Farmhouse and Artisan Cheese & Dairy Producers European Network

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JONGIA (UK) LIMITED
The Dairy Industry Experts

The 8th FACE Network Congress

The School of Artisan Food,
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Exploring the Mathematics of Sampling

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Sampling to Verify the Effectiveness of the HACCP Plan

- End-product microbiological sampling is actually a very poor way of guaranteeing food safety – that is why HACCP was developed.

- A batch or lot is defined as:

  "a group or set of identifiable products obtained from a given process under practically identical circumstances and produced in a given place within one defined production period."

- For the purposes of testing against microbiological criteria, the "batch" could consist of cheeses from several production dates.

Regulation (EC) 2073/2005 specifies minimum sample sizes for **verification of the effectiveness of the HACCP plan**.

Organism	Food	Criterion	n	c	m	M	In Plain English…
E. coli	**Cheeses made from milk or whey which has undergone heat treatment**	2.2.2	5	2	100 cfu/g	1000 cfu/g	In five samples, two may exceed 100 cfu/g as long as none exceed 1000 cfu/g**, at the time during manufacture when the count is expected to be highest.**
	Butter and Cream made from Raw Milk (or milk that has undergone a lower heat treatment than pasteurisation.)	2.2.6	5	2	10 cfu/g	100 cfu/g	In five samples, two may exceed 10 cfu/g as long as none exceed 100 cfu/g, **at the end of the manufacturing process.**

Introducing Percy Pig…

“Good Pig”
(Pink Ears)

“Bad Pig”
(Green Ears)

Probability of finding a Contaminant: 100 in a Lot (5% Prevalence)

Probability when sampling without replacement is calculated using **Hypergeometric Distribution**

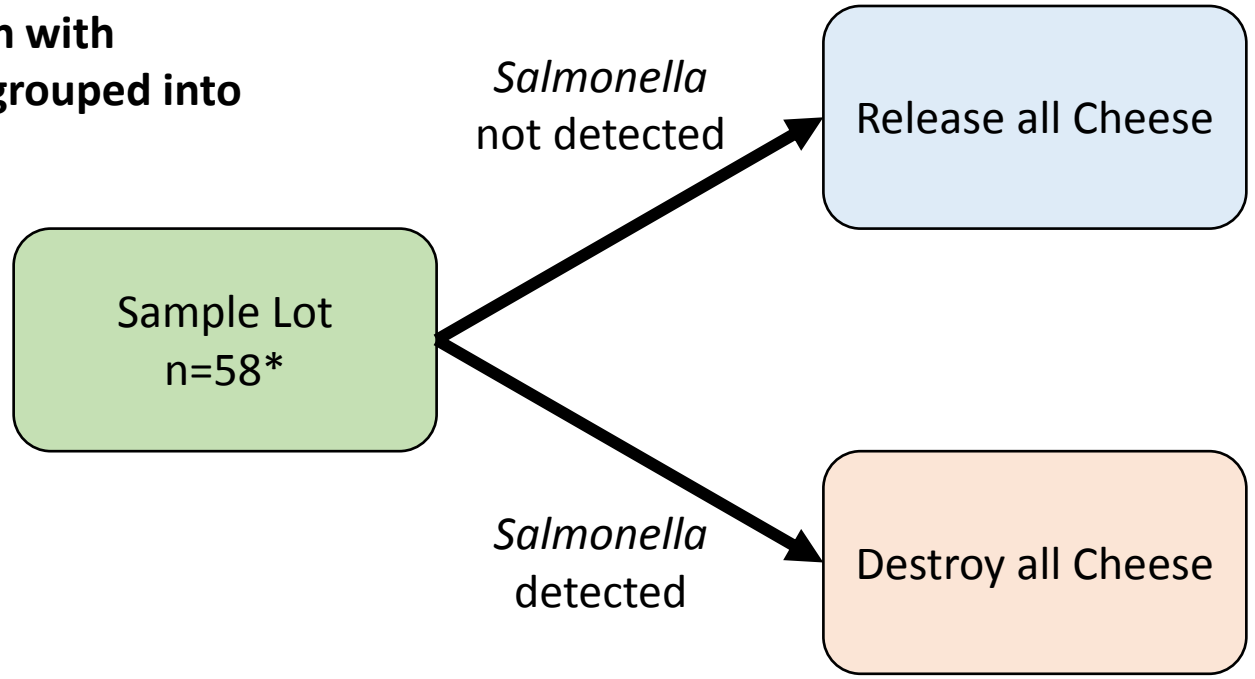
Sample size	Proportion of cheeses in lot which contain contaminant							
	50%	20%	10%	5%	2%	1%	0.50%	0.20%
1	50%	20%	10%	5%	2%	1%	0%	0%
2	75%	36%	19%	10%	4%	2%	0%	0%
3	88%	49%	27%	14%	6%	3%	0%	0%
4	94%	60%	35%	19%	8%	4%	0%	0%
5	97%	68%	42%	23%	10%	5%	0%	0%
10	100%	90%	67%	42%	19%	10%	0%	0%
20	100%	99%	90%	68%	36%	20%	0%	0%
40	100%	100%	100%	93%	64%	40%	0%	0%
60	100%	100%	100%	99%	84%	60%	0%	0%
80	100%	100%	100%	100%	96%	80%	0%	0%
100	100%	100%	100%	100%	100%	100%	0%	0%

