

A Public Health Challenge:

Salmonella in Dry Food and Feed Processing Environments

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agriculture.sc.gov/retail-food-safety

Agenda

- Scope of RRT exercise
- Public health burden associated with *Salmonella*
- How *Salmonella* is spread in the community
- Managing *Salmonella* in dry processing
- EMPs and finding *Salmonella* in the environment

Public Health Burden

CDC Estimates:

Nontyphoidal *Salmonella*:

- 1.3 million cases/year
 - *S. enteritidis*: 297,000 (23%); *S. Newport*: 179,000 (14%)
- 12,500 hospitalizations/year
- 238 deaths/year
 - *S. enteritidis*: 63 (26%); *S. typhimurium*: 40 (17%); *S. newport*: 17 (7%)

https://wwwnc.cdc.gov/eid/article/31/4/24-0913_article

Public Health Burden

Economic burden:

- *Salmonella spp.*, non-typhoidal illness: >\$17,000,000,000
 - Costs associated with deaths: @56% of total
- Product recalls:
 - Direct costs average \$10,000,000 per recall
 - Indirect costs 5 to 10x higher per recall



<https://www.ers.usda.gov/data-products/cost-estimates-of-foodborne-illnesses>

Recent Recalls, 2022-2025

Human Foods

Producer	Product	Date	Etiology
Super Greens	Dietary Suppl. Powder	Jan. 2026	<i>S. typhimurium</i>
Vallon Farm Direct PVT LTD	Moringa Leaf Powder	Dec. 2025	<i>S. richmond</i>
General Mills	Flour	Mar. 2023	<i>S. infantis</i>
Abbott Laboratories	Powdered Infant Formula	Feb. 2022	<i>S. newport</i>
The Whole Herb Co.	Organic Celery Seed	May 2025	<i>Salmonella spp.</i>
Olam Food Ingredients	Onion Powder	May 2023	<i>Salmonella spp.</i>
Baraka	Ground Black Pepper	Jun 2024	<i>Salmonella spp.</i>
J. M. Smucker	Peanut Butter	May 2022	<i>S. senftenberg</i>

Recent Recalls, 2006-2025

Animal Feed

Producer	Product	Date	Etiology	# Human cases
Mid-America	Multiple (all products)	Nov. 2023	<i>S. kiambu</i>	7
Puppy Love Pet Products	Multiple puppy treats	Nov. 2025	<i>Salmonella spp.</i>	31
Multiple producers	Raw pet food	2021-2024	<i>Salmonella</i> (XDR)	44
Pet Supplies Plus & Lennox Intl	Pig ear pet treats	July 2019	<i>S. Enterica</i> (multiple subtypes)	154
Diamond Pet Food	Dry dog food	2012	<i>S. infantis</i>	49
Mars Petcare US	Dry dog & cat food	2006-2007	<i>S. Enterica schwarzengrund</i>	79

How *Salmonella* is spread in the community

Human Foods

- Contaminated food, ingredient, or equipment
- Undercooking
- Infected food workers

Animal / Feed to human transmission

- Since 1999, 11 of 117 feed recalls linked to human outbreaks
 - 5 of the 11 involved multi-drug-resistant *Salmonella*
- Intimate association between humans and pets
- Trend: feeding raw and unprocessed foods
- Hand hygiene issues



Characteristics of *Salmonella*

- Facultative anaerobe
- Survival in environment
- Long-term survival in dry foods
- Viable / virulent in dormant state
- Thermal tolerance + dry conditions



Image source: CDC, Public Health Image Library

Managing *Salmonella* in Dry Processing

1. Prevent entry of *Salmonella* into facility

- Facility maintenance
- Receiving controls
- Pest control
- Traffic controls
- Employee hygienic controls

2. Strict hygienic controls in **Primary *Salmonella* Control Area (PSCA)**

- Passive controls (barriers)
- Control & direct worker and equipment/materials traffic
- Control air movement
- Master sanitation schedule /dry cleaning

Managing *Salmonella* in Dry Processing

Zone System



Zone 4 Distant Surfaces

- Hallways
- Bathrooms
- Non-Food Contact Areas



Zone 3

- Walls/ceilings
- Phone
- Non-Food Contact Surfaces
- Good Retail Practice (GRP) areas



