THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

COLLEGE OF EDUCATION AND HUMAN ECOLOGY

Agricultural Water Quality & Testing Workshop

Connecting Produce Growers in Ohio with Water Testing Laboratories

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Lindsey Hoover, OARDC

Water Quality Workshop

Part I: Agricultural Water, Sanja Ilic PhD 30 min

- Production water quality, indicators
- Preventing the risks

Part 2: FSMA revisions and requirements.
Lindsey Hoover, OARDC 30 min

- Outline of the standard
- Proposed requirements for untreated surface water
- Establishing the baseline and water quality profile

FSMA
What you need to know about water testing

Part 3: A to Z of water testing in a commercial lab, Gary Horrisberger

- Sampling procedures at the farm
- Sample storage and drop off
- In the lab: hands-on
- Get back in compliance
- Record keeping

Objectives

- Discuss the different uses for agricultural water
- Identify risks that impact the microbial safety of water sources
- Describe Indicators of contamination and importance of testing
- Risk Assessment: describe how application method and timing of water can impact crop contamination
- Risk Reduction: identify practices to reduce the potential for production water to contaminate produce
- Describe current water quality standards that are used to assess the microbial quality of water

Objectives

- Describe appropriate sampling procedures
- Describe storage, transport and drop off of water samples
- Describe the testing process in a commercial lab (microbiological tests, sample processing)
- Describe the options for getting back into compliance

Production vs. Post-harvest Water

Production: Agricultural water is used during produce growing activities for (other than sprouts) using a direct water application method

Direct contact with harvestable part of produce

- Irrigation
- Fertigation
- Crop sprays
- “Teas”
- Cooling

- Frost protection
- Dust abatement
- Crop establishment
- Other water uses

Post-harvest Water

Water that comes in direct contact with produce or food contact surfaces

Different standards!

- Commodity movement or cooling
  - (i.e. dump tanks/flumes)
- Ice
- Any postharvest application (fungicide, wax)
- Handwashing
- Cleaning and sanitizing

Agricultural Water Quality

- Pathogen microorganisms may be in water and contaminate produce.
- Many sources and uses of water on the farm.
- Many factors may impact the quality of water.
  - Application method, time

Outbreaks 1998-2008

Produce Type	*STEC E. Coli*	*Norovirus*	*Salmonella*	*Hepatitis A*	*Cyclospora*	*Shigella*	Total
Leafy greens	**42**	**187**	**17**	3	1	**9**	**281**
Sprouts	6	0	**19**	0	0	0	**35**
Tomato	0	7	**22**	1	0	1	**32**
Melons	0	6	7	0	0	1	**30**
Leafy green herbs	5	0	6	0	8	3	**23**
Carrots	0	5	3	0	0	2	**11**
Berries	0	2	1	2	0	1	**10**
Peppers	0	0	2	0	0	0	**10**
Fruit(s)	3	**32**	7	0	1	1	**56**
Vegetable(s)	3	**20**	7	3	0	0	**49**
Total	**70**	**311**	**136**	**15**	**17**	**21**	**643**

