

CA18105



RIBMINS

Risk-based meat inspection and
integrated meat safety assurance

Harmonised epidemiological indicators

Silvia Bonardi | 4-Feb-21 | Virtual Training School



**UNIVERSITÀ
DI PARMA**



Harmonised Epidemiological Indicator (HEI)

- ✓ **Prevalence or concentration of the hazard** at a certain stage of the food chain that correlates to a human health risk caused by the hazard
- ✓ **Indirect measure of the hazard** (such as audits on farms or transports) is also covered

Some examples of HEIs

- Prevalence of *Salmonella*, *Campylobacter*, STEC, *Yersinia enterocolitica*, *Toxoplasma gondii*, *Trichinella* spp., *Mycobacteria* at **key points** in the food chain of different species



Points where risk is first created, primarily on-farm, but also during transport or slaughter

What are HEIs for?

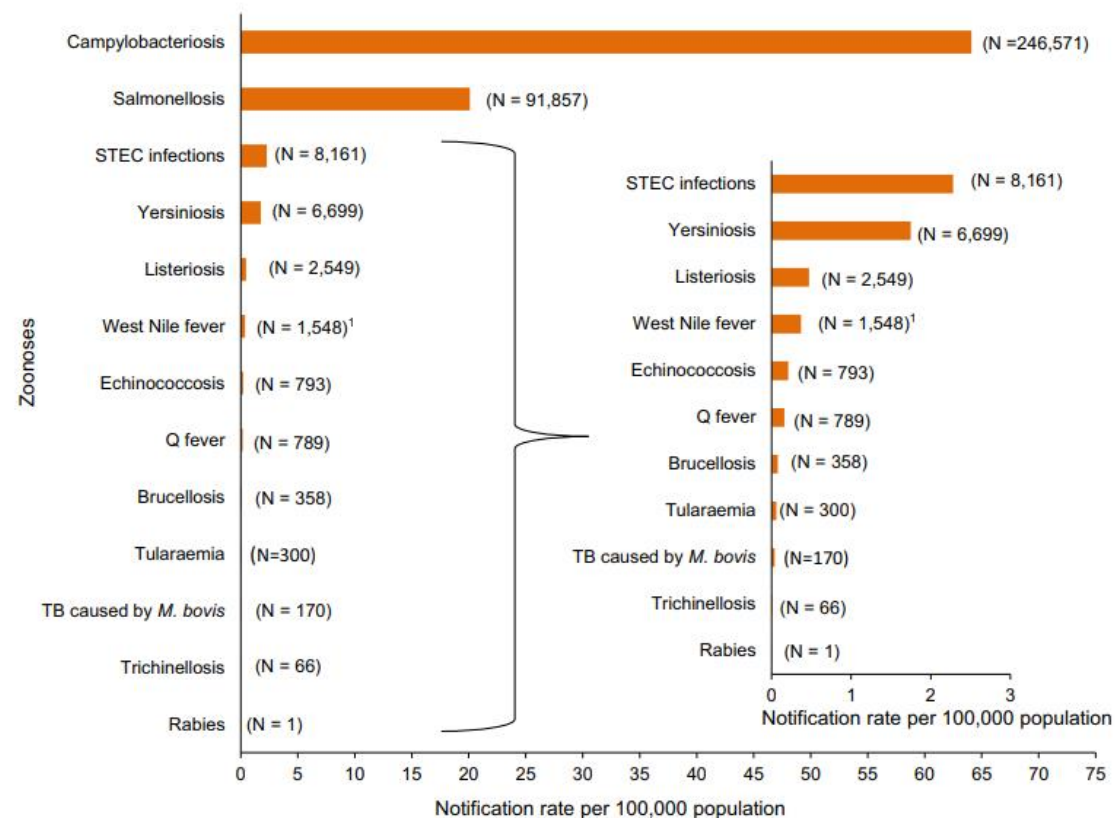
- ✓ enabling the Member States to carry out a risk analysis (or components thereof) to support **decisions** on any **adaptations of meat inspection methods**
- ✓ enabling the risk managers to consider **adaptations of meat assurance systems**

What are HEIs for?

- ✓ HEIs should be added to the **Food Chain Information** provided by the holdings supplying the animals to the slaughterhouse.
- ✓ **Reg. 853/2004 Annex II Food chain information:**
 - (a) the status of the holding of provenance;
 - (b) the animals' health status;
 - (d) diseases that may affect the safety of meat;
 - (e)including samples taken in the framework of the monitoring and control of zoonoses....

Which HEIs in this lesson?

EU One Health Zoonoses Report 2018



EFSA Journal 2019; 17(612): 5926

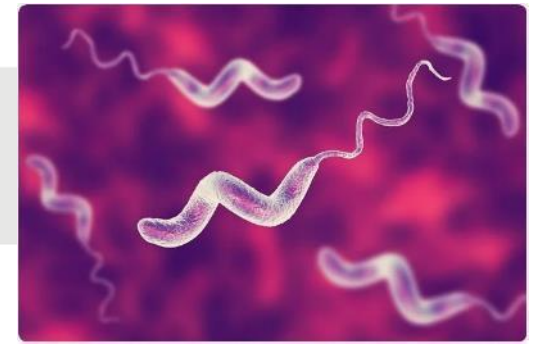
Which HEIs in this lesson?

EU One Health Zoonoses Report 2018



Directive CE 2003/99, Annex I
Zoonoses and zoonotic agents to be included in monitoring

HEIs for *Campylobacter*



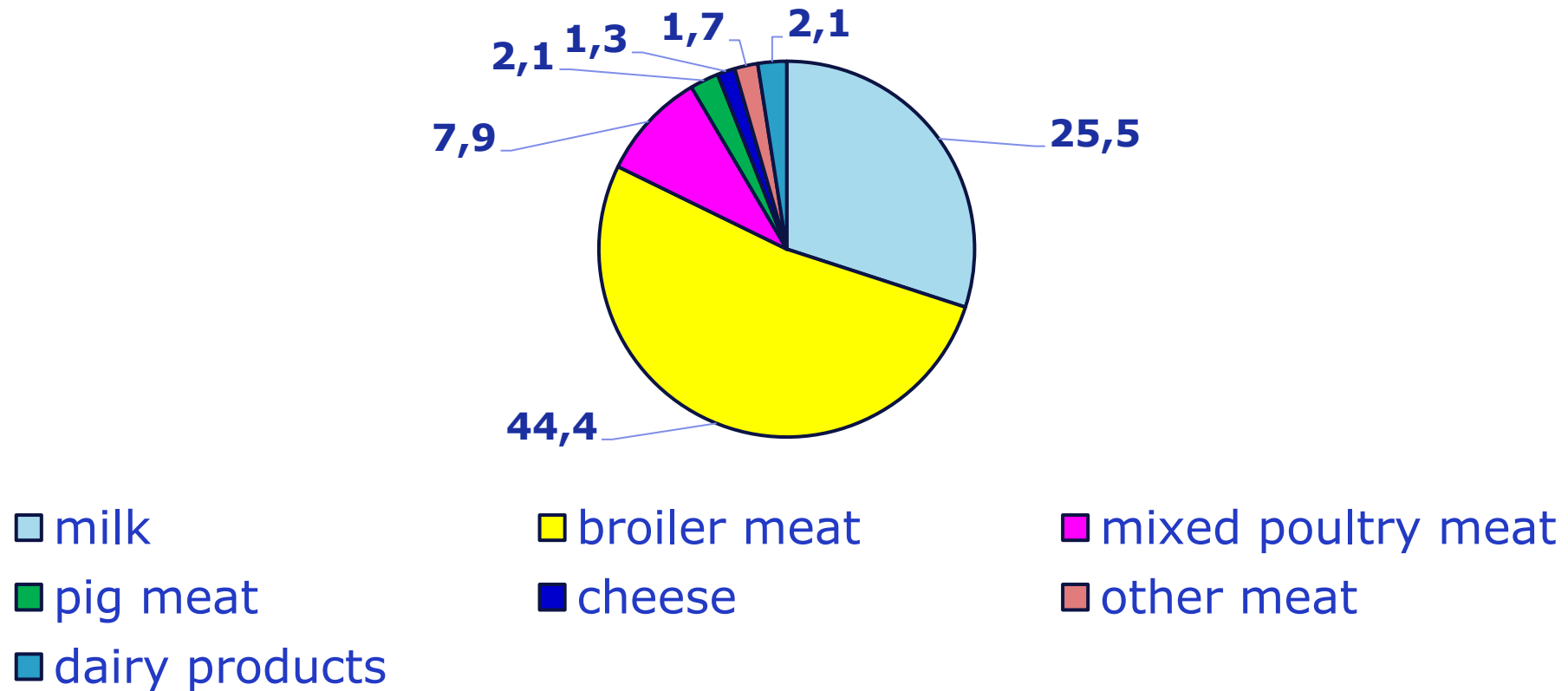
Most common thermotolerant *Campylobacter* :

