Intervention strategies to reduce *Escherichia coli* O157:H7 in beef feedyards

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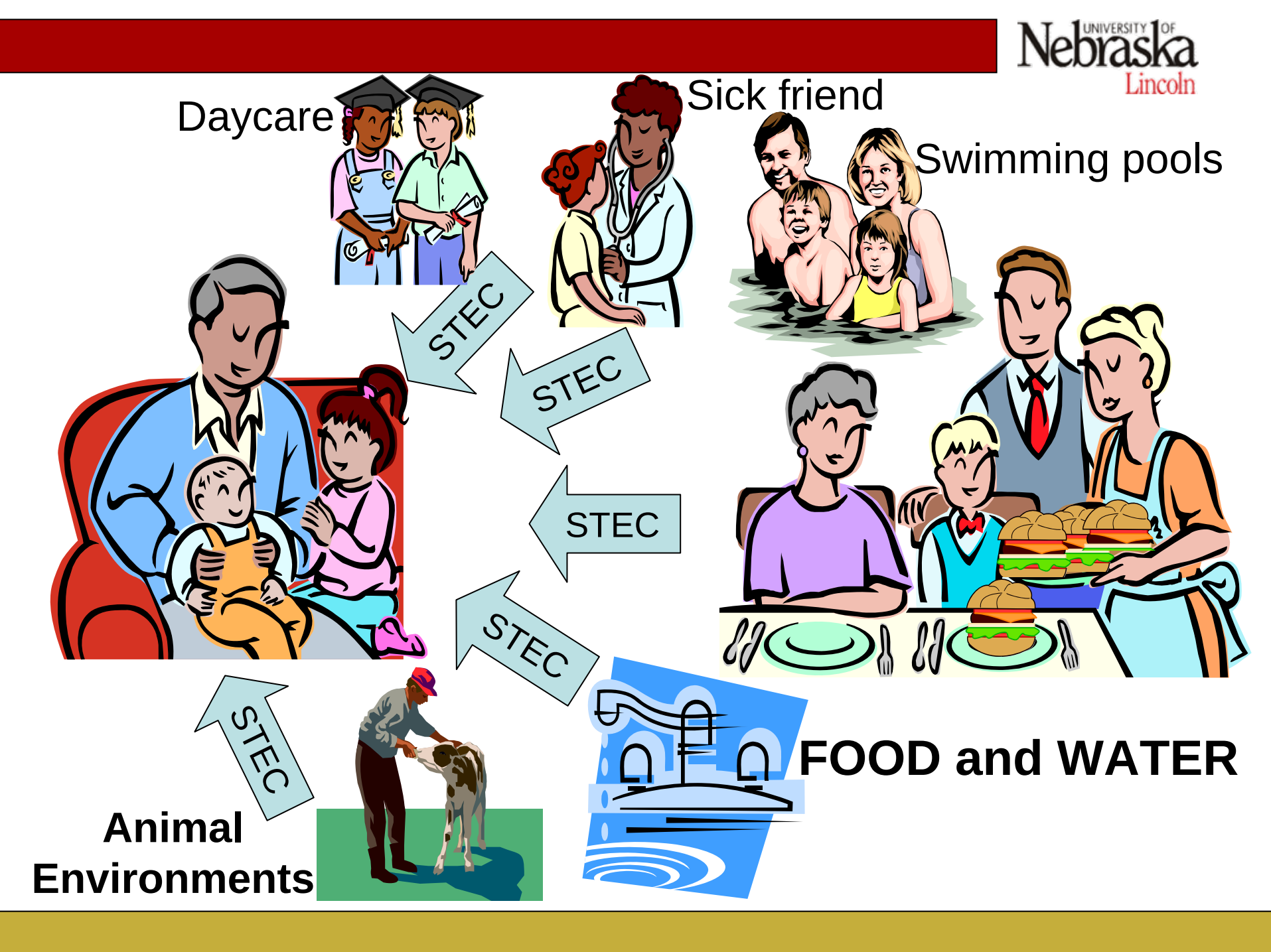
