

Crop Field Flooding and Food Safety: Industry and Extension Responses, Research, and Knowledge Gaps

Organized by: IAFP's Water Safety and Quality PDG

Moderator: Sonia Salas, Western Growers Association

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Panelists:

Dr. Channah Rock - University of Arizona

Elena Toro Rogers -North Carolina State University

Chris Callahan - University of Vermont

Jeff Hall - Canadian Produce Marketing Association

William Brodegard – Driscolls

Moderator: Sonia Salas – Western Growers



Weather and Climate Disasters Overview

Sonia Salas,
Associate VP Science



January 30, 2025

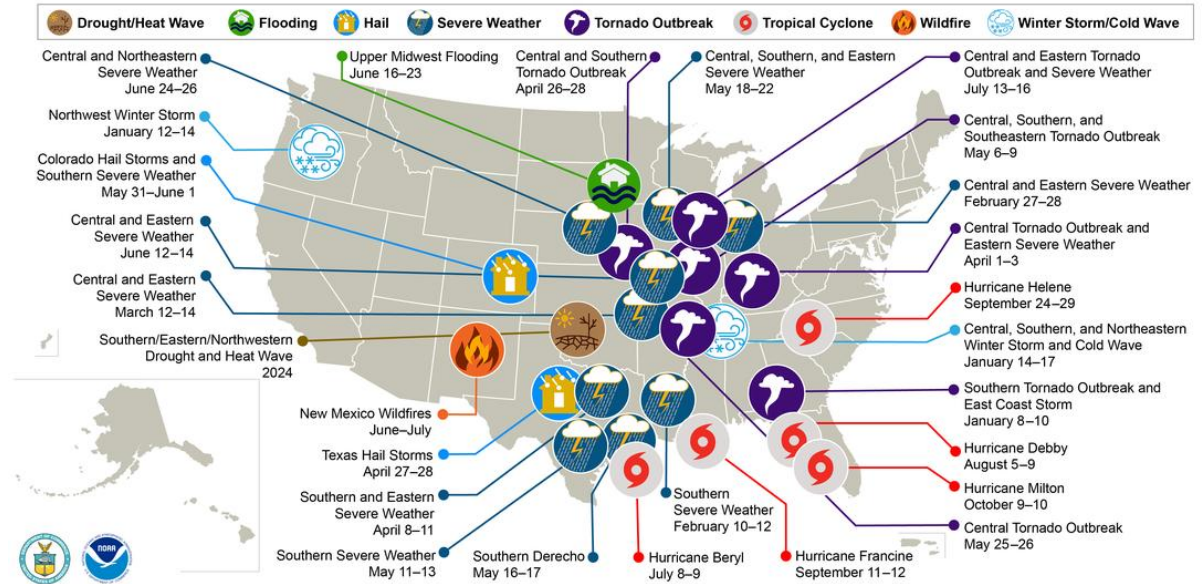


Weather and Climate Impacts

Weather and Climate Disasters (NOAA)

In 2024, there were 27 weather and climate disasters in the U.S. surpass billion dollars in losses

U.S. 2024 Billion-Dollar Weather and Climate Disasters

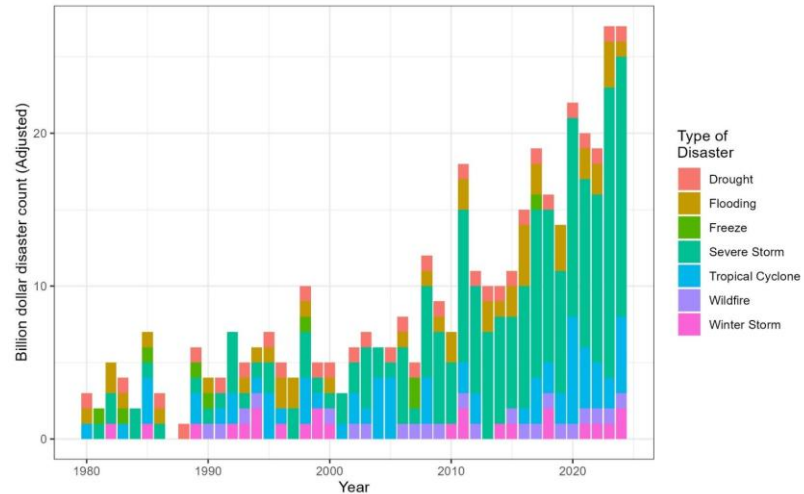


This map denotes the approximate location for each of the 27 separate billion-dollar weather and climate disasters that impacted the United States in 2024.

