

# ***Listeria* in controlled atmosphere storage facilities**

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## Overview

- Importance of *Listeria*
- What we currently know about *Listeria* in the apple production chain
- Where *Listeria* can be found in controlled atmosphere storage facilities
- Recommendations for controlling *Listeria* in CA storage

## What is *Listeria* and where can we find it?

- *Listeria* includes 20 different species
  - Only 1 is a human pathogen – *L. monocytogenes*
- Can be found almost everywhere
  - Soil, water
  - animals
  - Food processing facilities



## Importance of *Listeria*

- Can survive for lengthy periods of time
  - On foods and in food processing environments
    - Can persist for years in food processing facilities
  - Can grow even at refrigeration temps
- Potential for transfer from environment to food
  - Many outbreaks of *L. monocytogenes* linked to contamination events during processing
- Significant costs associated with recalls and outbreaks

# Recalls of apple products due to *L. monocytogenes* contamination

Year	Product Type	Reason
2012	Apple Slices	Processing Equipment
2013	Apples Slices	LM on apples
2014	Fresh-cut Apples	LM on apples
2014	Cut Apples	LM on apples
2014	Caramel Apples	LM on apples
2014	Caramel Apples	Associated with outbreak
2014	Caramel Apples	Associated with outbreak
2015	Caramel Apples	LM on apples
2015	Whole Apples	Associated with outbreak
2015	Apple slices with dip	Products positive
2015	Apple Slices	Environmental Samples
2015	Whole Apples	Possible LM
2016	Apple Slices	Products Positive
2017	Apple Slices	Products Positive
2017	Packaged products	LM on apples
2017	Whole Apples	LM on apples
2019	Whole Apples	LM on apples
2020	Apple Slices	Processing equipment

# Environmental monitoring / sampling

- Monitoring the processing environment to prevent cross contamination from environment to finished product
- Data collected over time
  - Identify area(s) of concern to be addressed
  - Identify patterns
  - Determine if practices need to be changed

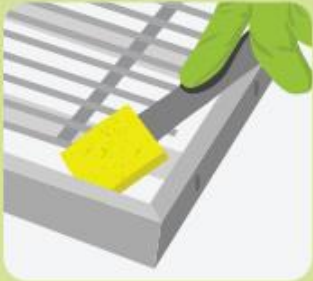




## ZONE 1

### Food Contact Surfaces

(Slicers, peelers, fillers, hoppers, screens, conveyor belts, air blowers, employee hands, knives, racks, work tables)



## ZONE 2

### Non-Food Contact Surfaces in Close Proximity to Food and Food Contact Surfaces

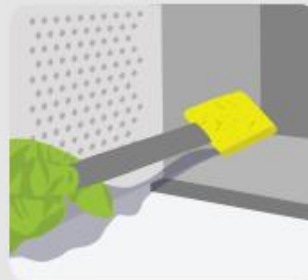
(Processing equipment exterior and framework, refrigeration units, etc.)



## ZONE 3

### More Remote Non-Food Contact Surfaces Located In or Near the Processing Areas

(Forklifts, hand trucks, carts, wheels, air return covers, hoses, walls, floors, drains)



## ZONE 4

### Non-Food Contact Surfaces Outside of the Processing Areas

(Locker rooms, cafeterias, entry/access ways, loading bays, finished product storage areas, maintenance areas)