- *C. jejuni*
- *C. coli*
- *C. lari*

- Low infective dose
- The most common zoonosis in the EU since 2005
- 2018 EU notification rate: **64.1 cases/100,000** population

Sources of infection for humans: strong-evidence outbreaks

***Campylobacter* outbreaks EU 2010-2017 (%)**



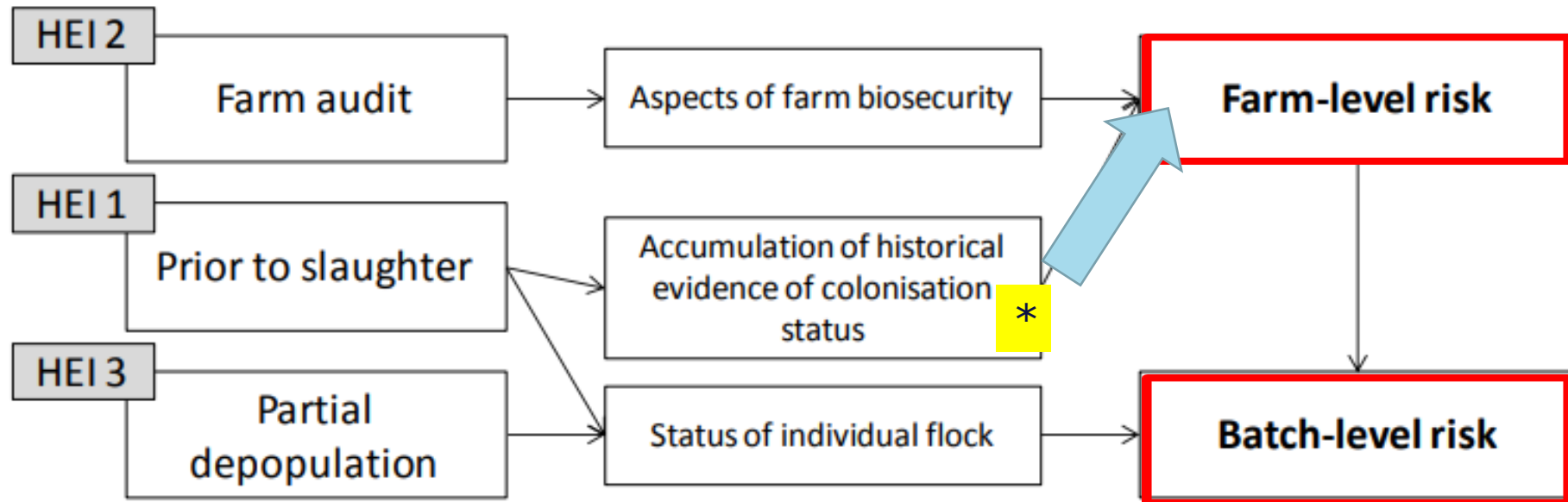
HEIs for *Campylobacter* in poultry

- Stages of the food chain:
 - **Farm** of poultry flocks (auditing; FCI; microbiology)
 - **Slaughterhouse** (microbiology)



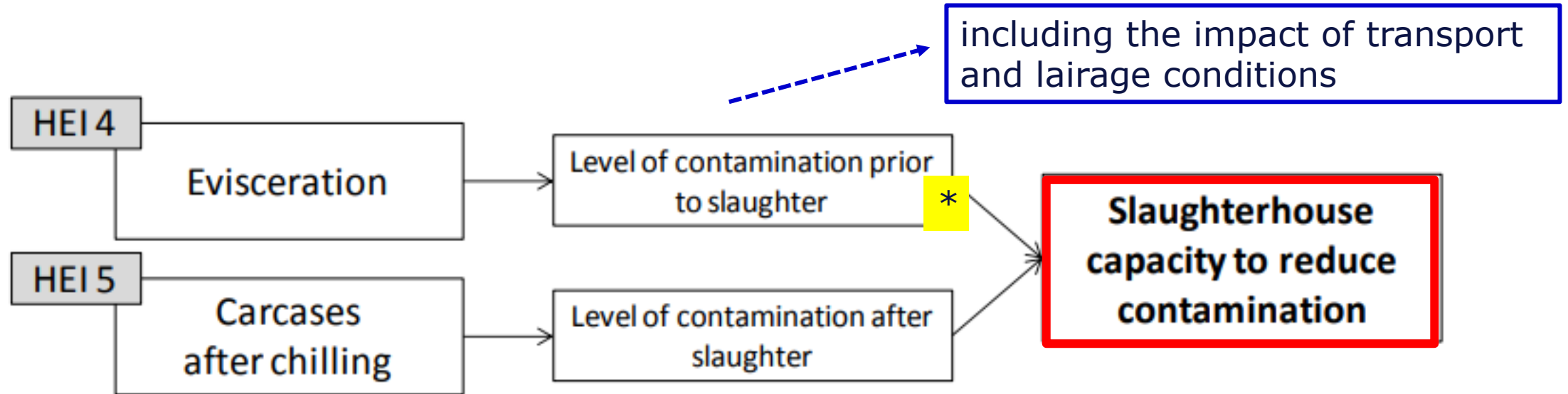
EFSA Journal 2012; 10(6): 2764

HEIs on farm



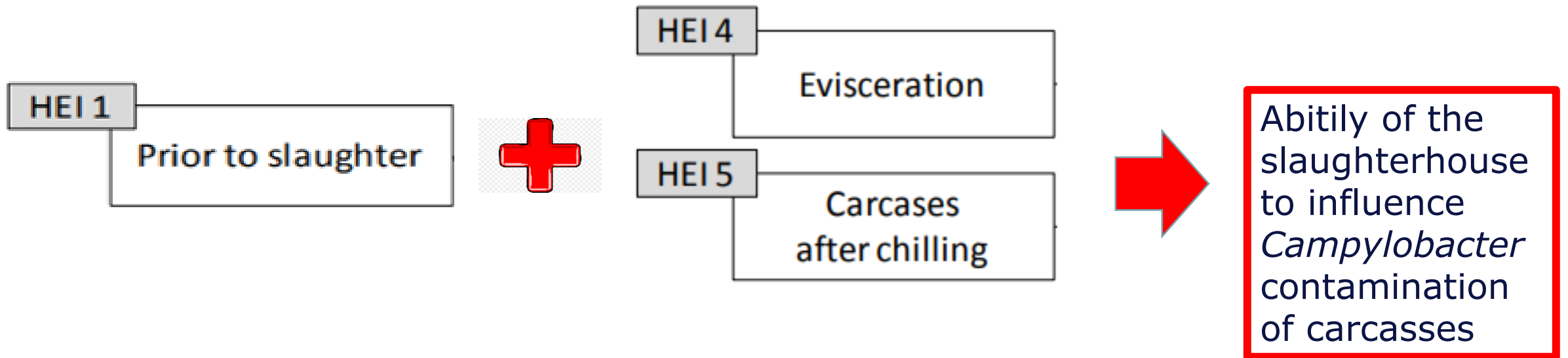
- * Short interval between testing and slaughter (2-3 days)
Regular testing of flocks to update the risk status of the farm

