

Pre-harvest food safety interventions (proven efficacy apart from Randomised Controlled Trials)

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RIBMINS Training School – 21 June 2022



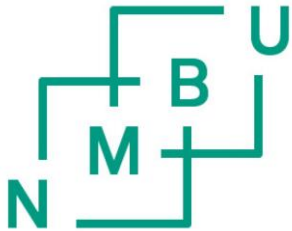
A short introduction of the lecturer dealing with Pre-harvest food safety interventions

My message to the participants is that intervention at herd level is one of the key elements for a sustainable and “clean” animal production also solving some general problems such as recycling of Salmonella and other zoonotic agents in the environment



Truls Nesbakken

Professor emeritus have been working with control of zoonotic agents since 1981



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Missing from the Systematic Review:

However, the criteria for this systematic review excluded some studies describing effective interventions to control *Salmonella* and other pathogens ...

In: Maria Rodrigues da Costa, Joana Pessoa, Diana Meemken, Truls Nesbakken. A systematic review on the effectiveness of pre-harvest meat safety interventions in pig herds to control *Salmonella* and other foodborne pathogens.

Microorganisms 2021, 9, 1825.



Intervention at herd level

- **Salmonella – the Nordic success – Norway as an example**
 - The EU Guarantee
 - The History
 - The test regime
 - The measures
 - Pre- or post harvest intervention? - solving the problem pre-harvest does give a sustainable environmental effect
- **Campylobacter in broilers – The co-operation between farmers and Food Safety Authority made it possible**
- **MRSA in pigs – The co-operation between farmers and Food Safety Authority made it possible**
- **Possibilities for intervention of other species at herd level in pigs**
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The EU Guarantee - Regulation (EC) No 1688/2005

- Norway, Sweden and Finland are allowed to reject shipments of meat products containing *Salmonella* from member states in the EU
- This is due to the low *Salmonella* level in cattle, pigs and poultry which these countries have documented every year since 1995
- In this lecture I am using Norway and pigs as an example. The principles and results are similar for cattle and poultry



Salmonella – Norway – The history

There were, **considerable problems** related to *Salmonella* some decades ago in Norwegian pigs: One example: ***Salmonella* was isolated from 27 (13.4 %) of 202 herds. *S. Typhimurium* was isolated from 16 of the herds (Bøvre, 1957)**



But

- **After implementing measures at herd level, *Salmonella* in farm animals hardly poses any risk for the meat industry and the human population of Norway today**



The test regime - the systematic Norwegian *Salmonella* Surveillance and Control programme

- **The national pig population is surveyed by sampling a representative proportion of all pigs slaughtered in Norway**



The test regime - the systematic Norwegian *Salmonella* Surveillance and Control programme

- The national pig population is surveyed by sampling a representative proportion of all pigs slaughtered in Norway
- **Annually ileocaecal lymph node and carcass samples from a total of 3,000 pigs (both sows and slaughter pigs) are collected after slaughter**
- **Why is the number 3,000 chosen**



The smallest number of negative analyzes that we must have in order to know with reasonable certainty that the findings are below a certain frequency

How safe is the result?			
Frequency (%)	90 %	95 %	99 %
0.01	23 025	29 956	46 050
<u>0.1</u>	2 302	<u>2 995</u>	4 603
1.0	230	299	459
5.0	45	59	90



Number of *Salmonella*-positive lymph nodes, carcass swabs and faeces samples from pigs isolated since the start in 1995

Category	Years (1995 – 2021)																				
	95	96-98	99	00	01	02	03	04	05-06	07	08-09	10	11	12	13	14-15	16	17	18	19	20
Lymph nodes (n=3,000)	4	0	4	2	0	4	2	1	0	0	0	1	1	1	0	0	1	3	3	2	1
Carcasses (n=3,000)	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	2	0	1
Faeces*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

*In addition: 1,500 – 1,700 faecal samples from elite and multiplier breeding herds each year



Conclusion

- **The number of positive lymph nodes, carcass swabs and faecal samples isolated since the start in 1995 has remained very low (below 0.3%) throughout the period.**
- ***S. Typhimurium* dominants among the few isolates**