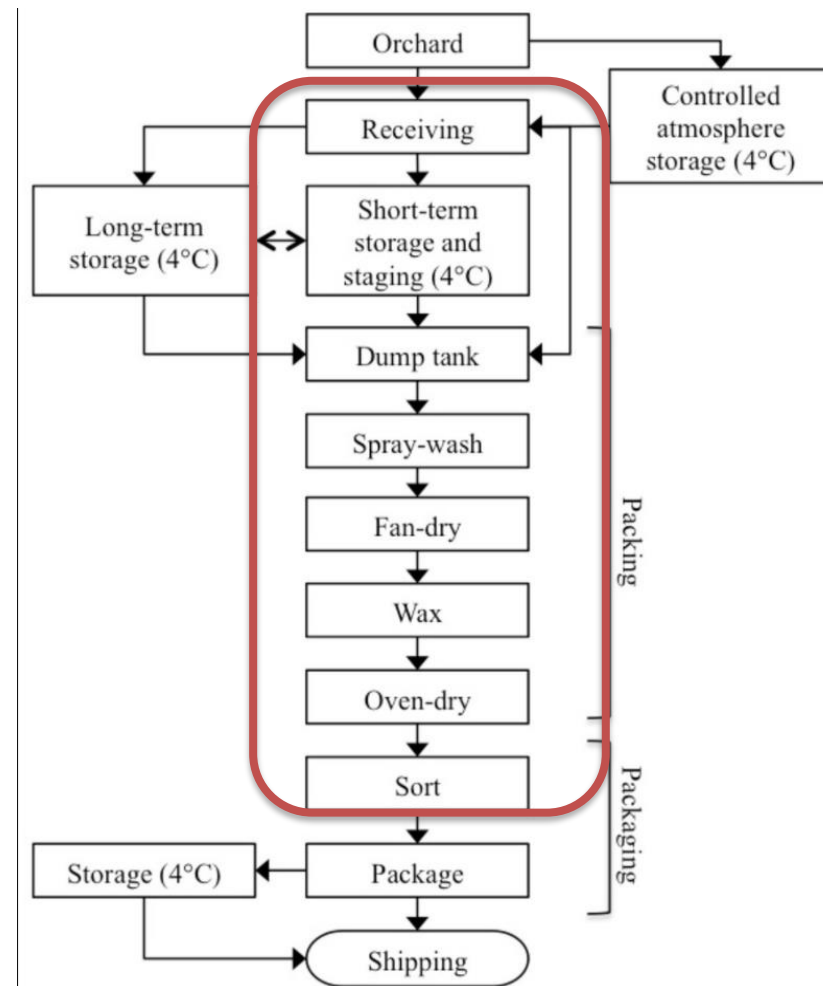


# Indicator organisms

- Indicator organism
  - Indicate whether an area, food source, etc. is capable of harboring associated pathogens when present
- *Listeria* spp.
  - FDA and USFPA recommends testing
  - *Listeria innocua*
    - Genetically and phenotypically similar to *L. monocytogenes*

## Potential contamination of *Listeria* in the apple processing chain

- Pre-harvest
  - Agricultural environment
- Post-harvest
  - Bins and forklifts
  - Storage rooms
  - Washing
  - Food contact surfaces
- Environmental monitoring studies at packinghouses



# Questions addressed in previous environmental monitoring studies of *Listeria* spp. in apple packing houses

- How often do we find *Listeria* at specific sites?
  - Testing for *Listeria* spp. in general rather than *L. monocytogenes*
  - Zones 2 and 3 often the focus
  - Positives, especially repeated positives over time, indicate potential for spread to other areas of facility

# Common apple packinghouse sites that are positive for *Listeria* spp.

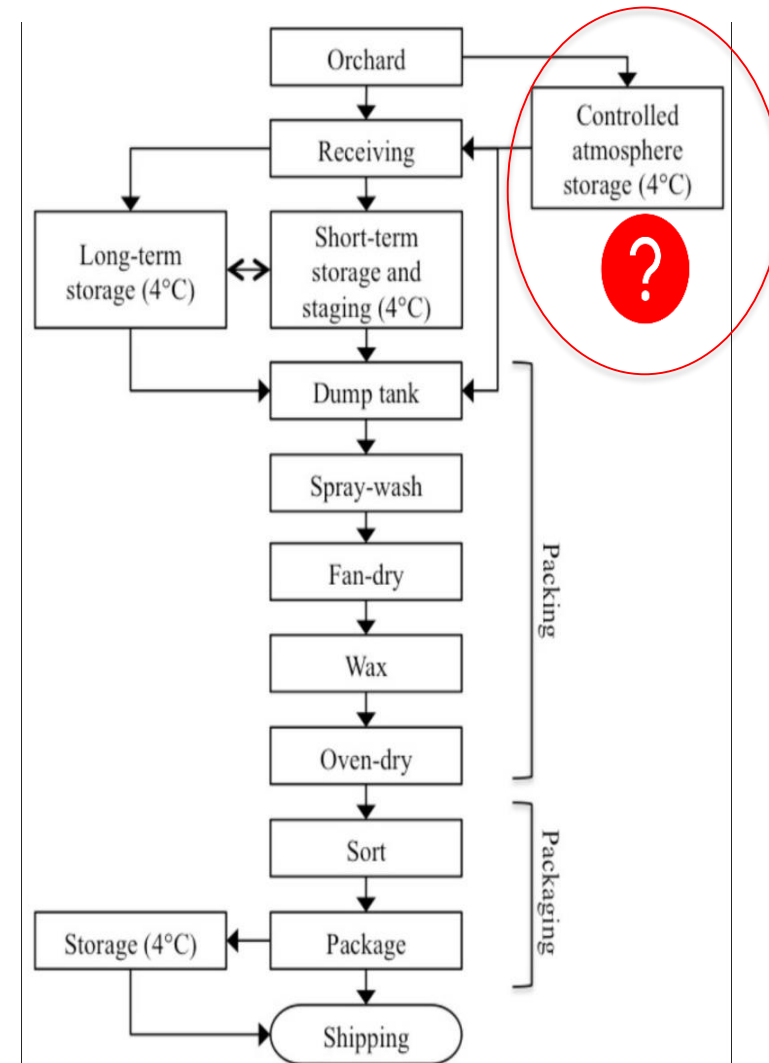
- 3 apple packing houses
- 40 NFCS
- Zones 2-3
- 1437 samples
  - *L. mono* = 17.5%

