

# Optimizing Sampling Plans for Identifying Sources of *Salmonella*: An Example from a Multi-State Turkey Processing Plant Study

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## ABSTRACT

Microbiological sampling of the plant environment is an important tool that food processors use to determine the effectiveness of their sanitation practices and processes in controlling pathogens, including *Salmonella* and *Listeria monocytogenes* (*L.m.*). Evaluation of the test results over an extended period of time can illustrate changes that should be made in test sample quantities, types, frequency, time, location or analysis. The PivotTable function in Microsoft Excel provides one method of summarizing the data sets that result from long-term sampling and analyses.

Environmental and raw product samples from commercial turkey slaughter plants in five states were analyzed for *Salmonella* and *L.m.* All samples were classified into seven sample types (drains; walls and floors; product contact surfaces and equipment; process/chilling water; workers, gloves, and boots; post-chill raw product; and fecal contamination) from one of four processing areas (transport through defeathering; evisceration; chilling; post-chill cut-up/packaging).

For the 1,429 samples collected, 284 (19.9%) were positive for *Salmonella*, 264 (18.5%) were positive for *Listeria* species, and 54 (3.8%) were positive for both. Of the samples positive for both *Salmonella* and *Listeria* sp., 10 (0.7%) were identified as *L.m.* The processing plant schematics below illustrate the location of these positive samples.

These analyses can be used for other data sets to determine which combinations of sample location, type, quantity, and frequency will optimize identification of target microorganism(s) and niches that can be hot spots for contamination of products. Regularly modified environmental sampling plans that can identify and predict the presence of *Salmonella* and *Listeria monocytogenes* are an important way to prevent food borne illnesses.

## Summary of *Salmonella* & *Listeria* analyses of samples collected from six turkey slaughter plants

Plant Area		Sample Type							TOTAL for Plant Area
		Drains	Walls, Floors, Air	Product Contact Surfaces, Equipment	Process or Chilling Water	People, Gloves, Boots	Carcass, Raw Product	Fecal Contamination	
Transport, Scalding, Defeathering	<i>Salmonella</i> positive	15	10	66	-	0	-	1	92
	<i>Salmonella</i> & <i>Listeria</i> positive	10	2	5	-	0	-	0	17
	Samples collected	28	52	164	-	1	-	8	253
Evisceration, Gizzard Harvest, Reprocessing	<i>Salmonella</i> positive	29	2	21	0	0	2	29	83
	<i>Salmonella</i> & <i>Listeria</i> positive	20	0	3	0	0	0	2	25
	Samples collected	70	56	133	1	10	26	81	377
Post-evisceration through Water Chilling	<i>Salmonella</i> positive	4	0	9	35	2	14	-	58
	<i>Salmonella</i> & <i>Listeria</i> positive	2	0	1	2	2	0	-	7
	Samples collected	30	57	124	121	23	41	-	396
Post-chill Cut-up, Grind, Packaging	<i>Salmonella</i> positive	2	1	7	3	1	31	-	45
	<i>Salmonella</i> & <i>Listeria</i> positive	1	1	1	0	0	2	-	5
	Samples collected	39	68	88	12	27	169	-	403
TOTAL for Sample Type	<i>Salmonella</i> positive	50	13	103	38	3	47	30	284
	<i>Salmonella</i> & <i>Listeria</i> positive	33	3	10	2	2	2	2	54
	Samples collected	167	233	509	134	61	236	89	1429