HEIs at slaughter



* *Campylobacter* count in caecal content reflects on-farm colonisation and transport/lairage impact

HEIs on farm and at slaughter



Regulation (EU) 2017/1495: the process hygiene criterion

Food category	Micro-organisms	Sampling plan		Limits		Analytical reference method	Stage where the criterion applies
		n	c	m	M		
Carcases of broilers	<i>Campylobacter</i> spp.	50	C=20 From 1.1.2020 C=15 From 1.1.2025 C= 10	1000 CFU/g		EN/ISO TS 10272-2	Carcases after chilling

Actions in case of unsatisfactory results:

Improvements in slaughter hygiene, review of process controls, of animals' origin and of the biosecurity measures in the farms of origin

National *Campylobacter* Control Programmes

Different approaches in the EU countries



The example of Denmark:

- Since 1998 all Danish broiler flocks have been tested for *Campylobacter* **at slaughter**
- Since 2002 the major slaughter companies have been tested flocks **on farm**

Control options in broiler primary production

SCIENTIFIC OPINION



ADOPTED: 18 March 2020
doi: 10.2903/j.efsa.2020.6090

Update and review of control options for *Campylobacter* in broilers at primary production

Aim

Are **on-farm control options** able to reduce *Campylobacter* flock prevalence?

Which impact on the relative risk of disease in humans?

Result

A **3-log₁₀ reduction** in broiler caecal concentrations was estimated to **reduce** the relative **risk of disease by 58%**

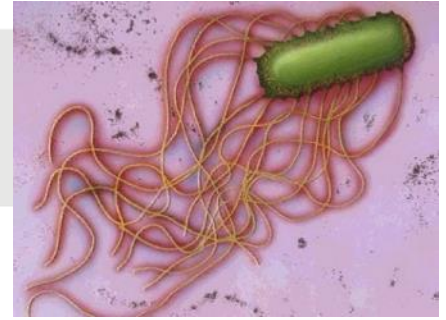
(instead of 90% as previously supposed)

Control options in broiler primary production

Selected control options	Relative risk reductions	90% PI *
Vaccination	27%	4-74%
Feed and water additives	24%	4-60%
Discontinued thinning	18%	5-65%
Well-trained staff	16%	5-45%
No standing water	15%	4-53%
Disinfectants in drinking water	14%	3-36%
Hygienic anterooms	12%	3-50%
Designated tools for broiler house	7%	1-8%

* Largely overlapping probability intervals (PI) make this ranking uncertain

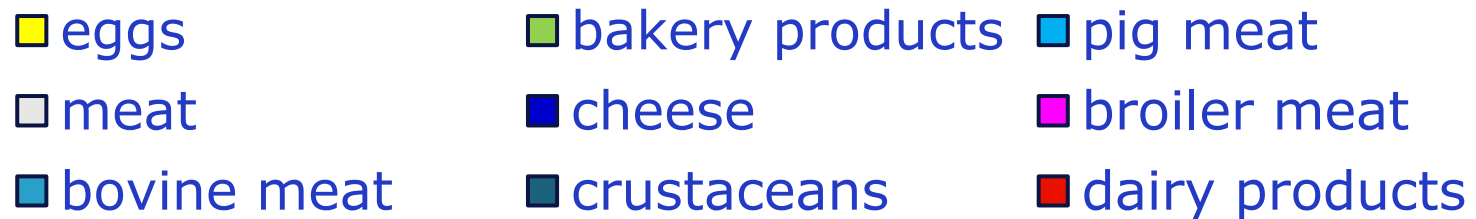
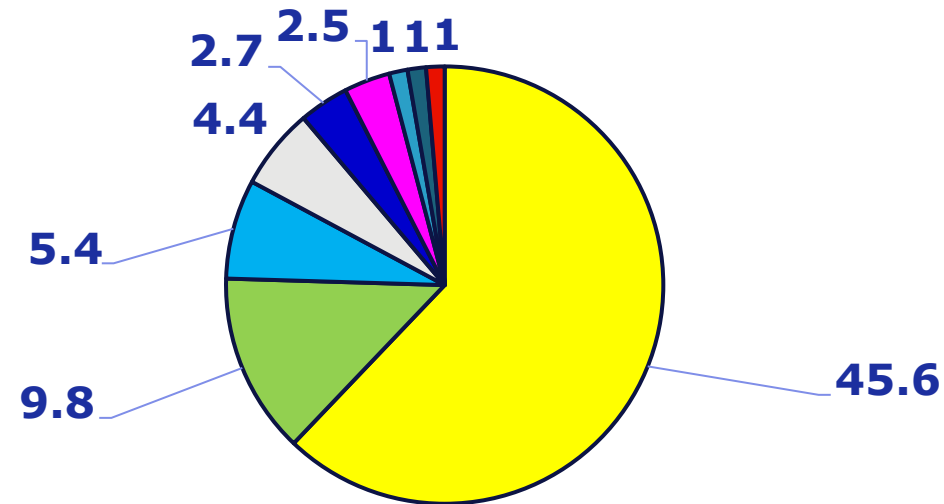
HEIs for *Salmonella*



- More than 2,600 serovars, most of them zoonotic
- Common reservoir: intestinal tract of domestic and wild animals
- Subclinical infections common; spread of *S.* on herds
- 2nd zoonosis in the EU
- 2018 EU notification rate: **20.1 cases/100,000** population