The measures



EFSA: “At farm level, risk reduction measures are based on **herd health programmes, closed breeding pyramids and GHP / GFP (Good Hygienic Practices / Good Farming Practices)”**



It may be argued that the Norwegian success is linked to a husbandry structure with limited animal density





However, Rogaland (Jæren) in Norway represents one of the regions with the highest density of livestock in Europe





- **Climate and temperature may be limiting the spread and persistence of *Salmonella* in our pig production and environment**





- **Climate and temperature may be limiting the spread and persistence of *Salmonella* in our pig production and environment**
- **Our pig population are separated from pigs from other countries through an industry-driven system to limit the import of live animals**





Requirements for heat-treatment of feed mixtures

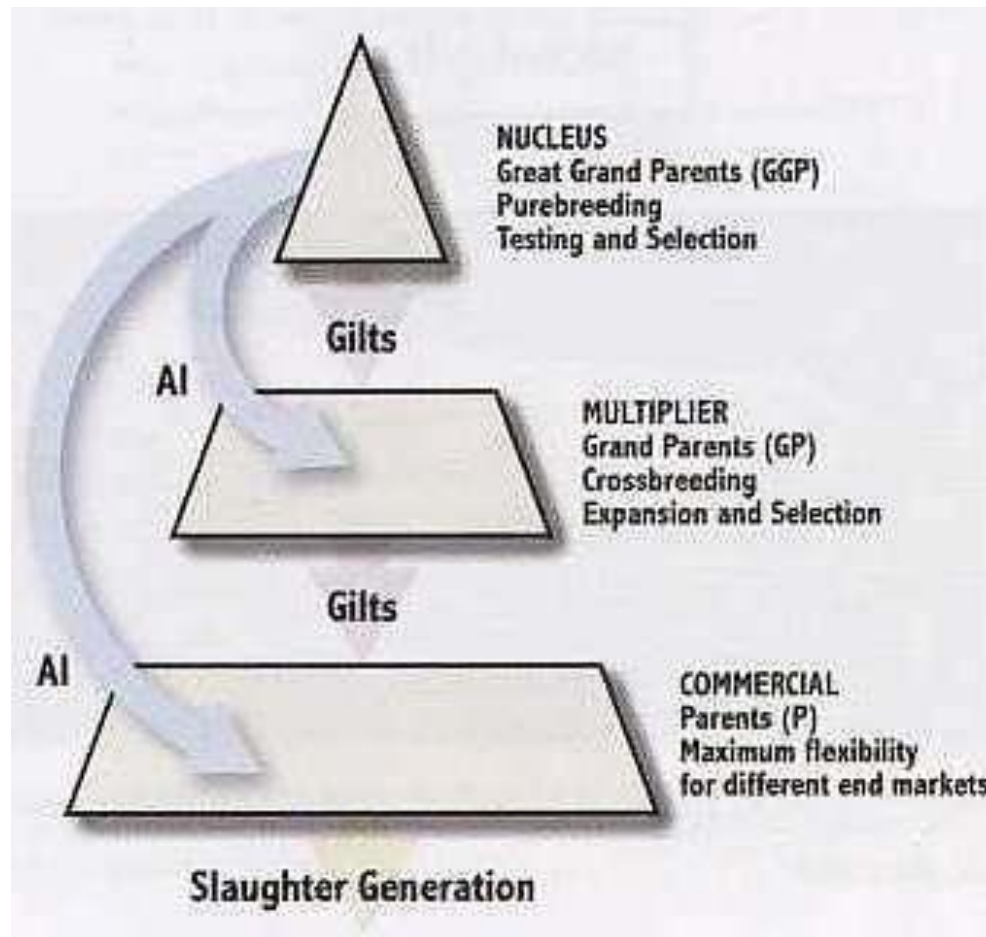
Whole feed and protein concentrates for poultry, pigs and ruminants must either be heat-treated by pelletizing where the temperature is at least 75 ° C measured in the feed before pressing,

or

By other methods where the feed's core temperature reaches at least 81 ° C.