How much do they cost?

Increasing costs, preparation is key!

- Billion-dollar disaster over time have increase
- From an average of 3.3 billion in 1980s to an average of 23 billion in 2020s



Flooding Resources

Western Growers



- Sampling and testing bulletin
- On farm flood management webinar
- Support resources (County and State)

CA LGMA



- Metrics
- Videos (English and Spanish)
- Fact sheets and one pagers
- Flooding webinar

FDA



- FDA Guidance for Industry: Evaluating the Safety of Flood-affected Food Crops for Human Consumption



Extreme Weather Events and Fresh Produce Safety: *Expect the Unexpected*

Channah M. Rock, PhD

Water Quality Specialist & Professor

Endowed Chair in Extension, Fresh-Produce Safety

January 30th, 2025



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Produce is easy!



If the produce has come in contact with flood water from overflowing streams or open bodies of water, it is considered adulterated by the FDA and cannot be used for food

Everything that comes after is hard...



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Assessing the role of environmental flood and runoff dilution factor is challenging...



Differentiating non-point source and point source run-off patterns against topography is a typical a first step



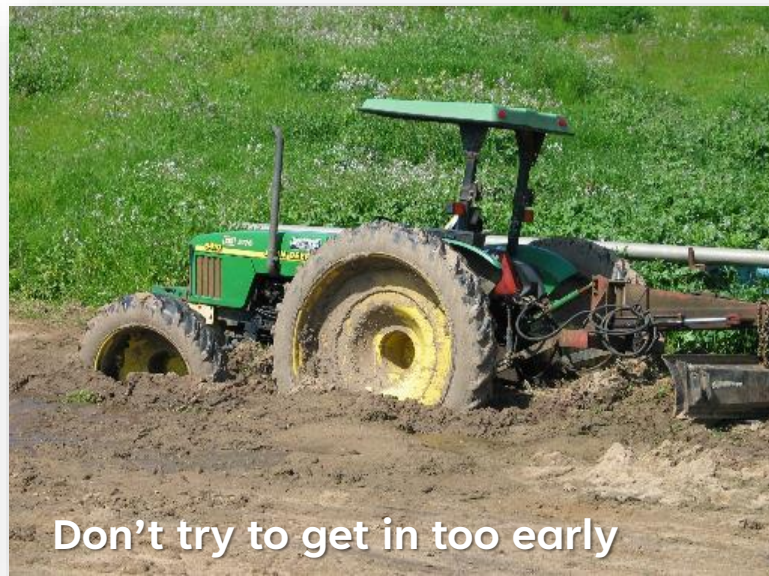
Runoff from adjacent land use may enter drainage system and blend with flood waters



Wildlife often enters flooded fields as waters recede



Equipment cleaning & sanitation is part of the overall response plan



Considerations for organic production



- Challenges in knowing if and what prohibited materials may be carried by...
 - Runoff from non-cropped farm operations
 - Runoff from adjacent farms
 - Flood waters from prohibited point-sources
- Potential for pre-plant organic amendments providing growth of bacterial pathogens
- Consult with organic certifying agent on your risk assessment



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Definitions that help inform risk evaluations

- Pooled Waters

- Accumulation of characterized water sources or rainfall
- Must exclude blended pooling from runoff
 - Excess water flowing from tailwater ditches, runoff ditches, and diversion basins

- Flood Water

- Waters entering cropped lands from surface water sources not characterized and outside the control of the farming operation
- Commonly considered an inherent risk or carries substances during flow from an inherent hazard and risk source

- Runoff

- In the context of flooding, slope-generated flow from a storm engorged source
- May or may not cross sources of significant inherent risk

Recognized Hazards for Flood Waters and Storm-Related Wastewater Discharge

- **Chemicals**

- Hydrocarbons
- Urban and industrial or non-farmed ag runoff

- **Heavy metals**

- Environmental, Commercial sites, and Urban

- **Pesticides**

Storage areas, wash-out basins, or land applied

- **Pathogens**

- Environmental
- AFO
- Composting Facilities
- 1° or 2° Wastewater Treatment
- Septic system discharge
- Carcasses



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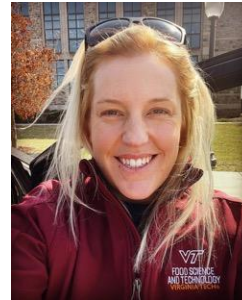
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Examples