Sources of infection for humans: strong-evidence outbreaks

***Salmonella* outbreaks EU 2018 (%)**



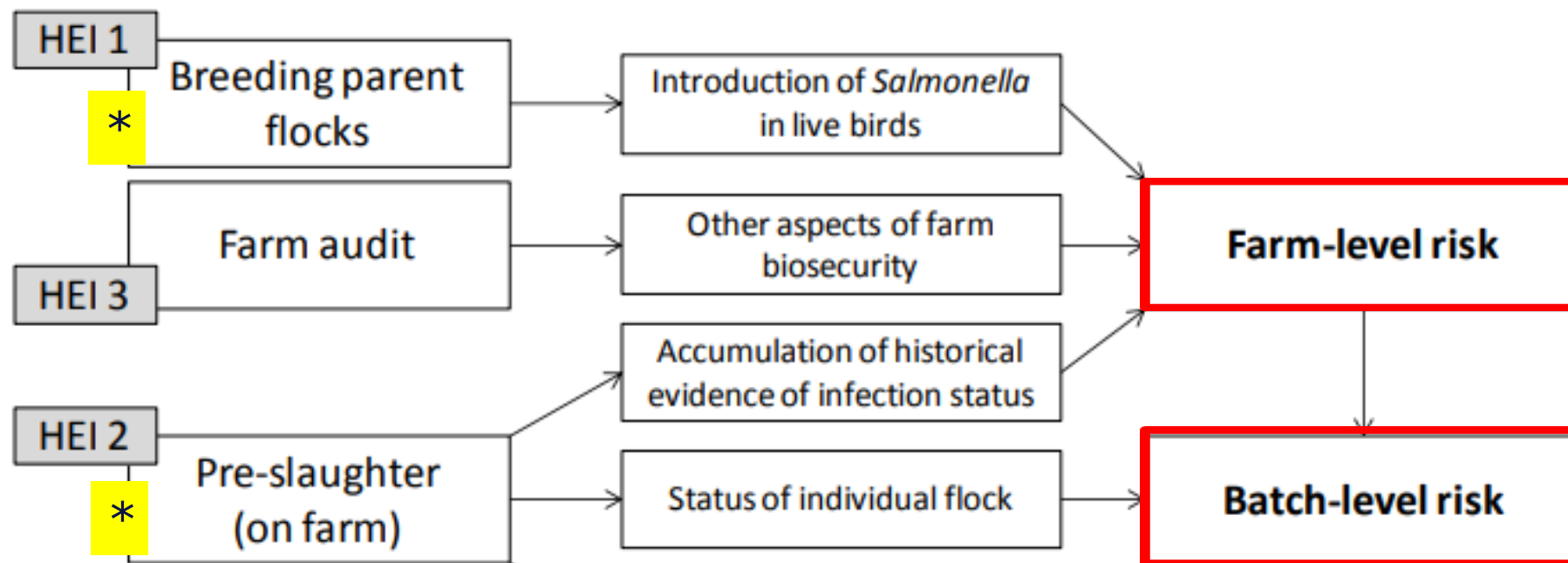
HEIs for *Salmonella* in poultry

- Stages of the food chain:
 - **Farms** of breeding and fattening flocks, laying hens (auditing; microbiology)
 - **Slaughterhouse** (microbiology)



EFSA Journal 2012; 10(6): 2764

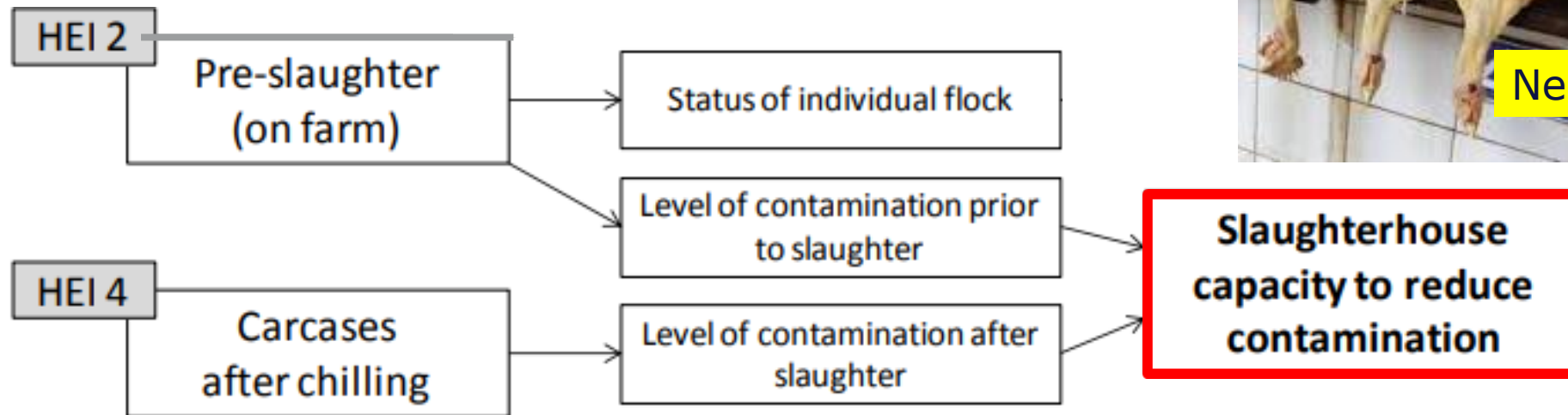
HEIs on farm



Boot swabs

* Data from mandatory *Salmonella* national control programmes in *Gallus gallus* and turkeys will provide information for HEI1 and HEI2

HEIs at slaughter



Neck skin

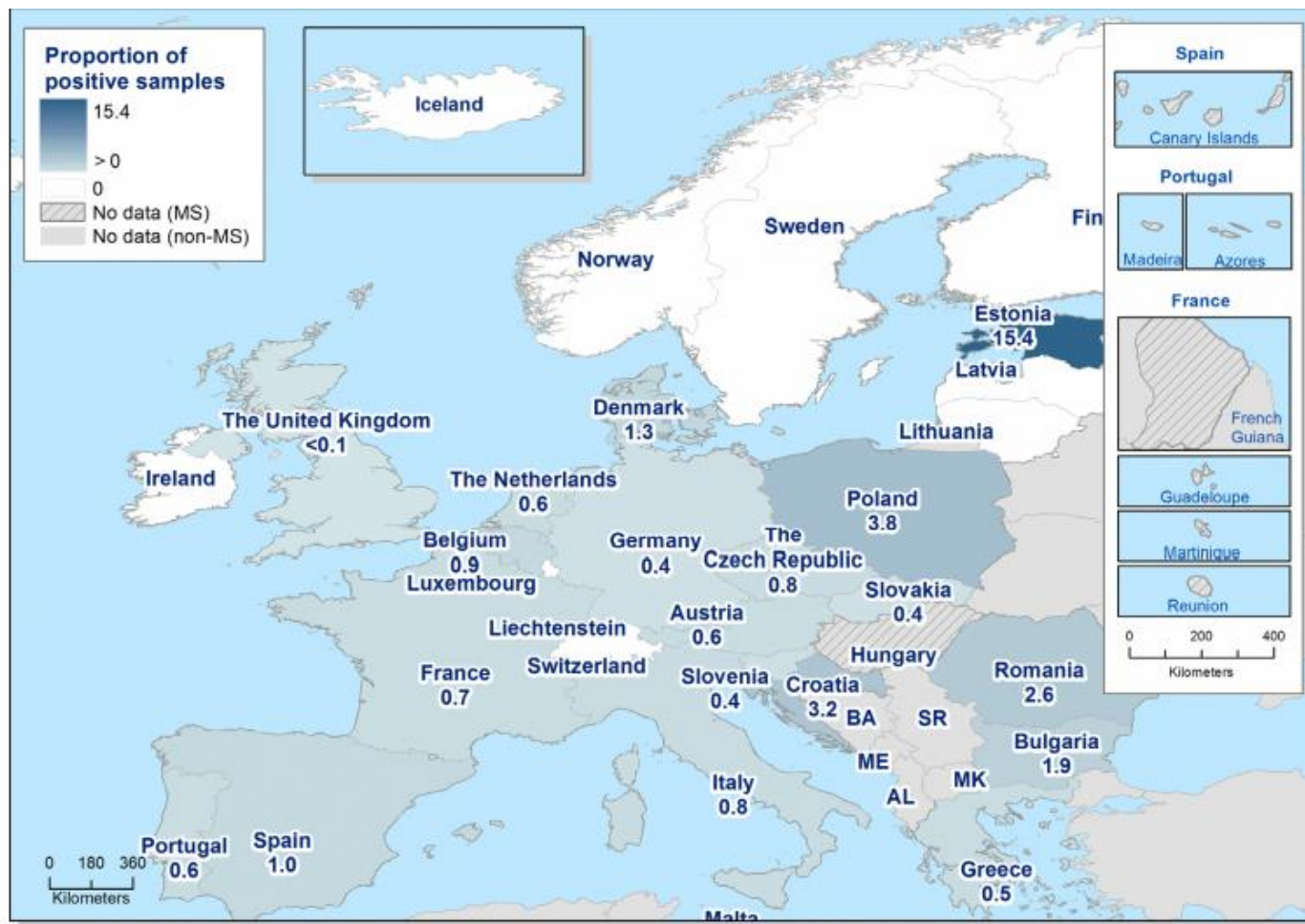
Serotyping is required

National *Salmonella* Control Programmes



Population	Maximum annual percentage (%) of flocks remaining positive	Target serovars	Legislation
Adult breeding hens (<i>Gallus gallus</i>)	1	<i>S. Enteritidis</i> , <i>S. Typhimurium</i> (including monophasic variant), <i>S. Infantis</i> , <i>S. Virchow</i> , <i>S. Hadar</i>	Regulation (EC) No. 200/2010
Adult laying hens (<i>Gallus gallus</i>)	2	<i>S. Enteritidis</i> , <i>S. Typhimurium</i> (including monophasic variant)	Regulation (EC) No. 517/2011
Broilers (<i>Gallus gallus</i>)	1		Regulation (EC) No. 200/2012
Adult breeding turkeys (<i>Meleagris gallopavo</i>)	1		Regulation (EC) No. 1190/2012
Fattening turkeys (<i>Meleagris gallopavo</i>)	1		Regulation (EC) No. 1190/2012