Heat-treatment of feed and starting with breeding animals free from *Salmonella* at the top of the breeding pyramid have been the most important measures



Biosecurity....

Risk factors connected to biosecurity that are taken care of are:

- Clean drinking water,
- Birds, rodents, humans that are not allowed entering the piggery
- An environment inside and outside free from *Salmonella* (manure etc.). **No recycling of *Salmonella***





The Norwegian Food Safety Authority



- The traditional co-operation between the farmers, abattoirs and the food safety authority is important



The Norwegian Food Safety Authority



Mattilsynet

- The traditional co-operation between the farmers, abattoirs and the food safety authority is important
- The food safety authority follows up positive herds by preventing transmission to other herds, humans and food by prohibiting the purchase and transportation of animals and foods from infected farms



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- The traditional co-operation between the farmers, abattoirs and the food safety authority is important
- The food safety authority follows up positive herds by preventing transmission to other herds, humans and food by prohibiting the purchase and transportation of animals and foods from infected farms
- The food safety authority also demands sampling until the herd is documented free from *Salmonella*
- ... also sampling of herds which have been in contact with the infected herd



Are measures in the slaughterhouse and later in the meat chain more cost-effective than measures at herd level?



**Risk management
must be based on
knowledge, research
and cost-benefit
assessment**



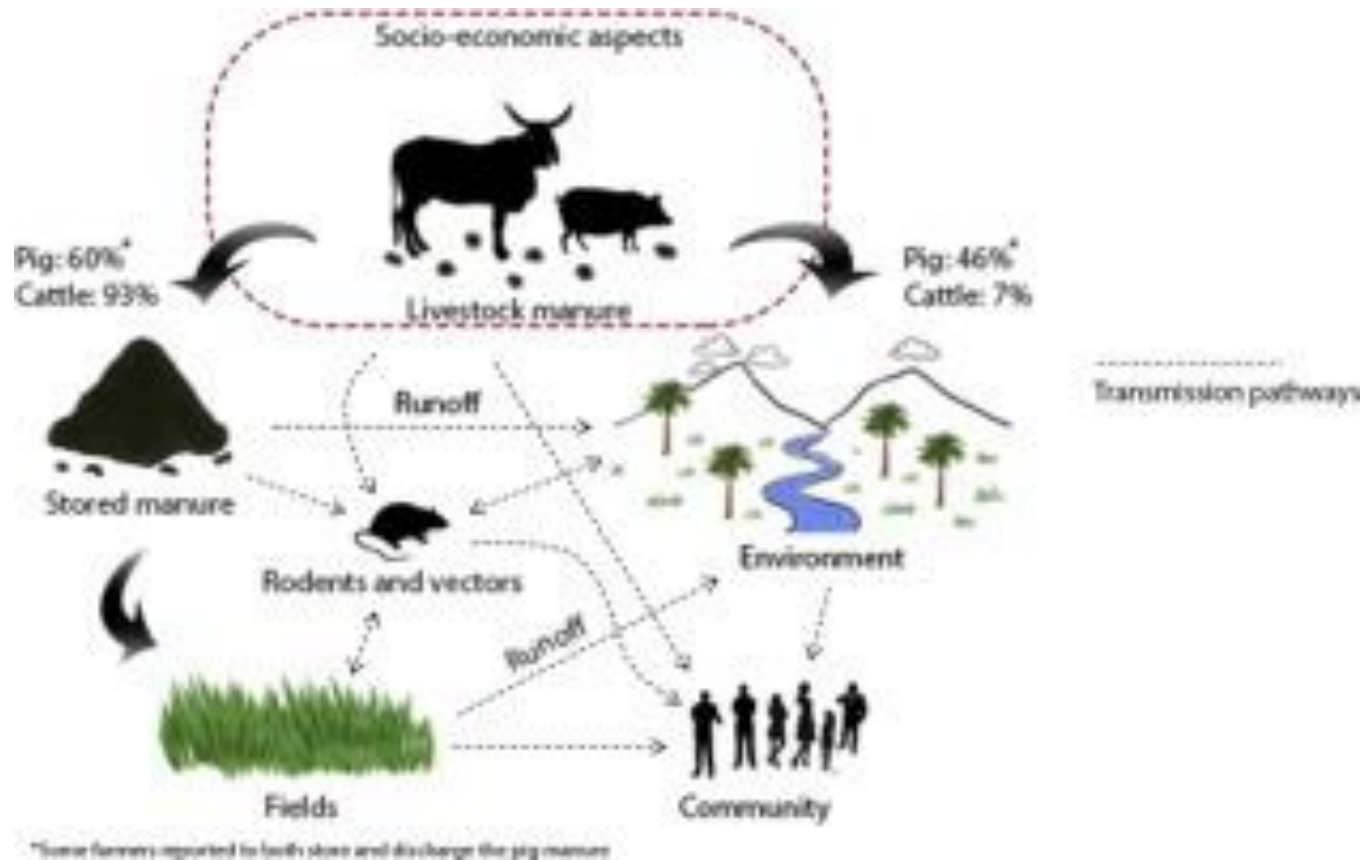
Conclusions

- But ... solving this problem post harvest does not give a sustainable environmental effect





This issue is linked to a sustainable and “clean” pig production from farm to fork solving some general problems connected to the environment recycling *Salmonella*





Conclusions (cont.)

- **Personally, I do not believe that any country has to live with a high level of *Salmonella* infections in their pigs**



Conclusions (cont.)

- Personally, I do not believe that any country has to live with a high level of *Salmonella* infections in their pigs
- But control of this agent is a continuous effort and the main elements linked to biosecurity, population management and feed control need to be focused all the time



Intervention at herd level

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Reduction of *Campylobacter* in broilers: "Action Plan against *Campylobacter* in Norwegian broilers"