1. Simulated Flooding following Superstorm Sandy – 2012-2016, Eastern Shore, Virginia
2. Atmospheric River – 2023, Monterey County, California



Channah Rock, University of Arizona



Laura Strawn, Virginia Tech



Simulated Flooding following Superstorm Sandy – 2012-2016, Eastern Shore, Virginia

- Opportunity to flood a research field by a water source that is naturally-contaminated with *Salmonella*
- Prior field experiments performed using this contaminated water source
 - Consistently low levels; high diversity of serovars (Simpson's Index of Diversity); monitored frequently over years

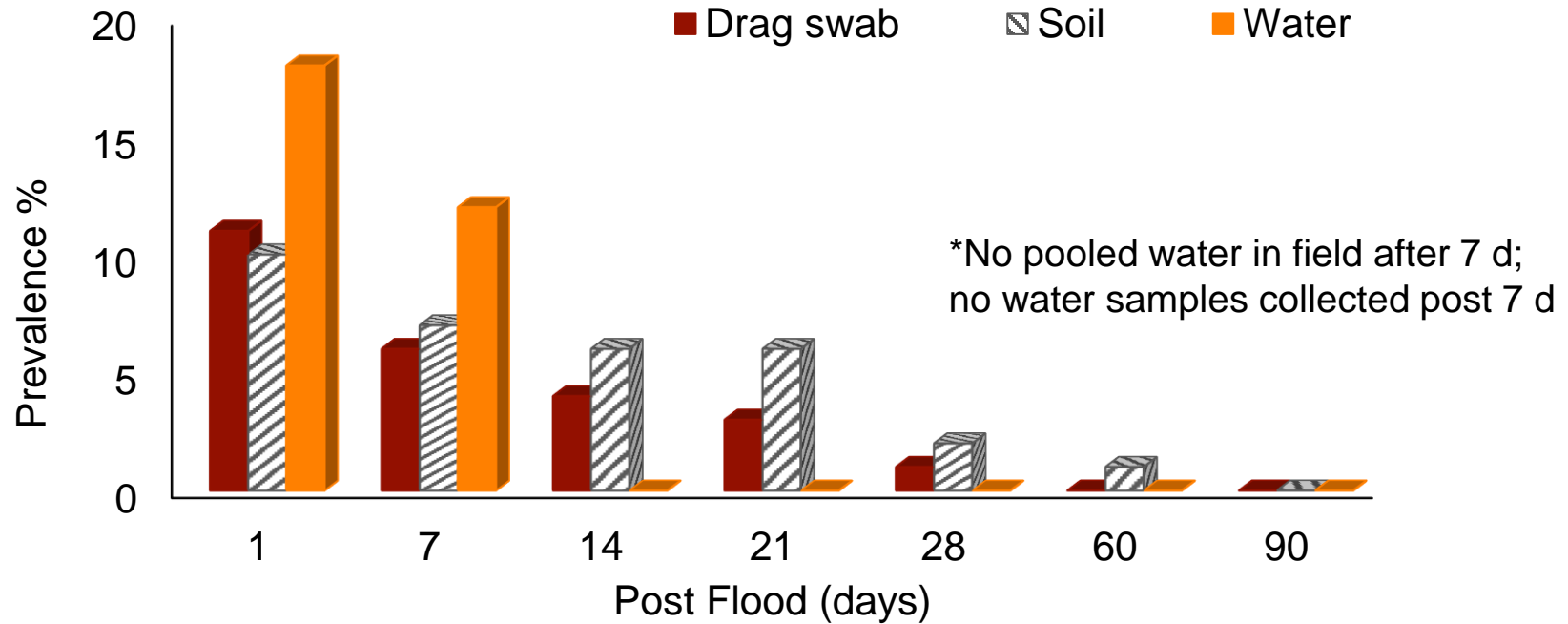


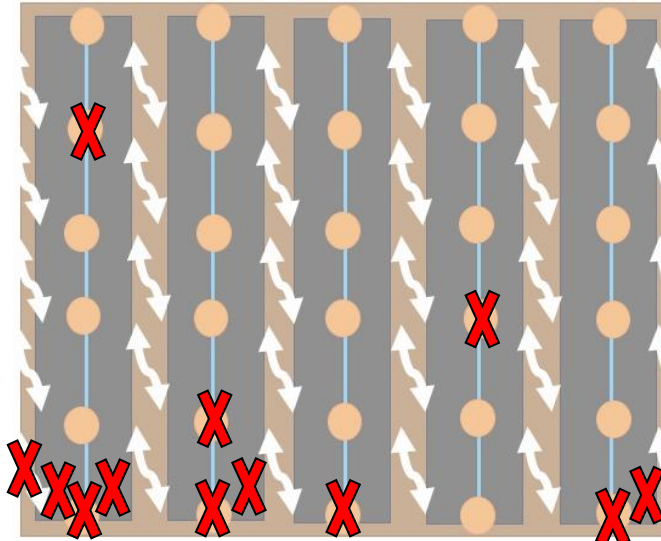
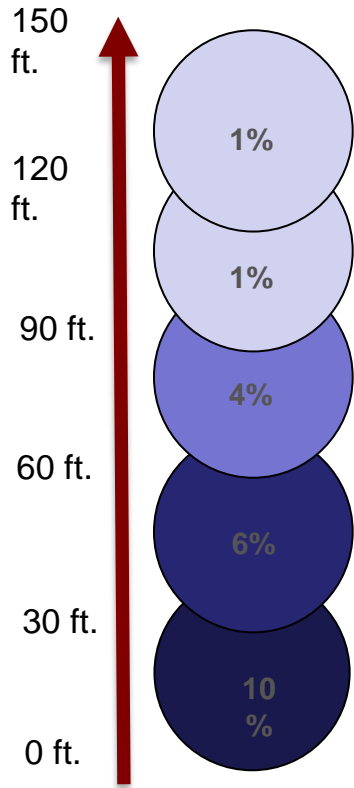
Key Flooding Questions

- Was the field contaminated with *Salmonella*?
- What was the extent of the contamination?
- When would the field be ready to re-plant?
- Investigate 30 ft. buffer? (in US LGMA metrics, based on radius needed to turn harvester outside of flooded area)



Prevalence of *Salmonella* in Samples





Drag swab samples (n=210; 30 each time-point): shaded purple intensity of *Salmonella*

Soil samples (n=210, 30 each time-point): red X's represent *Salmonella* positive

Salmonella Spatial Trends

Simulated Flooding Summary

Was the field contaminated with *Salmonella*?

Salmonella was not detected in soil and drag swab samples prior to the simulated flooding event (sampled the summer/fall before)

Contamination was highest directly post-flood, *Salmonella* prevalence decreased with time

What was the extend of the contamination?

Soil and drag swab samples collected in close proximity to the flooded water source were more likely to be positive for *Salmonella*