Daycare
Sick friend
Swimming pools
STEC
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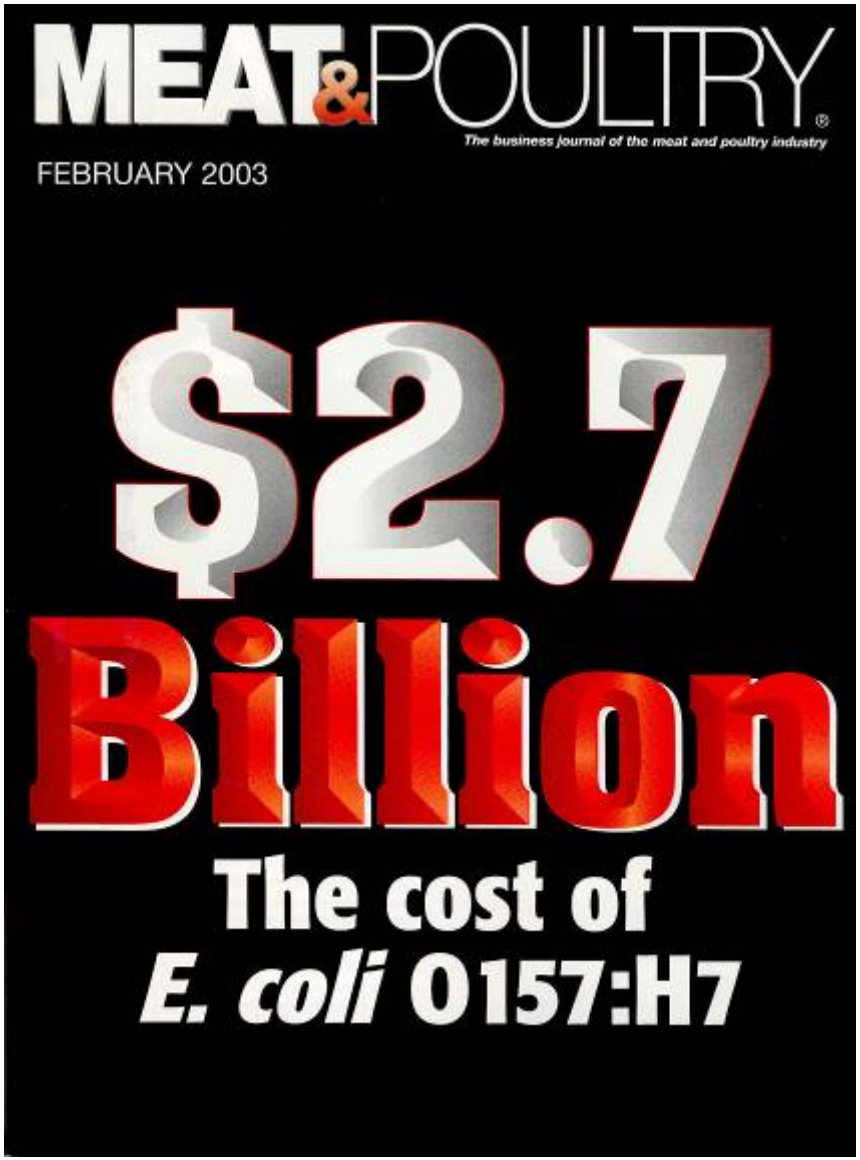
FOOD and WATER
Animal Environments