S. Enteritidis-positive laying hen flocks, 2018



27 MS
3 non-MS

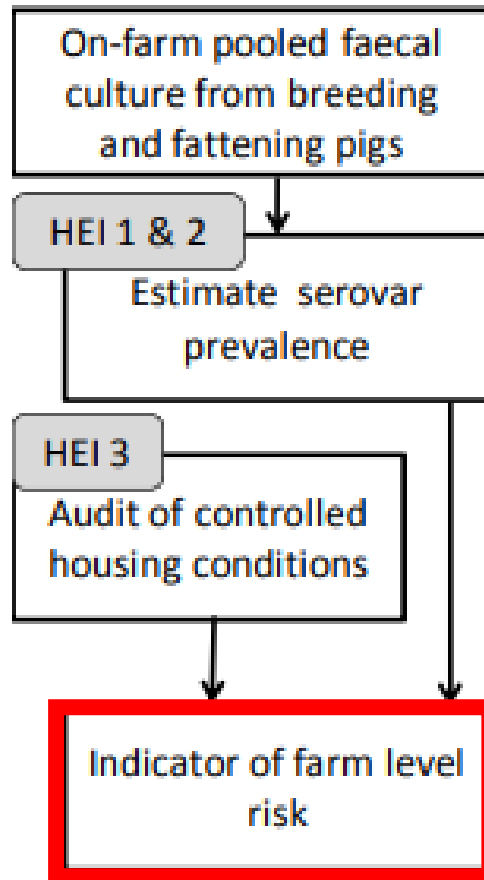
HEIs for *Salmonella* in pigs

- Stages of the food chain:
 - **Farm** (auditing; microbiology)
 - **Transport** and **lairage** (auditing)
 - **Slaughterhouse** (microbiology)



EFSA Journal 2011; 9(10): 2371

HEIs on farm

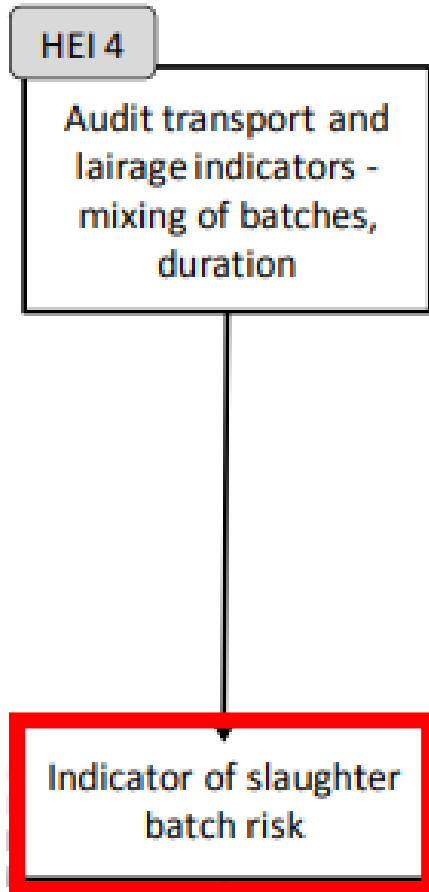


Pooled faeces

Breeders on farm
Fattening pigs on farm 1 month before slaughter

Serotyping is required
for epidemiological purposes

HEI during transport/lairage

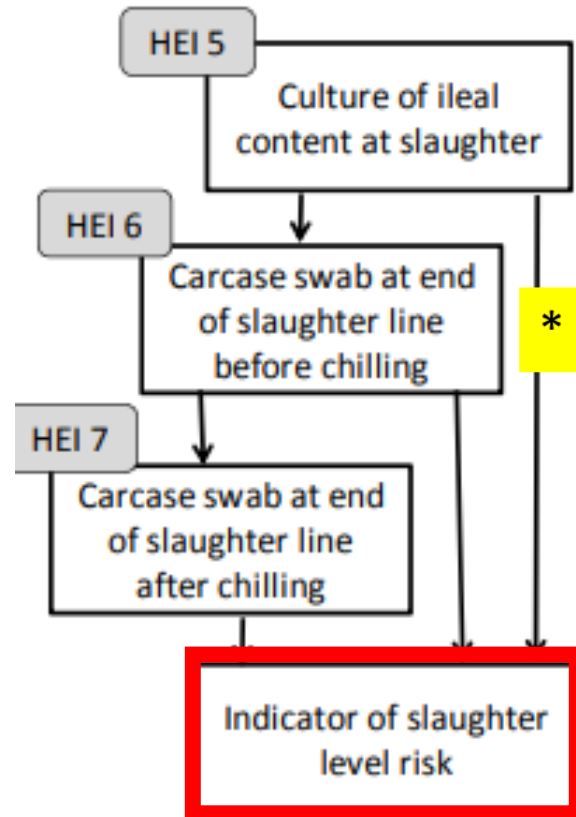


Covering specific aspects :

- transport time
- mixing of pig batches
- reuse of pens in lairage
- hygiene in lairage



HEIs at slaughter



* Best stage for carcass testing

Salmonella Control Programmes: **reduction plans**

Germany and Denmark

- Sampling in pigs is mandatory on farm and at slaughter
- ELISA-testing of serum or meat juice



Risk category	Prevalence (serum/ meat juice)		Corrective actions	
	Germany	Denmark	Germany	Denmark
I (low)	$\leq 20\%$	$\leq 40\%$	None	None
II (medium)	> 20 bis 40%	> 40 bis 65%	Check hygiene status	Penalty fee
III (high)	$> 40\%$	$> 65\%$	Bacteriological sampling, epidemiological investigation, corrective actions at farm	Penalty fee, slaughtered separately

Salmonella Control Programmes: **eradication plans**

Norway, Finland, Sweden



The example of Norway:

In pedigree breeder herds (piglets 2-6 weeks)

- Microbiological testing of pooled faeces

At slaughter

- Microbiological testing of ileo-caecal lymph nodes and carcass swabs
- Sample size: about 3,000 carcasses (1/500 pigs) per year

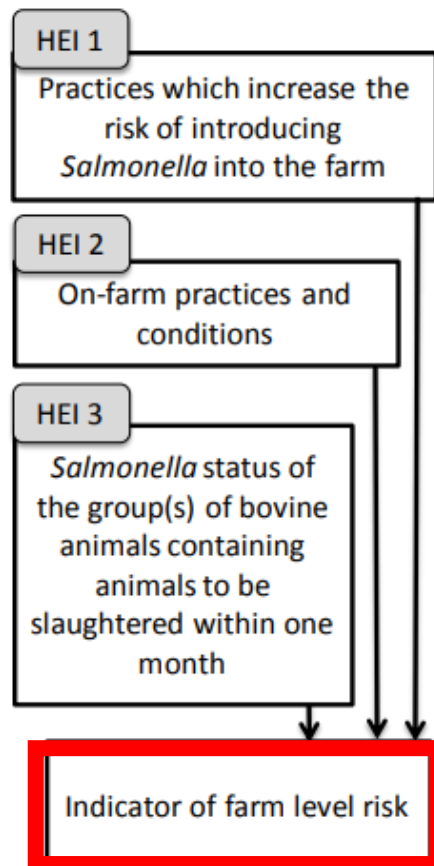
HEIs for *Salmonella* in cattle

- Stages of the food chain:
 - **Farm** (auditing; microbiology)
 - **Transport** and **lairage** (auditing)
 - **Slaughterhouse** (visual inspection of hides; microbiology)



