International Association for Food Protection® WEBINAR

IAFP's Foundations of Produce Safety in Hydroponic and Aquaponic Operations

Organized by: The Fruit and Vegetable Safety and Quality PDG

Moderator: Gretchen Wall, International Fresh Produce Association

Chair of the Fruit and Vegetable Safety and Quality PDG

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Webinar Housekeeping

- It is important to note that all opinions and statements are those of the individual making the presentation and not necessarily the opinion or view of IAFP.
- All attendees are muted. Questions should be submitted to the presenters during the presentation via the Questions section at the right of the screen. Questions will be answered at the end of the presentations.
- This webinar is being recorded and will be available for access by IAFP members at www.foodprotection.org within one week.

IAFP Fruit & Vegetable Safety & Quality PDG Updates

- Elections for Vice Chair – coming soon!
  - Nominations can be sent to Gretchen (gwall@freshproduce.com)
- IAFP Pittsburgh, PA – FVSQ PDG Meeting
  - Sunday, July 31, 2022 from 1-3 PM ET in Room 406
  - Development of annual PDG meeting agenda – send your ideas to Gretchen (gwall@freshproduce.com) or Kristin (Kristin.Esch@fda.hhs.gov)
- Other ideas, announcements, opportunities for learning?
  - Feel free to share directly via IAFP Connect or send to Gretchen/Kristin to share with group

Today's Moderators

Gretchen Wall, M.S.

Chair of Food Safety Education PDG

Director, Food Safety & Quality International Fresh Produce Association

Gretchen is the Director of Food Safety and Quality at the International Fresh Produce Association (IFPA) which was created from the transformation of the legacy associations Produce Marketing Association (PMA) and United Fresh Produce Association (United Fresh). She supports IFPA members and industry stakeholders by providing technical support, educational opportunities, and science-based information on all aspects of product safety and quality from farm to fork.

Gretchen's background in food science and food safety enables her to assist a wide variety of food producers as they navigate complex regulatory requirements and market demands. Her background in education and extension at Cornell University's Produce Safety Alliance allows her to guide growers and packers toward practical and achievable food safety outcomes, foster long-term business viability, and work towards achieving public health goals.

Gretchen earned her M.S. in Interdisciplinary Studies in Food Science and Safety at Colorado State University and her B.S. in Food Science at The Pennsylvania State University. She is the current Chair of the International Association of Food Protection's (IAFP) Fruit and Vegetable Safety and Quality Professional Development Group and a Provisional Subject Matter Expert for the Center for Produce Safety (CPS) Technical Committee.

Today's Panelist

Sean Fogarty, Research Specialist

Northeast Center to Advance Food Safety (NECAFS)

Sean Fogarty is a Research Specialist at the Northeast Center to Advance Food Safety (NECAFS), which is a regional food safety hub based at University of Vermont Extension. Before joining NECAFS, he earned a B.S. in Sustainable Agriculture and Food Systems at the University of New Hampshire (UNH) as a non-traditional student while also holding several research assistant and technician positions contributing to long-term ecological and agricultural research projects. He then earned an M.S. in Agricultural Sciences from UNH, where his thesis research focused on water quality and produce safety in coupled aquaponic systems. In his current role at NECAFS, Sean is contributing to regional and national research efforts and the development of educational resources regarding produce safety in hydroponic and aquaponic operations for growers, regulatory officials, extension educators, and other stakeholders.

Foundations of Produce Safety in Hydroponic and Aquaponic Operations

Sean Fogarty – Presenter

Northeast Center to Advance Food Safety (NECAFS)

sean.z.fogarty@uvm.edu

Gretchen Wall – Organizer

International Fresh Produce Association

gwall@freshproduce.com

PC: Nicholas van der Wal

Webinar Outline

- Learning Objectives
- Attendee Poll
- Presentation – Learning Objectives:
  1. What do hydroponic and aquaponic operations look like?
  2. What are key produce safety considerations in hydroponic and aquaponic operations? (Applying the IPS pyramid in HP/AP)
  3. What are the primary considerations relevant to FSMA Produce Safety Rule compliance in hydroponic and aquaponic operations? (Applying the PSR in HP/AP)
- Discussion / Q&A

Learning Objectives

1. Understand what hydroponic and aquaponic (HP/AP) operations look like and the amount of diversity among operations.

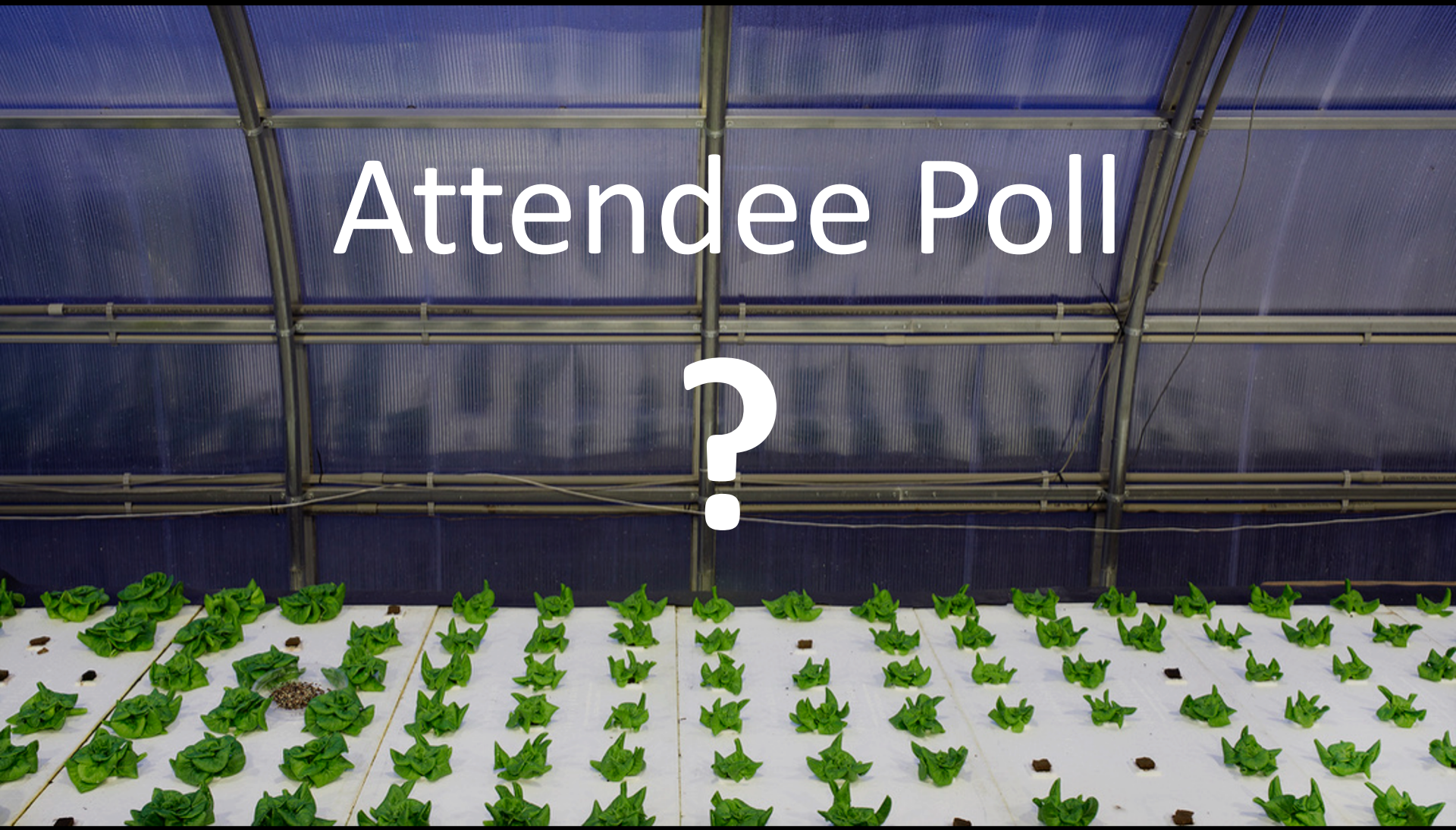
2. Gain awareness of key topic areas relevant to produce safety in HP/AP operations.