- **Sampling from the herds before shipment to the slaughterhouse has been the most important measure to achieve the current low levels in fresh poultry products**



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- A significant reduction in the incidence of *Campylobacter* in herds and products of broilers has been achieved since its implementation in 2001
- **However there has not been a reduction in cases of human disease caused by *Campylobacter***



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Control strategy for MRSA* in the pig population in Norway

This includes:

- Population-wide annual surveillance
- Contact tracing upon detection of MRSA in pig farms and farm workers
- Restrictions prohibit trade of live pigs carrying MRSA, other than directly to slaughter

* **MRSA: Methicillin-resistant Staphylococcus aureus**



Control strategy for MRSA in the pig population in Norway

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- Population-wide annual surveillance
- Contact tracing upon detection of MRSA in pig farms and farm workers
- Restrictions prohibit trade of live pigs carrying MRSA, other than directly to slaughter
- **Depopulation of pigs at the farm**
- **The farm owner is responsible for thorough washing and disinfection of farm premises**
- **After a mandatory down-time, the farm is repopulated with pigs from MRSA-negative herds**



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- **The surveillance programme in 2019 detected only one pig herd with MRSA. In total, 722 herds were included in the survey**



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December 2007

RESEARCH

Pig Herds Free from Human Pathogenic *Yersinia enterocolitica*¹

Truls Nesbakken,^{*} Terje Iversen,[†] and Bjørn Lium[‡]



At herd level it is already some systems implemented that might be useful for control of zoonotic agents...

One example:

- **Specific Pathogen Free (SPF)** – means free from specific agents causing animal disease
- Could such herds also be free from specific zoonotic agents being **Specific Human Pathogen Free (SHPF) ?????**



The closed SPF-herds in Norway

This closed SPF breeding pyramid is defined and **kept free from important animal diseases such as**

- sarcoptic mange,
- swine dysentery
- enzootic pneumonia etc. (a long list)





1996: SPF-nucleus herd no. 1 was established by hysterectomi





The SPF-pyramid today

(asteriks – means herds established but not fully approved yet)

SPF-nucleus herds (established 1996 – 2022): n= 21 + 5*

↓

**SPF-multiplying herds and combined herds:
established (1997 – 2022 by purchase of **gilts from the nucleus herds** above: n= 64 + 24***

↓

Slaughter pig herds (n=??)