MEAT&POULTRY
The business journal of the meat and poultry industry
FEBRUARY 2003
$2.7
Billion
The cost of
E. coli O157:H7

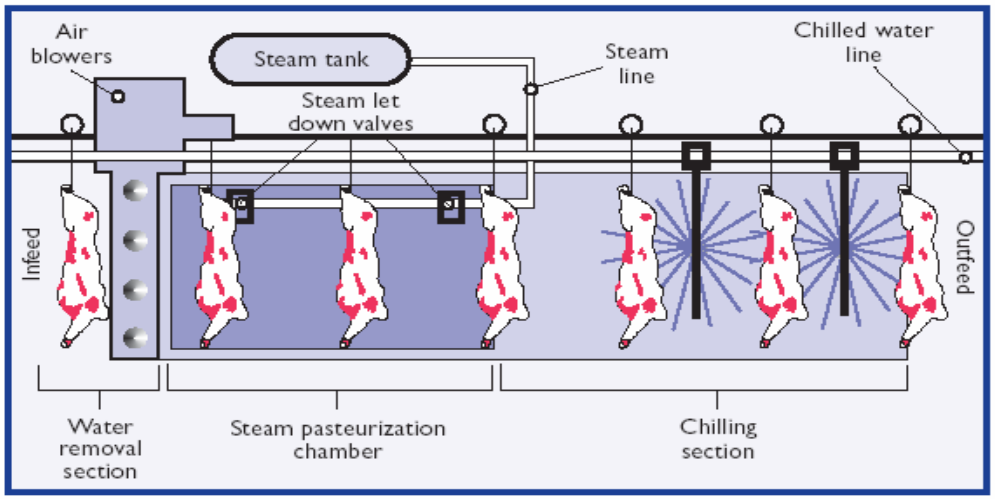

Newsweek
WOMEN'S B-BALL ON THE LINE
SWINGING MOSCOW
Can This Meat Kill You?
THE E. COLI THREAT— IT'S WORSE THAN YOU THINK
BEEF CHUCK GROUND
SAFE HANDLING INSTRUCTIONS
AUG 26

Beef industry interventions

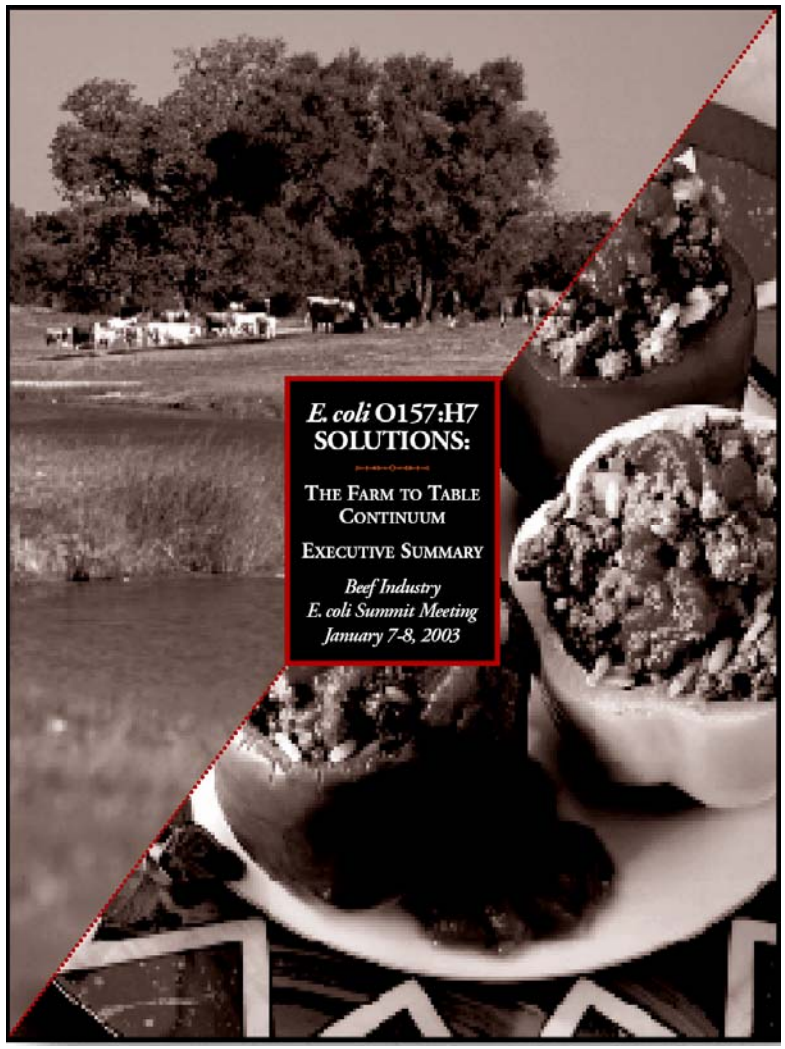
Post-harvest

- Carcass washes
- Steam pasteurization
- Test and hold

Figure C-3
Beef Steam Pasteurization System — Static Chamber Unit



Source: Frigoscandia Equipment



Good News:

There is less probability to detect *E. coli* O157:H7 in ground beef

FSIS Food Safety and Inspection Service
United States Department of Agriculture
Washington, DC 20250-3700