3. Understand the primary considerations relevant to PSR compliance in HP/AP operations.

4. Participants share questions, experiences, and perceived educational and research needs, contributing to discussion and future programming and materials development.

Attendee Poll

?



PC: Nicholas van der Wal

Learning Objective 1:

What do hydroponic and aquaponic operations look like?

- Hydroponic system types
- Defining Aquaponics
- Diversity of operations

Definitions To Remember

Hydroponics

Soil-free plant farming

Aquaponics

Fish farming + soil-free plant farming

Aquaculture

Fish Farming

HP/AP = Hydroponics and Aquaponics

PC: Todd Guerdat

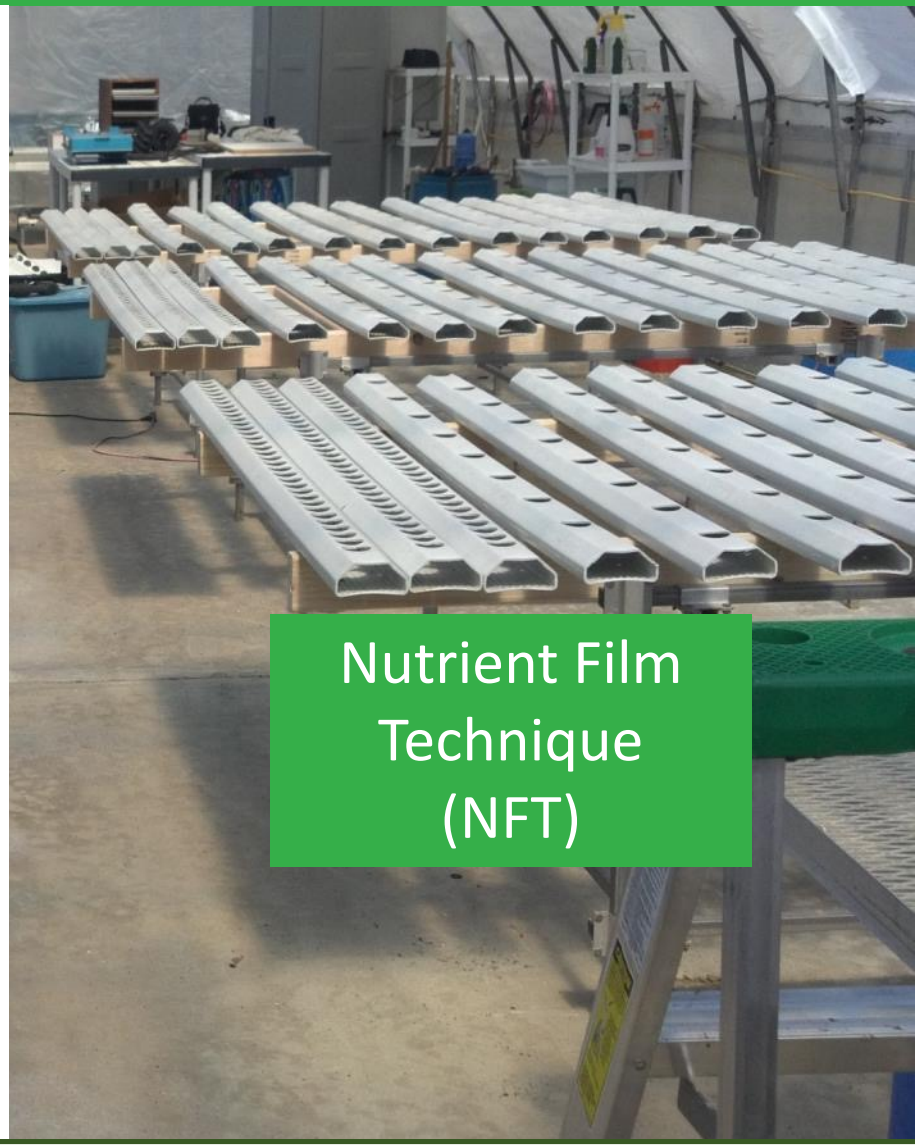
Hydroponic System Types

- Nutrient Film Technique (NFT)
- Flood and Drain (aka ebb and flow, ebb and flood)
- Deep Water Culture (DWC), aka floating raft
- Media-Filled Beds (MFB) – Common in aquaponics
- Drip Irrigation
- Less common:
  - Vertical towers
  - Wicking beds
  - Aeroponics

And on, and on, and on…

Hydroponic System Types

PC: Peter Konjoian



Flood and Drain Bok Choi Production

PC: Peter Konjoian

Flood and Drain: Baby Greens

PC: Peter Konjoian

Flood and Drain: Carrots

Nutrient Film (NFT) Batch Lettuce Production

Nutrient Film Channel: Progressive Harvest

PC: Peter Konjoian

Deep Water Culture (DWC)