Probability is Similar Regardless of the Number in the Batch/Lot

Sample size	100,000 in Lot 5%	100,000 in Lot 5%	1,000,000 in Lot 5%
1	5%	5%	5%
2	10%	10%	10%
3	14%	14%	14%
4	19%	19%	19%
5	23%	23%	23%
10	42%	40%	40%
20	68%	64%	64%
40	93%	87%	87%
60	99%	95%	95%
80	100%	98%	98%
100	100%	99%	99%

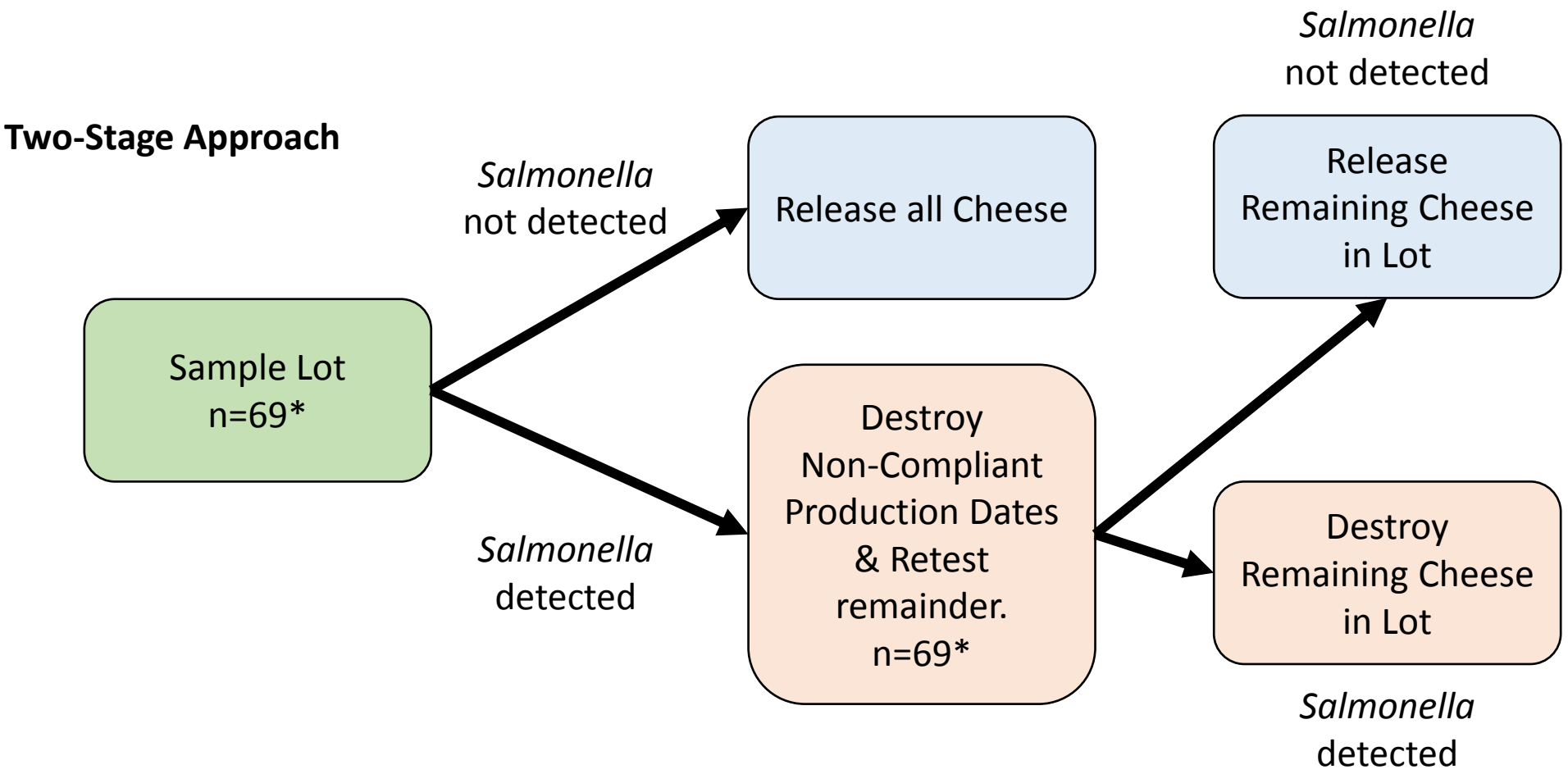
Case Study: Release of Products Under Suspicion of Contamination