## RESULTS AND CONCLUSIONS

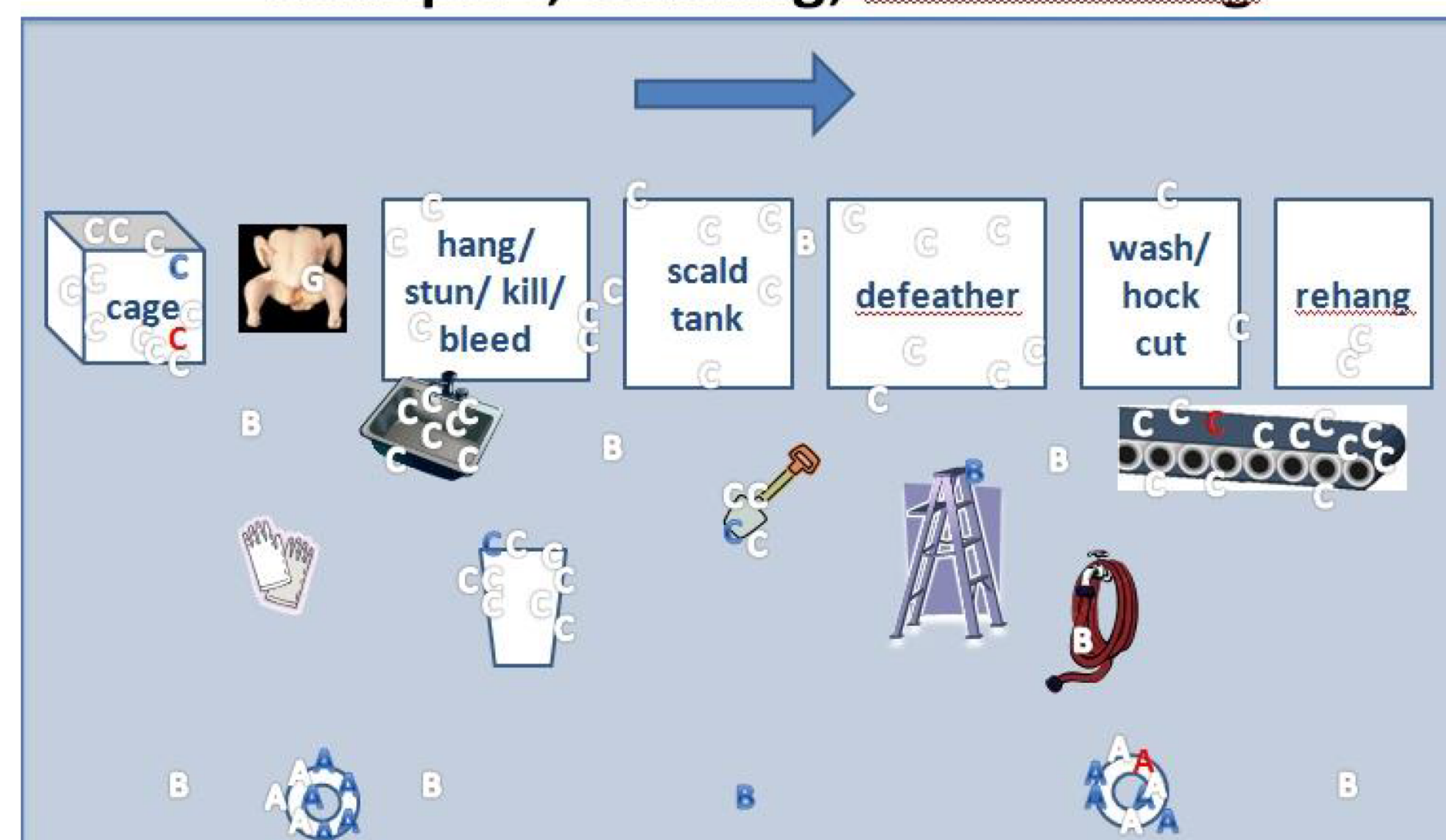
- 284 of 1429 samples (19.9%) were positive for *Salmonella*. For each processing area, incidence ranged from 11.2% to 36.4%.
- 54 of 1429 samples (3.8%) were positive for *Salmonella* and *Listeria* species. For each area, incidence ranged from 1.3% to 7.1%.
- 10 of 1429 samples (0.7%) were positive for *Salmonella* and *Listeria monocytogenes*: 4 each from drains and equipment, and 1 each from structures and water.
- Proportion of samples collected from drains that were positive for *Salmonella* and *Listeria* species was ten times as high as for any other sample type.
- Proportion of samples positive for *Salmonella* were <5% on structures and personnel, but >25% in drains, process/chill water, and fecal contamination found on product. Highest: Fecal contamination, 33.7%. Lowest: Personnel, 4.9%.
- Prevalence of *Salmonella* was highest in Summer (27.1%), and lowest in Winter (4.9%).

Examples of how the study could be used to adjust a sampling plan:

- To maximize finding *Salmonella*, sample from drains the most, and from personnel (gloves, boots, etc.) the least.
- To maximize finding *Salmonella*, sample from the areas earlier in processing. Prevalence decreased from the highest in transport through defeathering areas and to the lowest in post-chill operations.
- In this study, 15 samples must be collected to have 95% confidence of finding one sample positive for *Salmonella*. A positive result for *Salmonella* and *Listeria* sp. requires 79 samples.