Area	Sub-area	Sample site description	Zone	Sample ID#	P1	P2	P3
					Lm prevalence (%)		
Cold storage	Short-term and staging	Floor 1/3	3	01	33.3	8.3	8.3
		Floor 2/3	3	02	66.7	58.3	8.3
		Floor 3/3	3	03	33.3	25.0	8.3
		Floor crack/seam 1/2	3	04	16.7	0.0	16.7
		Floor crack/seam 2/2	3	05	41.7	16.7	8.3
		Foot of fruit storage bin	3	06	8.3	0.0	0.0
	Long-term	Floor 1/3	3	07	16.7	16.7	0.0
		Floor 2/3	3	08	16.7	33.3	0.0
		Floor 3/3	3	09	0.0	25.0	16.7
		Floor crack/seam	3	10	16.7	33.3	0.0
		Foot of fruit storage bin	3	11	0.0	8.3	0.0
Packing line	Dump tank	Rim above water line 1/2	2	12	0.0	0.0	0.0
		Rim above water line 2/2	2	13	0.0	0.0	0.0
		Bin loading equipment	2	14	0.0	8.3	8.3
	Spray-wash	Bin unloading equipment	2	15	8.3	0.0	0.0
		Interior of cull bin	3	16	8.3	33.3	0.0
		Spray or structural bar over brushes	2	17	0.0	8.3	0.0
		Drip pan	3	18	0.0	0.0	0.0
		Scraper or structural bar under brushes	2	19	25.0	0.0	0.0
		Floor directly below line	3	20	33.3	91.7	0.0
		Structural support/flow partitions above the line	2	21	0.0	41.7	8.3
Fan-dry	Drip pan	3	22	8.3	66.7	0.0	
	Scraper bars and drip pan funnel below line	3	23	0.0	91.7	8.3	
	Floor directly below the line	3	24	25.0	100.0	0.0	
	Structural support/wax spray bar over brushes	2	25	0.0	33.3	8.3	
Wax	Flow partition dividers/wax drip area	2	26	8.3	66.7	0.0	
	Drip pan/wax drip area	3	27	16.7	100.0	16.7	
	Structural support/wax drip area below the line	3	28	0.0	91.7	16.7	
	Floor directly below line	3	29	8.3	100.0	16.7	
	Catwalks adjacent to lines 1/2	3	30	8.3	58.3	8.3	
	Catwalks adjacent to lines 2/2	3	31	16.7	41.7	25.0	
	Adjacent floor drains along the packing line	3	32	33.3	91.7	0.0	
	High traffic floor adjacent to packing line 1/2	3	33	0.0	0.0	0.0	
Potential cross-contamination sites	High traffic floor adjacent to packing line 2/2	3	34	0.0	33.3	0.0	
	Forklift tine	3	35	8.3	0.0	8.3	
	Forklift wheel	3	36	8.3	16.7	0.0	
	Floor directly below sorting line	3	37	0.0	16.7	0.0	
	Sorting line equipment	2	38	0.0	33.3	0.0	
	Floor directly below pack line	3	39	0.0	16.7	0.0	
	Line equipment	2	40	0.0	8.3	0.0	

□ 0%, ■ 0-25%, ■ 26-50%, ■ 51-75%, and ■ >75%.