Evidence of spatial patterns of contamination (areas where pooling of water was typically observed)

Atmospheric River in Monterey County 2023



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Flood Characterization

- **Four Unique Ranches**

- Gilroy/Holloway
- Salinas
- Spence
- King City

- **Flooding Type**

- Overflow from adjacent creek, grazing operations adjacent land (F)
- Overflow from adjacent creek, tributary grazing (H)
- Salinas River, adjacent neighbor ranch (S)
- Salinas River, grazing operations adjacent land (T)

LGMA Metrics

BEFORE PLANTING AFTER A FLOODING EVENT

Wait a minimum of 60 days; soil must be sufficiently dried out.



Soil testing can shorten the interval to 30 days:

- Collect a representative soil sample of the entire flooded area
- Soil test results:
 - Fecal coliforms are < 100 MPN / gram of total solids
 - Salmonella: Negative || STEC: Negative
- Soil Screening Guidance: Technical Background Document (US EPA 1996) provides guidance
- Third party environmental consultants and/or accredited labs can provide sampling services

This document provides an overview of a section of the LGMA Metrics (food safety practices). It is not a substitute for the full Metrics document, which can be found on the LGMA Tech Resources Page.

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Sample Types



Water
(Ultrafilter)



Water
(Grab)



Soil
(Composite)



Soil
(Grab)



Sampling Strategy

- Pathogens (Enrichment 25 grams Soil)
 - Salmonella
 - STEC
- Indicators (MPN/gram Soil)
 - Total Coliform bacteria
 - Fecal Coliform bacteria
 - Generic *E. coli* bacteria
- Heavy Metals, Salinity, Soil Moisture