EFSA Journal 2013; 11(6): 3276

HEIs on farm

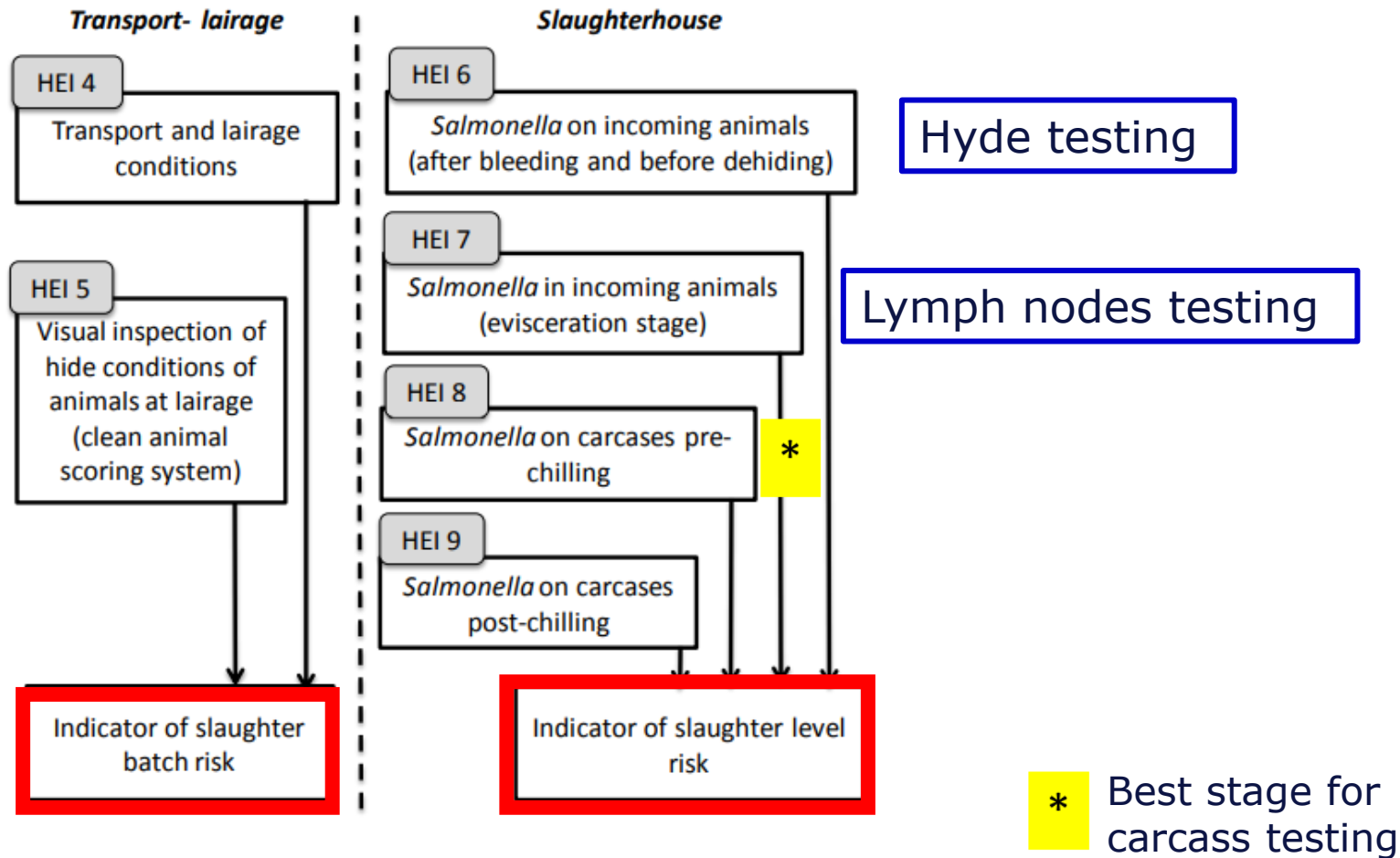


- purchase policy
- contact with other herds
- access to open pasture /surface water

Pooled faeces 1 month before slaughter

Serotyping is required for epidemiological purposes

HEIs during transport/slaughter

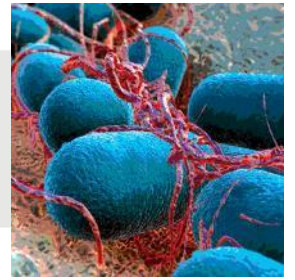


Salmonella process hygiene criteria

Food category	Microorganism	Sampling plan		Limits	Reference method	Stage where the criterion applies	Regulation EU
		N	C				
Carcasses of broilers and turkeys	<i>Salmonella</i> (serotyping for Typhimurium and Enteritidis)	50	5	Not detected in 25 g of a pooled sample of neck skin	EN/ISO 6579-1	Carcasses after chilling	1086/2011
Carcasses of pigs	<i>Salmonella</i>	50	3	Not detected in the area tested per carcass	EN/ISO 6579-1	Carcasses after dressing but before chilling	217/2014
Carcasses of cattle	<i>Salmonella</i>	50	2				2073/2005

Amended by Regulation No. 2019/229

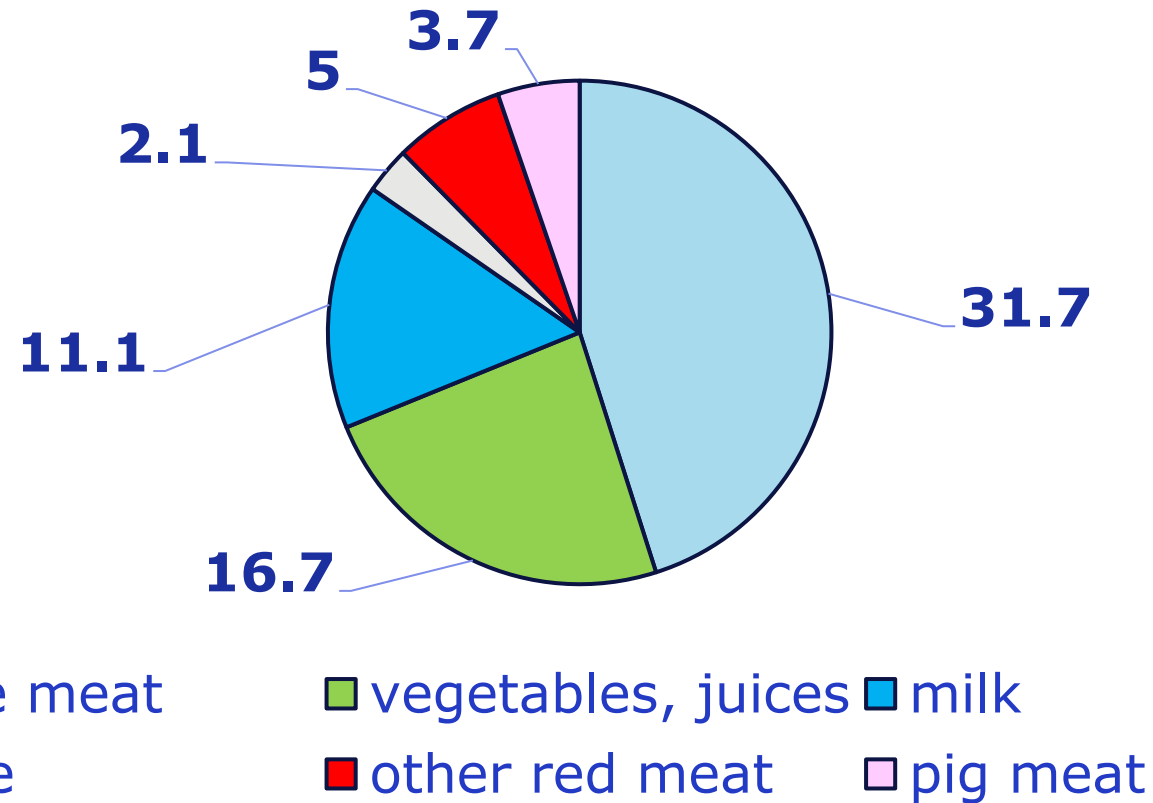
HEIs for Shiga-toxin producing *E. coli* (STEC)