# Data Gaps and Needs

- Is *Listeria* present in CA storage rooms?
  - Temperature, modified air, humidity, and organic matter
  - No environmental monitoring studies in CA storage rooms
  - (Hamilton et al., 2022)
    - *Listeria* can survive on apples in CA rooms
  - (Estrada et al., 2021)
    - *Listeria* found in cold storage
    - What is the potential for spread?
- Where is *Listeria* spp. most often located in CA rooms
  - Bin use, movement, cleaning, etc.
  - How do these impact potential for *Listeria*?



# CA Storage Room Selection and Sample Timing

- 3 Facilities
  - Coded “A”, “B”, and “C”
  - 3 CA storage rooms
- 2 years (4 seasons)
  - Year 1: Fall 2021 and Spring 2022
  - Year 2: Fall 2022 and Spring 2023/Fall 2023
- Collected two times during storage season
  - Before apples were harvested
  - After apples were removed

# Sample Collection

## CATEGORY 1 HIGH TRAFFIC

- A – Floor near door (12 inches from door)
- B – Floor of corner near door
- C – Floor near stacked bins (where forklift would be driving)

## CATEGORY 2 CONDENSER UNITS

- A – Floor below condenser unit #1
- B – Floor below condenser unit #2
- C – Floor below condenser unit #3

## CATEGORY 3 FLOOR WALL JUNCTURE

- A – Curb location #1
- B – Curb location #2
- C – Curb seal

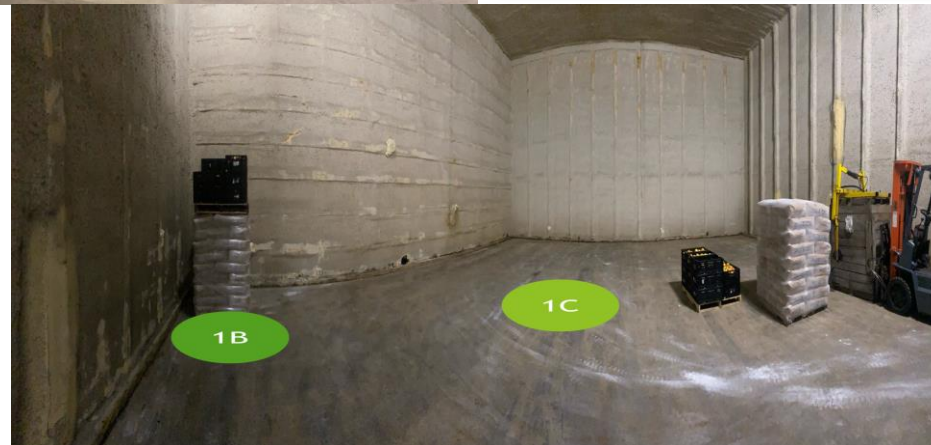
## CATEGORY 4 WALL

- A – Wall 2 feet above floor

## CATEGORY 5 STANDING WATER

- Collect 10 ml of standing water, if possible, from each room

# Sample Collection





# Sample Collection



# *Listeria* Detection Process



Collect environmental swabs from CA storage rooms

- 10 swabs per room

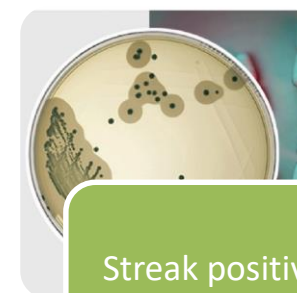


Enrich samples in LESS PLUS medium for growth of *Listeria*

- 24 h



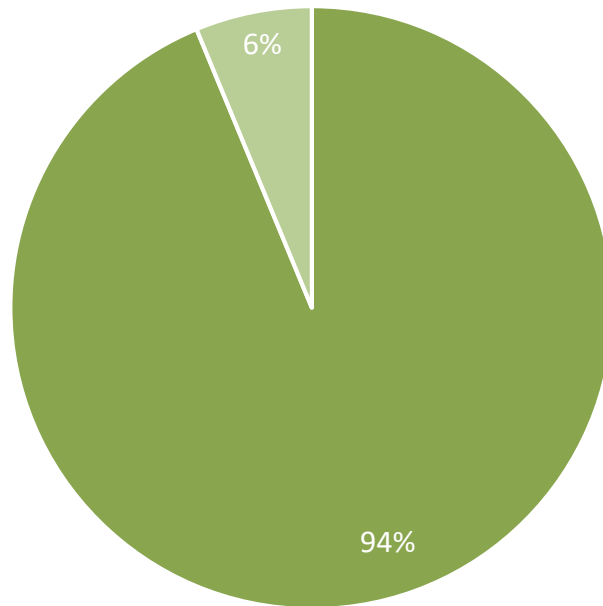
Detection of presumptive *Listeria* spp. by ANSR system



Streak positive enrichments to isolate *Listeria* spp.