News & Events

News Releases

FSIS Ground Beef Sampling Shows Substantial *E. coli* O157:H7 Decline In 2004

Congressional and Public Affairs
(202) 720-9113
Steven Cohen

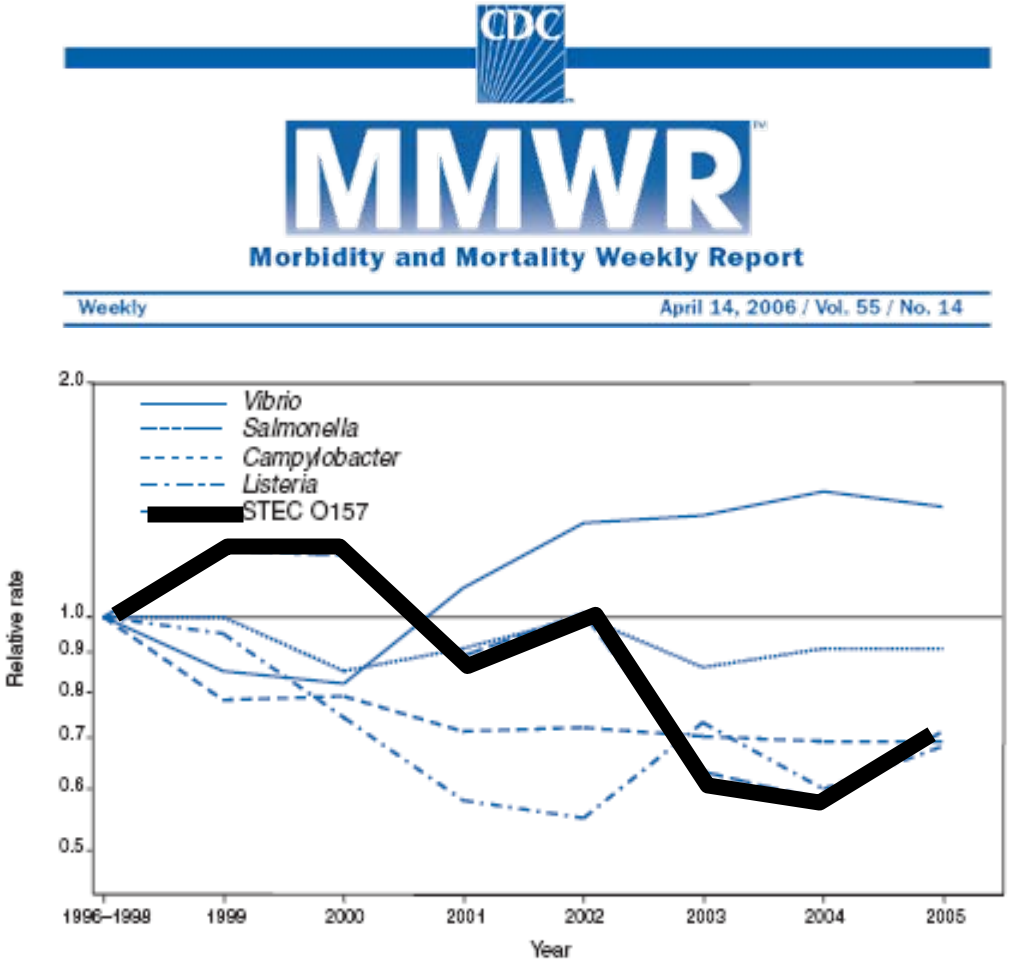
WASHINGTON, Feb. 28, 2005 - The U.S. Department of Agriculture's Food Safety and Inspection Service today released data showing a 43.3% drop in the percentage of *E. coli* O157:H7 positive ground beef regulatory samples collected in 2004 compared with the previous year.

http://www.fsis.usda.gov/News_&_Events/NR_022805_01/index.asp

Human illness due to *E. coli* O157:H7 has decreased

"The declines in the incidence of STEC O157 infections observed in recent years suggest that coordinated efforts by regulators and industry have been effective in reducing contamination and illness related to ground beef"

MMWR April 14, 2006. 55(14)