Sample Approach Map

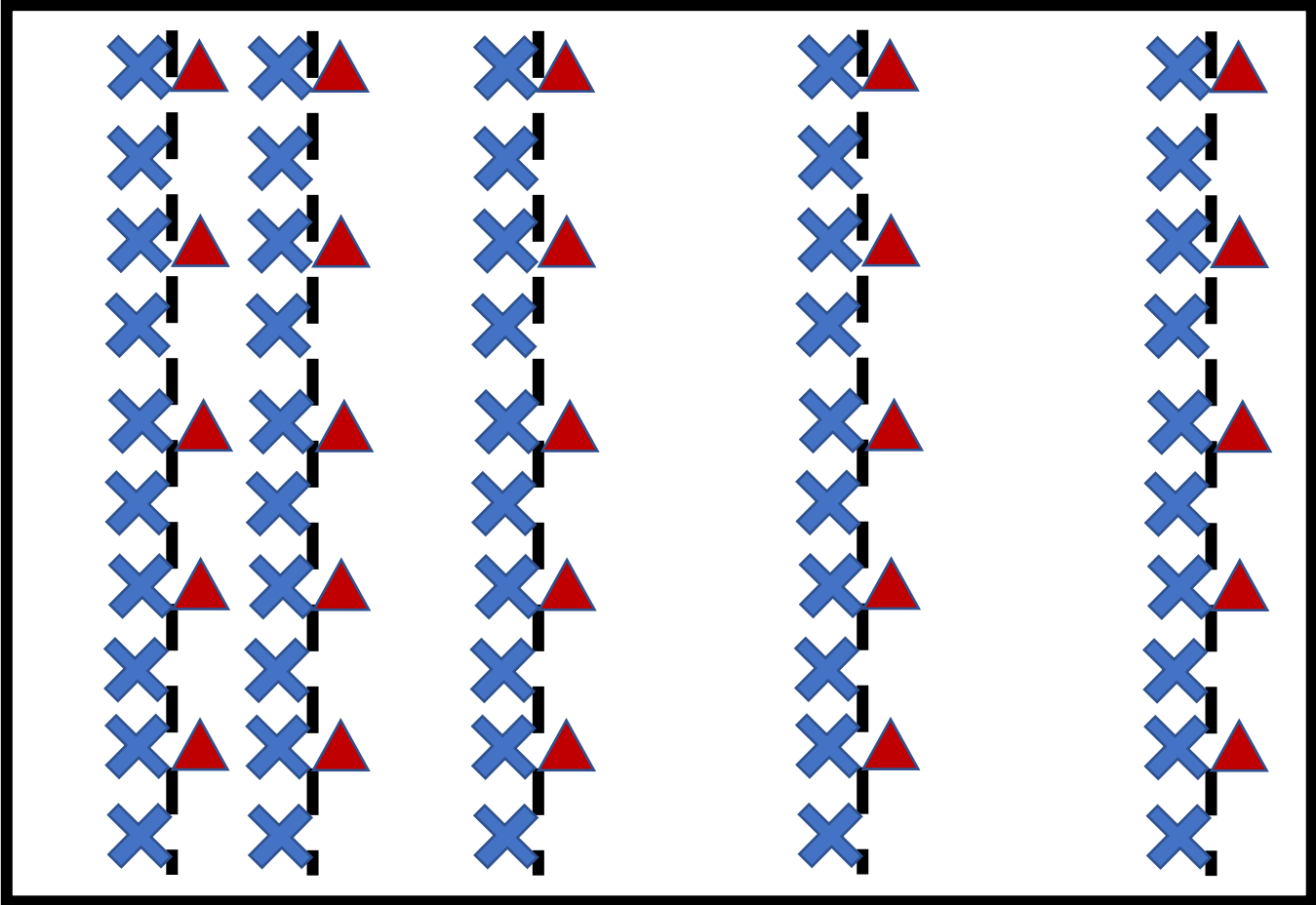
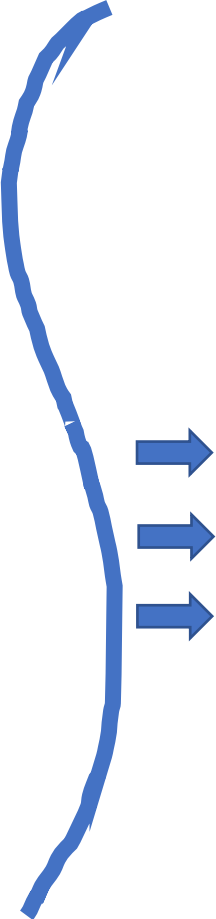
100ft


