberries, which possibly were contaminated by deer feces in the field.”

- 
- Regardless if have a formal audit or not, you should have a food safety program on farm
    - Resources available
      - FamilyFarmed.org – “Create Customized Food Safety Plans for Free” – Prepares you for an audit
    - Knowledge of your high risk areas
    - Prepared for customer request(s)

# Food Safety Program or GAP Audit

- Develop Food Safety Plan (Protocols)
- Two critical components
  - Education of employees
  - Documentation of practices

# What is the USDA GAP Audit?

- Series of questions to ensure a food safety program was developed and utilized for the farm
- Some questions require records, documentation, policy statements or yes/no/not applicable answers.
- Need a farm tailored standard operating procedure (SOP)



# USDA GAP and GHP Audit for Fruit and Vegetable Programs

Released: May 11, 2007  
Revised: November 9, 2009  
Revised June 2011



# USDA GAP Audit



- Universal for all fresh fruits and vegetables
- Commodity specific standards and audits complete for tomatoes, mushrooms and leafy greens
- FDA specific guidance documents for leafy greens, melons, tomatoes, fresh cut fruits and vegetables

# GAP Resources

USDA: Fresh Product Grading and Quality Certification and the User's Guide:

[www.ams.usda.gov/fv/fpbapghp.htm](http://www.ams.usda.gov/fv/fpbapghp.htm)

ISDA FFV Food Safety Program:

[www.idahoag.us/Categories/InspectionsExams/FoodSafety/indexfoodSafetyHome.php](http://www.idahoag.us/Categories/InspectionsExams/FoodSafety/indexfoodSafetyHome.php)

GAP Network for Education and Training Cornell University: [www.gaps.cornell.edu](http://www.gaps.cornell.edu)

University of Idaho GAP Audit Manual for potatoes:

[www.kimberly.uidaho.edu/potatoes/gap.htm](http://www.kimberly.uidaho.edu/potatoes/gap.htm)





# Discussion



# Acknowledgements

---

This presentation created by Anusuya Rangarajan,  
Marvin P. Pritts and Elizabeth A. Bihn.

Images provided by USDA (92cs0587, 94cs3904,  
94c3824, 99c1541, 95cs1969, 80cs0453, 96c1794,  
97c3121, 95cs2808, 93cs3825, 95c4185, 93cs3829,  
95c7125, 85c0114, 96c0197), Barbara Bellows,  
Anusuya Rangarajan, Courtney A. Weber, Donna L.  
Scott, and Yuan Chen.

GAP slides from Dr. Nora Olsen, UI Potato Specialist