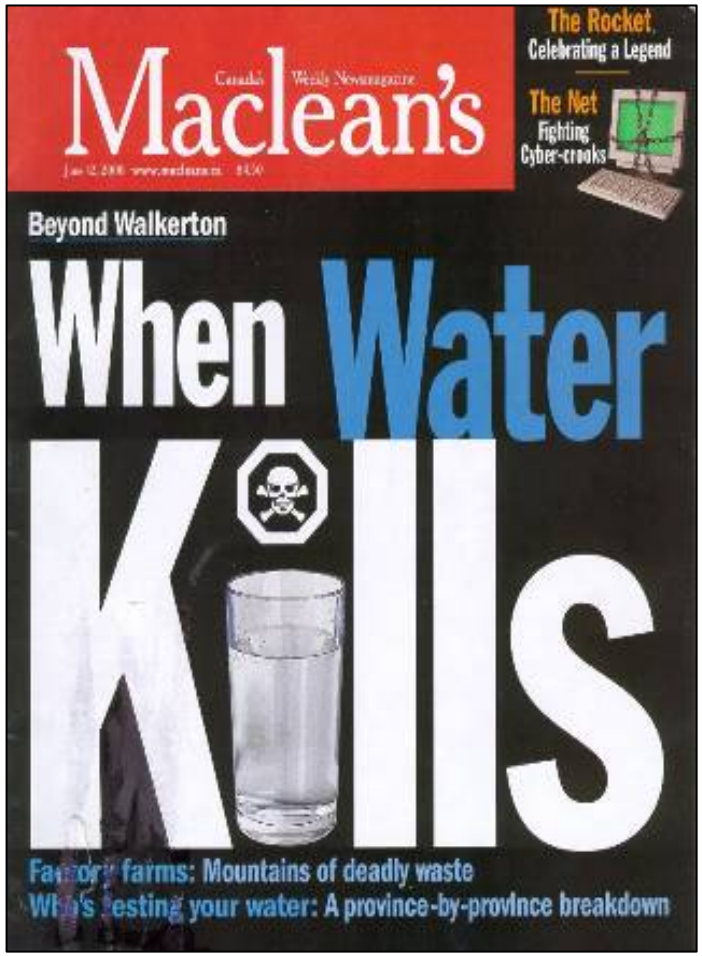
HEALTHY PEOPLE 2010

STEC O157 2005: 1.06 / 100,000

2010 goal: 1.00 / 100,000

http://www.healthypeople.gov/document/html/volume1/10food.htm

Live cattle populations are a major reservoir of *E. coli* O157:H7



Live cattle populations are a major reservoir of *E. coli* O157:H7

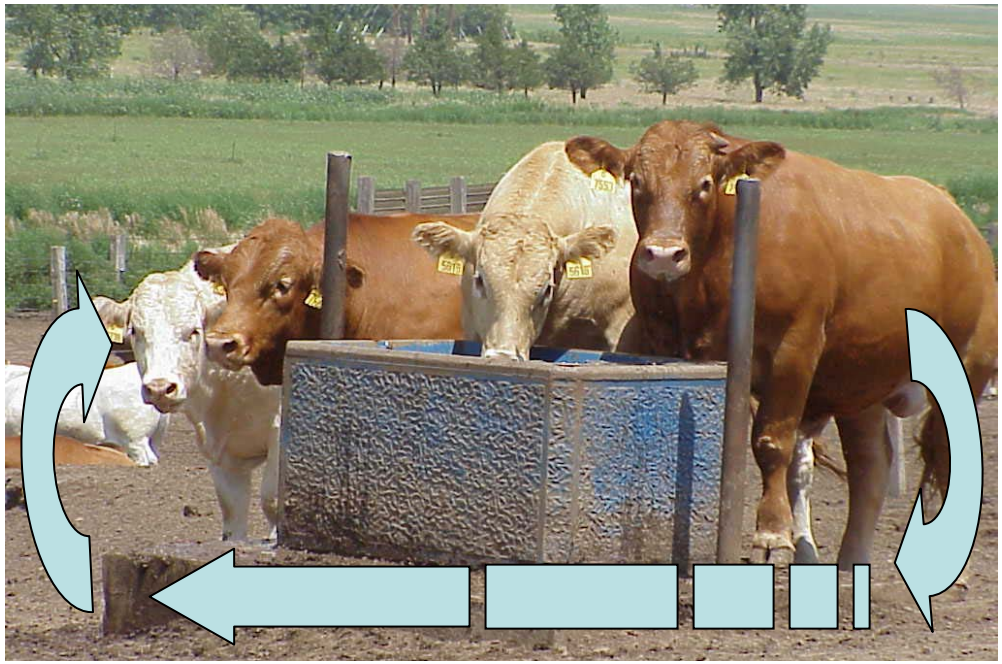
What affects the probability for cattle to shed the organism?

What can we do about it?

Q: What affects the probability for cattle to shed *E. coli* O157:H7?

A: The natural ecology of *E. coli*

Smith et al. Foodborne Pathogens and Disease. March, 2005, Vol 2(1): 50-60



What can we do about it?