200ft


400ft

800ft

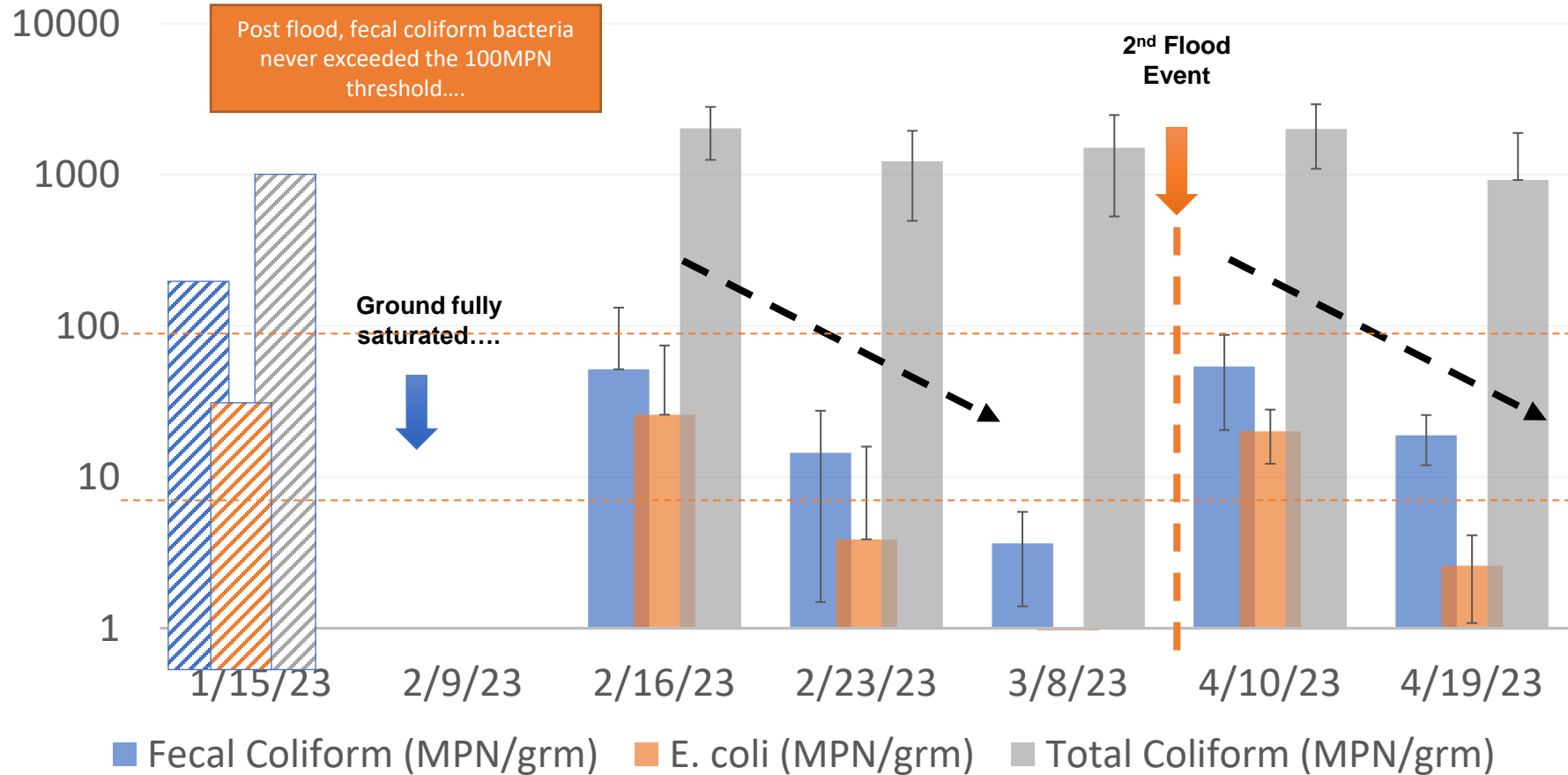
1600ft



 = Grab

 = Composite

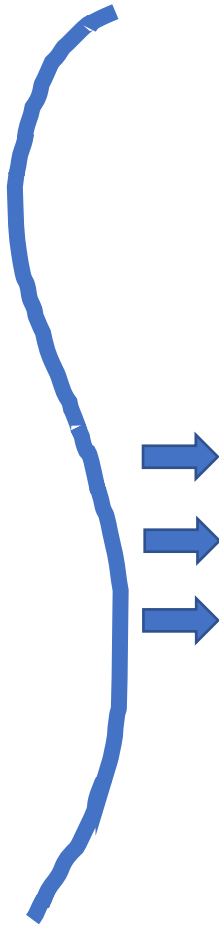
Bacterial Die-off Over Time (Ranch H - Trib)