- Top six serogroups:
O157, O26, O103, O111, O145, O104
- Many other serogroups are pathogenic to humans
- Very low infective dose
- Serious diseases in humans (HC; HUS)
- **Ruminants: main reservoirs**
- 3rd zoonosis in 2018
- 2018 EU notification rate: **2.28 cases/100,000** population

Sources of infection for humans: strong-evidence outbreaks

STEC outbreaks EU 2010-2017 (%)



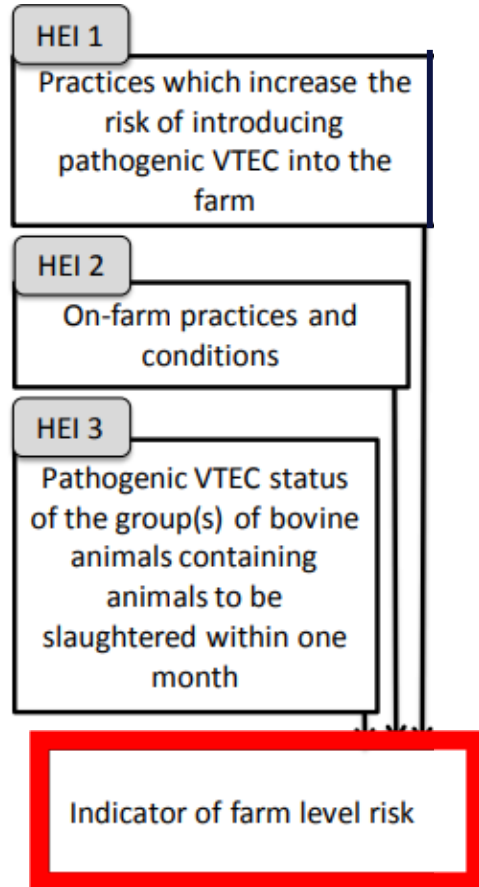
HEIs for STEC in cattle

- Stages of the food chain:
 - **Farm** (auditing; microbiology)
 - **Transport** and **lairage** (auditing)
 - **Slaughterhouse** (visual inspection of hides; microbiology)



EFSA Journal 2013; 11(6): 3276

HEIs on farm

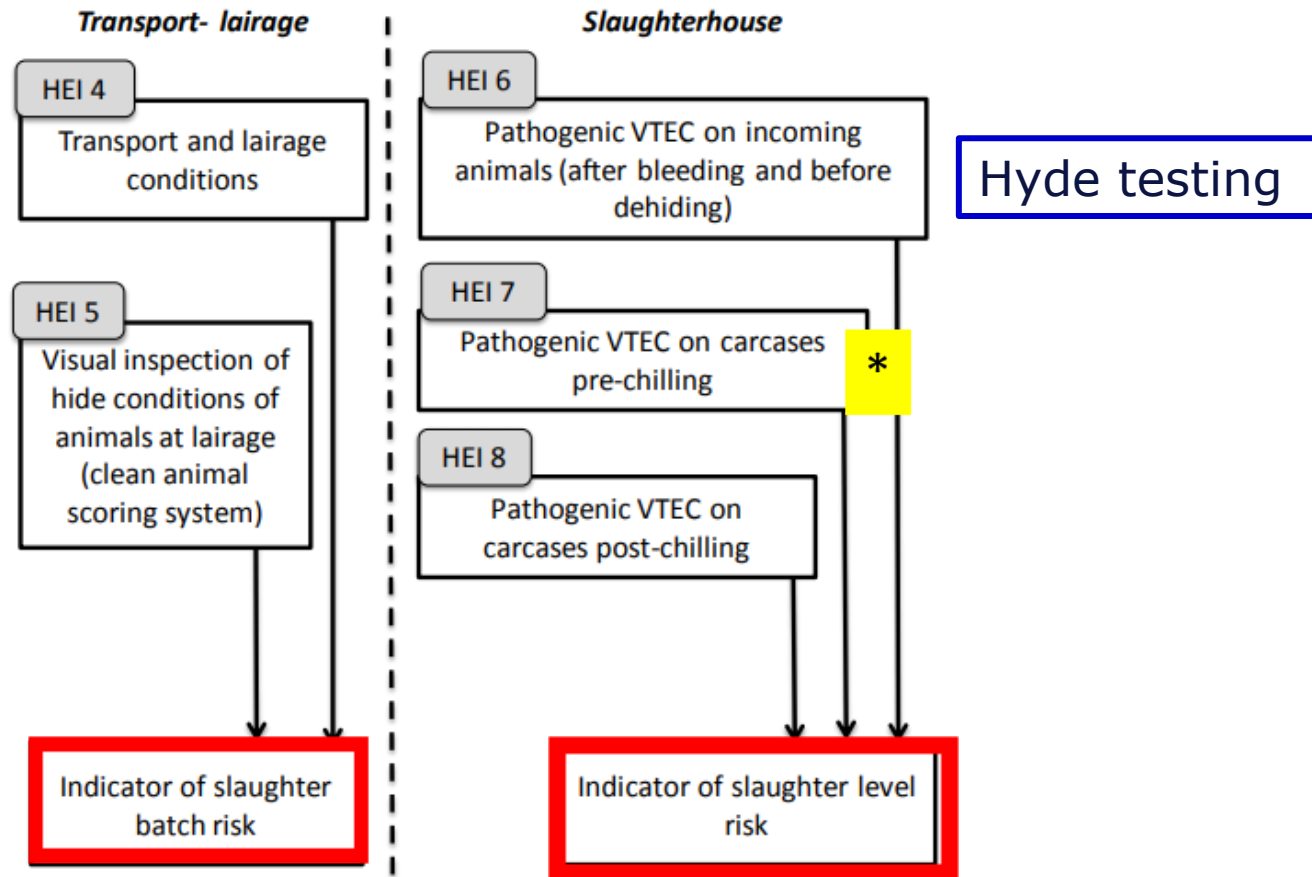


- purchase policy
- contact with other herds
- access to open pasture /surface water

Pooled faeces 1 month before slaughter

Serogroup typing is required for epidemiological purposes

HEIs during transport/lairage/slaughter



* Best stage for carcass testing

STEC contamination of hides

6

Research

Veterinary
Record
Open

Shiga toxin-producing *Escherichia coli* O157, O26 and O111 in cattle faeces and hides in Italy

S. Bonardi,¹ I. Alpigiani,¹ R. Tozzoli,² A. Vismarra,¹ V. Zecca,¹ C. Greppi,³
C. Bacci,¹ I. Bruini,¹ F. Brindani¹

Bonardi S, et al. *Vet Rec Open* 2015;**2**:e000061. doi:10.1136/vetreco-2014-000061