Standard Approach with Production Dates grouped into 'batches' or 'lots'



- Sample number chosen so as to give 95% certainty of detecting *Salmonella* with 5% prevalence.
- 1946 Cheeses tested as 15 Production dates: 870 samples. Cost> £10,000.
- Tested as one lot, sampling would cost <£1,000.

An alternative approach: Balancing Cost with Risk of Failure



* Sample number chosen so as to give 97% certainty of detecting *Salmonella* with 5% prevalence.

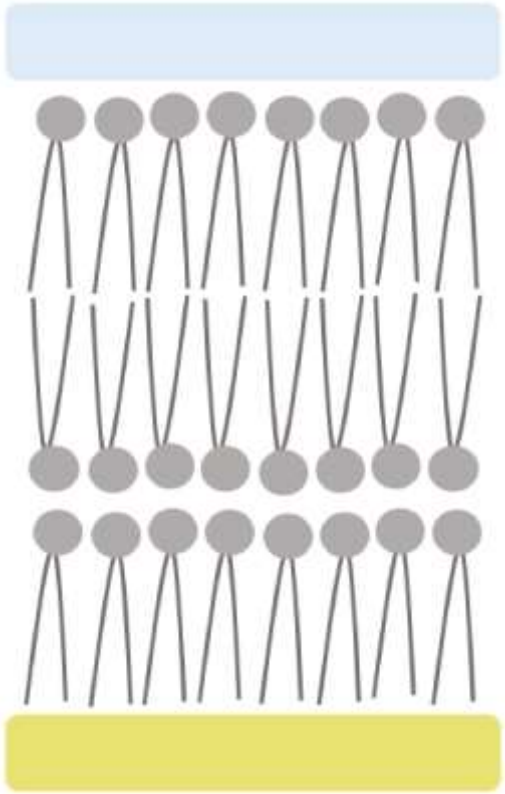
Making the Numbers Work

A 25ml milk sample can be tested for presence of *Listeria (*n=1).

- A milk filter which has filtered 1000L of raw milk and which is tested for *Listeria* could be considered equivalent to testing **40,000 x 25ml** samples but at the same cost as a single sample.

For Washed-Rind Cheeses:

- 'Positive release' is an ineffective way to manage food safety; a single sample has a low probability of detecting a low-level contaminant.
- Testing the cloth or smear water increases the number of cheeses represented by the sample.



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