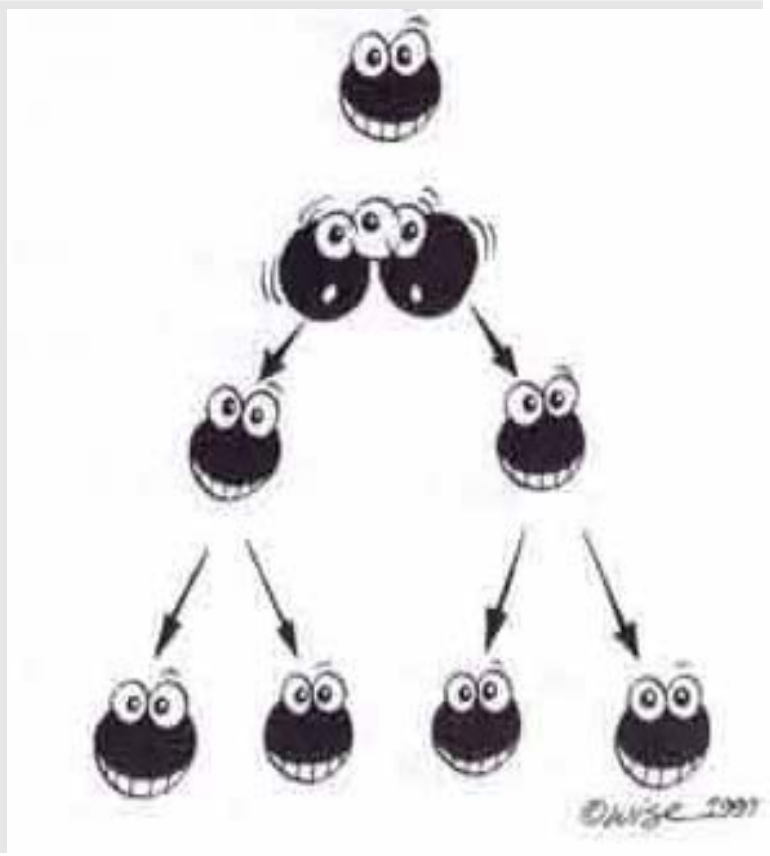
Source: Scoping review data, Ilic 2011

Water Microbiology

- Organisms that are too small to be seen with the naked eye
  - Bacteria
  - Viruses
  - Parasites

Growth of Bacterial Cells

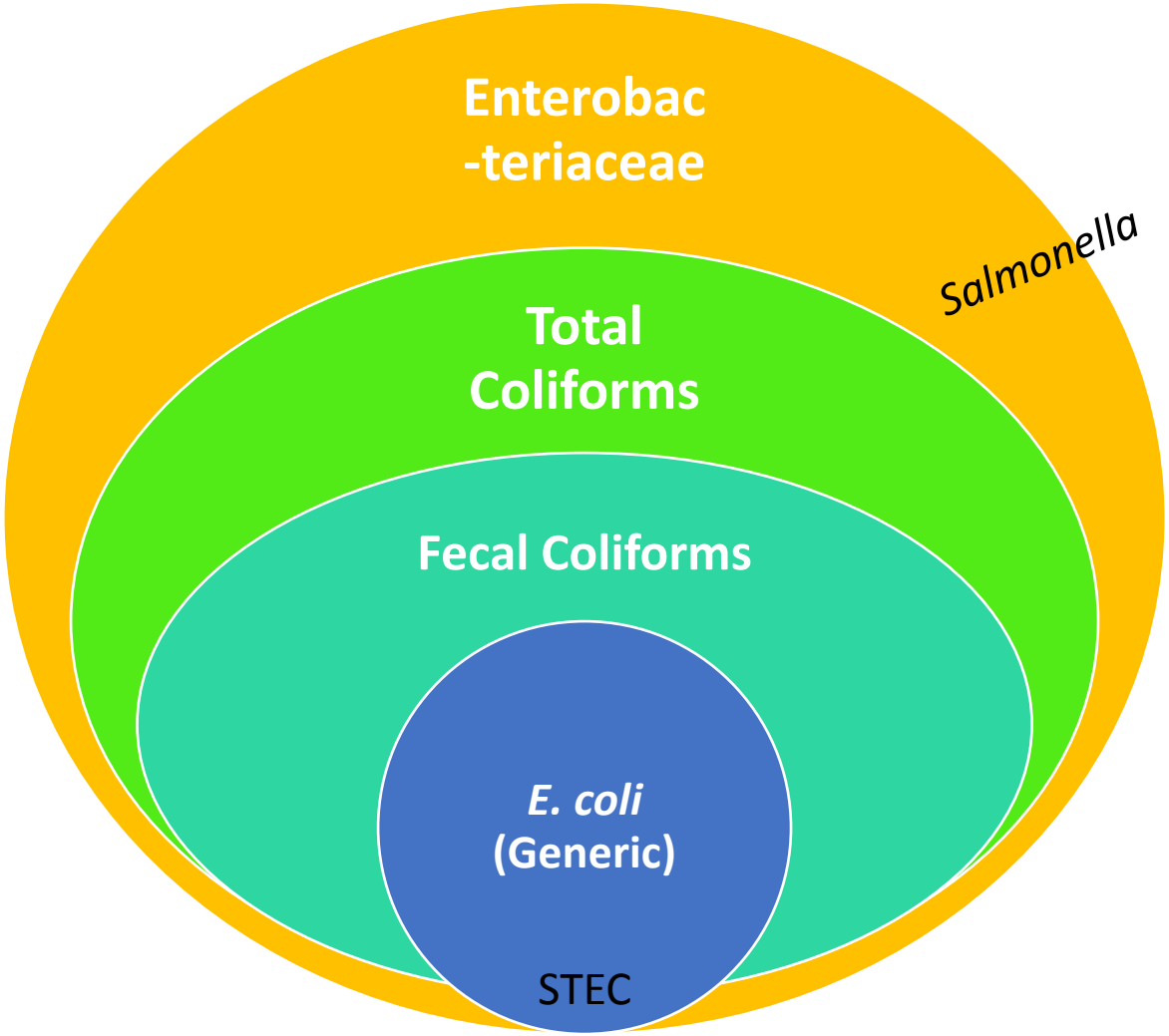
- Called “growth” or “multiplication”
- Under *the best* conditions
  a cell can divide every
  20 to 30 minutes