Zone 2

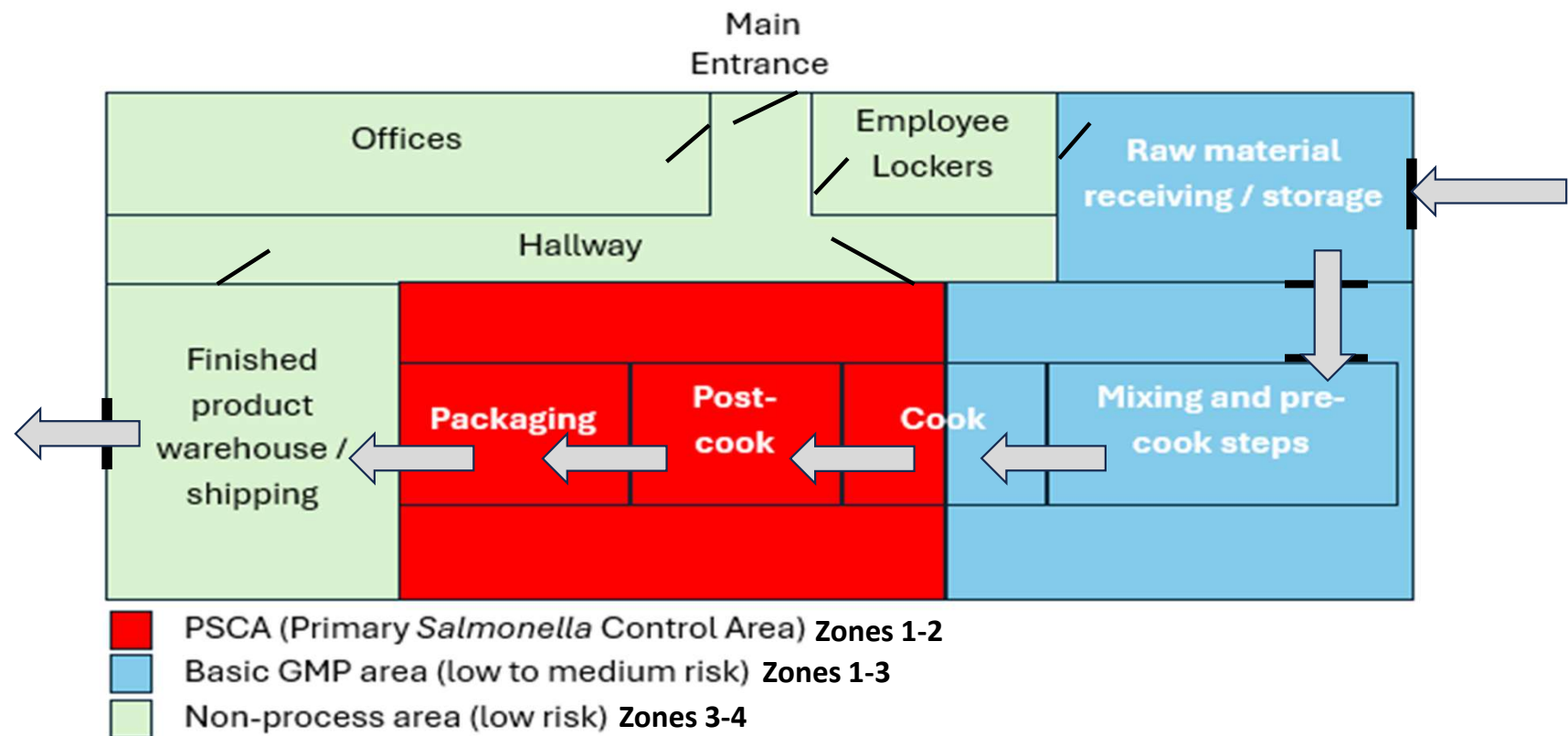
- Exterior of equipment
- Carts
- Ventilation
- Surfaces that support zone 1 surfaces (table under a cutting board)



Zone 1 - Direct Food Contact

- Slicers
- Mixers
- Utensils
- Trays
- Racks
- Work tables
- Gloves

Managing *Salmonella* in Dry Processing



Managing *Salmonella* in Dry Processing

3. Hygienic design of facility & equipment

- Challenge of non-hygienic design
- Separation of low-, medium-, and high-risk areas
- Sanitary design and layout of equipment
- Control water / moisture

4. Prevent / minimize growth of *Salmonella* in facility

- Water/moisture: the most significant risk factor
- Dry cleaning – remove the dust!
- Eliminate “niches”

Managing *Salmonella* in Dry Processing

5. Establish a raw ingredient control program

- Identify and control “sensitive” ingredients
- Approved suppliers

6. Validate control measures to inactivate *Salmonella*

- Data demonstrates effectiveness of intended process controls
- D-value reduction required depends raw ingredients & intended use

Managing *Salmonella* in Dry Processing

7. Establish verification procedures for *Salmonella* controls

- Written pre-requisite program
- Assess and verify effectiveness of sanitary and hygienic controls
- Environmental monitoring – identify transient /resident *Salmonella*
- Scheduled routine site sampling + random sampling
- Search, detect and destroy
- Prioritize non-product contact surfaces in PSCA, then outside PSCA
- Corrective action: contain, identify, eliminate



Managing *Salmonella* in Dry Processing

Common Environmental Sampling Sites

Air ducts intake/exhaust	Maintenance tools	Air conveyance system	Pallets
Eroded flooring	Floor scrubber	Disassembled pump	Difficult to reach areas
Wall/floor junction	Floor squeegee	Drains	Doorways
Conveyor rollers, belts	Mop heads	Central/portable vacuums	Receiving dock
Bucket elevator	Brooms	Exposed insulation	Employee locker room
Fork lift	Drains	Unsealed control panels	Path to trash compactor
Fans	Dust collection system	Under sinks	Insect light traps
Catwalks	Filter sock	Damaged/worn equipment	Leaky roof

Processing Issues

Where production falls short

- Absence of standardized lethality measures
- Insufficient validated alternate interventions



In Summary

- Public health impact of *Salmonella* in LMFs
- *Salmonella* challenges normal control measures
- Prevention at multiple levels
- Verification: Environmental monitoring

References

Foodborne Illness Acquired in the United States—Major Pathogens, 2019

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Salmonella Presence and Risk Mitigation in Pet Foods: A Growing Challenge with Implications for Human Health

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Control of Salmonella in Low-Moisture Foods I: Minimizing Entry of Salmonella into a Processing Facility

<https://www.foodprotection.org/members/fpt-archive-articles/2009-06-control-of-salmonella-in-low-moisture-foods-i-minimizing-entry-of-salmonella-into-a-processi/>

Control of *Salmonella* in Low-moisture Foods II: Hygiene Practices to Minimize *Salmonella* Contamination and Growth

<https://www.foodprotection.org/publications/food-protection-trends/archive/2009-07-control-of-salmonella-in-low-moisture-foods-ii-hygiene-practices-to-minimize-salmonella-cont/>

Control of Salmonella in Low-moisture Foods III: Process Validation and Environmental Monitoring

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Questions?



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