X = *Salmonella* (36.3% of total)  
 X = *Salmonella* & *Listeria* sp. (6.7% of total; 18.5% of above)  
 X = *Salmonella* & *L.m.* (1.2% of total; 17.6% of above)

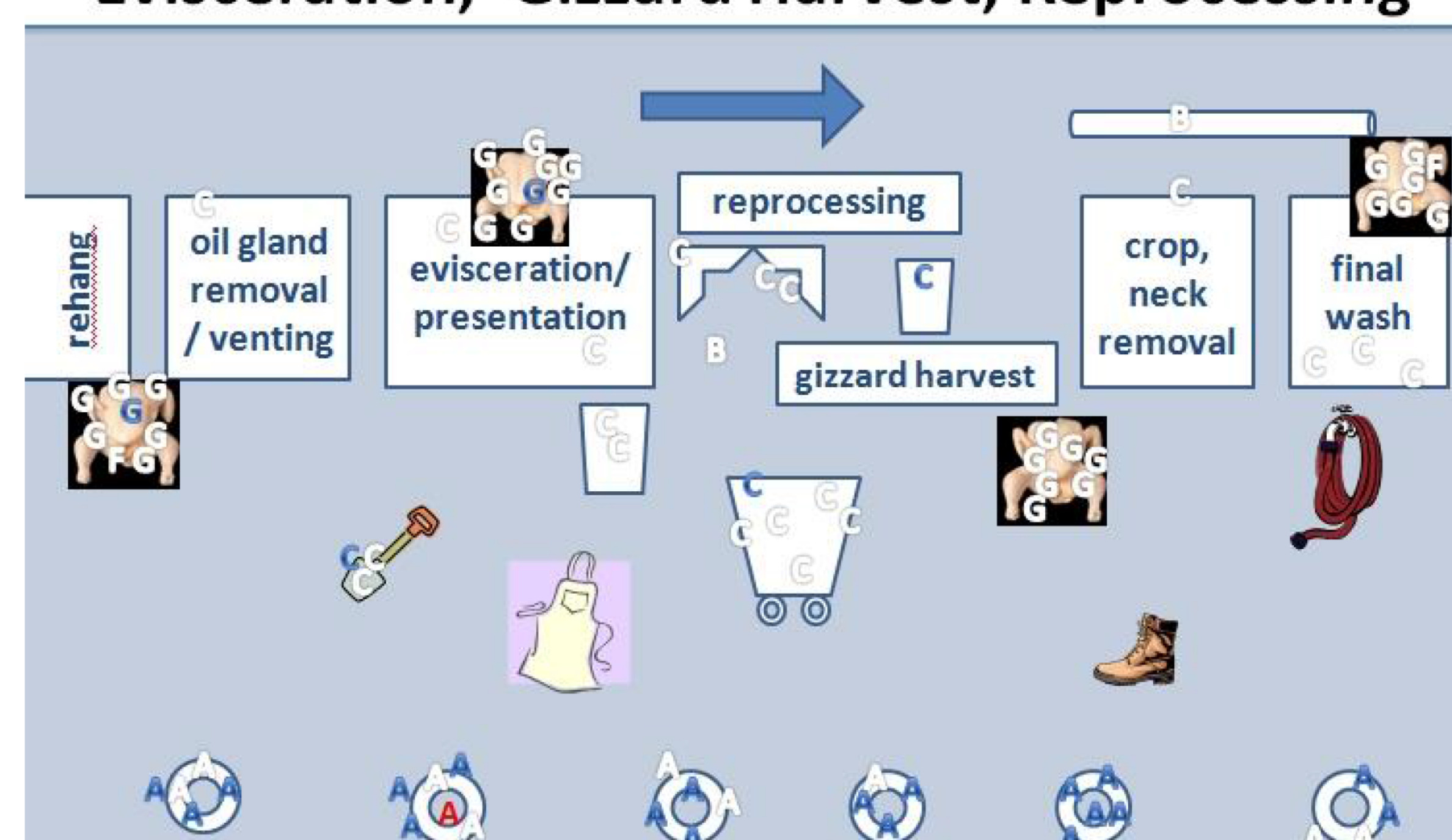
### Transport, Scalding, Defeathering



Sample type: A= drains; B= walls, floors, air; C= product contact surfaces, equipment; D= process or chilling water; E= people, gloves, boots; F= carcass, raw product; G= fecal contamination

X = *Salmonella* (22.0% of total)  
 X = *Salmonella* & *Listeria* sp. (6.6% of total; 30.1% of above)  
 X = *Salmonella* & *L.m.* (0.3% of total; 4.0% of above)

