International Association for Food Protection WEBINAR

Risk-Based Approaches to Sanitation in Dry Processing Environments

Moderator: Jennifer Acuff, University of Arkansas

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Please consider making a contribution

This webinar is being recorded and will be available to IAFP members within one week.

International Association for Food Protection

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 Q&A section on your 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 within one week.

Todays Panelists

Abby Snyder - Cornell University

Karl Thorson - General Mills

Nathan Mirdamadi – Kerry

Jennifer Acuff, Moderator – University of Arkansas

Risk-based approaches to sanitation in dry processing environments: Contamination and Control

Jennifer C. Acuff, Ph.D.
Assistant Professor of Food Microbiology and Safety,
Department of Food Science

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RESEARCH & EXTENSION
University of Arkansas System

FOOD SAFETY, MICROBIOLOGY AND RESEARCH TECHNOLOGY LABORATORY

“Known or Reasonably Foreseeable Hazards”

- *Salmonella* spp.
- *Cronobacter* spp.
- Other foodborne pathogens may also contaminate through the environment or be naturally present on ingredients

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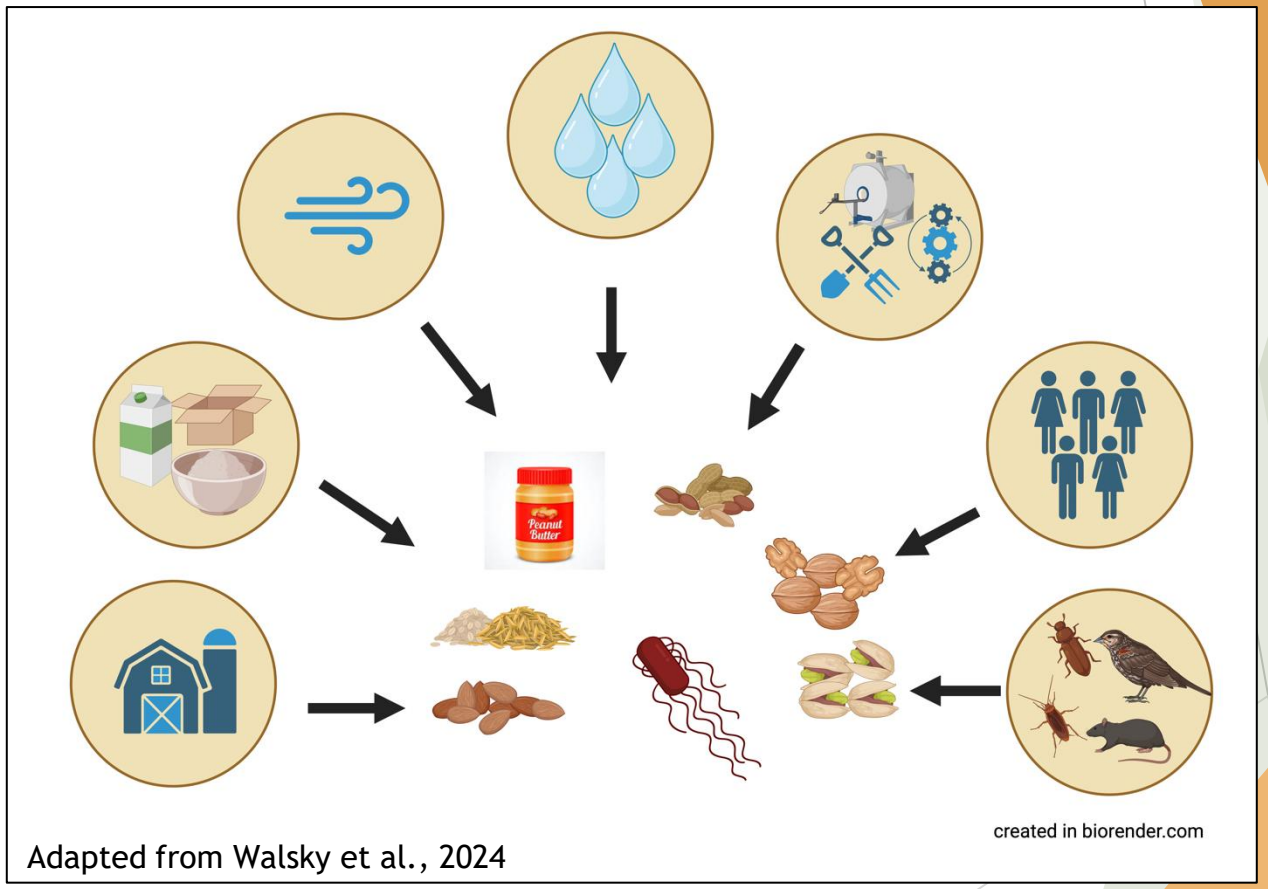
External Contamination Routes

- Raw ingredients
- Facility design and upkeep
- Employees and pests

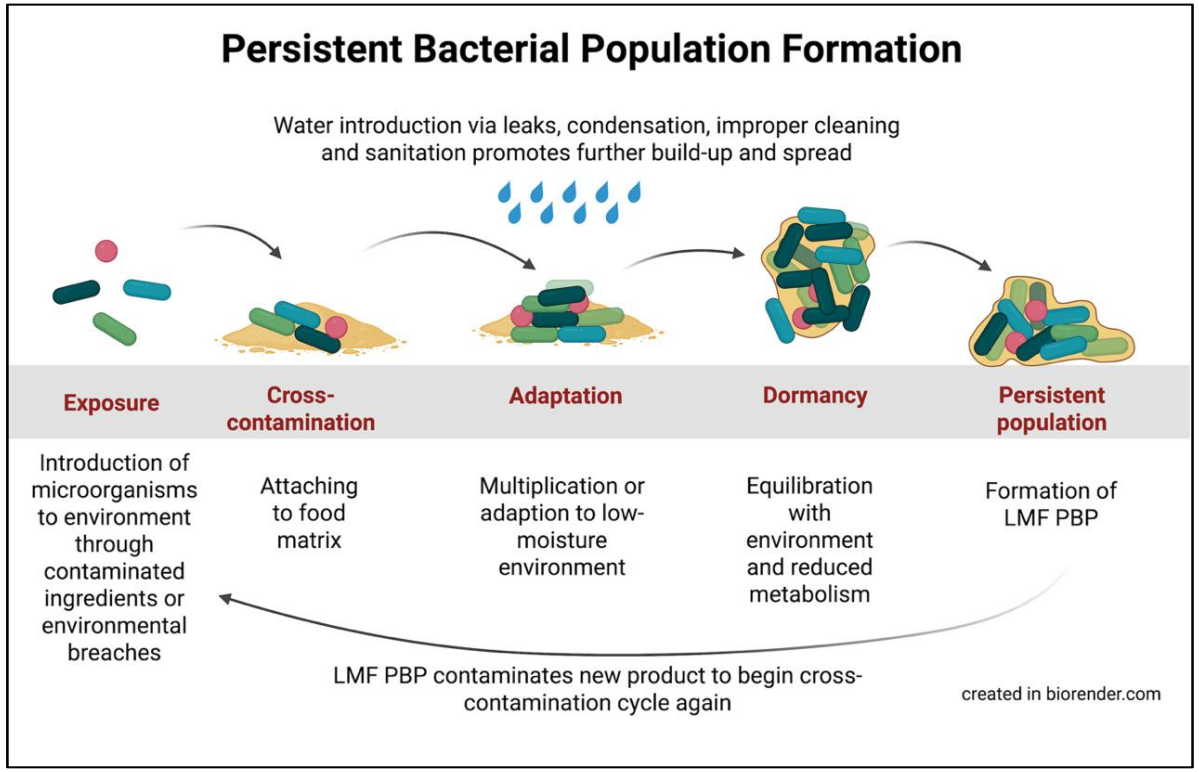


Adapted from Walsky et al., 2024

Funk, J. (2007). Moisture led to *Salmonella* outbreak. *USA Today*, *4*(5), 2007.

Podolak, R., Enache, E., et al. (2010). Sources and risk factors for contamination, survival, persistence, and heat resistance of *Salmonella* in low-moisture foods. *J Food Prot*, *73*(10), 1919-1936.

Internal Contamination Routes



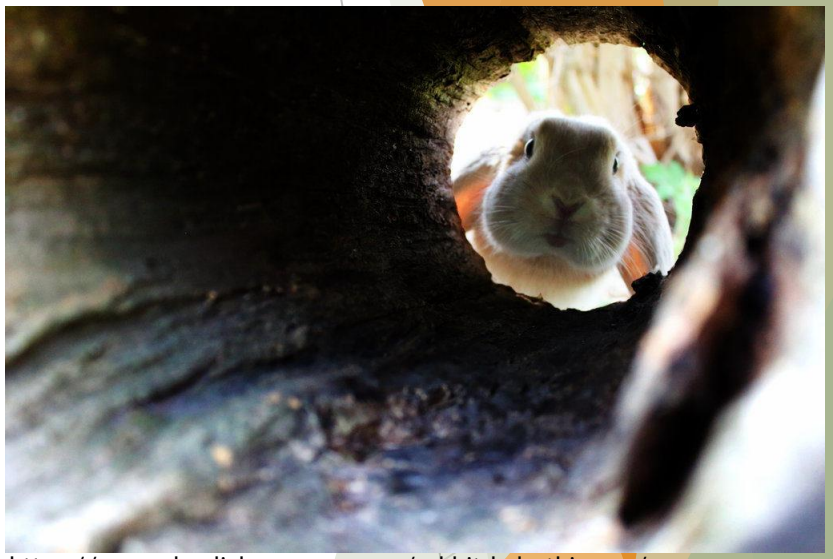
- Zoning
  - Employee entrance/exit crossing wet/dry areas
  - Poorly sectioned areas for wet cleaning
- GMPs and Equipment Design
  - Condensation collection
  - Leaky and motion activated sinks
- Insufficient cleaning and sanitation
- Cross-contamination

CDC, 2012. Multistate Outbreak of *Salmonella* Bredeney Infections Linked to Peanut Butter Manufactured By Sunland, Inc. (Final Update)

Podolak, R., Enache, E., et al. (2010). Sources and risk factors for contamination, survival, persistence, and heat resistance of *Salmonella* in low-moisture foods. *J Food Prot*, *73*(10), 1919-1936.