PC: Sean Fogarty

PC: Nicholas van der Wal

Drip Irrigation: Slab

PC: Backyard Farms

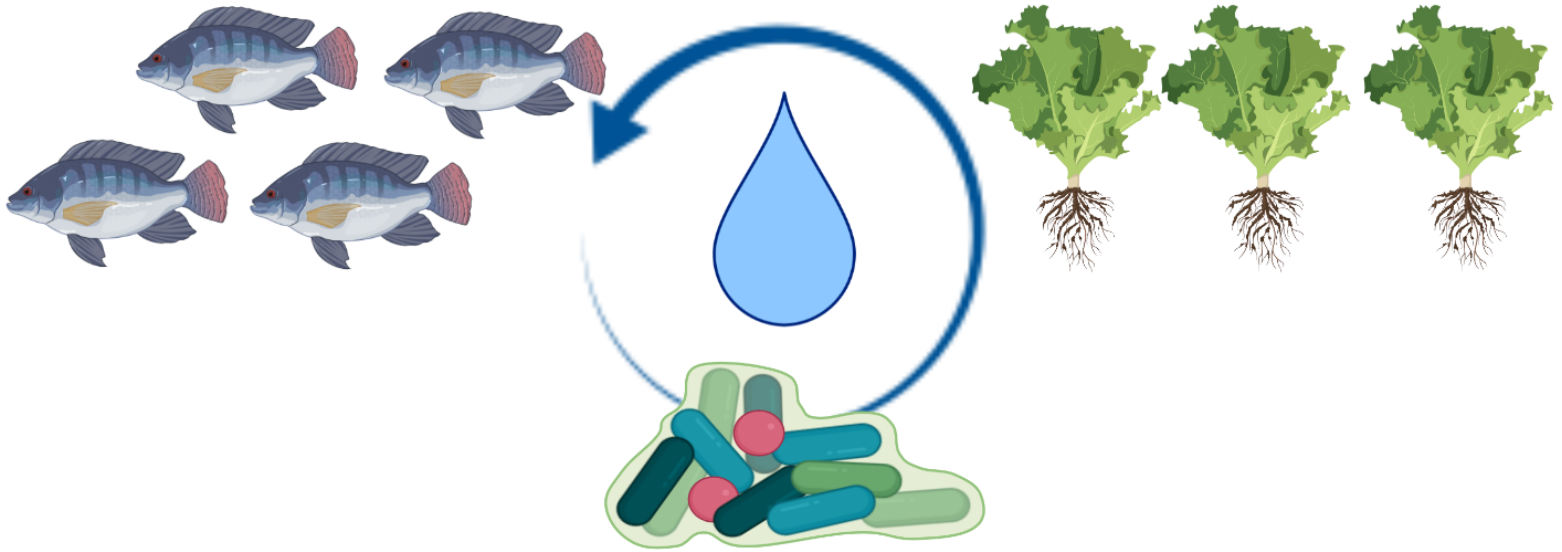
Drip Irrigation: Dutch / Bato Bucket

PC: Sean Fogarty

Media-Filled Beds (MFB)

PC: Canopy Farms

Aquaponics



Nutrient cycling among fish, bacteria, and plants – through the medium of water.

Figure made with BioRender.com

Fish in Aquaponics

- Fish do not typically host human enteropathogens.

AND

- The concentrations of human pathogens found in fish feces generally reflect those in the surrounding environment.

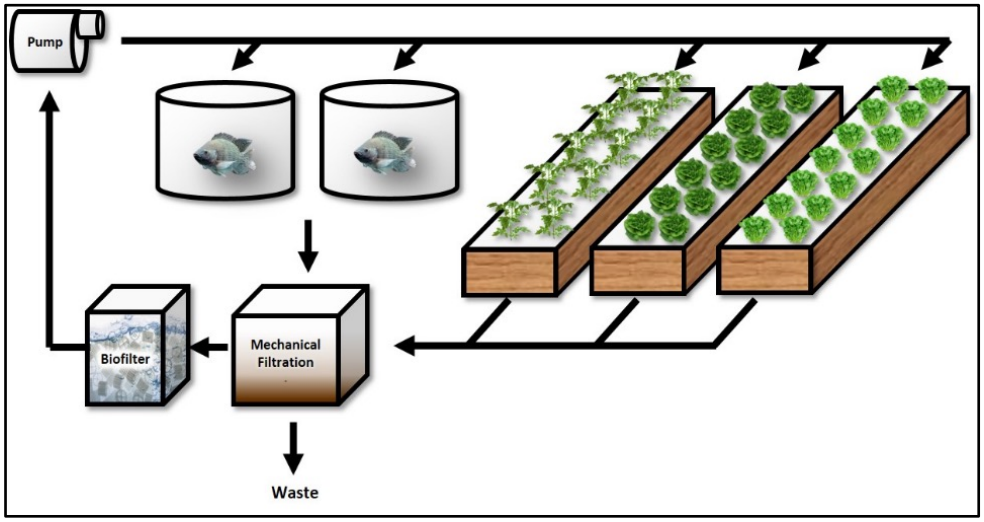
SO…

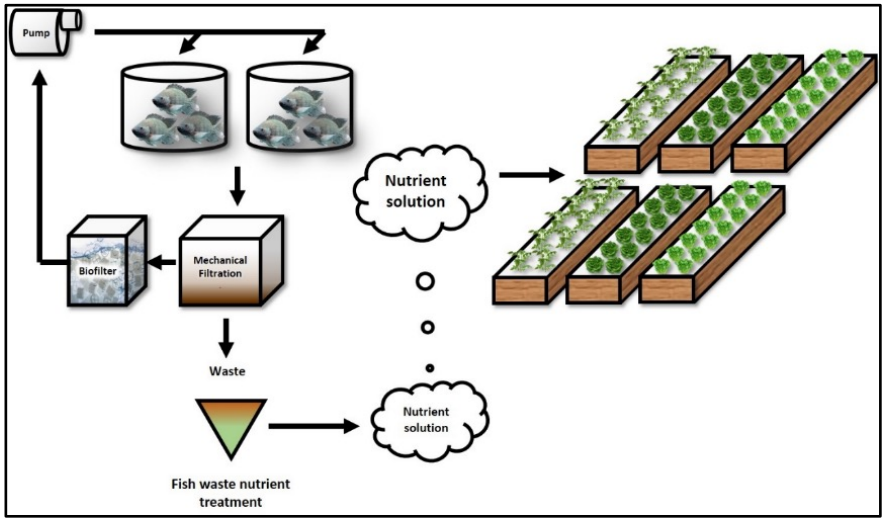
- Fish in aquaponics do not pose a direct produce safety hazard.

HOWEVER,

- Fish waste is rich in nutrients and may provide habitat for introduced pathogens if not managed properly.