During the last years are a lot of slaughter pig herds established based on the **SPF-level above**



Isolation of *Y. enterocolitica* from faeces and blood - sampling





Antibodies against *Y. enterocolitica* O:3 in blood samples and culture of feces from pigs in a closed system of 16 SPF herds in Norway*

Herd no. (year of establishment)	Serologic testing (1996–2007), no. pos/no. tested	Culture (2005–2006), no. pos./no. tested
Nucleus herds		
1 (1996)	10*/397	0/20
2 (1999)	0/150	0/20
Multipliers		
3 (1997)	1/61	0/21
4 (1997)	0/19	0/20
5 (1998)	0/30	NT
6 (1999)	0/34	0/20
7 (1999)	0/20	0/20
8 (2000)	0/60	0/20
9 (2001)	0/30	NT
10 (2002)	1/61	0/20
11 (2002)	0/20	0/20
12 (2003)	0/30	0/22
13 (2003)	0/51	0/18
14 (2004)	15/30	11/24
15 (2004)	0/50	0/23
16 (2004)	0/30	0/20



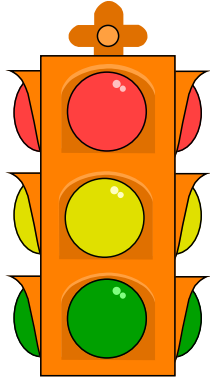
SPF = SHPF in Norway?

- ***Yersinia enterocolitica*-free? All SPF-herds except one of the investigated herds!**



What is the situation in herds outside the SPF-system?

- More than 50% of these herds are carriers of *Yersinia enterocolitica*!
- However, measures were introduced post-harvest in most abattoirs in Norway in 1994





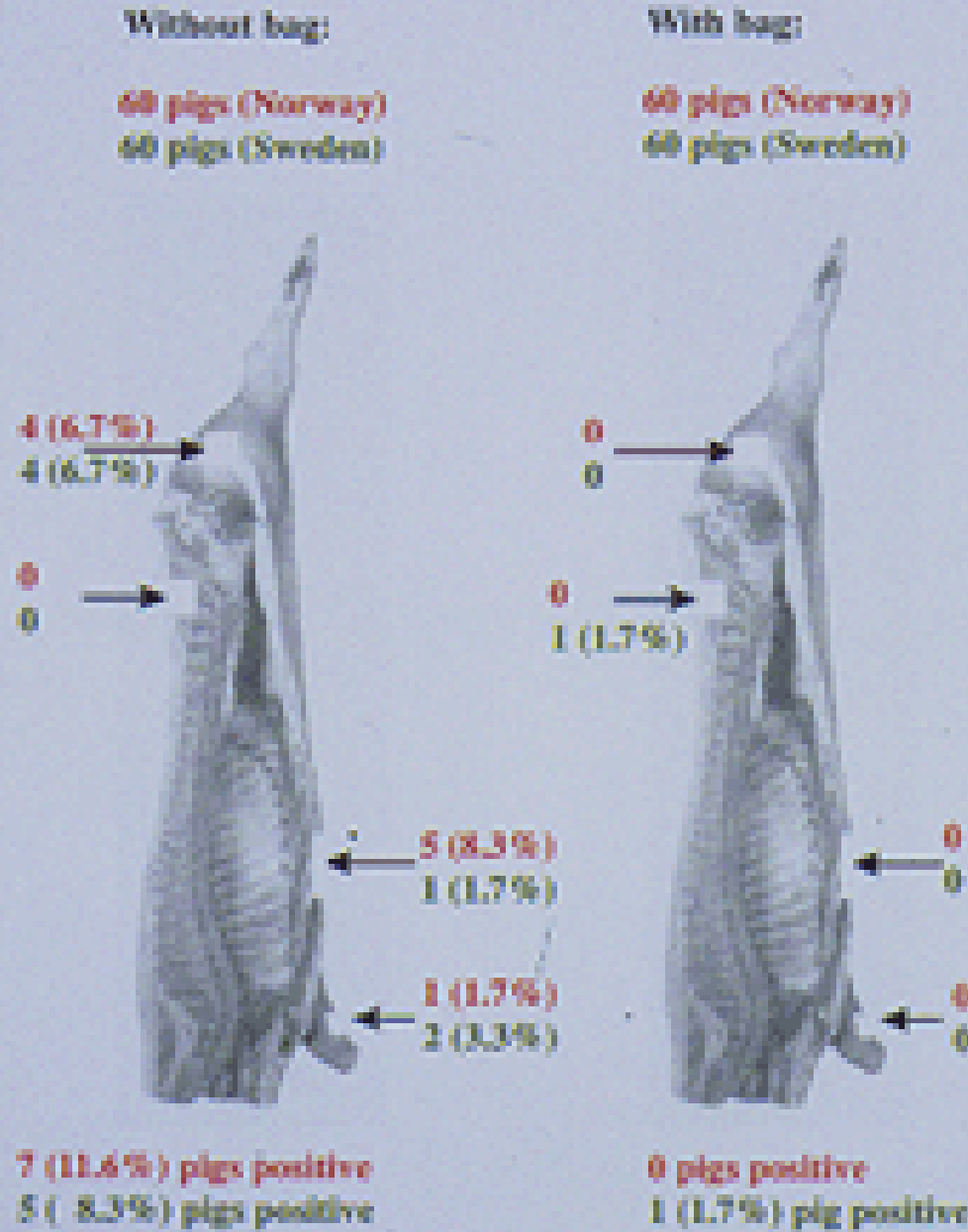
The plastic bag to avoid fecal contamination