Multiplying Bacteria:
30 minute doubling time

- **8 a.m.** — **1 cell**
- **9 a.m.** — **4 cells**
- **10 a.m.** — **16 cells**
- **11 a.m.** — **64 cells**
- **12 p.m.** — **256 cells**
- **1 p.m.** — **1024 cells**
- **2 p.m.** — **4096 cells**
- **3 p.m.** — **16,384 cells**
- **4 p.m.** — **65,536 cells**
- **5 p.m.** — **262,144 cells**
- **6 p.m.** — **1,048,576 cells**

Indicators: Coliforms and generic *E. coli*



Coliforms

A Non-fecal: Soil, vegetation, insects
B Fecal: Human sewage and animal waste- septic systems, sewage spill, animal yards, run-off etc.

- Aerobic or facultative anaerobic, Gram$^-$
- Non-spore forming rods

- Test media include lactose with dyes and/or surface-active agents
- Ferment lactose, forming acid and gas within 48 h at 35°C
- Fecal at 44.5 to 45.5°C

E. coli

- *E. coli* is both a coliform and a fecal coliform
- Found in the intestinal tract of warm-blooded animals

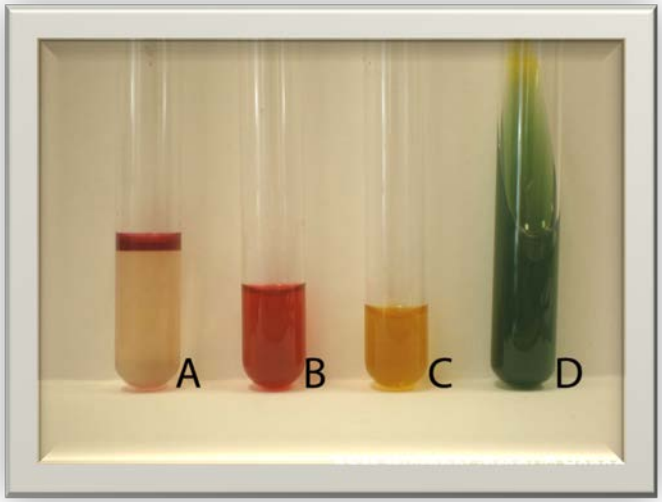
Traditionally *E. coli* was identified with the "++---" or "-+---" pattern in the IMViC test

"I" – produces Indol from tryptophan metabolism

"M" – ferments glucose to high acid, measured by Methyl Red

"Vi" – Vogues-Proskauer reaction (2,3 butaendiol/ acetoin from glucose)

"C" can use citrate as a sole source of carbon



Coliforms and *E. coli* as indicators

- In theory, indicator organisms signal the increased likelihood of pathogen presence
- Ex = presence of generic *E. coli* in water as an indicator of *Salmonella* contamination
- Numerous studies have determined that:
  - Indicator organism presence does not always mean presence of a pathogen
  - Indicator organism absence does not always mean absence of a pathogen

Coliforms and *E. coli* as indicators

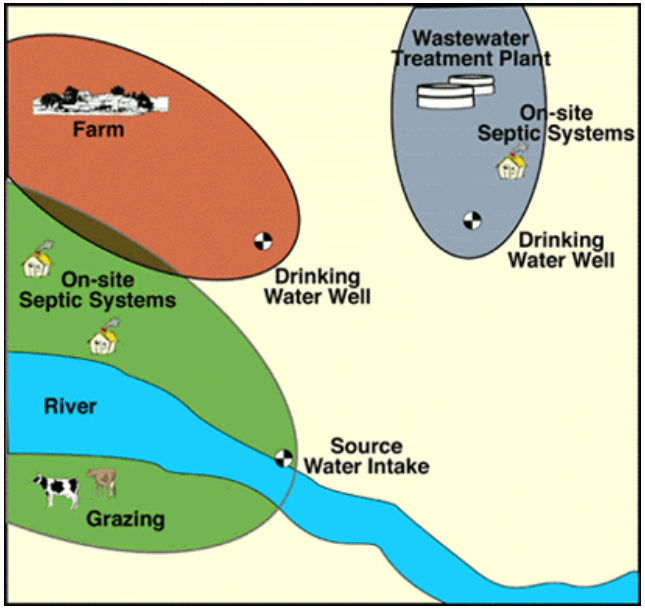
- Use is most useful in an assessment of the overall quality of hygienic conditions present during production
- *E. coli* is regarded as being the most valid indicator of fecal contamination of raw foods