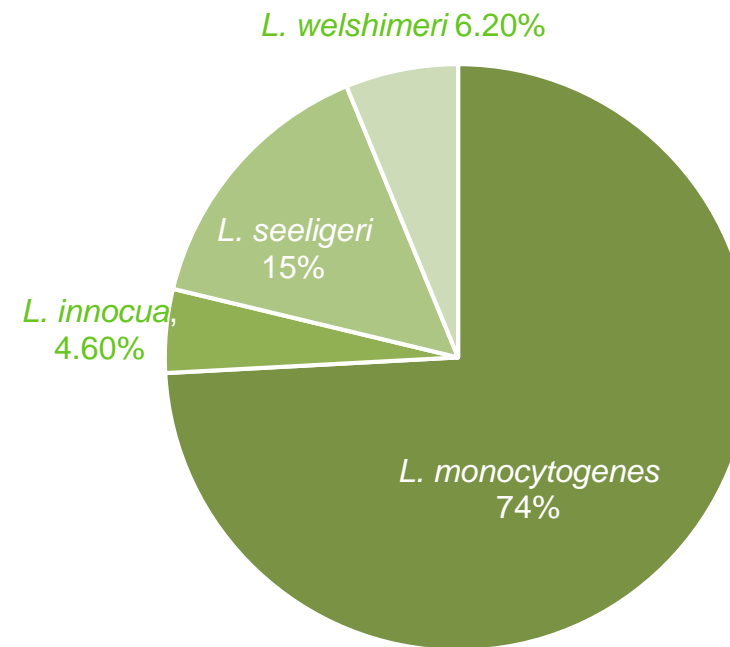
# Prevalence and Characterization of *Listeria* spp. in CA Storage Rooms

Samples positive for *Listeria* spp.