Sanitation Preventive Controls
LMF Remix

- Identifying the hazard that will occur if a preventive control is not in place when
  - Environmental contamination could occur prior to packaging
  - Severity of illness is extreme
- Ask all the questions (go down the rabbit hole)
  - Flow of product and employees
  - Equipment maintenance, repair, wear and tear
- Cleaning and sanitation with defined procedure, frequency, monitoring and verification activities, and records
- Preventive control must be:
  - validated (prove reduction or elimination of the hazard) and
  - verified (prove that it is being performed correctly).



https://www.claudialamoreaux.com/rabbit-hole-this-way/

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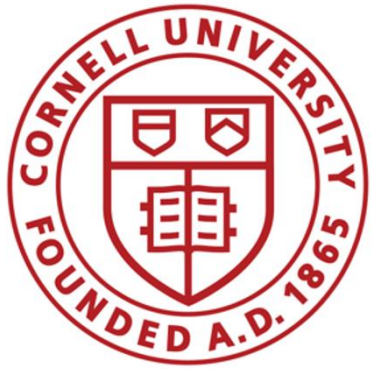
Sanitation Preventive Controls Tools

- Strengthening cGMPs and SSOPs already in place
- Environmental monitoring to “seek and destroy” or “seek and control”
- Corrective actions
  - Plan what you’ll do when you get a positive
  - Be ready to *change* something to prevent it in the future
- Flexibility – be prepared to reevaluate and adjust (follow the clues left by the organisms)

https://cjwerlinger.wordpress.com/tag/national-treasure/

Research that supports optimizing risk-based approaches to dry sanitation



Abby Snyder, PhD
Associate Professor
snyder@cornell.edu

Risk-Benefit Tradeoffs

Sanitation

Moderate Risk

Moderate Benefit

Moisture Introduction

Breach Line Integrity

Pathogen Transfer

Pathogen Reduction

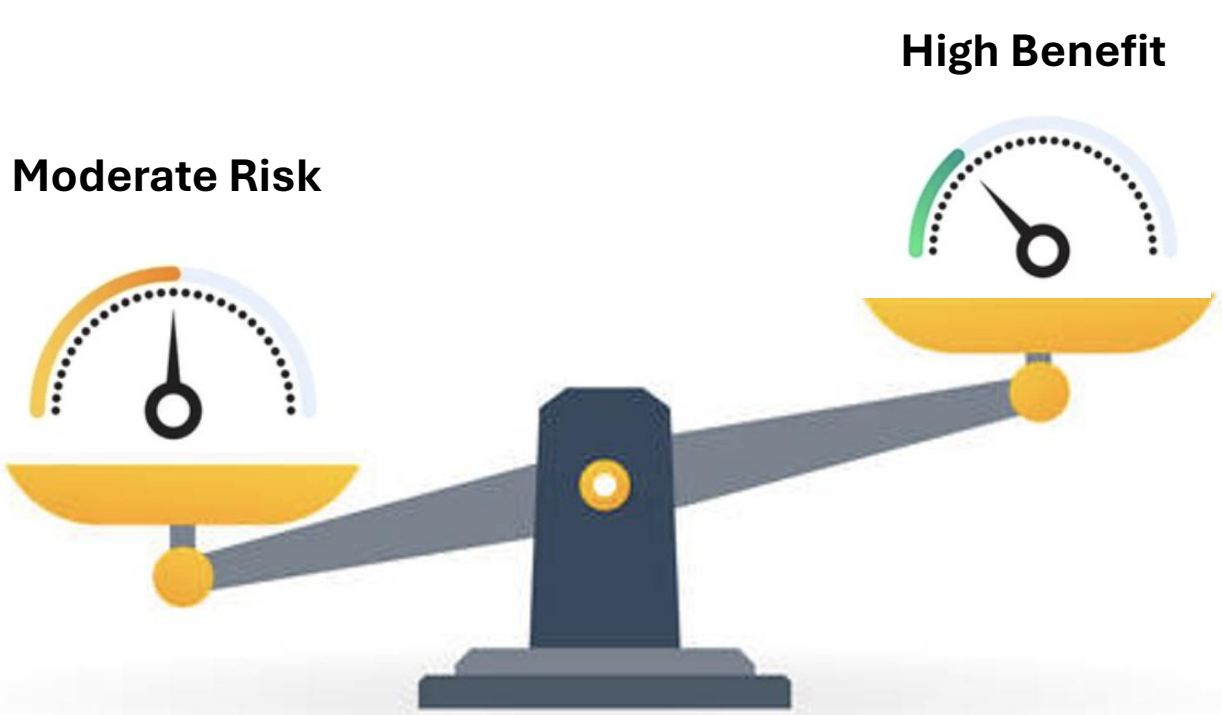
Allergen Reduction

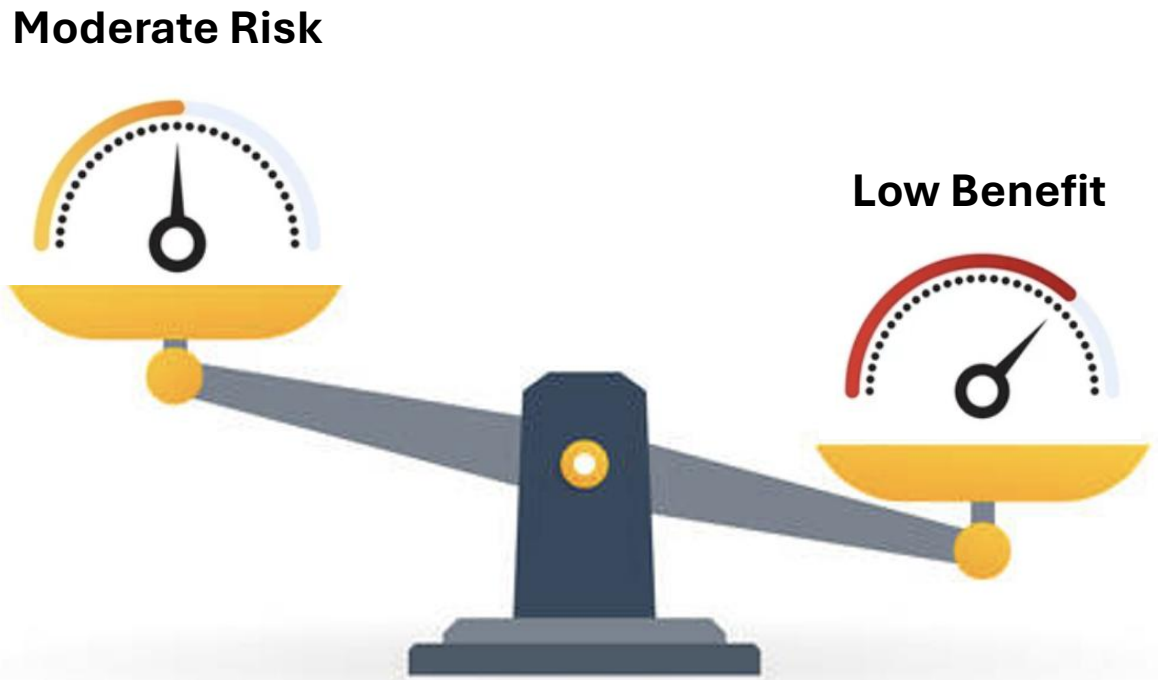
Food Residue Removal

Risk-Benefit Tradeoffs

Sanitation Provides A High Level of Risk Reduction

Sanitation Provides A Low Level of Risk Reduction

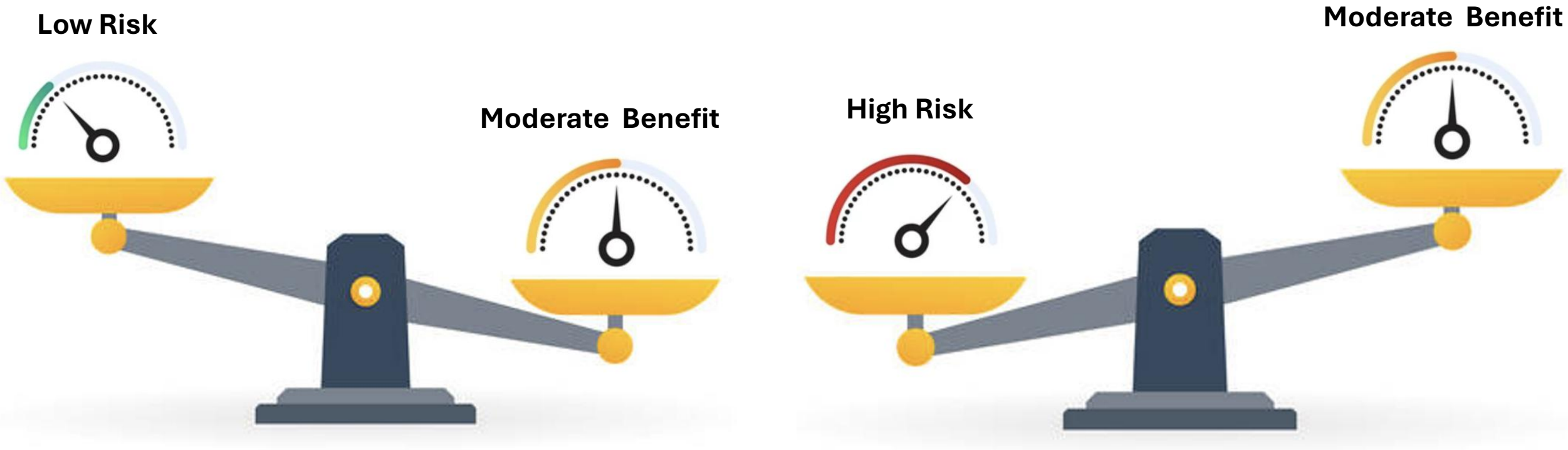




Risk-Benefit Tradeoffs

Sanitation Introduces A Low Level of Risk

Sanitation Introduces A High Level of Risk



Wet Sanitation

Wet Cleaning

- ❑Washing with water and detergent

Wet Sanitizing

- ❑Aqueous chemical sanitizer

Dry Sanitation

Dry Cleaning

- ❑Brushing, Wiping, Scraping, Sweeping
- ❑Vacuuming
- ❑Material Flush

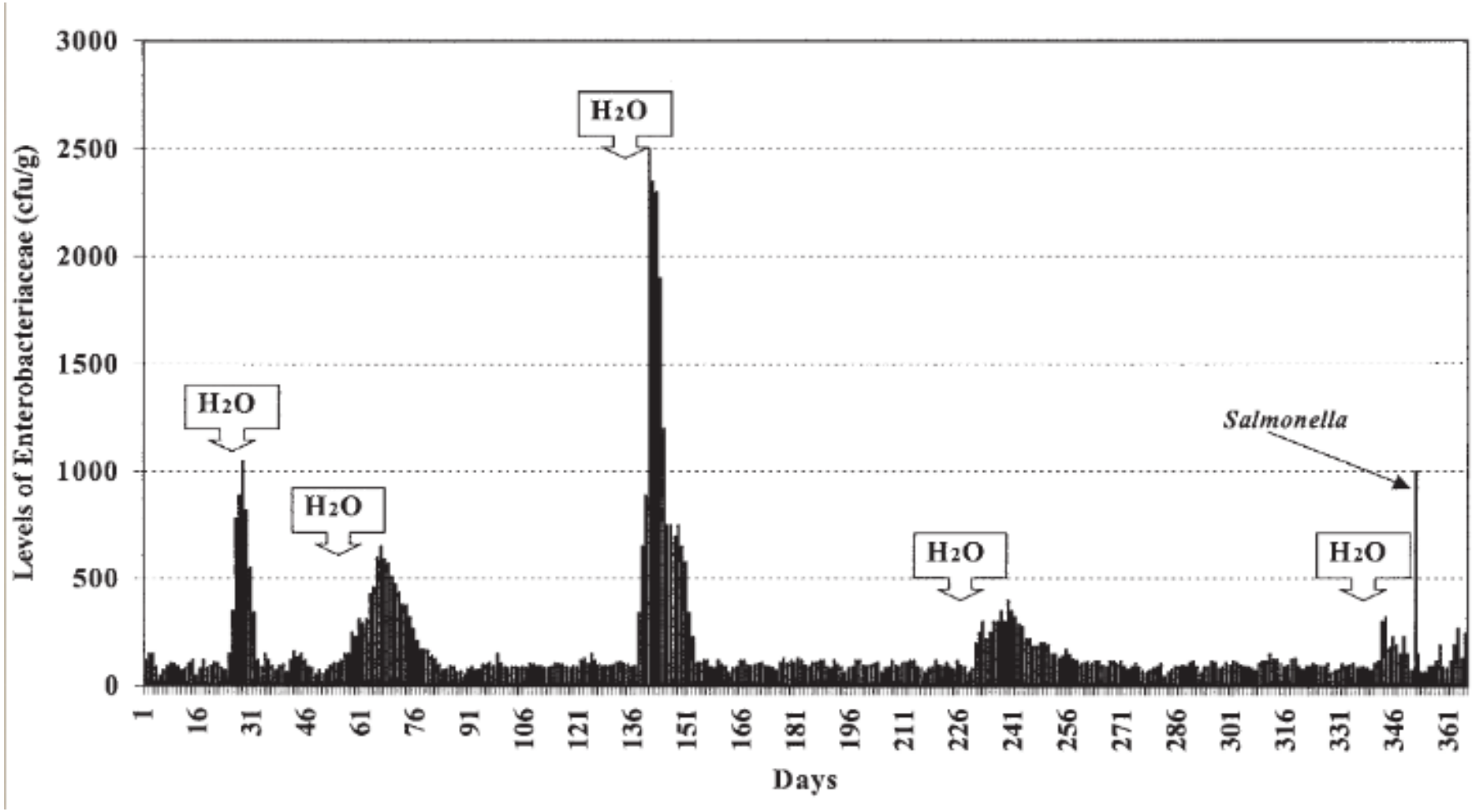
Dry Sanitizing

- ❑Hot Oil Flush
- ❑Heat
- ❑Gaseous Chemical Sanitizers
- ❑Alcohol Wipes

There are tradeoffs associated with wet sanitation in LMF facilities.