*Prevalence ~ rate of exposure * duration of infection*

Strategies for intervention:

Limiting exposure

Reducing the duration of infection (colonization)

Vaccination as a strategy to reduce shedding of *E. coli* O157:H7 in cattle populations

Stimulate immunity against type III secreted proteins that mediate bacterial attachment to intestinal cells

Courtesy Dr. Brett Finlay

Potter et al. 2004. Vaccine 22:362-369

Phase III (Large-scale) Vaccine Trial

This project was supported by the National Integrated Food Safety Initiative of the USDA Cooperative State Research, Education and Extension Service, grant number #2003-04266

Vaccine

- Prepared by Bioniche Life Sciences, Inc.

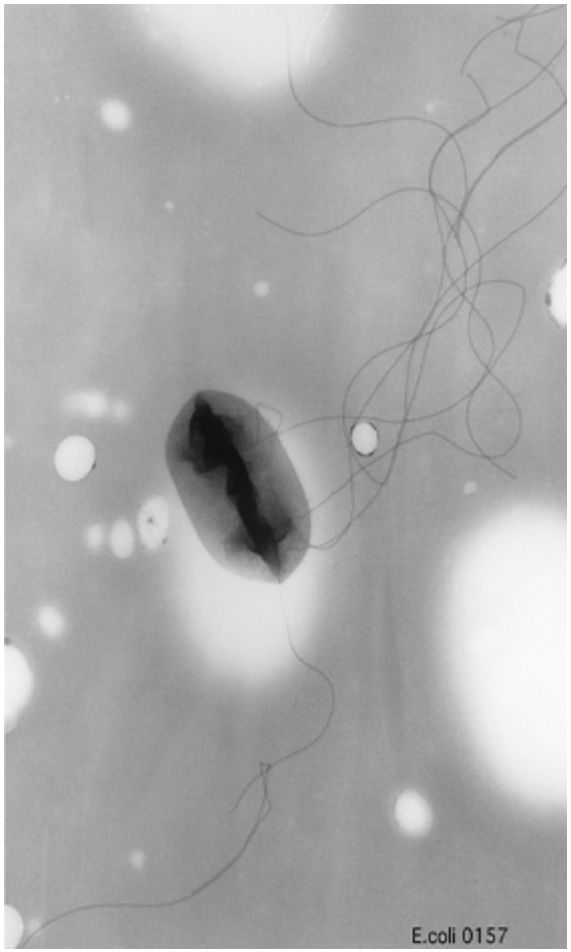
Objectives

- Test vaccine efficacy in commercial feedyards
  - Treatments applied to pens of cattle

Outcome measures

- Culture of E. coli O157:H7
  - ROPES
  - Mucosal cells of the terminal rectum

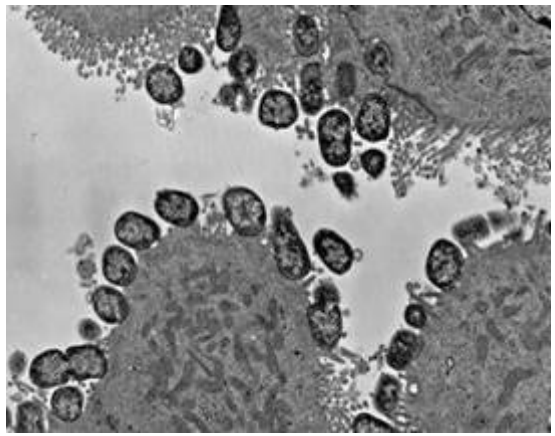
E. coli O157:H7



- selective enrichment
- O157 IMS
- CT / SMAC
- MUG- / MAC+
- latex aggl. O157
- PCR confirmation
  - sxt_1, sxt_2, eae_{O157}
  - $rfbE_{O157:H7}$
  - $fliC_{h7}$


ROPES
Smith et al. 2004. Epid Infect 132:297-302

Rectoanal junction mucosal cells



To identify cattle <u>colonized</u> with *Escherichia coli* O157:H7

- Aseptic technique
- Mucosa of the terminal rectum 3-5 cm proximal to the rectoanal juncture was scraped using a glass microscope slide
- Approximately 1.5 grams of rectoanal mucosa was placed in transport media and returned to the laboratory for bacterial culture.