Fecal Coliform Heat Map

100ft	200ft	400ft	800ft	1600ft
43.3	91.4	37.2	64.0	277.8
39.8	108.1	53.5	9.6	39.8
1986.3	387.7	25.4	396.8	107.7
20.3	13.8	866.4	18.1	14.7
11.3	16.7	26.0	791.5	27.8

2/16/23



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Log Reductions

- Log reductions across all fields assayed ranged from -0.28 to 0.34 over the course of the 13-week study for Total Coliform bacteria.
- Log reductions across all fields assayed ranged from 0.04 to 0.80 over the course of the 13-week study for Fecal Coliform bacteria.
- Log reductions across all fields assayed ranged from 0.00 to 0.95 over the course of the 13-week study for *E. coli* bacteria.



Pathogens

- Not all floods are the same
- **Soil sample >10mpn gEC**
increased likelihood of
detecting pathogens
- We were able to **confirm**
STEC more often in samples
collected from fields
adjacent to flooded
tributaries/creeks

Flood Description	STEC SerO group
Adjacent Ranch/Salinas River	not detected
Adjacent Ranch/Salinas River	not detected
Adjacent Ranch/Salinas River	O26,O103
Salinas River	O26, O103, O45, O121
Salinas River	O111, O26, O103, O45, O121
Tributary	not detected
Tributary	O103, O45
Tributary	O103, O45
Tributary	O145, O103, O45, O121
Salinas River	O103, O45, O121
Salinas River	O45
Tributary	O145, O103, O45, O121
Tributary	O45
Tributary	O103, O45
Tributary	O103, O45, O121
Tributary	O45, O121

Industry Guidance



- Fecal Coliform bacteria **may not** be the best indicator of pathogen risk
 - Highly variable across space and time
 - Not correlated to STEC or Salmonella
- Generic ***E.coli*** much more consistent, allows growers to get back into fields sooner post flood
- Not all flood waters are equal risk!
- Flood waters from adjacent creeks/tributaries **greater likelihood** of detecting pathogens (STEC)
 - Water and Soil
- Bacterial numbers declined or **recovered** before 30-day interval in all ranches (LGMA is highly conservative)



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Channah Rock, PhD
Professor & Extension Specialist

***Jim Brennan Endowed Chair in
Extension Fresh Produce Safety***

The University of Arizona

Channah@cals.Arizona.edu



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PANEL DISCUSSION

Flooding and Flood-affected Crops

Research Learnings and GAPS

Research Learnings and GAPS

- Waiting period for the soil to dry out is necessary. Are growers willing to wait?
- Timely assessments are critical but not always possible.
- Not all flood events are alike.
- Depending on the assessment results, may need to test for heavy metals and other contaminants. What are the guidelines for the produce industry?
- Do we understand the impact of catastrophic flooding events on different water sources such as surface water (lakes, ponds, reservoirs)? Groundwater?

Flood Assessment Tool



Flood Assessment

After a **flood event** takes place in an area that could potentially affect your crops, you must perform a **flood assessment** which includes:

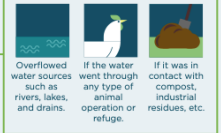
Company Logo	Company Name	
	FLOODING ASSESSMENT	
Issued	Version	Date of Assessment:
Name of Assessor:	Date of Assessment:	
SITE INFORMATION		
Farm Name:		
Farm Location:		
What type of water is present? Pooled or Flood Water? If flood water provide the necessary information below* See LGMA Flooding Fast Sheet for more information		
SITE FEATURES		
Total land area assessed	— acres	Soil Type(s):
Area impacted by flooding	— acres	(Sandy, clay, silt, loam, other)
Crop area impacted by flooding	— acres	Other Site Information: (changes of elevation, topography, etc)
FIELD FLOODING ASSESSMENT:		
Date when the flooding started:		
Date when the water receded:		
Flood water source: (River, creek, pond, lake, adjacent runoff, other)		
Hazards related to the flood water source:		Biological:
		Chemical:
		Physical:
Details about how the flood water is impacting the soil and/or crops		
FARM AGRICULTURAL WATER ASSESSMENT		
Are water sources impacted? If yes, which sources are impacted? - Open Water Source (Reservoir, river, canal, creek, etc) - Well - Municipal/Tertiary Treated - Other		
Yes / No		
How are the water sources impacted? (i.e. Wastewater Treatment, industrial waste, domestic waste, animal waste, other?)		
RESULT OF THE ASSESSMENT OF THE AGRICULTURAL WATER SOURCES		
Compliant		
Non-compliant		
CORRECTIVE ACTION PLAN: For non-compliant agricultural water sources what was done to assure the water is safe to use?		
RESULT OF THE ASSESSMENT OF THE FIELD		
Compliant		
Non-compliant		
CORRECTIVE ACTION PLAN: For non-compliant fields what was done to assure the field is safe to reseed? (Wait a minimum of 60 days after water has receded before planting, Wait 20 Days before replanting with Soil Sampling, Buffer flood area from non-flood areas, Other)		
Additional details:		

The **date** of the flooding event.