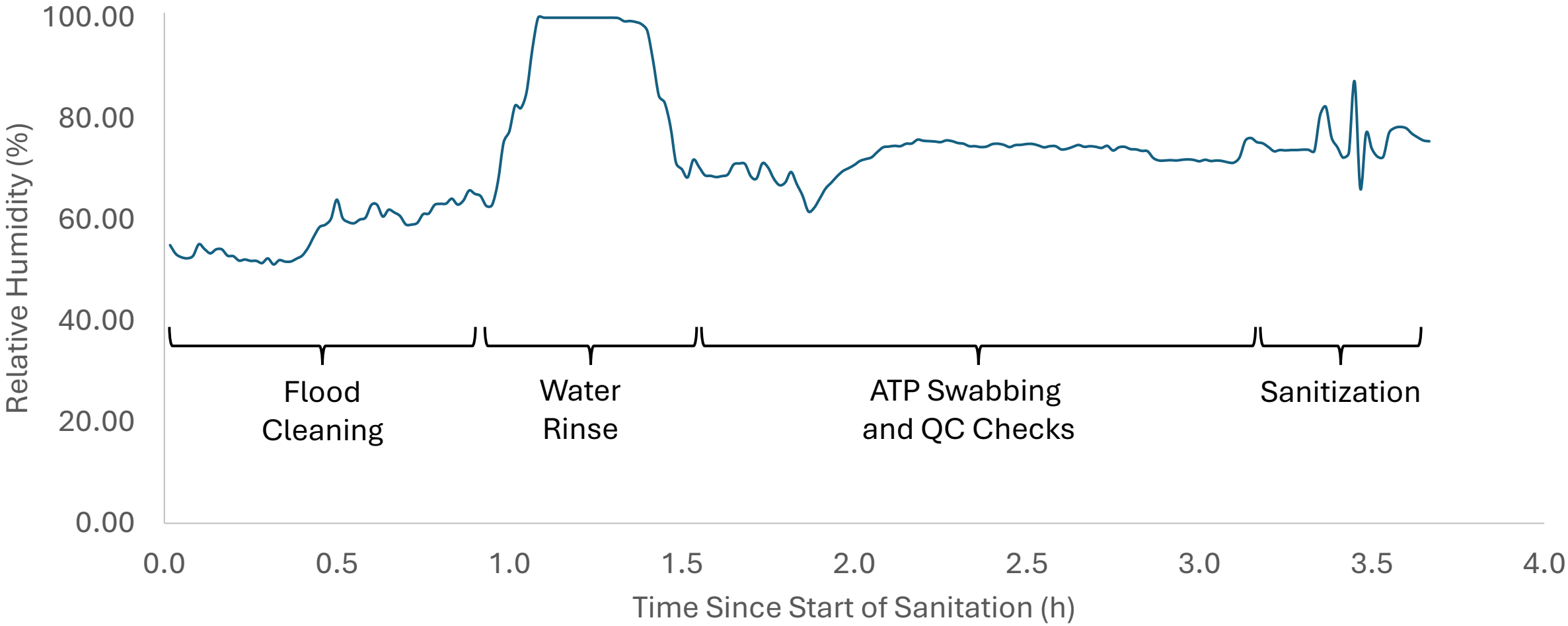
Moisture elevates risk in dry processing environments

- Dry processing environments pose unique challenges for environmental cleaning and sanitation. Introducing water leads to microbial growth and harborage.



3. Cordier (2007)

Wet sanitation in dry facilities significantly raises environmental relative humidity up to100% RH

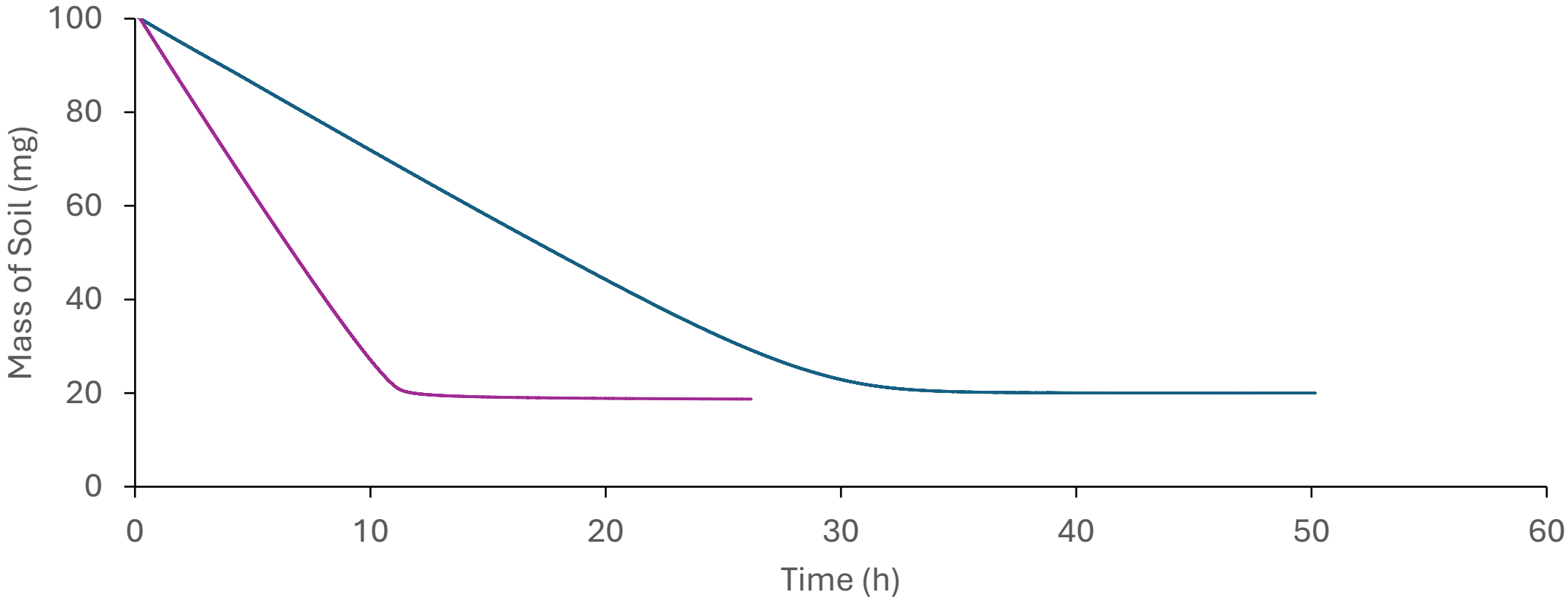


Unpublished Data (Slaughter et al., 2025)

Humidity changes the evaporation kinetics of surface moisture

33% RH = Low Moisture Retention

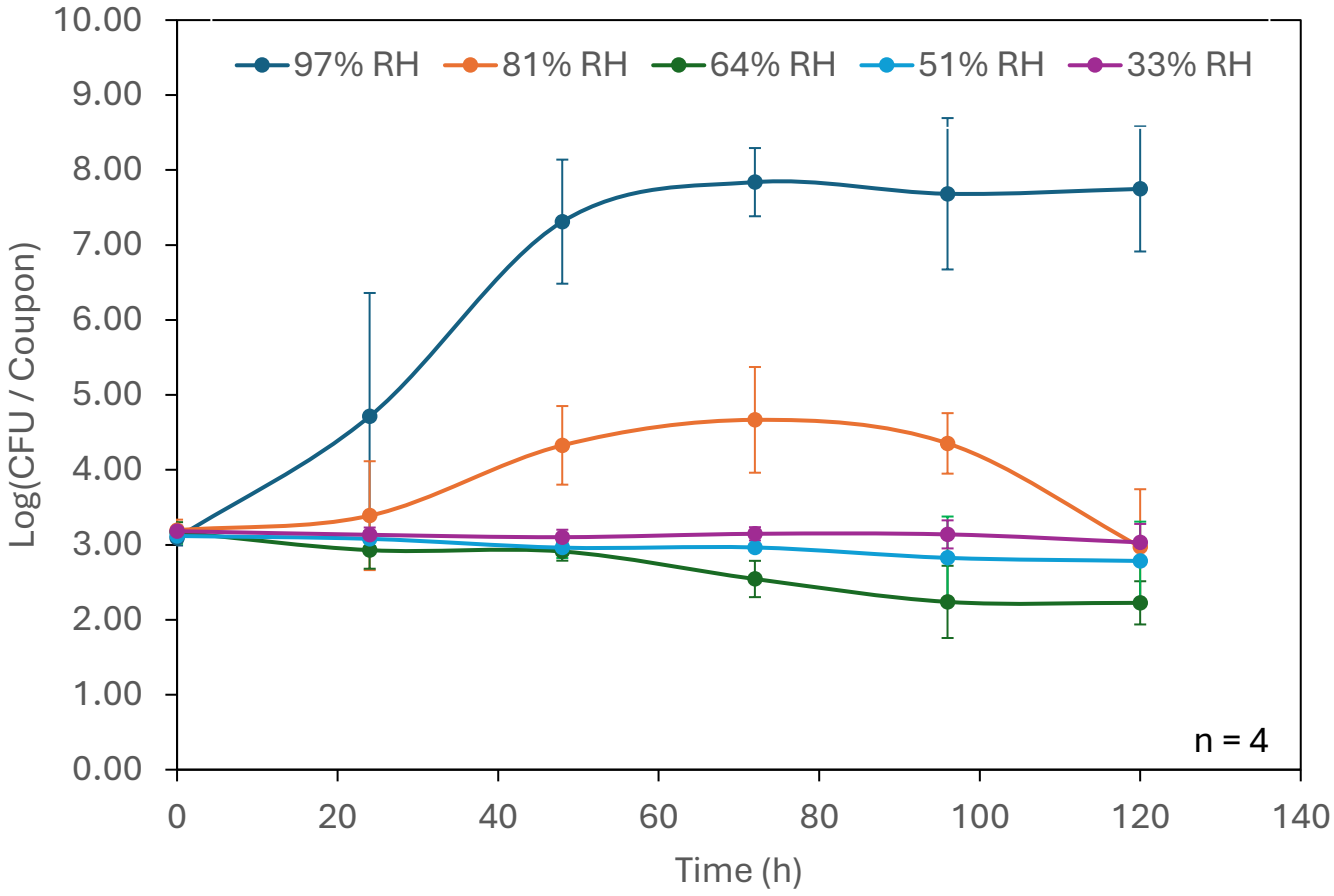
97% RH = High Moisture Retention



Unpublished Data (Slaughter, Chuang, McLandsborough, and Snyder, 2025)

Preliminary Results: Humidity impacts *Salmonella* Growth on Soiled Surfaces

- **> 4-log increase** in CFU within **48 h** of inoculation of PIF soiled coupons **at 97% RH**.
- **> 1-log increase** in CFU within **48 h** of inoculation of PIF soiled coupons **at 81% RH**.
- **Reduction** in Log(CFU) occurred after **72 h at 81% RH**, but **not at 97% RH**
- High relative humidities and condensation created by wet sanitation have the potential to support the growth of pathogens on insufficiently cleaned and sanitized food contact surfaces.