STEC-positive samples:
13.1% faeces
3.8% hides



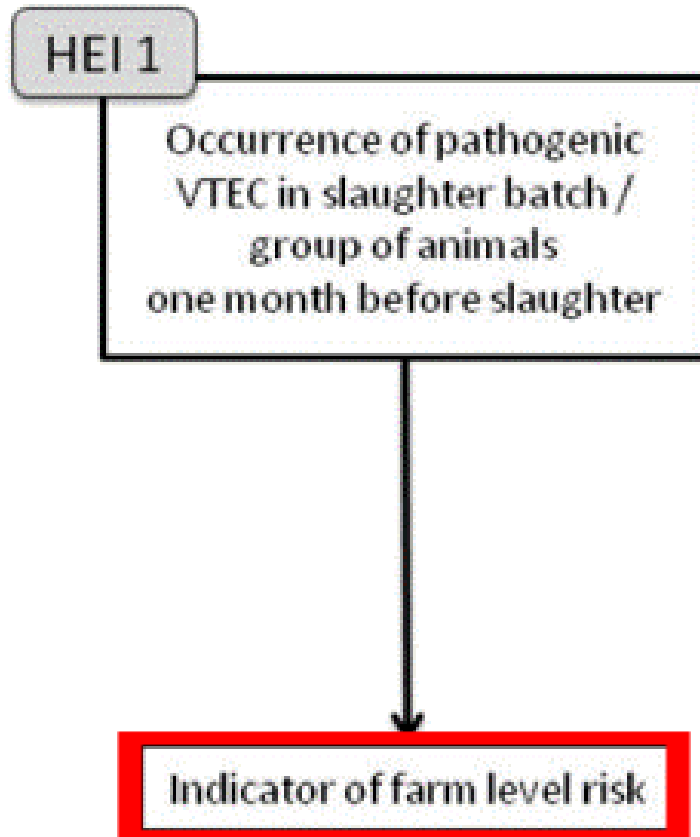
HEIs for STEC in sheep and goats

- Stages of the food chain:
 - **Farm** (microbiology)
 - **Slaughterhouse** (microbiology)



EFSA Journal 2013; 11(6): 3277

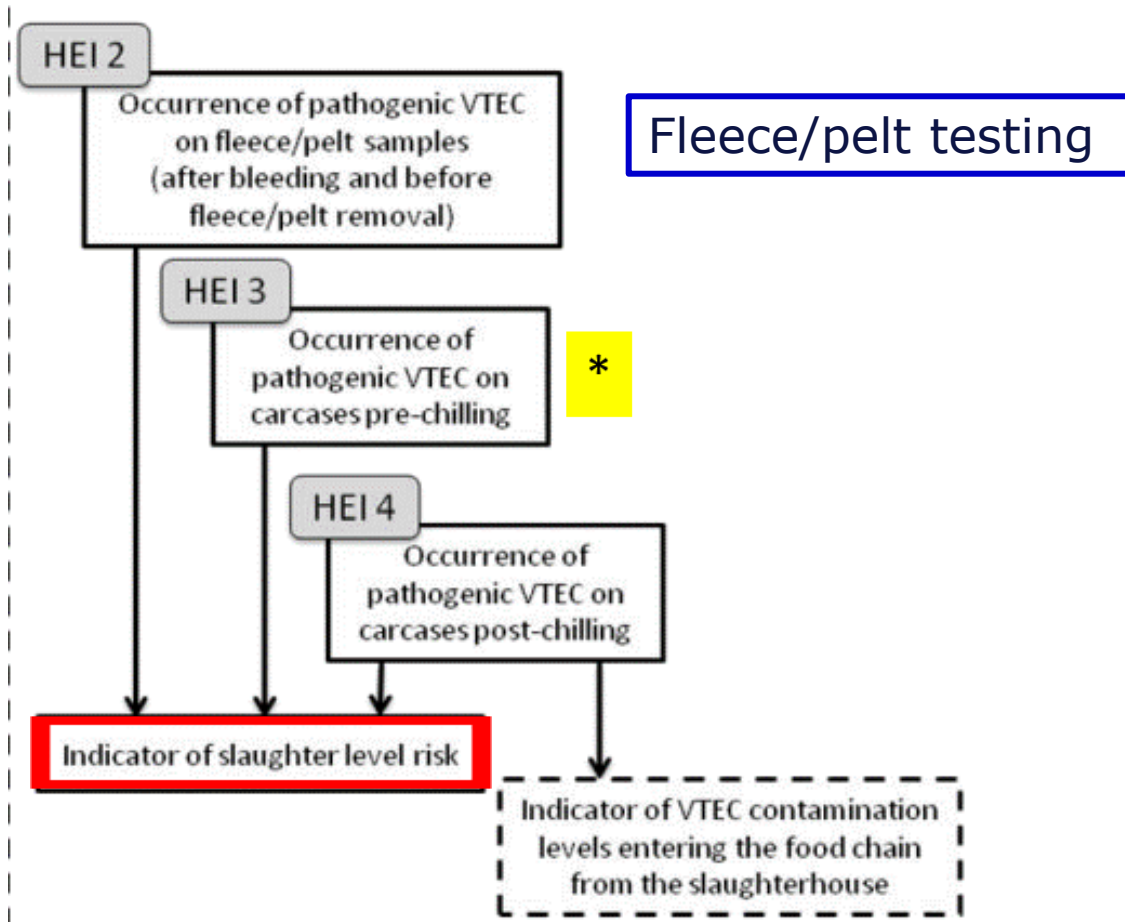
HEIs on farm



Pooled faeces 1 month before slaughter

Serogroup typing is required for epidemiological purposes

HEIs at slaughter



Best stage for carcass testing

STEC outbreaks



Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

CDC, several states, and the U.S. Department of Agriculture's Food Safety and Inspection Service investigated a multistate outbreak of Shiga toxin-producing *Escherichia coli* (*E. coli*) O103 infections linked to ground beef.

- [Reported Cases](#): 209
- [States](#): 10
- Hospitalizations: 29
- Deaths: 0



MICROBIAL GENOMICS

OUTBREAK REPORT

Wilson et al., *Microbial Genomics* 2018;4
DOI 10.1099/mgen.0.000160



Farm-to-fork investigation of an outbreak of Shiga toxin-producing *Escherichia coli* O157

Deborah Wilson,¹ Gayle Dolan,² Heather Aird,³ Shirley Sorrell,⁴ Timothy J. Dallman,⁵ Claire Jenkins,^{5,*} Lucy Robertson⁶ and Russell Gorton²

and seven cases developed haemolytic uraemic syndrome. A case control study found a statistically significant association with the purchase of raw and/or ready-to-eat (RTE) food supplied by the implicated butchers' shops. Isolates of STEC O157 were detected in two raw lamb burgers taken from one of the butchers' premises. Subsequent environmental sampling identified STEC O157 in bovine faecal samples on the farm supplying cattle to the implicated butchers for slaughter. Whole genome sequencing (WGS) was performed on the Illumina HiSeq 2500 platform on all cultures isolated from humans, food and cattle during the investigation. Quality trimmed Illumina reads were mapped to the STEC O157 reference genome Sakai using BWA-MEM, and single nucleotide polymorphisms (SNPs) were identified using GATK2. Analysis of the core genome SNP

Conclusions

- HEIs are selected according to the most important biological hazards carried by food-producing animals and their impact on human health
- Their correct application can achieve:
 - ✓ **Classification of farms** (capacity to reduce prevalence)
 - ✓ **Classification of slaughterhouses** (capacity to reduce contamination)
- ✓ Their ultimate goal is the **protection of human health**



THANK YOU!

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