- **Implemented in most abattoirs in Norway during 1994**
- **This was based on studies in Norway and Sweden**
- **Rectum was enclosed in a plastic bag immediately after circum anal incision and loosening and protected from decontaminating of the carcass during the dressing process**





Yersinia enterocolitica 0:3



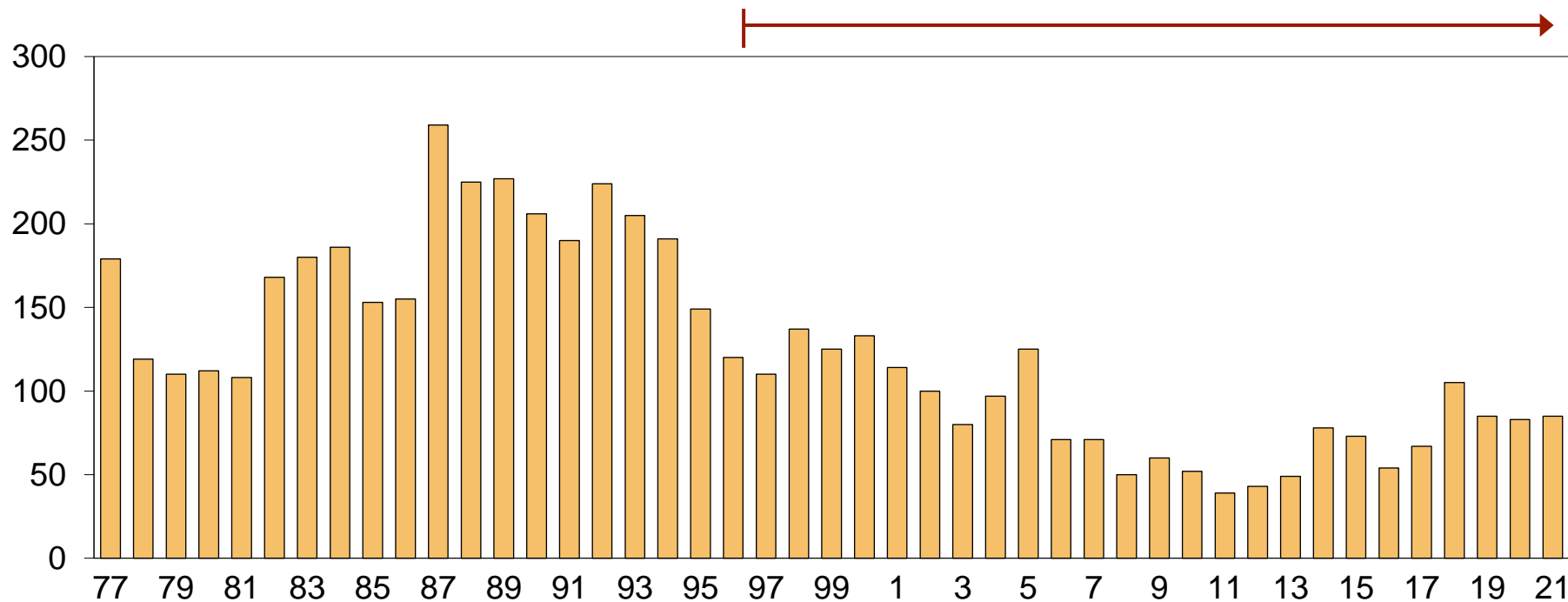
A drastically reduction of contamination with *Yersinia enterocolitica* (from 10% to 0.8% of the carcasses)