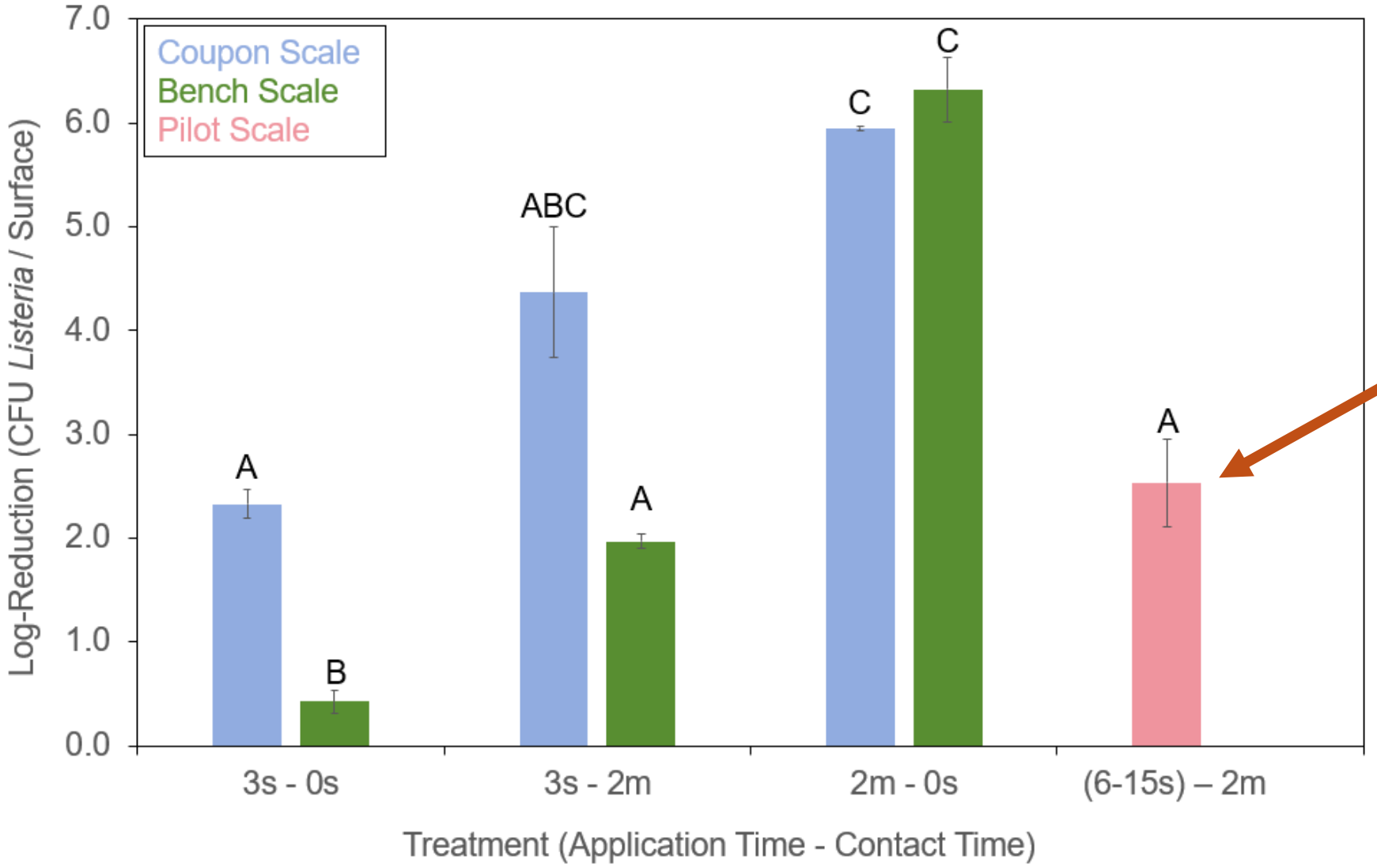


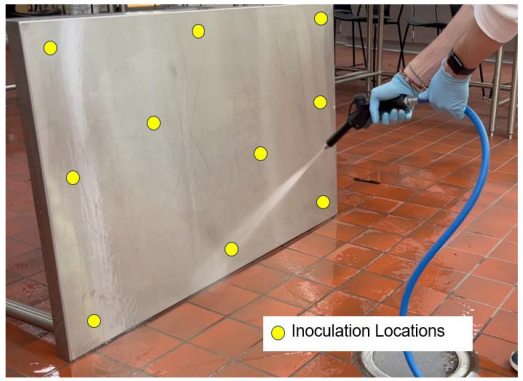
PIF soiled coupon (0.02 g / coupon)

Un-soiled coupon

Unpublished Data (Slaughter et al., 2025)

Application method affects the efficacy of sanitizers





Manual Spray
(Pilot Scale)

Submitted for publication (Jiao et al., 2025). Pre-print available:

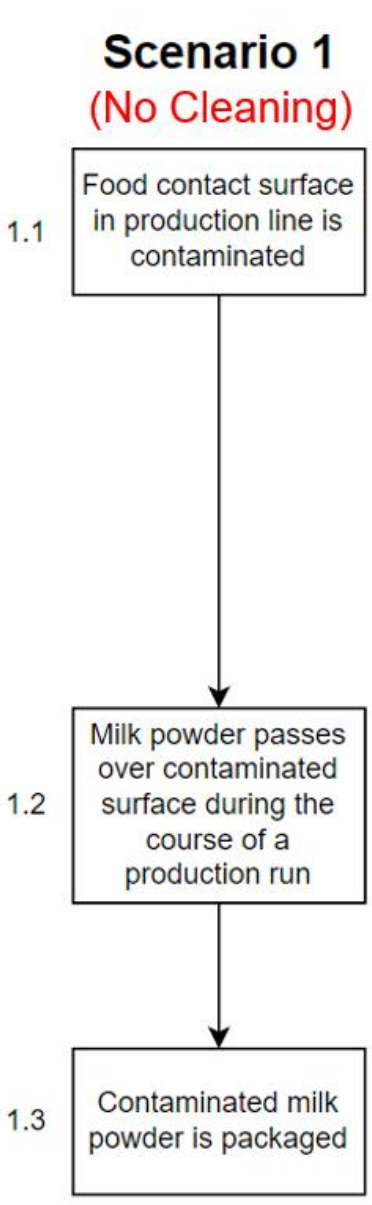
Considerations for sanitizing

- Sanitizers are bactericidal and effective at killing vegetative pathogens.

- Bench-scale efficacy tests do not provide evidence of real-world risk reduction. *Sanitation efficacy is hard to study.*

- **Microbial reduction comes from both cleaning and sanitizing.**

Microbial reduction from dry physical cleaning



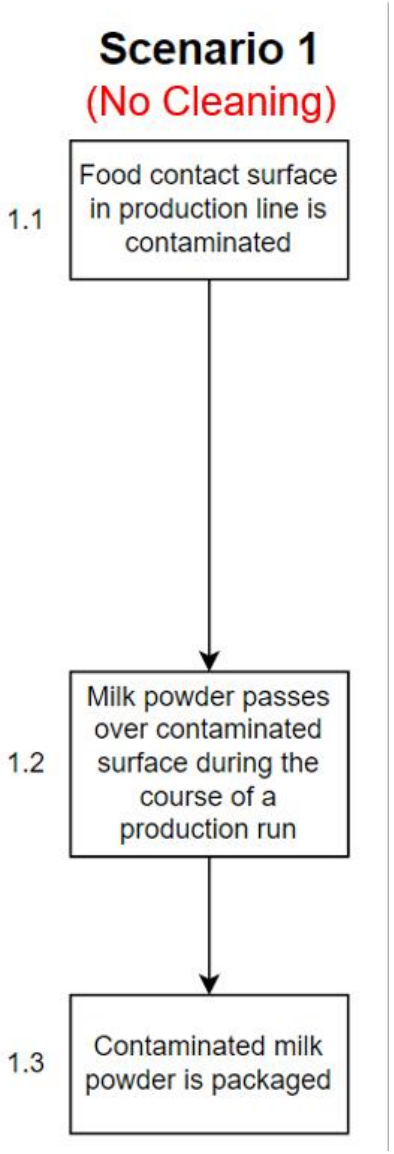
Simulated Production Campaign

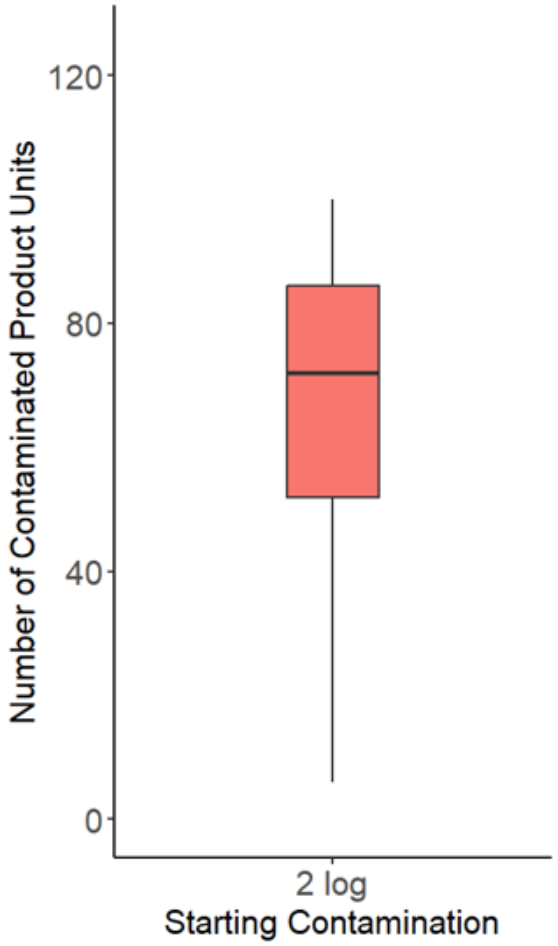
- 30,000 kg of milk powder processed in one production run.
- Milk powder is packaged in 300 g consumer-sized units.
- 100,000 milk powder units are produced in one production run.
- For a given scenario, 1,000 production runs are simulated.
- Initial contamination levels: 100, 10,000, or 1,000,000 cells of *Salmonella*.

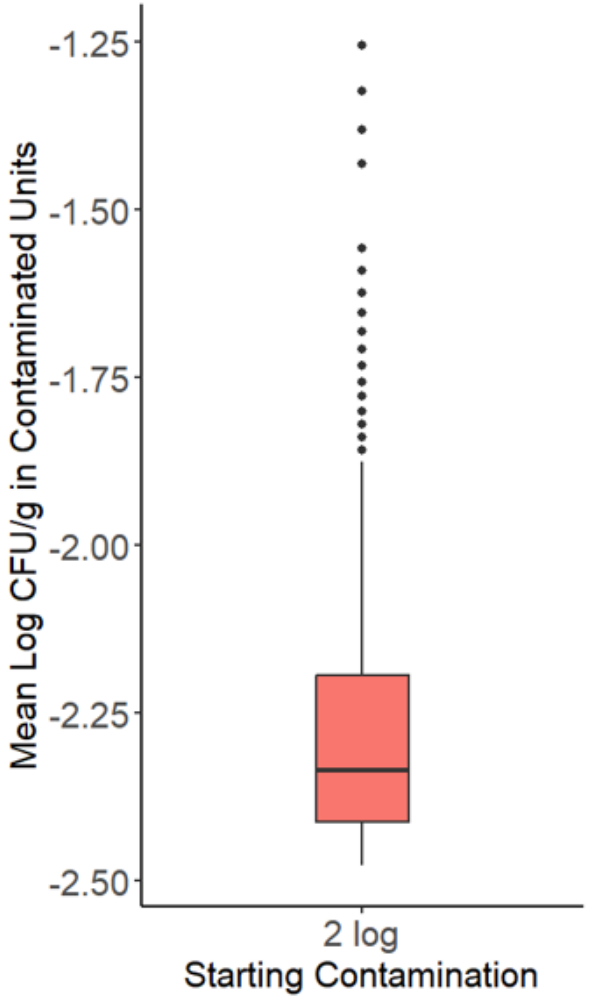
Illustration by Celeste Withiam

Daeschel et al., 2025. Applied Environmental Microbiology. Available here:

Scenario 1: How does a surface contaminated with *Salmonella* cross-contaminate milk powder?