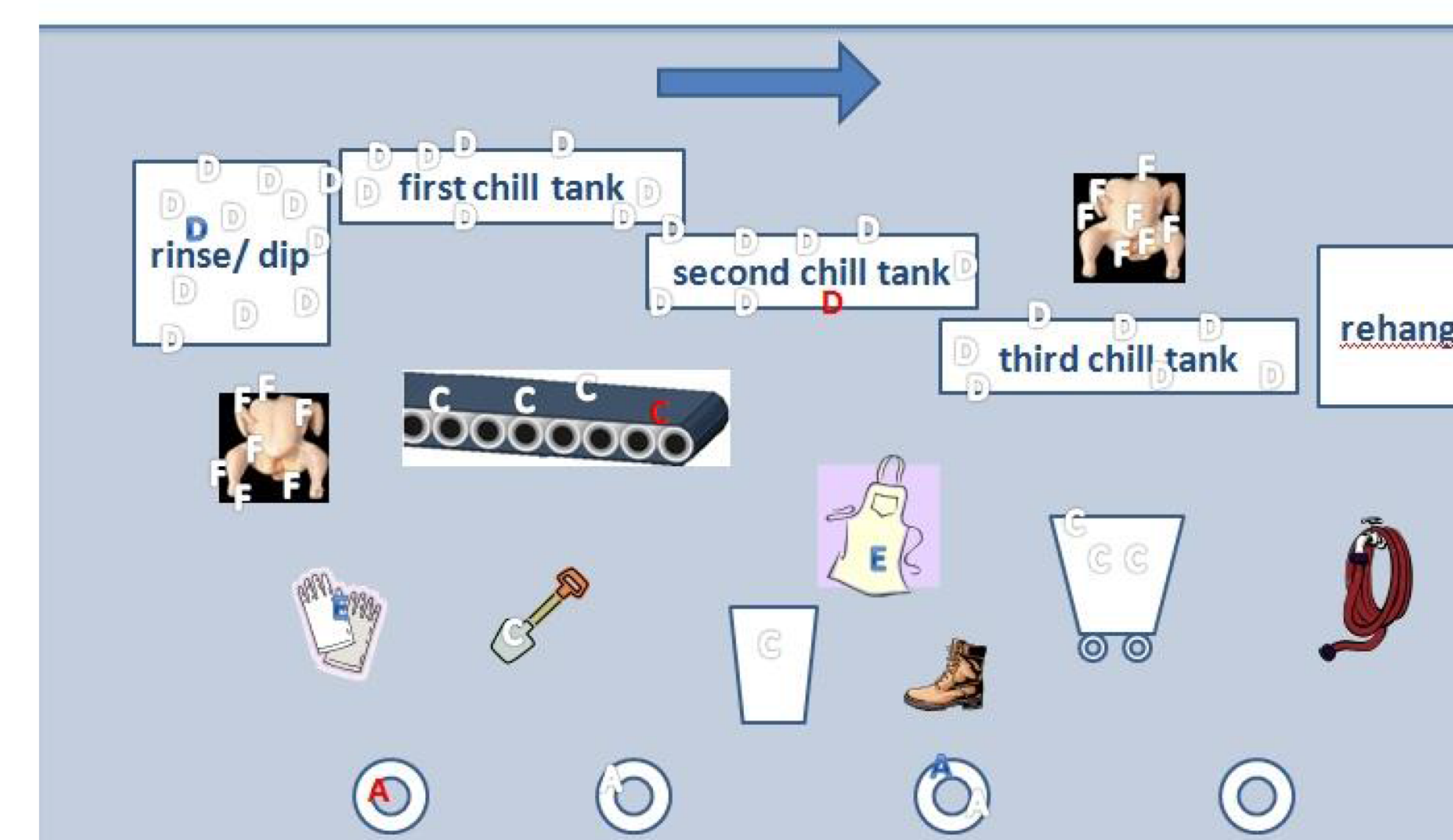
### Evisceration, Gizzard Harvest, Reprocessing



Sample type: A= drains; B= walls, floors, air; C= product contact surfaces, equipment; D= process or chilling water; E= people, gloves, boots; F= carcass, raw product; G= fecal contamination

X = *Salmonella* (16.2% of total)  
 X = *Salmonella* & *Listeria* sp. (1.8% of total; 10.9% of above)  
 X = *Salmonella* & *L.m.* (0.8% of total; 42.9% of above)