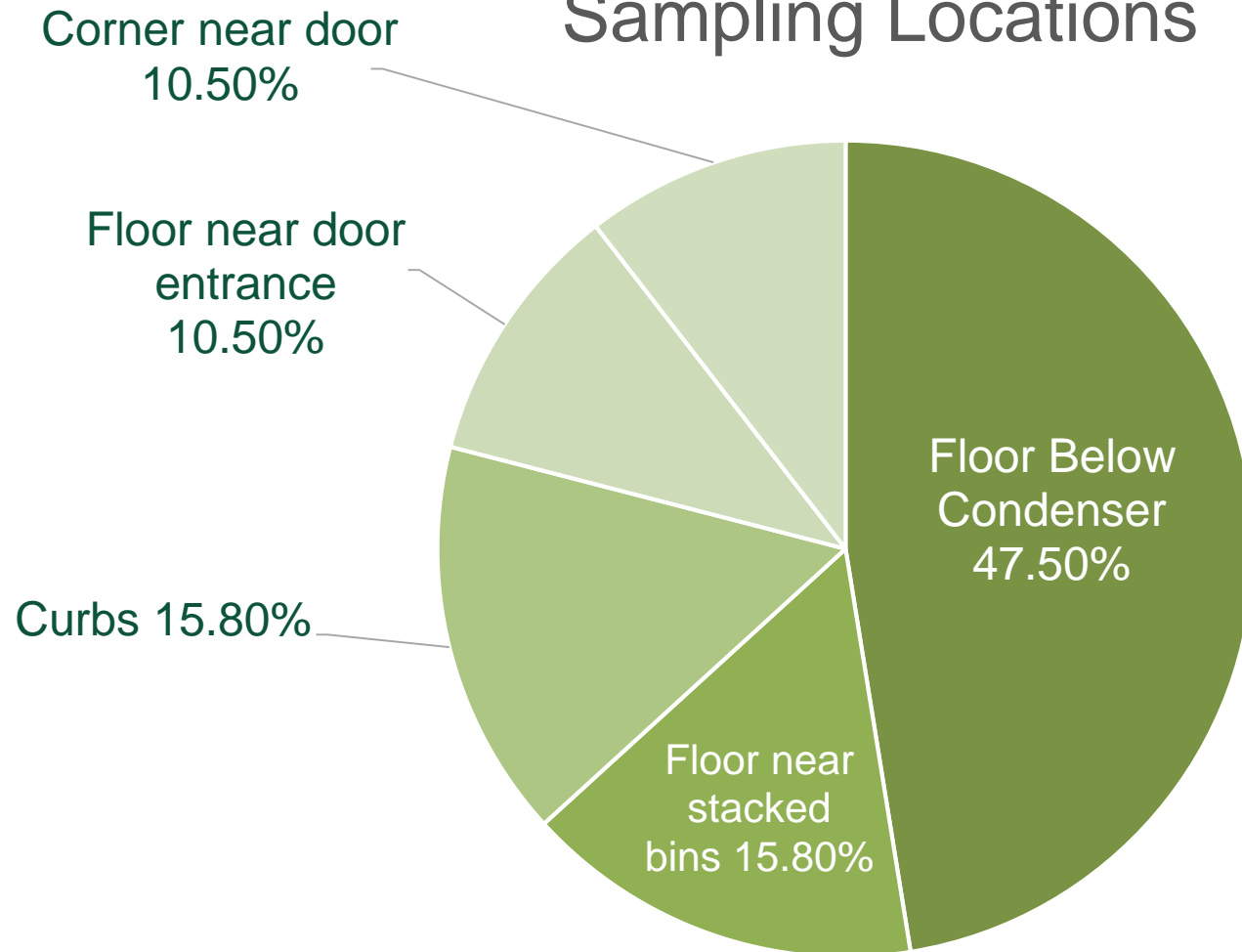
■ Negative ■ Positive

*Listeria* spp. present in CA storage rooms



# Distribution of *Listeria* spp. in CA Storage Rooms

## Sampling Locations



# Recommendations

- Eliminate *Listeria* prior to storage
  - Monitor sites after cleaning/sanitation
    - If positive, clean/sanitize again
- Avoid storing fruit under condensing units
- Minimize introduction of *Listeria* via movement of materials
  - Forklift sanitation
  - Forklift use
    - Dedicated use in certain areas

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  - USDA AMS
- **CA Facility managers**

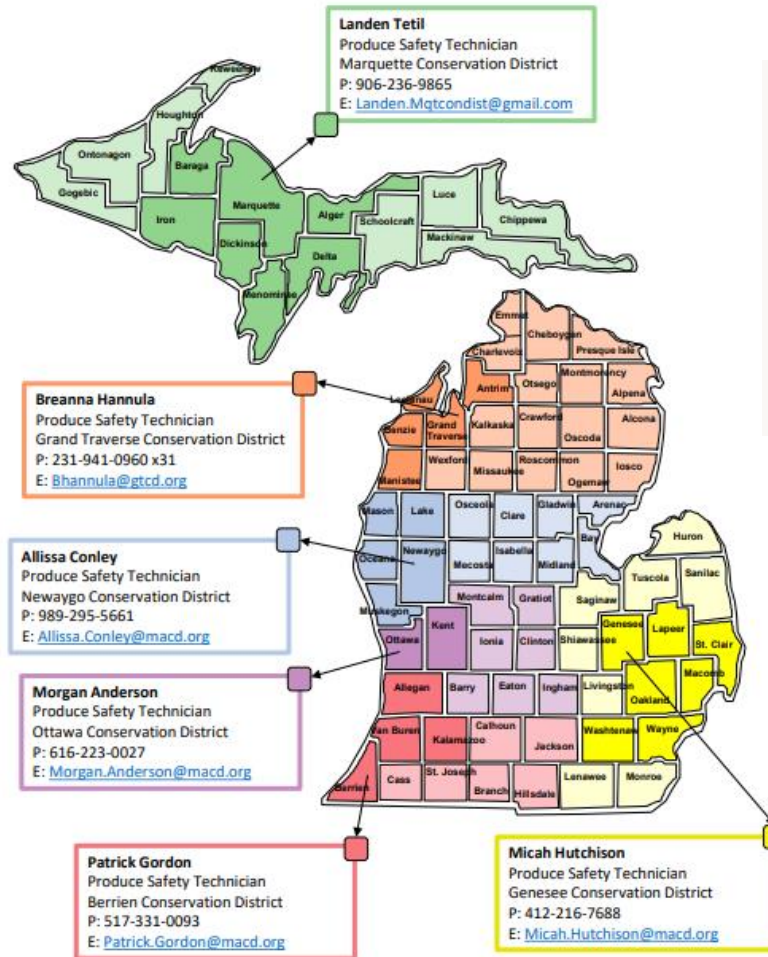
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# Produce Safety Technicians