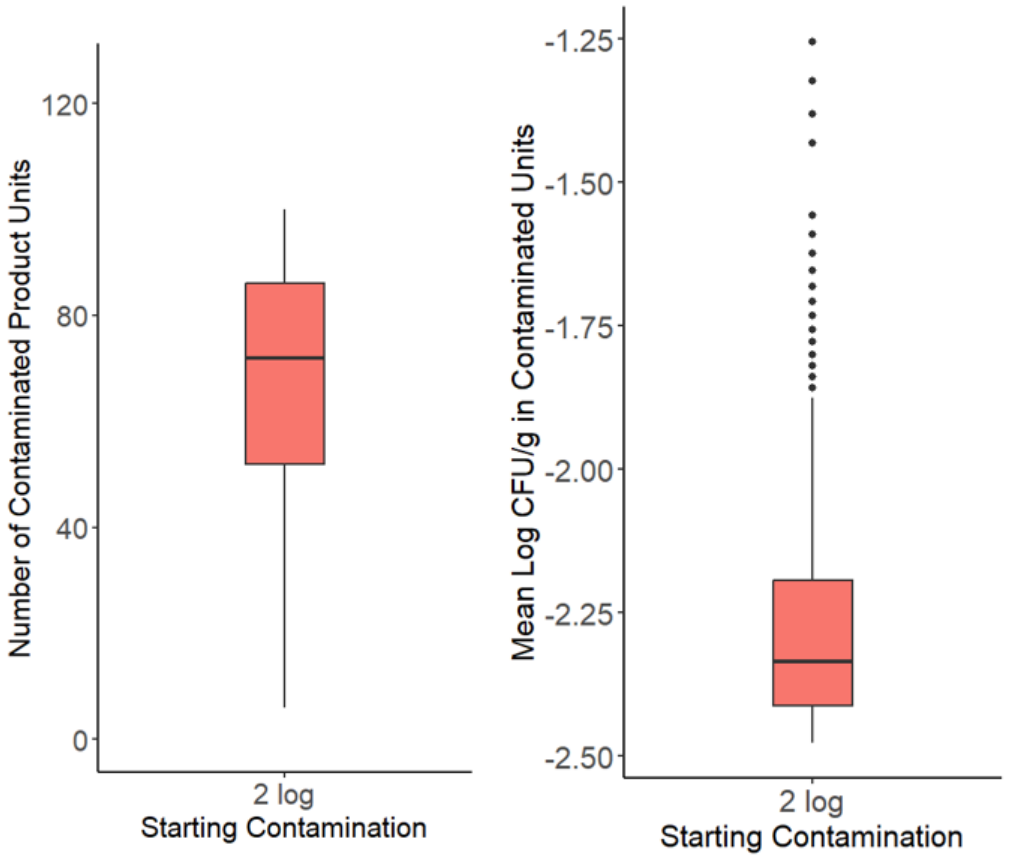
Results:

Median number of units contaminated with *Salmonella*:
72 [p5: 24, p95: 96]

Concentration of *Salmonella* within units:
-2.33 log cfu/g [p5: -2.46, p95: -1.86]

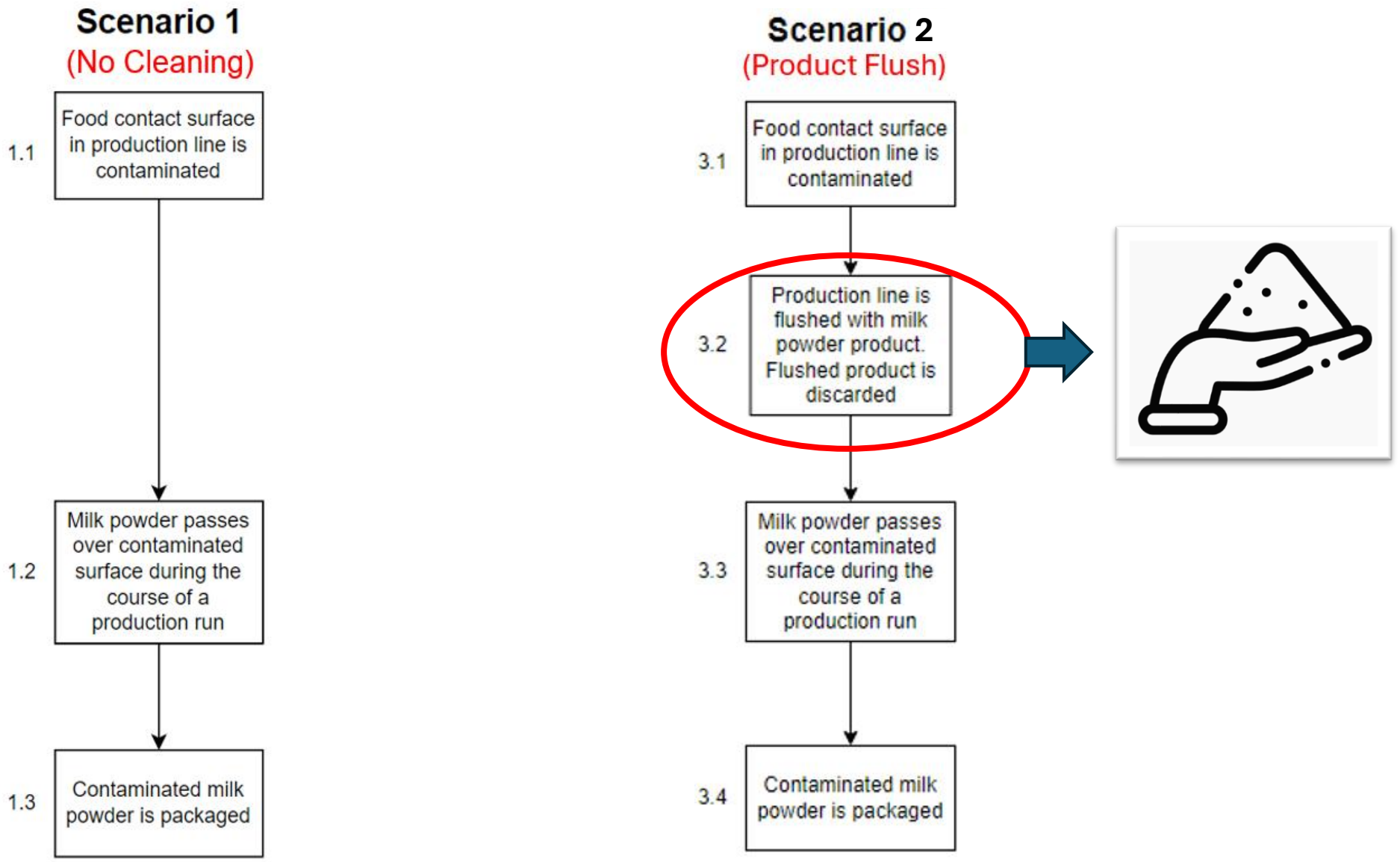
1 to 4 *Salmonella* per product unit

Scenario 1: How does a surface contaminated with *Salmonella* cross-contaminate milk powder?

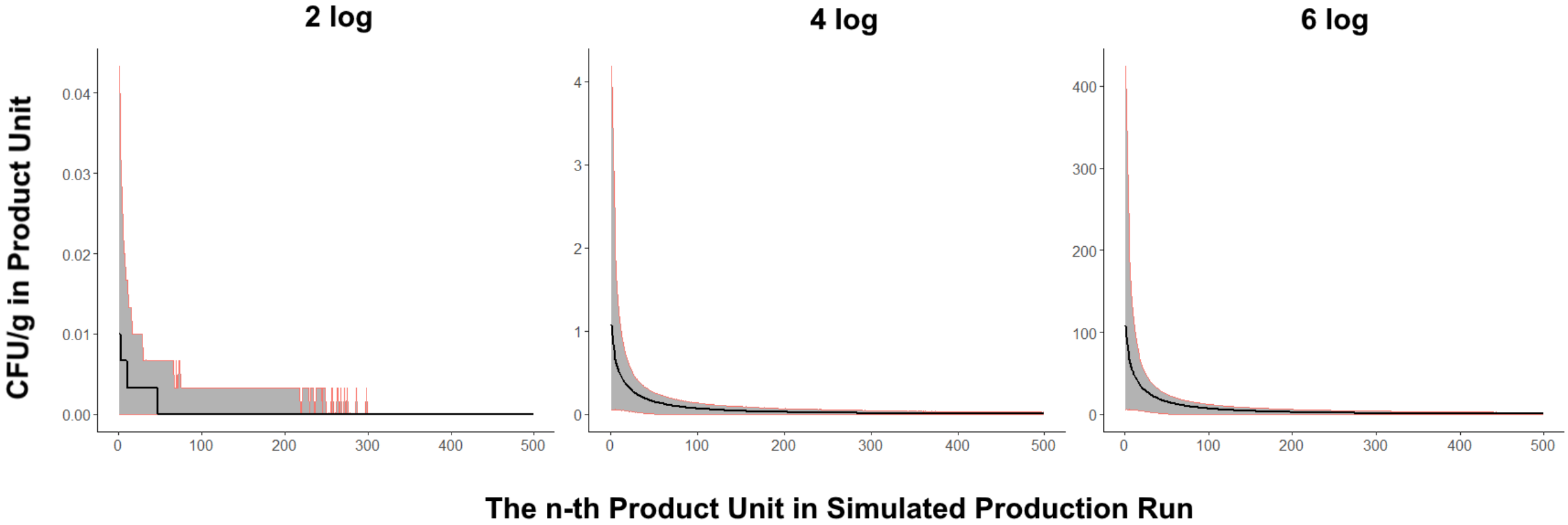


Recalled Product Details	Organism	Reported Contamination Concentration	Contamination Concentration (Log CFU/g) or (Log MPN/g)	Reference
-Recalled Powdered Infant Formula (PIF) -Produced in January 2007 -22,000 kg batch was recalled -Product packages contained two 400g bags	*Cronobacter* spp.	-2.78 Log CFU/g	-2.78 Log CFU/g	(Jongenburger et al. 2011)
-Recalled PIF -Produced in 1985 -PIF was packaged in 25kg bags.	*Salmonella* Ealing	1-6 CFU/450g	-2.65 to -1.87 Log CFU/g	(Rowe et al. 1987)
-Recalled wheat flour -Produced in 2016 -1kg and 10kg bags	*E. coli* O121	0.15 to 0.43 MPN/100g	-2.82 to -2.37 Log MPN/g	(Gill et al. 2019)
-Recalled raw wheat flour used in baking mix. -Produced in 2008	*Salmonella* Thyphimurium	0.0036 to 0.024 MPN/g	-2.44 to -1.62 Log MPN/g	(McCallum et al. 2013)

How do cleaning interventions reduce the prevalence and concentration of *Salmonella* contamination?