Aquaponic Approaches





Coupled

Water recirculates

fish → plants → fish

Decoupled

Water flows one direction

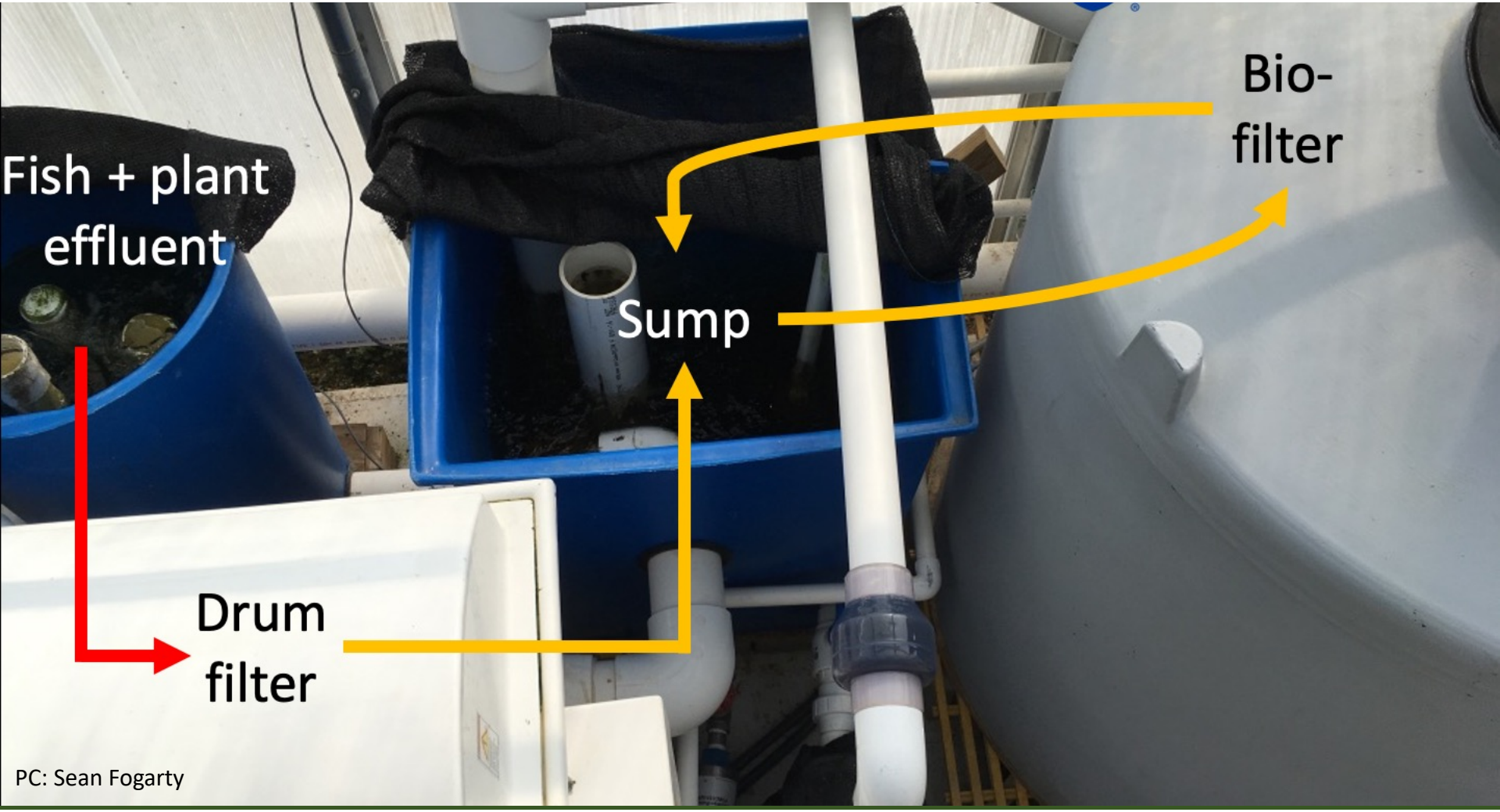
fish → plants

Figures: Todd Guerdat

Coupled Aquaponics @ UNH (Experimental)

PC: Sean Fogarty

Coupled Aquaponics @ UNH: Waste Treatment



Diversity of operations

Indoor ⟷ Outdoor

High tech ⟷ Low tech

Small scale ⟷ Large scale

Learning Objective 2:

What are key produce safety considerations in hydroponic and aquaponic operations?

- Integrated Produce Safety (IPS)
  - Engineering and System Design
  - Human – System Interaction
  - Biological Control
  - Chemical Control