Sources of Contamination

Agricultural run off

Manure application

Wildlife



Waste water discharge

Storm water

Septic tank/ sewage

Susceptibility to Contamination

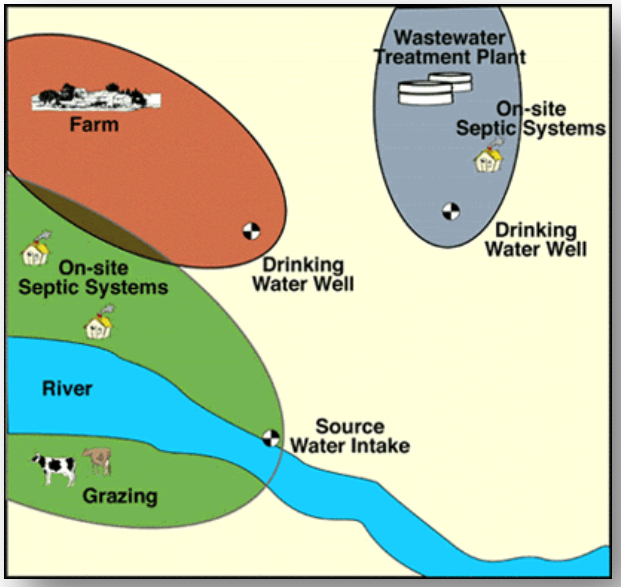
Lower Risk → **Higher Risk**

Public Water Source	**Ground**	**Surface**
		
Treated	Protected	Open to Environment

Curtesy of Dr. Betsy Bihn, Produce Safety Alliance

Understand your water source

- Source, distribution system
- Inspect the entire agricultural water system under your control, identify any conditions that are reasonably likely to introduce known or reasonably foreseeable hazards



- Assess surrounding areas, topography, water source, distribution methods, and animal activity (both wild and domestic)
- Can help reduce the chances that water sources become contaminated.
- Test water, establish baseline

Preventing Contamination of Surface Water Sources

- Assess nearby land use and upstream water activities to identify risks
  - Work with neighbors and local watershed groups to understand and minimize identified risks
- Assess run-off risks
  - Install berms or containments to minimize run-off from manure and compost piles, livestock feeding areas, or storm run-off
- Monitor and control animal access to irrigation water sources where practical (e.g. irrigation reservoirs)

Source: E. Bihn, G. Wall

Preventing Well Water Contamination

- Inspect well to ensure it is in good condition
- Inspect well head to ensure it is properly capped and elevated
- Be sure land slopes away from well head to prevent run-off contamination into the well
- Install backflow prevention devices

Source: E. Bihn, G. Wall

Preventing Public Water System Contamination

- Public water systems are treated to meet microbial drinking water standards, but if there is reason for concern:
  - Assess the delivery system downstream of the individual connection to the public water system
  - Test the water if you have any concerns

Source: E. Bihn, G. Wall

Less Contact with Water = Lower Risk

- If no contact the risk from water is reduced
- If there is direct contact of water with harvestable part of the produce the quality of the water and the timing of the application should be assessed
- Testing

Source: E. Bihn, G. Wall

Water Application and Timing

- If water contacts the harvestable portion of the crop, maximizing the time to harvest may reduce the risk
- Proposed FSMA Produce Rule outlines a microbial die-off rate of 0.5 log per day between the last irrigation event and harvest
  - *This will be important if your water does not meet standard criteria!*

Key Points

- Determine water source quality through testing
- If the water application method DOES NOT contact the harvestable portion of the crop, the risks are lower
- Extend time between application of water and harvest to reduce risks if water quality is a concern
  - Consider 0.5 log reduction per day
- Treating water is an option to reduce risks

Acknowledgements

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