Phase III (Large-scale) Vaccine Trial

- 19 commercial Nebraska feedyards
  - 2 doses of vaccine administered subcutaneously in the neck
    - Processing and reprocessing
  - Treated and untreated pens of cattle were randomized within the feedyard
  - Treated and untreated pens pair-matched on re-processing date

- ROPES as outcome measure
  - 4 test periods for each pen
  - 21 day intervals
- TRM colonization
  - Subset of cattle at harvest
- Initiated Feb 16, 2004 and completed Oct 31, 2004

Results

20,556 cattle, 140 pens, 19 commercial feedyards

Mean number of cattle per pen =146.8 (range =53-300)

- 86 pair-matched pens in feedyards feeding DFM
- 54 pair-matched pens in feedyards not feeding DFM

485 pen ROPES observations

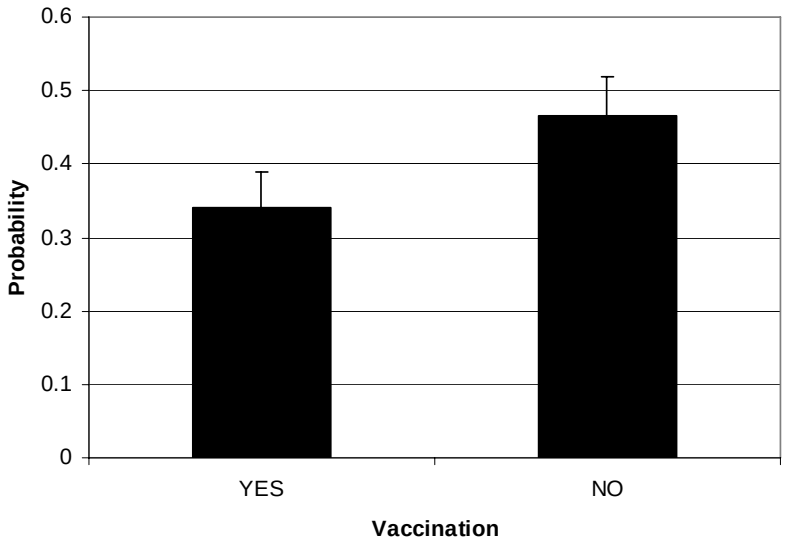
242 ROPES-positive (50%)

Results

Factors explaining the probability for pens to culture ROPES-positive

- **Vaccinated pens of cattle were less likely to be ROPES-positive (OR=0.59, p=0.004)**

- Other fixed effects
  - Month (p=0.001)
  - Region (p=0.0001)
  - Pen size (p=0.009)
  - Pen condition (p=0.07)
  - **No interaction of test period and treatment**



TRM Colonization Sampling strategy

- Pens of cattle were selected by convenience from the 140 pens in the larger trial (ROPES)
  - Logistics of following the cattle to processor
  - Blind to previous culture results

- The sample of cattle to test from a pen was calculated for the number of cattle within each pen.
  - 95% confident to estimate *E. coli* O157:H7 prevalence at 50% with 15% precision
  - Systematic selection

Results

- 720 cattle tested from 21 pens within 8 feedyards
  - 11 pens vaccinated, 10 pens not-vaccinated
  - 13 pens fed DFM, 8 pens not fed DFM
  - Mean number of cattle/pen = 175.4 (56-289)
  - Mean sample/pen = 34.3 (25-38)

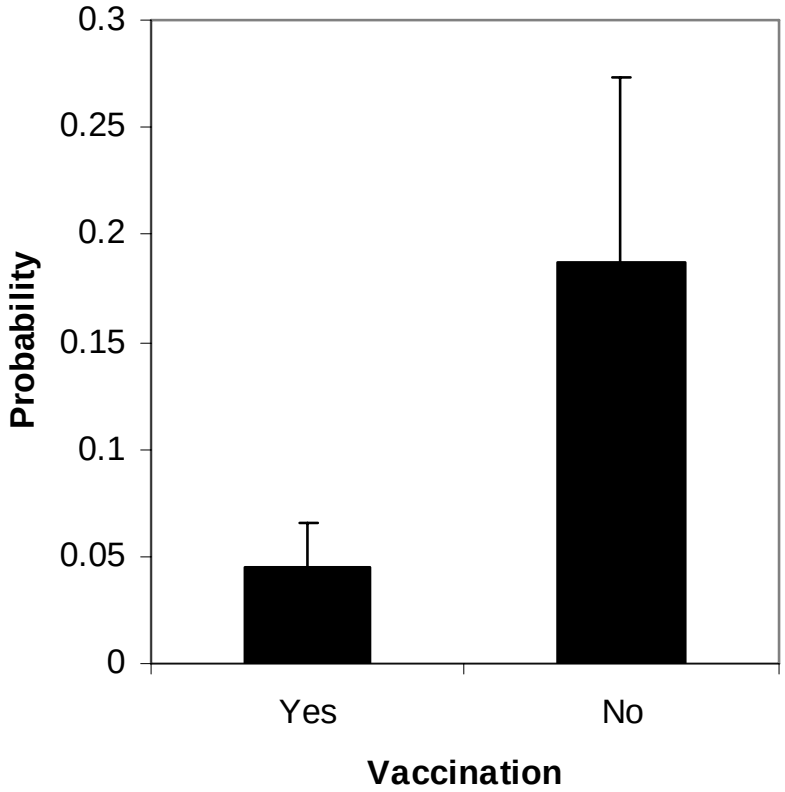
- In total, 82 of 720 samples (11.4%) tested positive for *E. coli* O157:H7