Holistic Approaches to Crop Management

Integrated Pest Management (IPM) Triangle

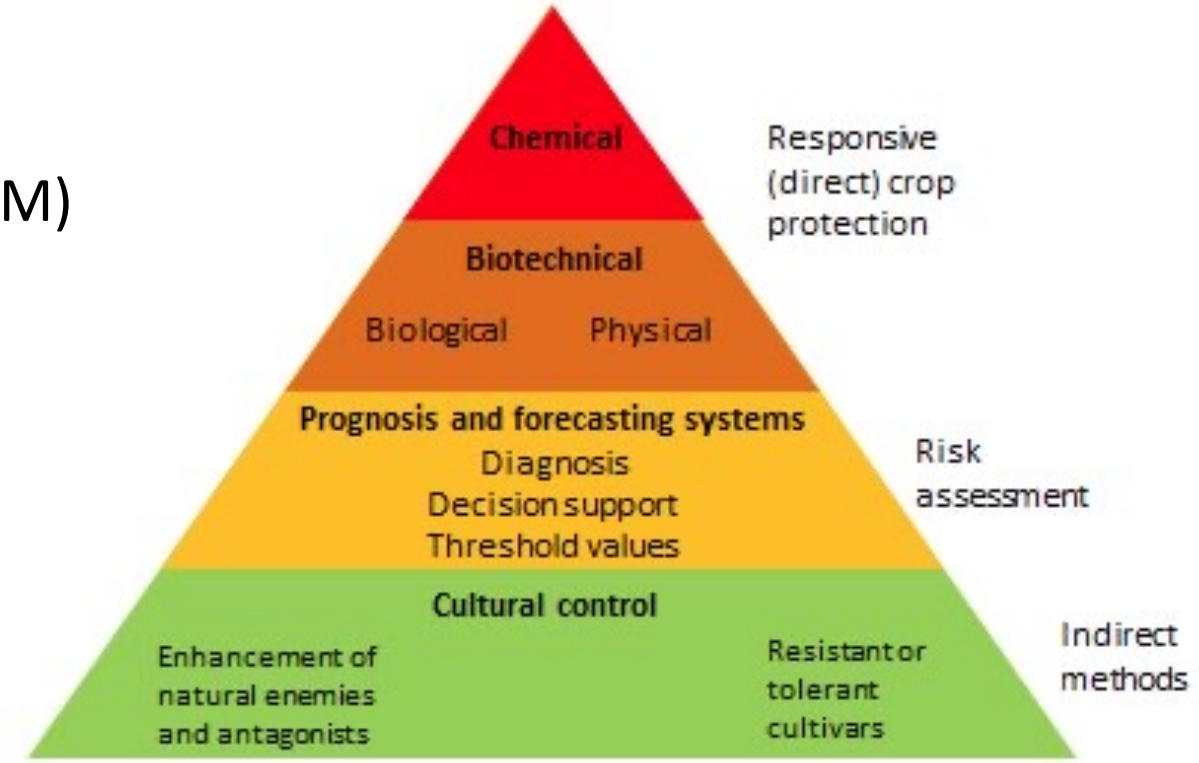
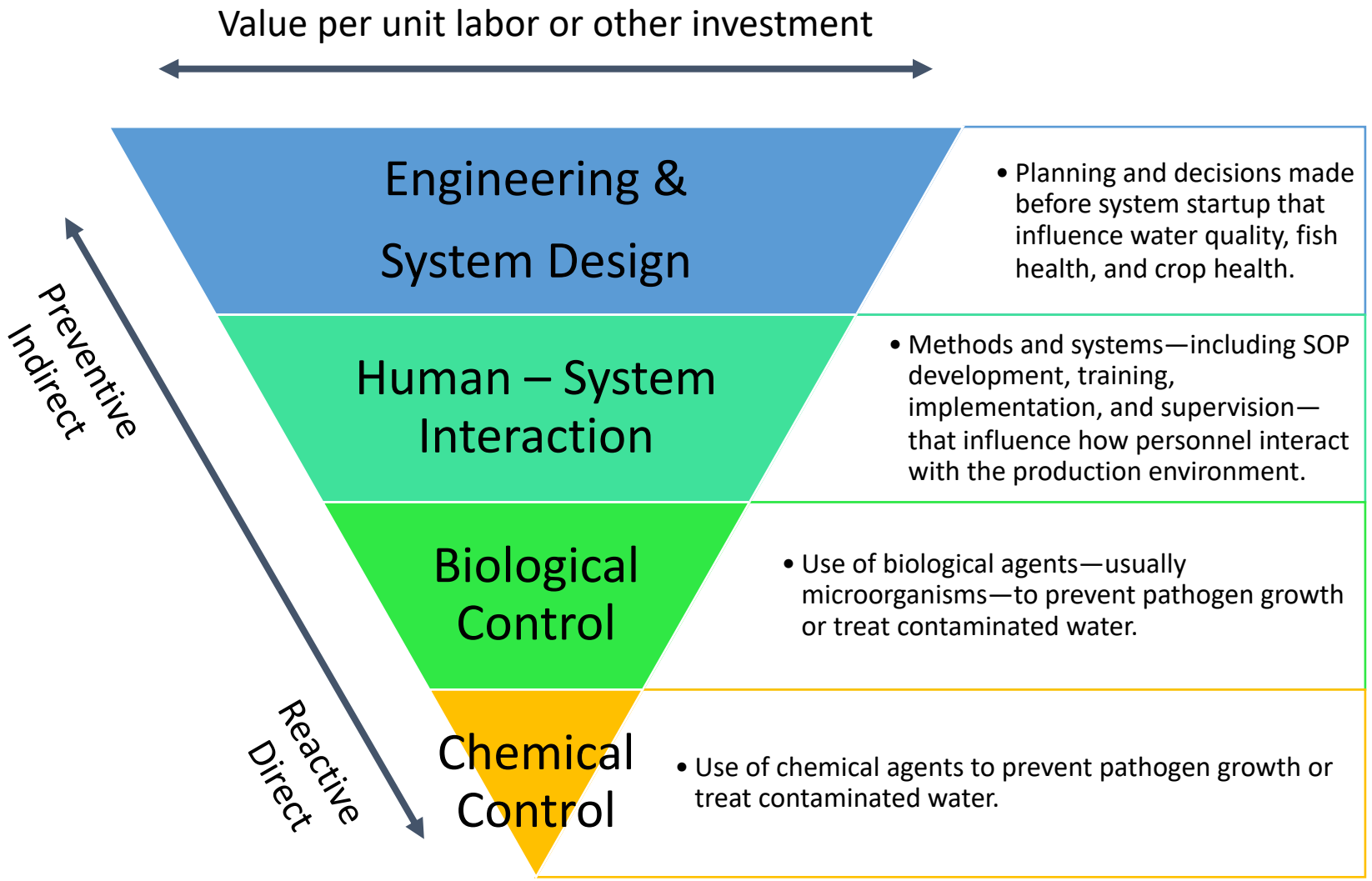
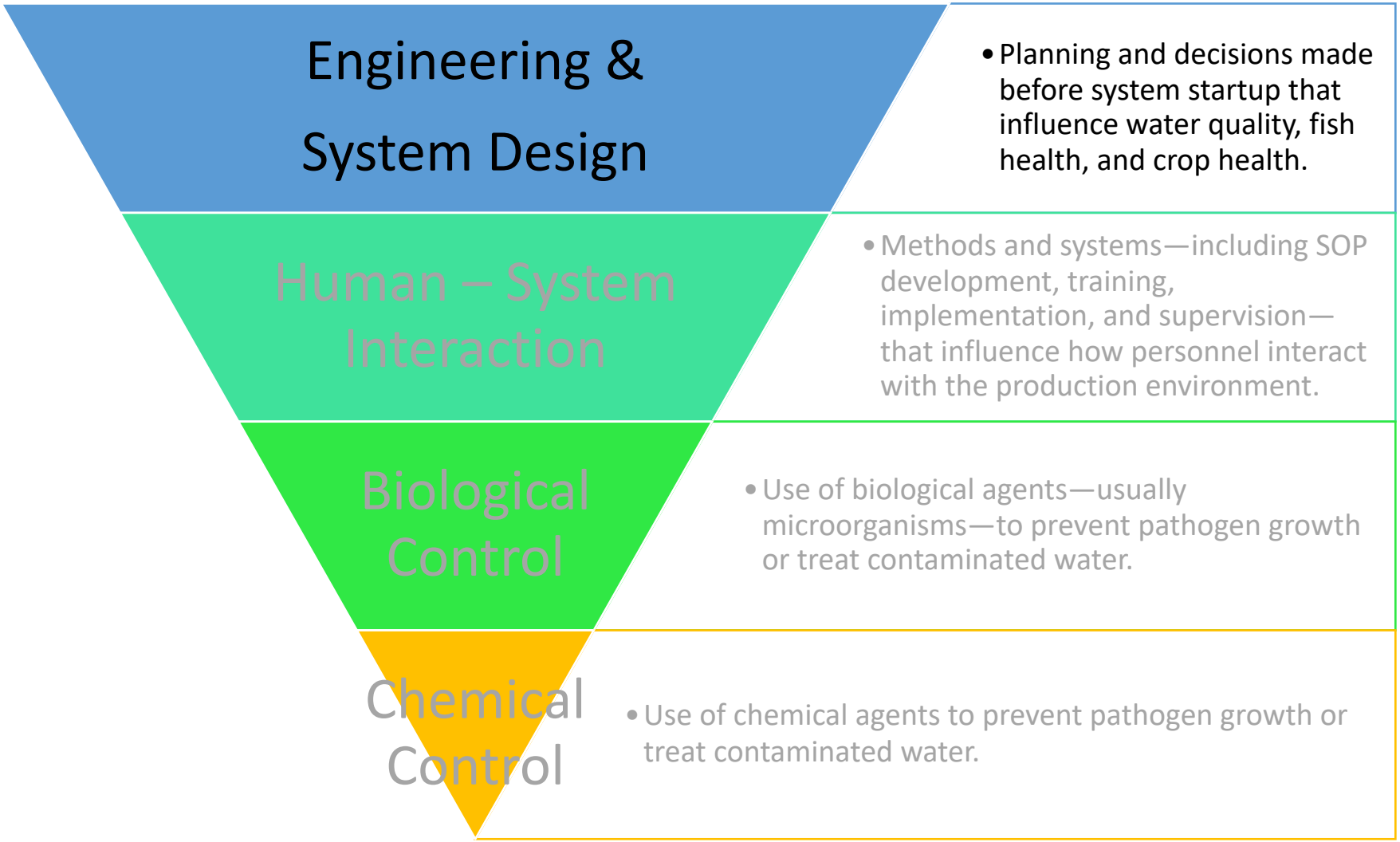