Nesbakken et al.
Int J Food Microbiol 1994,
23, 197-208



Sporadic cases of human yersinosis in Norway 1977-2021

After introduction of the plastic bag





SPF = SHPF in Norway?

- ***Yersinia enterocolitica*-free? All SPF-herds except one of the investigated herds!**
- ***Salmonella*-free? Yes (< 0.1 % at individual level in the whole Norwegian pig population)**
- ***Trichinella*-free? Yes (not detected by the compulsory control since 1994)**



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- **What about:**
 - **Toxoplasma?**



***Toxoplasma* in pigs in the general pig population (serology - ELISA)**

- **1.385 pigs from 277 herds were investigated:**
 - **5.2 % of the slaughter pig herds were positive**
 - **2.0 % of the combined (farrow to finishing) herds were positive**
 - **1.2 % of the multiplying herds were positive**
 - **Due to the fact that SPF-herds are better protected than the herd types above, the carrier state for *Toxoplasma* is probably nearly zero**



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What about *Campylobacter* in pigs from SPF-herds?

- From the literature we know that almost all pigs are carrying *Campylobacter coli*!



Zoonoses and Public Health 2015, 62, 125–130

Specific Pathogen-Free Pig Herds also Free from *Campylobacter*?

Kolstoe, Iversen, Østensvik, Abdelghani, Secic and Nesbakken



Occurrence of *Campylobacter* spp. in feces from ten SPF herds

Herd no. (year established)	Month/ Year	Carriers with <i>Campyl.</i> spp. (%)			
		Piglets (n=10)	Sows (n=10)	Slaughter pigs (n=20)	Total (n=40)
Nucleus					
1 (1996)	Oct'08	0	0	0	0
	June'10	0	0	0	0
Multipliers					
4 (1998)	Nov'08	0	0	0	0
	Aug'10	0	0	0	0
5 (2001)	Oct'08	0	0	0	0
	June'10	0	0	0	0
10 (2007)	Dec'08	0	0	0	0
	Aug'10	-	0	0	-
	Sept'10	0			-
7 (2004)	Sept'08	10 (100)	3 (30)	17 (85)	30 (75)
	May'10	9 (100)	9 (90)	20 (100)	38
Nucleus					
2 (1999)	Oct '08	1 (10)	1 (10)	3 (15)	5 (12.5)
3 (2005)	Oct '08	7 (70)	5 (50)	15 (78.9)	27
Multipliers					
6 (2003)	Nov'08	2 (20)	1 (10)	12 (60)	15 (37.5)
8 (2006)	Nov'08	2 (20)	10 (100)	3 (15)	15 (37.5)
9 (2001)	Nov'08	1 (10)	8 (80)	6 (30)	15 (37.5)



Specific Pathogen-Free Pig Herds also Free from *Campylobacter*?