- Variables tested to explain culture-positive results:
  - Vaccination
  - Feeding DFM (Bovamine)
  - Region
  - Month of harvest
  - Gender
  - Number of cattle in the pen
  - Days from vaccination to revaccination
  - Days from revaccination to harvest
  - Interaction of vaccination and DFM

Results: TRM colonization

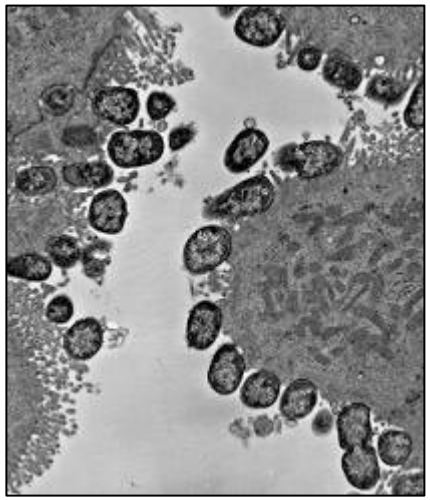
Factors explaining the probability for mucosal cells to culture positive for *E. coli* O157:H7 at slaughter:

- *E. coli* O157:H7 was less likely to be cultured from the mucosal cells of vaccinated cattle (OR=0.2, p=0.03)
- Vaccine efficacy = 76% within feedyard



Conclusion

Vaccination reduced the probability for colonization of cattle (TRM) and environmental detection of *E. coli* O157:H7 (ROPES) in commercial cattle feeding systems



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Summary of UNL vaccine efficacy studies 2002-2005

Year	# of cattle	regimen	Outcome	Odds ratio	Vaccine efficacy	P-value	Comments
2002	192	3-dose	Feces	0.36	59%	0.04	“bench-top” vaccine
2003	608	1-dose	Feces	0.25	68%	0.0001	
		2-dose	Feces	0.26	67%	0.0001	
		3-dose	Feces	0.20	73%	0.0001	
		0-dose	Feces	0.36	59%	0.0003	herd immunity?
2003	1003	3-dose	RAMS	0.67	NS	>0.10	ranch vaccination, low prevalence
			Feces	0.81	NS	>0.10	
2004	288	3-dose	TRM	0.014	98%	0.0001	
			Feces	0.81	NS	0.56	low prevalence
2004	20,556	2-dose	TRM	0.20	75%	0.03	720 cattle
			ROPES	0.59	27%	0.004	19 NE feedlots
2005a	504	2-dose	Feces	0.35	62%	0.002	Between pens
			TRM	0.71	NS	0.65	
			Hides	0.45	54%	0.005	
2005b	168	2-dose	Feces	0.40	58%	0.005	Within pens
			TRM	0.73	NS	0.48	
			Hides	0.70	28%	0.06	

Communication of Food Safety Research

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  - ISVEE
  - VTEC
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Acknowledgments

Technical Staff

- Jeramie Abel
- Ammon Anderson
- Michelle Bader
- Doreen Bailey
- Jennifer Balcerak
- Brandy Beekley
- Emil Berberov
- Mark Blackford
- Lacey Bloedorn
- Virgil Bremer
- Gustavo Bretschneider
- Sharon Clowser
- Becky Fluckey
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- Christen Riggert
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- Nancy VanAckeren
- Mikayla Ward
- Travis Wolf
- Spring Younts

Bioniche Life Sciences

National Cattlemen's Beef Association