Figure: Slunge et al., 2015

Integrated Produce Safety (IPS) Triangle



Integrated Produce Safety (IPS) Triangle



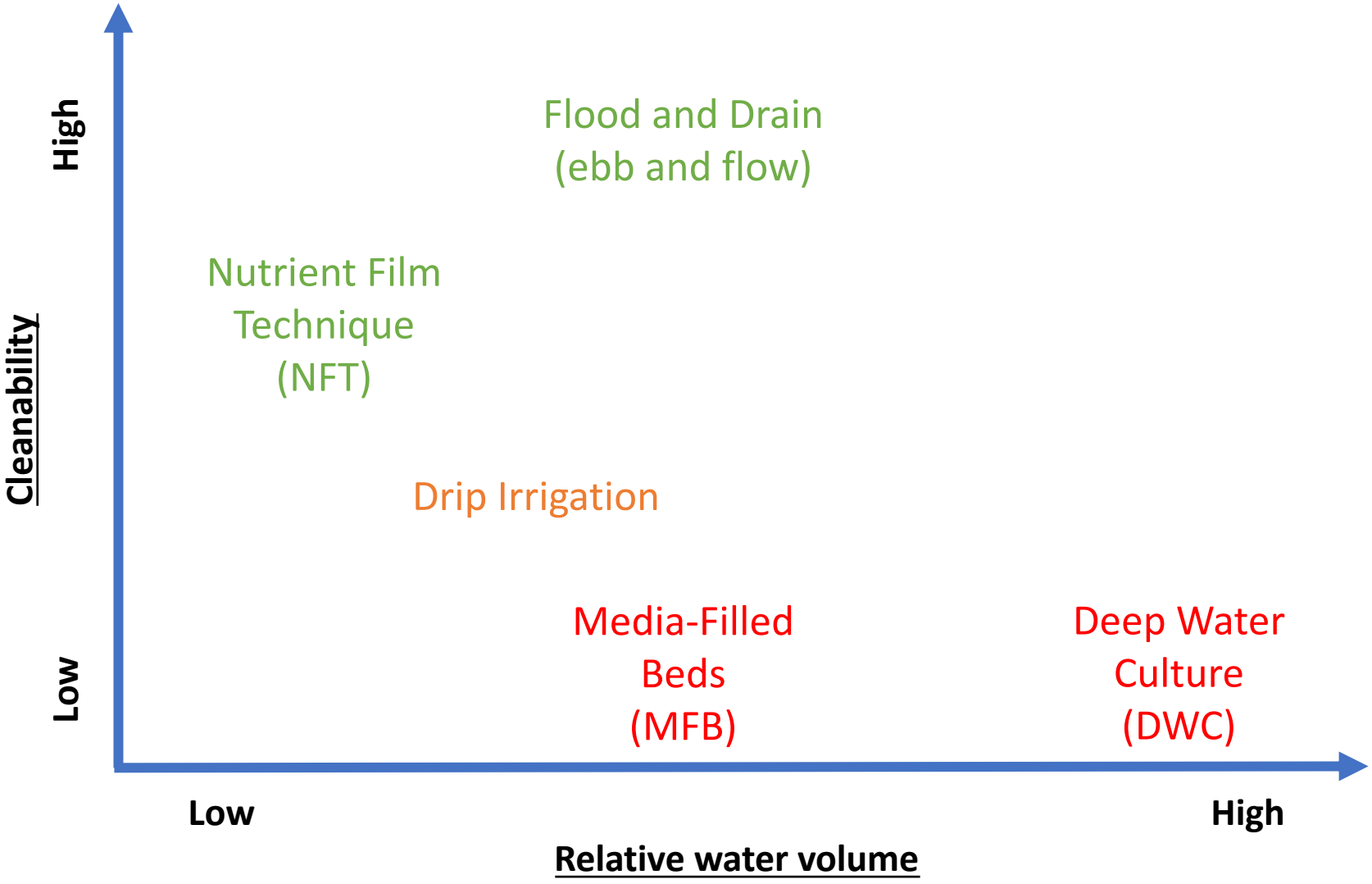
Integrated Produce Safety (IPS) Triangle

Engineering & System Design

- Planning and decisions made before system startup that influence water quality, fish health, and crop health.