The **date and time** when the water started receding from the affected areas.



The **flood water source** and the **hazards** that may accompany the water:



The **impact** of the flood event on the crop and/or equipment, for example:



A **map** of the affected areas (you can include photographs as well).



Challenges After Flooding

- If growers are not aware of the risks associated with flooding ahead of a flooding event, they may not realize what actions need to be taken before resuming operations or replanting fields.
- Confusion regarding steps to take to ensure the safety of crop when flooding may impact some farming operations and not others.
- Not prepared to test water and/or soil, challenges with getting samples to the labs during catastrophic events.
- Look back at field records, what are areas that historically flood?
- Have a plan in place for when flooding occurs.

Managing flooding events



The Three Types of Flooding

V.1 January 2024

Determining the type of flooding your fields are experiencing will help you make informed decisions on the next steps to take:

Product That Has Come Into Contact With Flood Water

Product in Proximity to a Flooded Area That Has NOT Been in Direct Contact With Flood Water

A Field That Was Partially or Completely Flooded Before a Crop Is Planted



Buffer the area where product came into contact with flood water and 30 ft from the high-water mark or more if indicated by the food safety professional.



Do NOT harvest product inside the buffer area and avoid walking through it to minimize cross contamination to other areas of the production area.



Place markers to identify the high-water mark and 30 ft from it to prevent harvesting any product from that area.



Provide enough space for equipment to turn outside the marked area.



Clean and sanitize any equipment that may have been in contact with flooded soil.



Wait a minimum of 60 days to allow the soil to dry sufficiently (20 days if soil testing requirements are met.)

V.1 January 2024



Industry guidance

The FDA recognizes LGMA's soil testing protocol as an acceptable method to assess microbial contamination after a flood event.

This testing protocol is used to guide decisions about early replanting. It is not mandatory to do but if a farm wants to replant before 30-60 days it can provide valuable information.

Planting After a Flooding Event

- 1 Perform a field assessment.



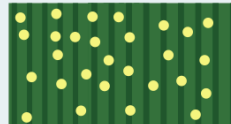
You can use the help of a food safety professional, a consultant, or your laboratory.

- 3 You can shorten the clearance period to 20 days through soil testing if the criteria required are met.

Test for:

Target	Acceptance criteria
STEC and/or EHEC	Negative or non-detect.
<i>E. coli</i> O157:H7	Negative or non-detect.
<i>Salmonella</i>	Negative or non-detect.
Generic <i>E. coli</i>	≤ 10 MPN/gram of soil

- 5 Use a randomized sampling pattern and concentrate more samples closer to the area where the flood waters entered and exited the field.

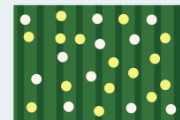


- 2 Let the field dry for 60 days or more after the water started receding.



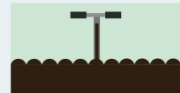
The survival of any pathogenic microorganisms that could be present in the soil is less likely with enough time and with sufficient drying of the soil.

- 4 Take 20 soil samples of at least 100 grams per sample.



- Test the 20 samples for generic *E. coli*.
- Test 10 of the 20 samples for pathogen targets.
- Each sample has to be tested individually.

- 6 Sample from 2 to 6 inches of depth from the surface.



If the acceptance criteria is NOT met:

Turn the soil with tractors and other implements to promote aeration and accelerate soil drying.



Repeat the sampling and testing until the criteria is met.



Or wait until 60 days from the date when the water started receding have passed.

60 days

If the acceptance criteria is met:

Planting activities can start. ✓



BEST PRACTICES BEFORE REPLANTING

CROP OR REGION-SPECIFIC CONDITIONS

Resources



FDA Guidance for Industry: Evaluating the Safety of Flood-affected Food Crops for Human Consumption



Disaster Resources



Industry Guidance: Flooding Resources



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