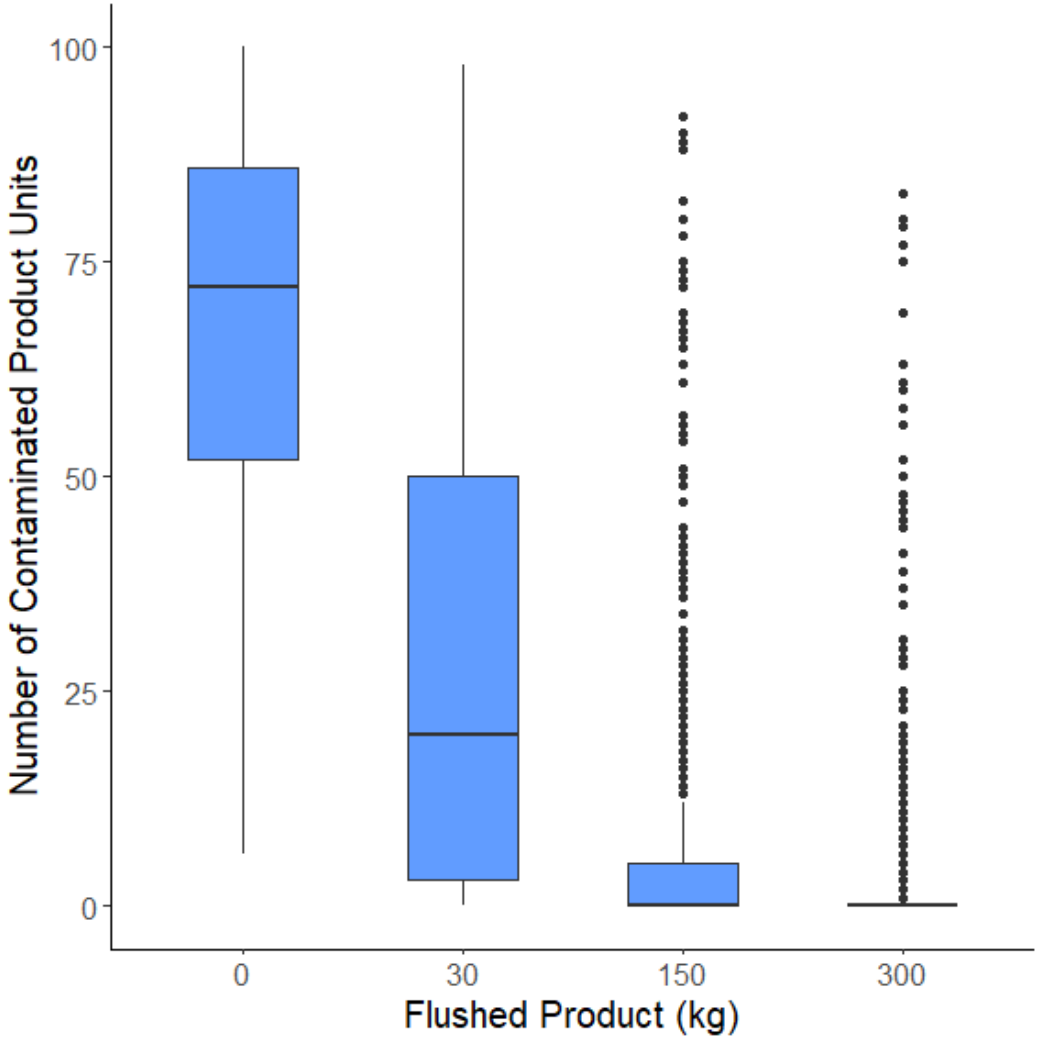
Scenario 1: How *Salmonella* contaminates sequential units produced during production.



1st unit produced after 6 log contamination breach: 100 CFU/g

500th unit produced after 6 log contamination breach: 1 CFU/g

Scenario 2: Product Flushing



Median number of units contaminated with *Salmonella* after flushing:

No flushing: 72 [24, 96]

30 kg flush: 20 [0, 82]

150 kg flush: 0 [0, 42]

300 kg flush: 0 [0, 16]

Percentage of simulations where flushing removed all *Salmonella* before production:

No flushing: 0%

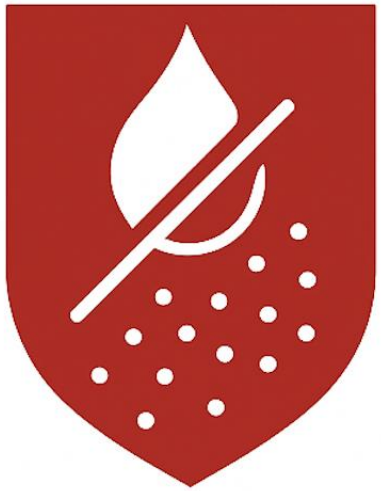
30 kg flush: 17%

150 kg flush: 63%

300 kg flush: 80%

Where do we go from here?

- We are working with the industry to conduct studies that:
  - Establish a process to identify the most problematic niches in a processing line.
  - Demonstrate how to quantify microbial reduction in those niches.
  - Develop a QMRA that can be used to compare outcomes among different sanitation regimens.



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DRY SANITATION
RESEARCH
ADVISORY COUNCIL

Contact Us: snyder@cornell.edu

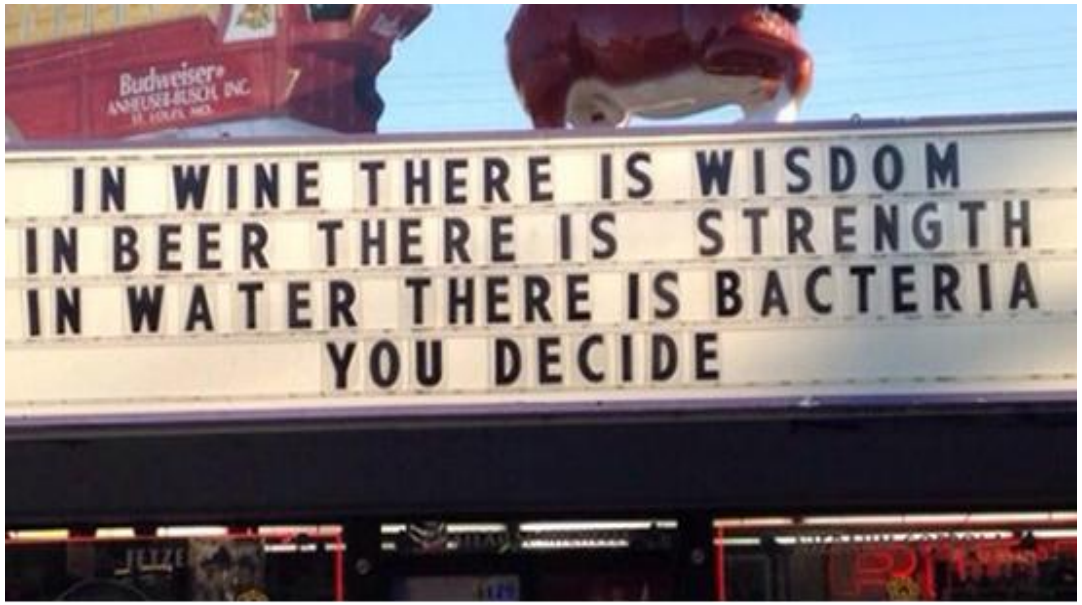
DMI
DAIRY MANAGEMENT INC.™

USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

FREE Low Moisture Food Safety Series

- **June 24th 12-1 pm: Supply Chain Food Safety Through Disruption**
- *Speakers:* Martin Wiedmann (Cornell), Aaron Adalja (Economist, Cornell), Mark Nisbet (Mars Wrigley) and Hazel Tatosian (Ingredion)
- **July 1st 12-1 pm: Process Validation in Low Moisture Foods - Reducing the Risk of Failure**
- *Speakers:* Wendy White (Georgia Tech), Kaitlyn Casulli (Risk Busters), Brian Farina (Deibel Labs)
- **July 15th 12-1 pm: Allergen Control Programs: Transitioning to Risk-Based Management Systems**
- *Speakers:* Joe Baumert (Nebraska Lincoln), Ben Remington (Nebraska Lincoln), Abby Snyder (Cornell)
- **July 23rd 12-1 pm: Product testing methods and schemes for low moisture foods – limitations and opportunities**
- *Speakers:* Martin Wiedmann (Cornell), Matt Stasiewicz (Illinois), Pam Wilger (Post), Catharine Carlin (mxns)

https://cals.cornell.edu/institute-for-food-safety/resources/virtual-office-hours



Treat water like glass…the war on water

Is your kitchen “clean”?

Is your kitchen dry?

Leaks
Drips
Condensation
Pooling
Stagnant

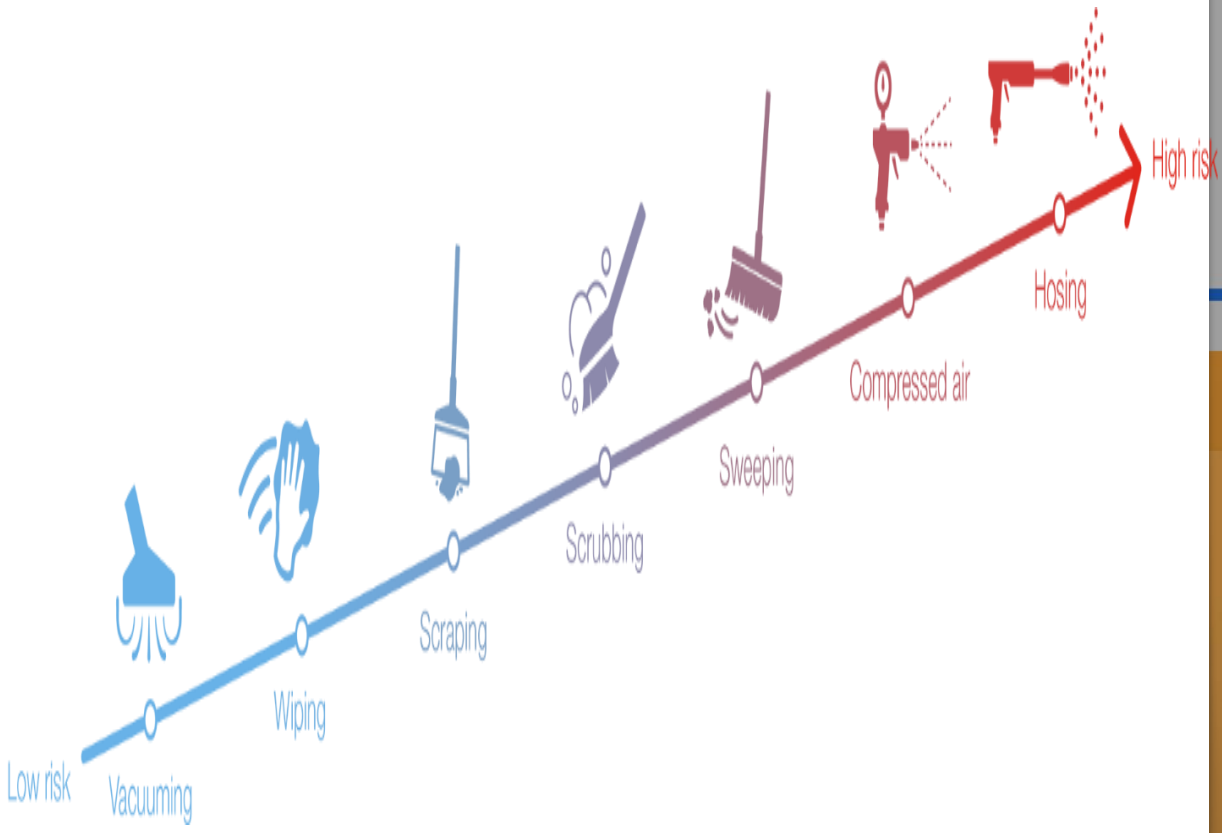
The War on Water

- Contamination risk
  - Chemical
  - Physical
  - Microbiological
  - Regulatory

From a microbiological standpoint…

Unnecessary water is like gasoline for a fire.