PC: Sean Fogarty

Hydroponic System Types: Water Volume and Cleanability



Integrated Produce Safety (IPS) Triangle

Engineering & System Design

- Planning and decisions made before system startup that influence water quality, fish health, and crop health.

Human – System Interaction

- Methods and systems—including SOP development, training, implementation, and supervision—that influence how personnel interact with the production environment.


PC: Peter Konjoian

PC: Todd Guerdat

Human – System Interaction: Activity Logs

System: _____ Daily KF WQ Data Sheet BLANK Year: _____

Date	Time	DO Tank A (mg/L)	Temp Tank A (°c)	DO Tank B (mg/L)	Temp Tank B (°c)	EC (mS/cm)	pH	Alkalinity (mg/L as CaCO3)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	Fe	Bicarb Added (g)	Feed - Tank A/B (g)	Feed Calc Day #	# of Fish per Tank	Initials	Notes
Target Parameters ----->		>5.0mg/L	>24°C	>5.0mg/L	>24°C	1.8mS/cm	6.7-7.2	20-30mg/L	<1.0mg/L	<0.1mg/L	150mg/L	>1.8 mg/L	-	-	-	-	-	
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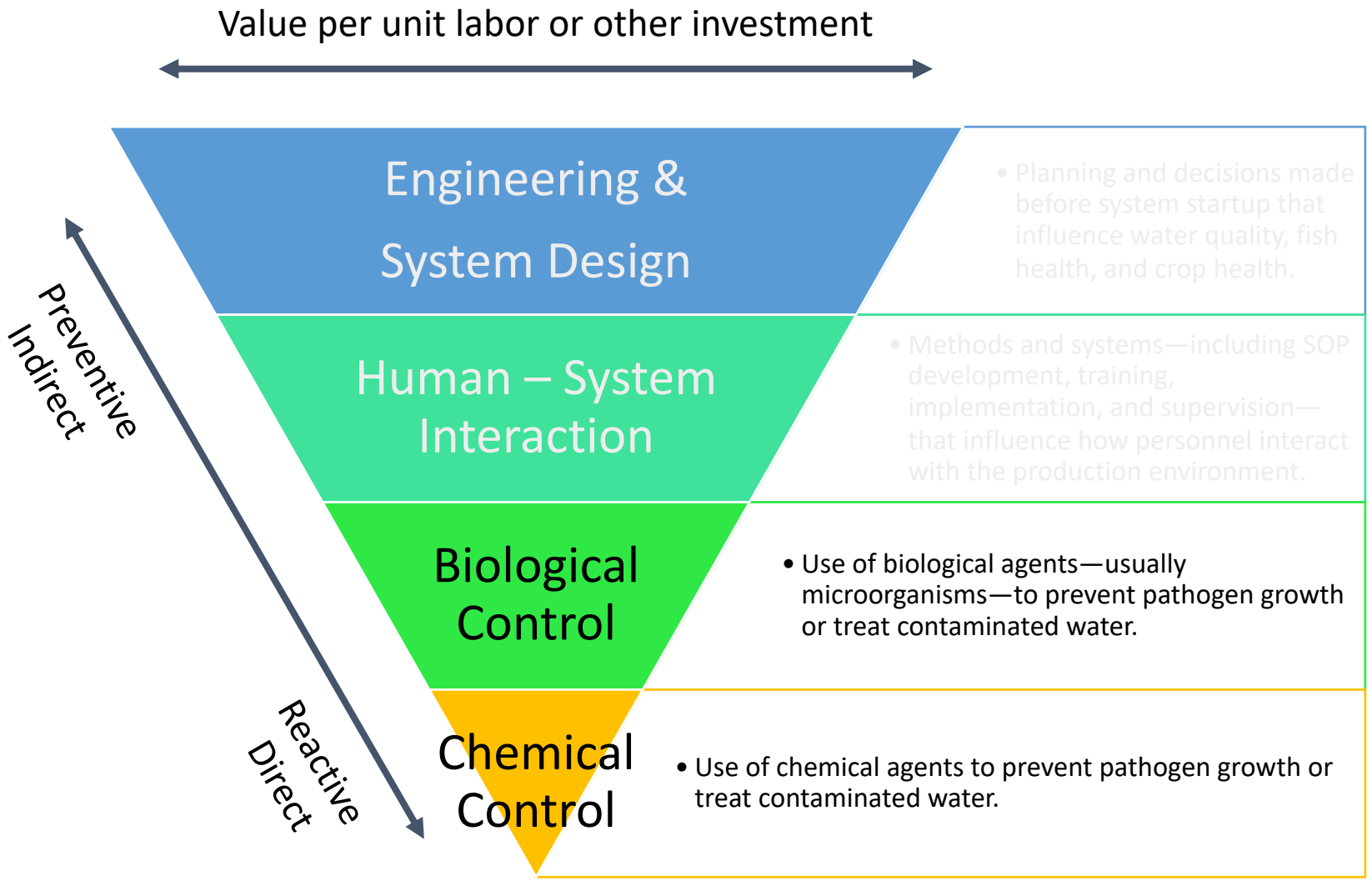
Human – System Interaction: Visitors