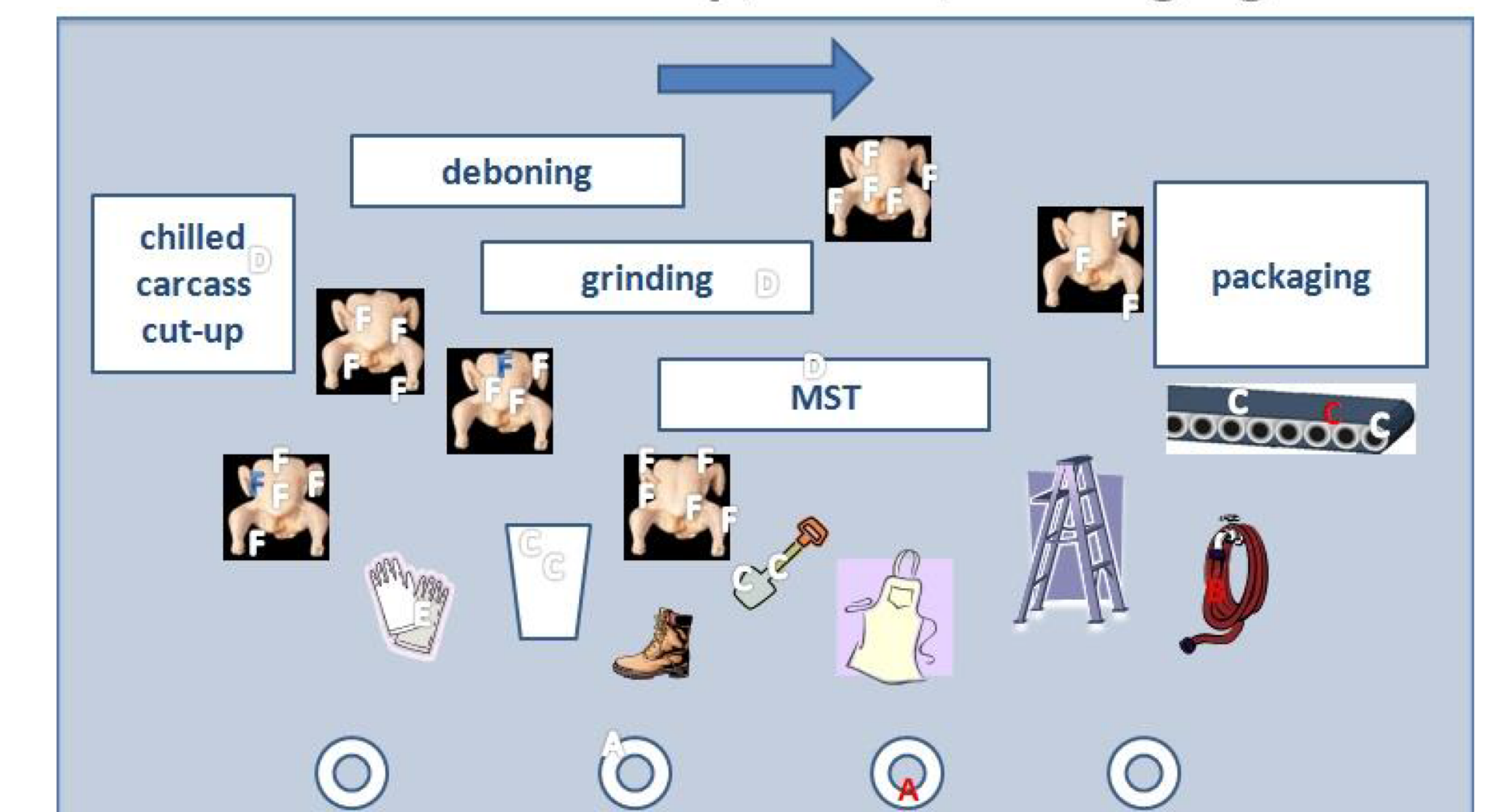
### Post-evisceration through Water Chilling



Sample type: A= drains; A= walls, floors, air; C= product contact surfaces, equipment; D= process or chilling water; E= people, gloves, boots; F= feces, carcass, raw product

X = *Salmonella* (11.2% of total)  
 X = *Salmonella* & *Listeria* sp. (1.2% of total; 11.1% of above)  
 X = *Salmonella* & *L.m.* (0.7% of total; 60.0% of above)

### Post-chill Cut-up, Grind, Packaging



Sample type: A= drains; A= walls, floors, air; C= product contact surfaces, equipment; D= process or chilling water; E= people, gloves, boots; F= feces, carcass, raw product