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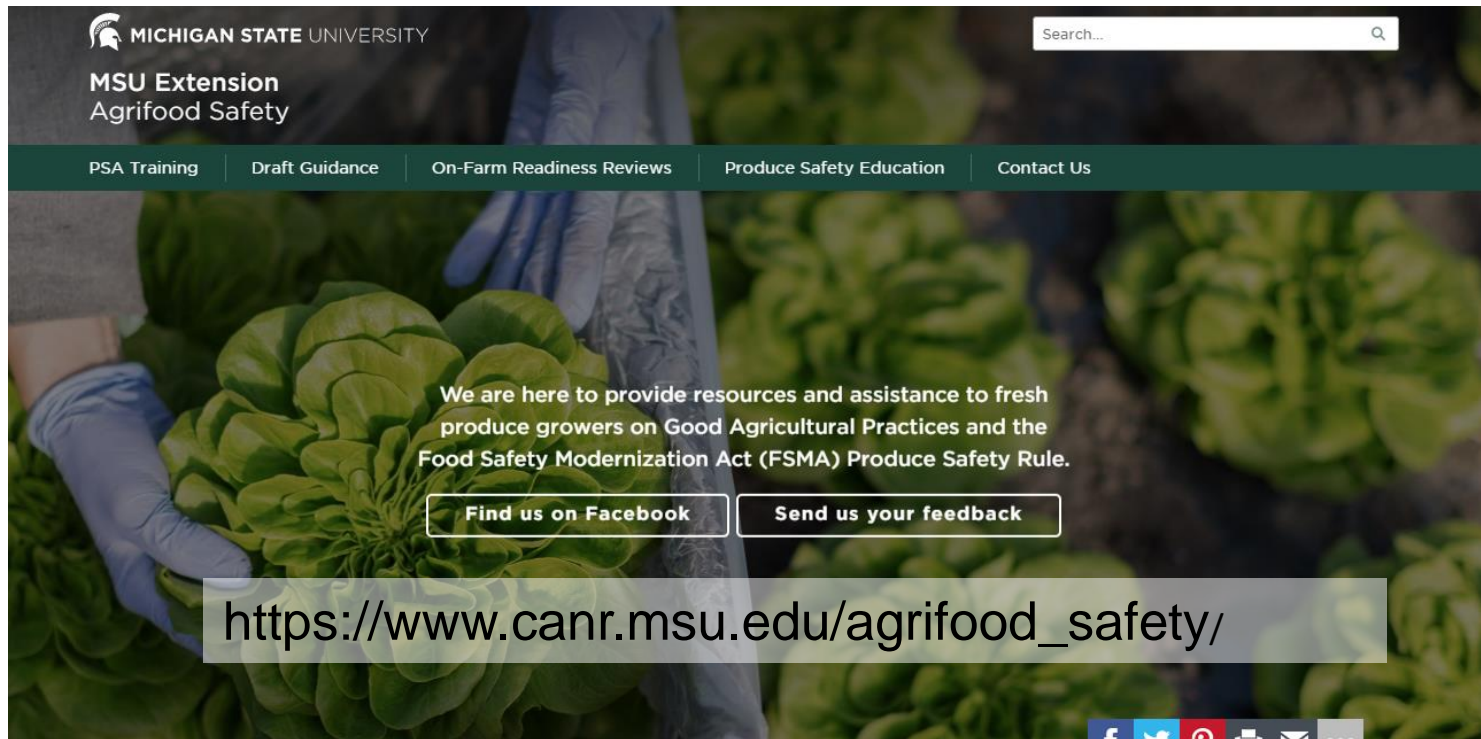