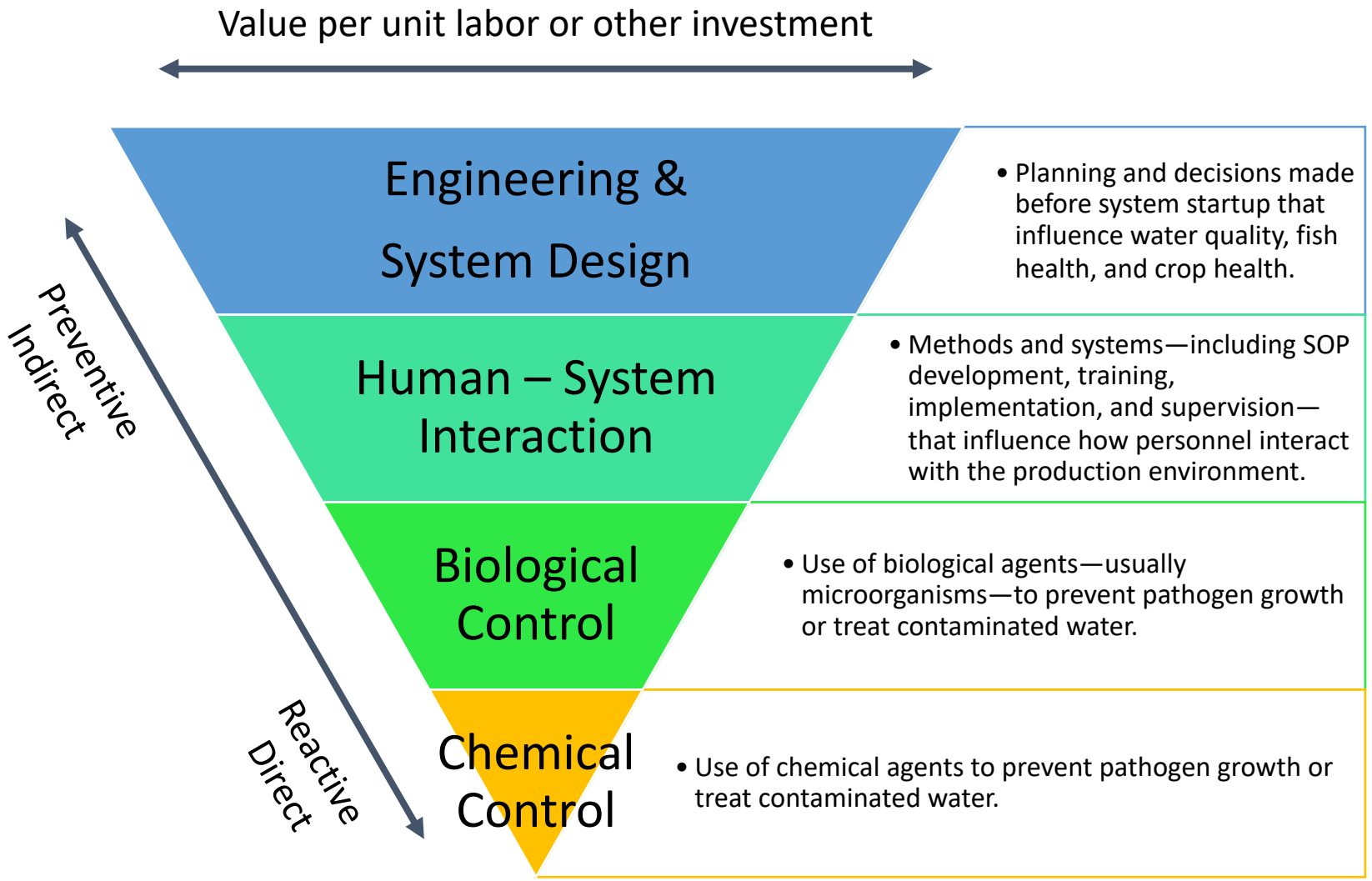
PC: Sean Fogarty

1. Visitors **must** be made aware of the farm food safety plan.
2. If visitors are going to touch or otherwise interact with a system, they **must** receive the same training as personnel who perform similar functions.

Integrated Produce Safety (IPS) Triangle



Integrated Produce Safety (IPS) Triangle



Learning Objective 3:

What are the primary considerations relevant to FSMA Produce Safety Rule compliance in hydroponic and aquaponic operations?

- Ag Water Rule
- Wildlife
- Operator and Personnel Training
- BrightFarms outbreak

Is it Ag Water?
Contact between water and edible portion


PC: Sean Fogarty


PC: Peter Konjoian

Ag Water Classification: Municipal, ground, or surface?

PC: Canopy Farms

Proposed Ag Water Rule: Ag Water Systems

- Ag Water System (AWS) = " a source of ag waterm the water distribution system, any building or structure that is part of the water distribution system, and any equipment used for application of ag water to covered produce"
- HP/AP systems = AWS
- Proposed rule would require **annual inspection of all AWS**

Testing Ag Water
How often is enough?

- Surface water testing – frequency suggested in proposed rule:
  - 20 samples within first 2 – 4 years
  - 5 samples per year after that

- The flexibility built into the proposed rule would require growers to determine appropriate testing programs based on their own unique situations.

- This may mean that HP/AP growers should test more frequently than the proposed rule's suggestions for surface water.

- Consider a hydroponic greens operation that harvests weekly, 52 weeks a year.
  - Is an average of 5 samples per year adequate in HP/AP?
  - If not, what would be?

Proposed Ag Water Rule: Outcomes

Determination	Proposed outcome	Applicability to HP/AP
Water is not safe or of adequate sanitary quality for intended use(s).	Immediately discontinue use And take corrective measures before resuming use.	Takeaway: The proposed implementation timeline for mitigation measures is designed for field agriculture. HP/AP operations should inspect systems often and implement mitigation measures as soon as possible following recognition of a hazard, due to: • Continuous nature of production • recirculation of water • Lack of time interval between irrigation and harvest
≥1 known or foreseeable hazard related to animal activity, BSAAOs, or untreated human waste	Implement mitigation measures promptly, and **no later than the same growing season**	
≥1 known or foreseeable hazard not related to animal activity, BSAAOs, or untreated human waste	Implement mitigation measures as soon as practicable and **no later than the following year** Or Test as part of assessment and implement appropriate measures, as needed, accordingly	
No known or foreseeable hazards for which mitigation is necessary	Inspect and adequately maintain the water system(s) **≥1 time per year**	

- Again, consider a hydroponic greens operation that harvests weekly, 52 weeks a year.

Wildlife

- Crops and production water may attract wildlife if they are not effectively excluded.
- Fish in aquaponics, while not an inherent produce safety risk, create secondary hazards:
  1. Attraction of predators to fish tanks
  2. Attraction of scavengers to uneaten fish feed on and around fish tanks


PC: Sean Fogarty


PC: Todd Guerdat

Training HP/AP operators and personnel in produce safety

- Many of the fundamentals of PS training are the same as in field ag.
- PS training for HP/AP should be tailored to the particular hazards and control points in HP/AP to effectively minimize risk.
- Emphasize co-benefits of sanitation and hygiene practices -- where GAPs align with produce safety goals and the law


PC: Canopy Farms


PC: Nicholas van der Wal

Outbreak!
Salmonella Typhimurium from hydroponic lettuce

- 31 illnesses and 4 hospitalizations in 4 states
- June to August, 2021

FDA Investigation

- Deep Water Culture (DWC) with floating rafts in plastic-lined grow ponds at ground level
- Firm reported treating water with PAA when generic *E. coli* was detected in weekly water samples.
- Growth media was stored outdoors and unsecured.
- Leaves that contacted water were not systematically excluded from harvest and packing.
- Condensate from chillers was dripping on produce.
- Nearby stormwater retention basin contained *Salmonella Typhimurium*, but no specific contamination route was observed.
- Cleaning and sanitizing of equipment, tools, and buildings was not adequately documented.
- Investigation did not identify the specific source or route for lettuce contamination.

Discussion

PC: Peter Konjoian

Contact Information

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Gretchen Wall gwall@freshproduce.com

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