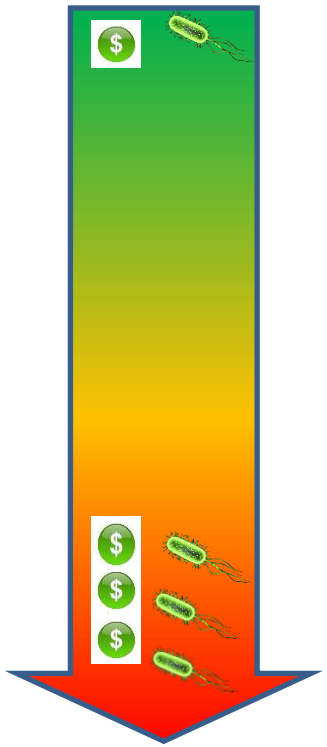
Water should be by exception only.



Why is the WOW (War On Water) important?

- Leads to significant microbiological growth in our product environments
  - Pathogens – *Listeria*, *Salmonella*, etc.
  - Spoilage – Yeast, Mold, etc.
- Human safety hazard
  - Chemical usage
  - Slip hazards
- Equipment reliability and function
  - Electrical issues
- Regulatory focus
- Environmental and sustainability goals

Cleaning Method – Order of Preference



1. No cleaning needed
    a. Redundant or dedicated equipment (isolated)
2. Purge (next product or inert material)
3. Dry clean
4. Dry clean w/chemicals
5. CIP (Clean in Place)
6. Controlled wet clean – out of place
    a. Automated washer
7. ACS (Assisted Cleaning System)
8. Controlled wet clean – in place
9. Flood cleaning

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Control Water/Moisture

Necessary Water	
– Process water	Minimize/Manage
– **Wet washing**	**Eliminate/Reduce**
Unnecessary Water	
– Condensation	Fix Root Cause
– Leaks	Fix Root Cause
– Ingress	Fix Root Cause
– Internal	Fix Root Cause
– Drains (leak or back-up)	Fix Root Cause

Action plan

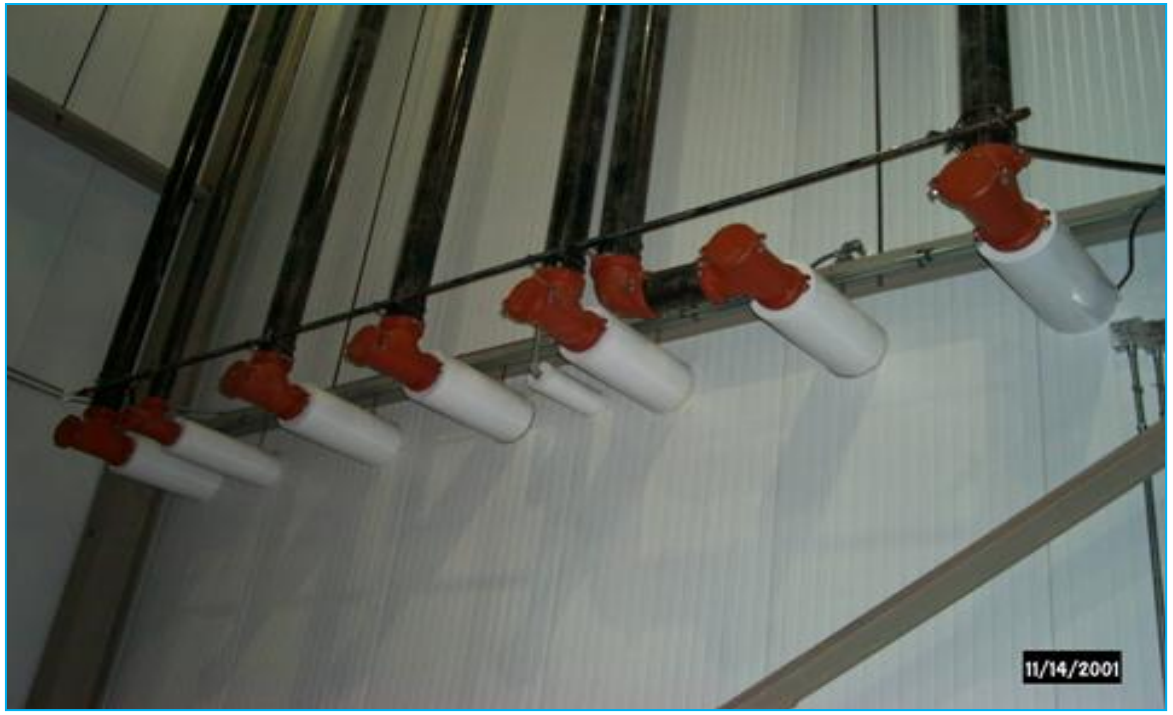
- Find it
- Fix it
- Prevent it

Find it

- Water Audit
  - Uncontrolled water
    - Condensation
    - Wet cleaning
    - Leaks
    - Drips
    - Pooling
    - Ice/frost
    - Steam

Fix it

- Corrective action plan
  - Guidance documents
    - Insulate surfaces
    - Heat surfaces
    - Dry air
    - Dry surfaces
    - Seal spaces
    - Ventilate
    - Pressurize spaces
    - Isolate
    - Maintain as sanitary

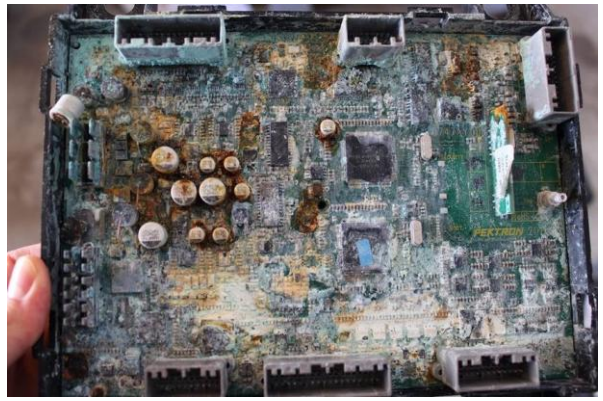


Prevent It

- Early Management
  - Discuss uncontrolled water risk early and often
- Engineering focus > design it out
  - Facility and system
    - HVAC
    - Plumping

Key Takeaways

- Develop a ***Water Control Program***
  - design
  - train
  - audit/inspect
  - respond



- Follow the ***ranked cleaning method proposal*** to minimize the impact of cleaning

- Establish a ***risk based framework*** to ensure that the appropriate cleaning and sanitation protocols are applied.

Key Learnings

- Clearly define clean expectations to cross functional teams
- Wet/dry zoning is needed
- Component level of disassembly
- If you get it wet, you must fully clean and validate
- If it is dry, keep it dry – treat water like glass
- If you wet clean, get it dry quickly, then keep it dry
- Mechanical action is critical – focus on low flow areas
- Spend time on the plant floor auditing and reviewing practices
- Visual inspection is everyone's best sanitation tool!

I used to be addicted to soap...

But I'm clean now.

What is a niche

And their impact on dry cleaning

Nathan Mirdamadi, Global Director of Sanitation

A Growth-led Industry Leader

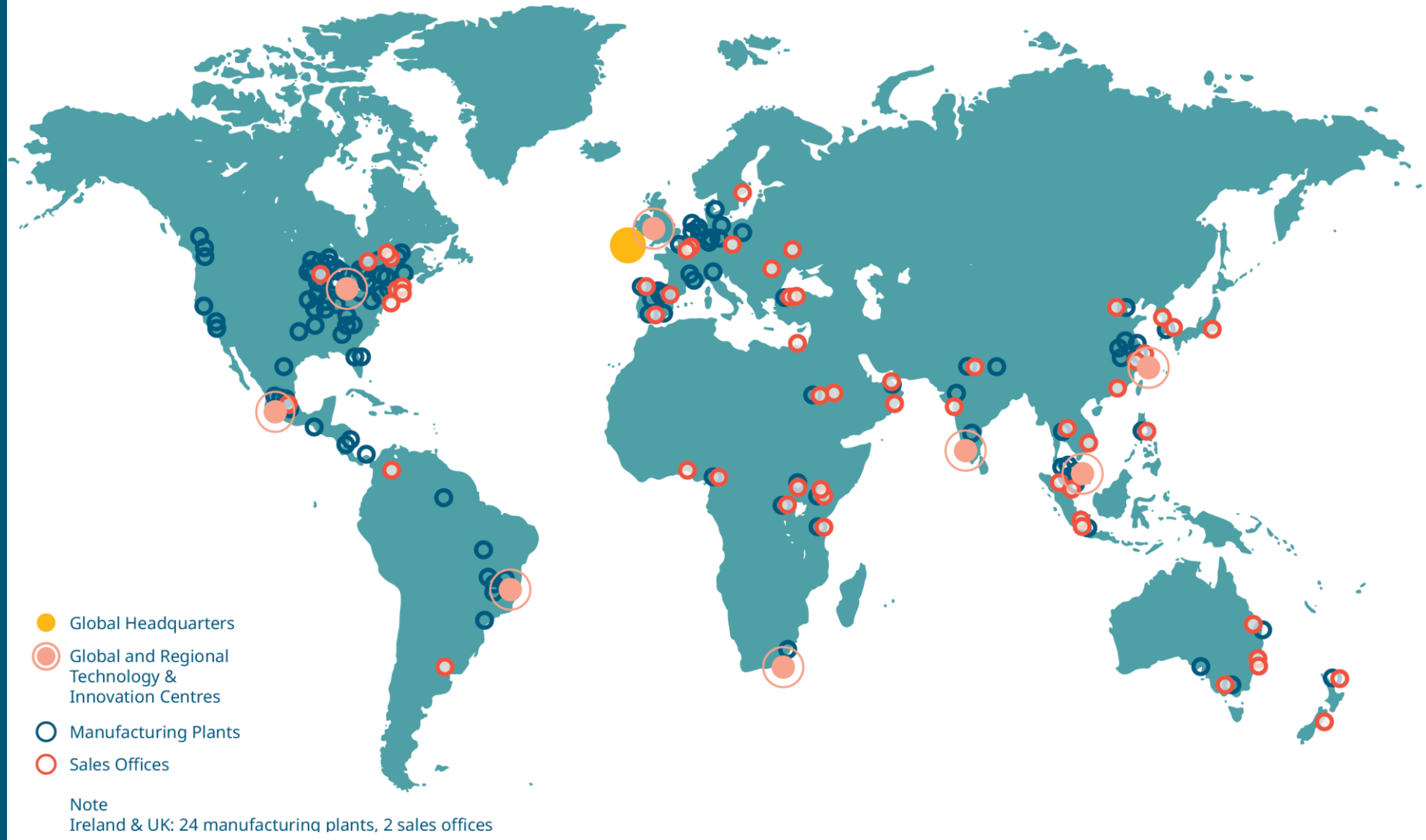
137
Manufacturing locations

70+
Technology and Innovation centres

21,000+
Employees

1,100+
R&D scientists

- Spray Drying
- Seasons/Flavors
  - Dry & Liquid



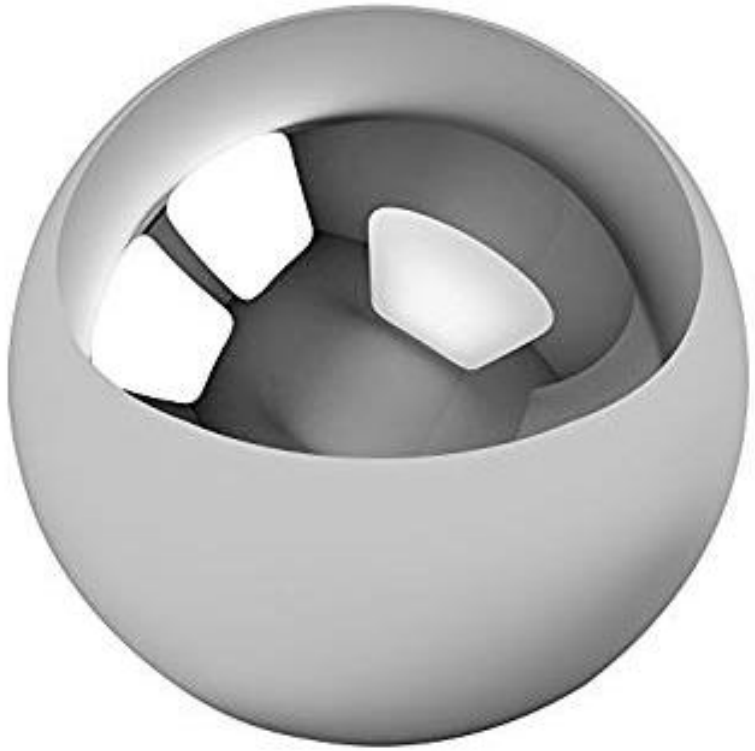
OUR CONSUMER…

Our obligation:

- **Our customers (& families)**
- **Our Brands/Businesses**

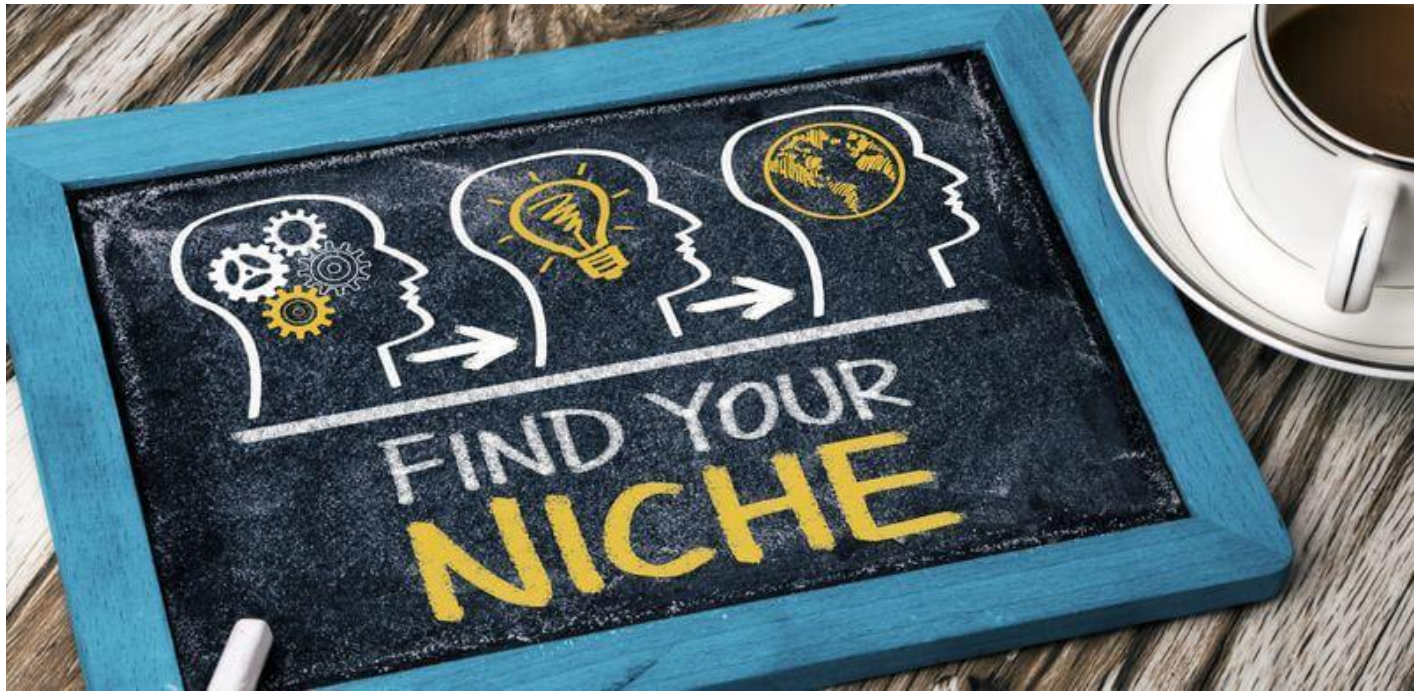
PERFECTION

- The BIG Picture of Food Safety
- Leverage existing HD Guidance
  - 3A, NAMI, GMA, EHEDG
- Identify the gaps and develop Periodic Equipment Cleaning (PEC)
  - Determine Foundational vs Priority PEC Tasks



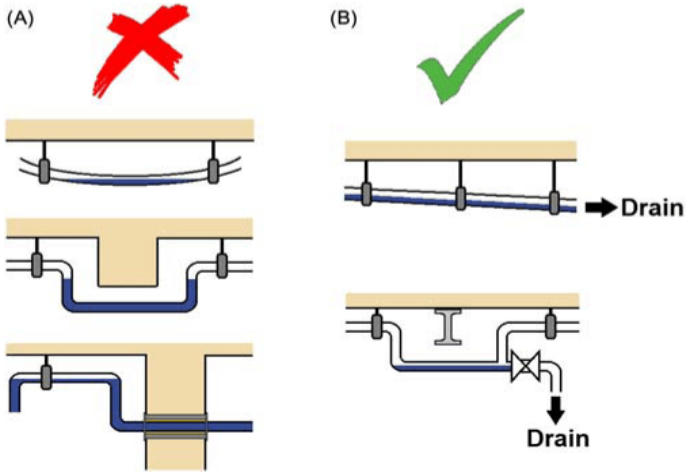
What is the problem with a Niche?

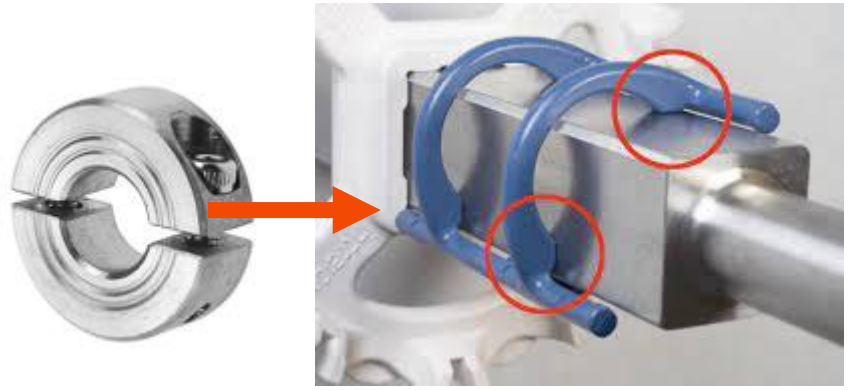
- A segment of the market
- A place where microorganisms can establish themselves, multiply, and potentially contaminate food



WHERE DO WE FIND NICHES?

- Pits
- Cracks
- Recesses
- Open seams
- Un-hermetically sealed joints
- Poorly design connections
- Dead ends/legs
- Areas were food/water accumulates





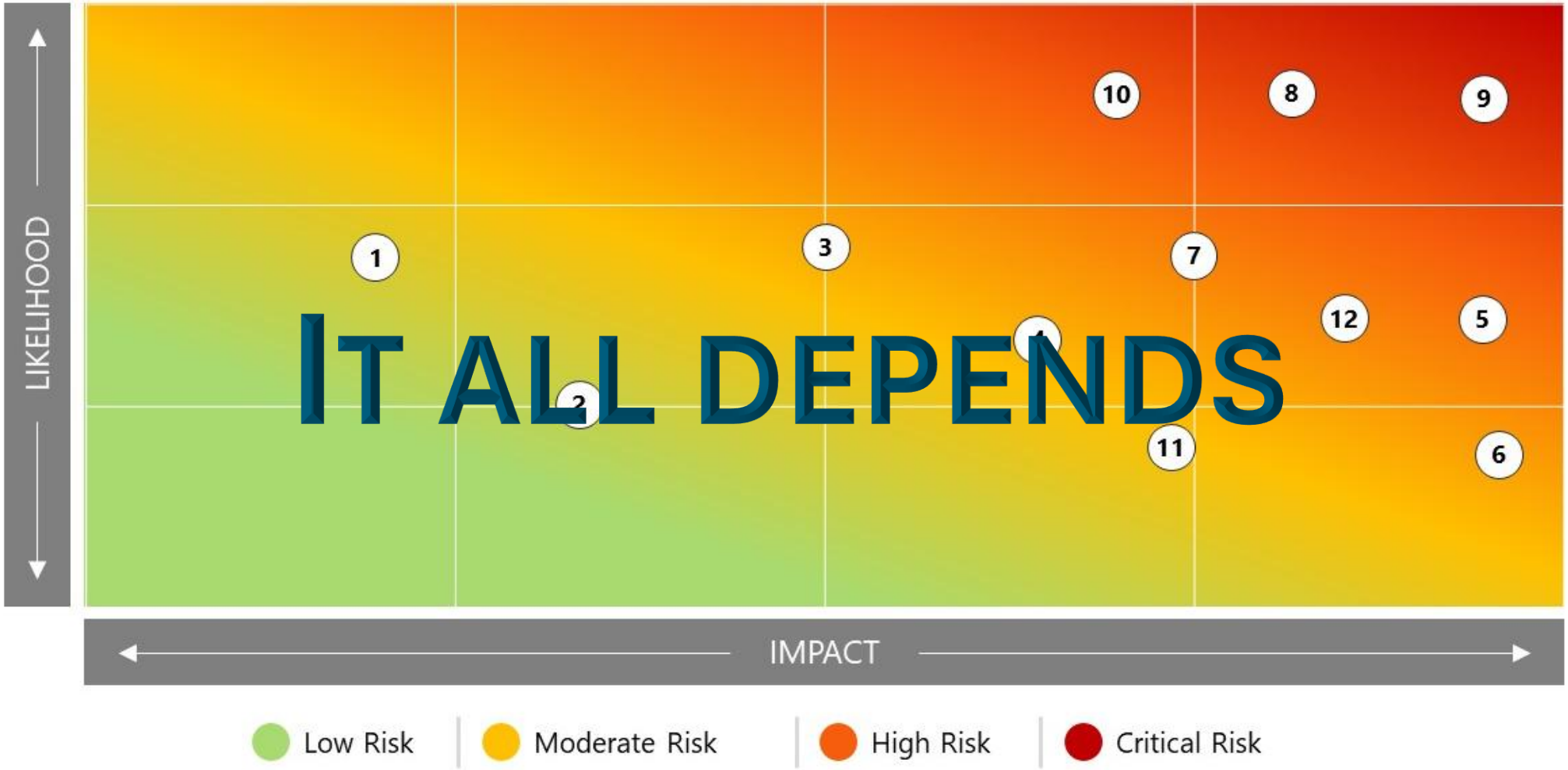
WHO CAN WE BLAME FOR NICHES?

- Maintenance Technicians
- Bean Counters
- Design Engineers
- Food Safety
- Company Culture

WHY ARE NICHES A PROBLEM?

- Ignorance
  - Lack of focus
  - Appreciation (in low-moisture products)
- Poor cost analysis
  - Initial Cost vs Total Cost Ownership
  - Resource vs Materials
    - Assumptions
- Realities of Fabrication & Construction
- USE OF PRESENCE OF WATER
- INCREASES DIFFICULTY OF DRY CLEANING

When are niches problematic?



How Do we manage and avoid them?

- Sanitary Design
  - New or Existing Equipment
- Period Equipment Cleaning

Define the Gap & Urgency

- Define the Risks
  - Microbiological, Chemical, Physical
  - Public Health, Regulatory, Business
- Determine Ideal Case (End in Mind Thinking)

KERRY

THANK YOU

Questions?

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