Impacts:

- **Intervention at herd level might be possible for *Campylobacter* since four of 10 herds tested negative in samples from both autumn 2008 and summer/early autumn 2010**



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- Intervention at herd level might be possible for *Campylobacter* since four of 10 herds tested negative in samples from both autumn 2008 and summer/early autumn 2010
- **The four negative herds were all located in remote areas several km away from conventional pig farming while the positive SPF-farms were all situated in neighborhoods with conventional pig production**



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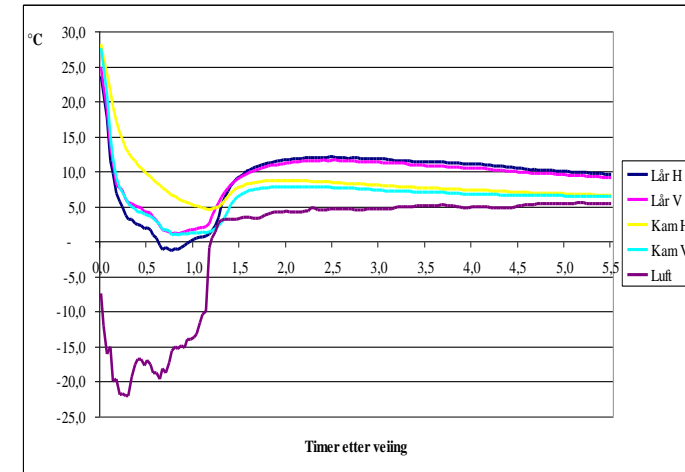
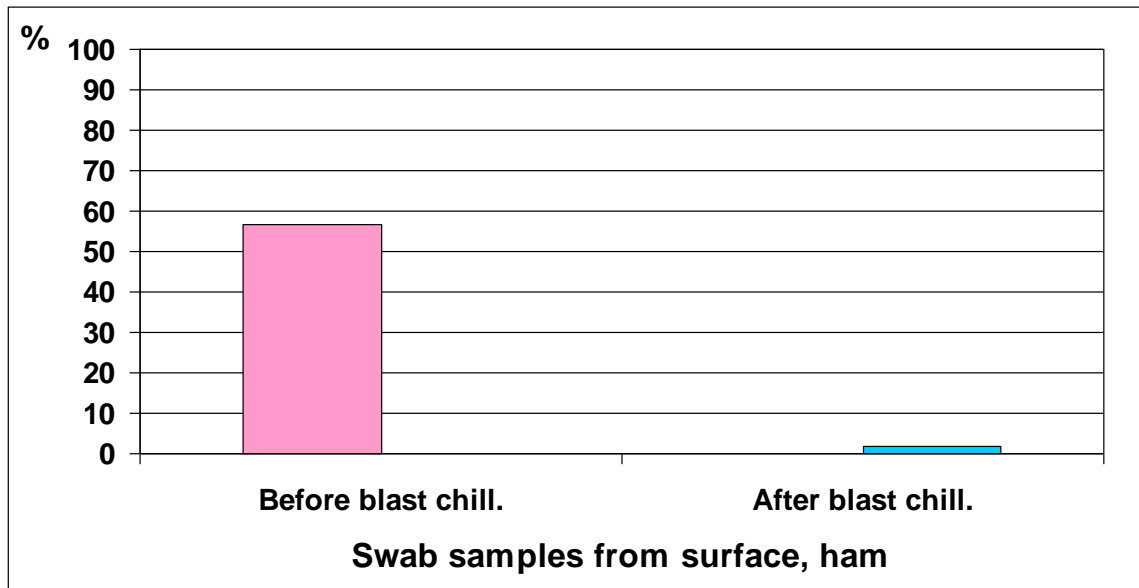
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Anyway - blast chilling is an efficient procedure in the abattoir



SPF herds do not need to be *Campylobacter* free with the use of blast chilling processing techniques

- *Campylobacter*





Specific Pathogen-Free Pig Herds also Free from *Campylobacter*?

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Anyway - blast chilling is an efficient procedure in the abattoir

In conclusion it is not cost-efficient to fight *Campylobacter* at herd level when we are talking about pigs



A general conclusion for this lecture.....

Intervention at herd level is a strategy that is efficient and sustainable also **solving some general problems connected to the environment... among them recycling zoonotic agents.....**



Some questions:

- Are there examples of strategies involving intervention of zoonotic agents at herd level in your country?
- Do you have SPF-pig herds that might also play a role regarding zoonotic agents in your country?
- What do you think about the role of intervention at herd level regarding solving problems of recycling of zoonotic agents?
- What is the significance related to the last question above?