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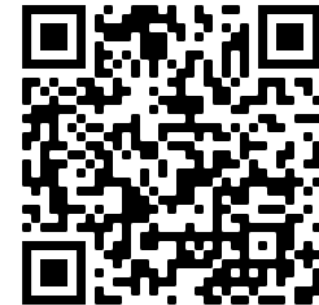
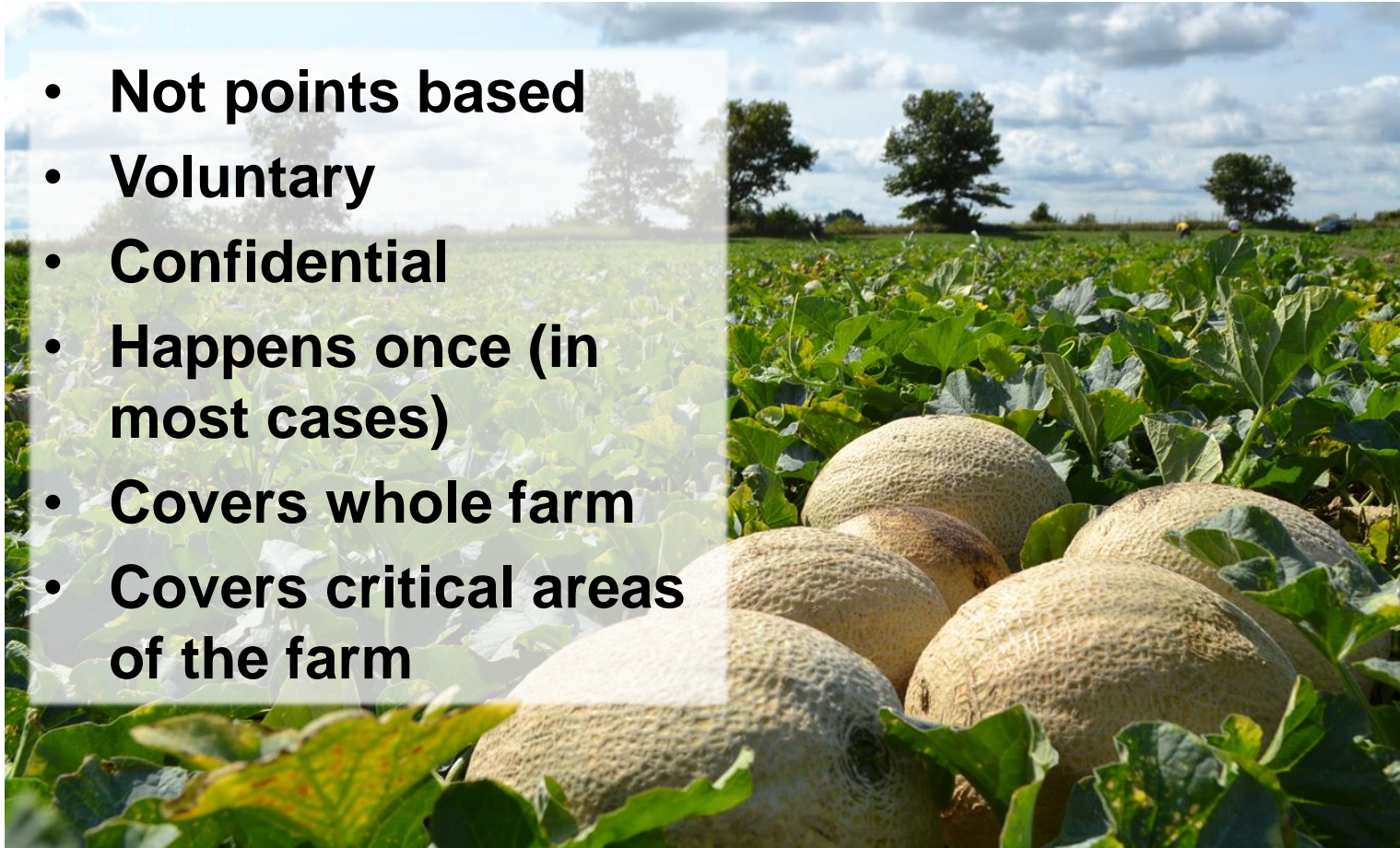


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From the Desk of  
The **Produce Safety** Team

October 23rd, 2023

VIDEO

## Power-washing Only Spreads the "Evidence"

Phil Tocco | Michigan State University Extension Educator  
Alison Buskirk | Digital Media Designer



This spooky video shows how power washing equipment can spread filth onto other surfaces. To reduce food safety risks, use low pressure water to wash equipment and follow



# Questions?

