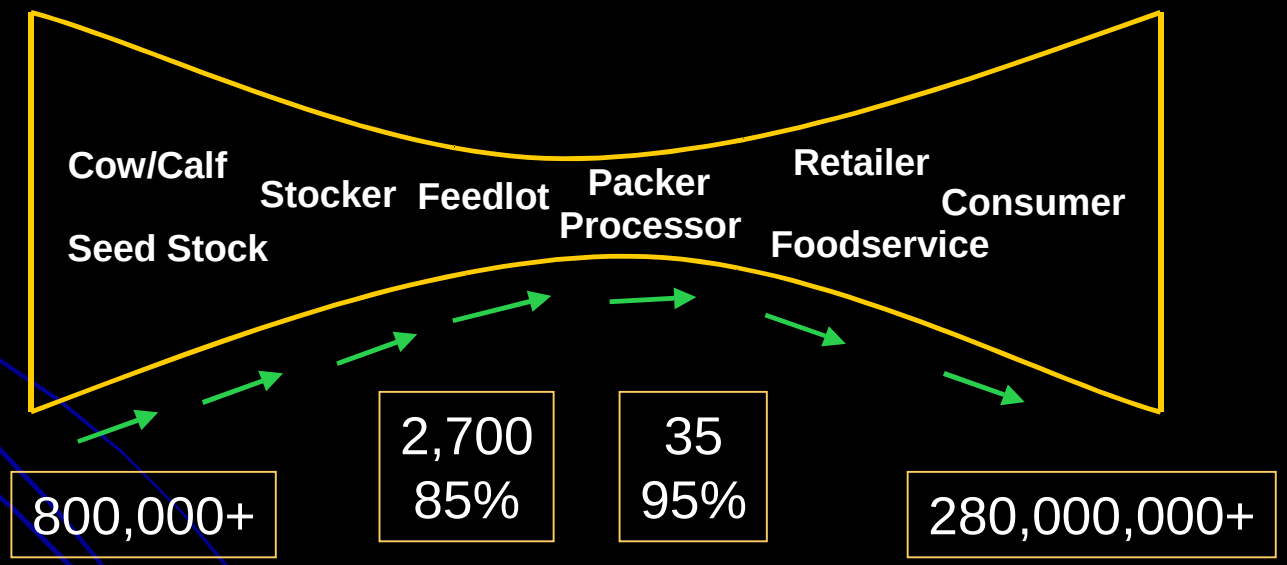
Interventions for a Beef Safety System

April 9, 2008

Mandy Carr, Ph.D.
Executive Director, Beef Safety Research
National Cattlemen's Beef Association

Beef Industry's Commitment to Safety

- History to the approach
- Focus 880,000+ cattle at 35+ processing facilities



- This began efforts to develop multiple interventions

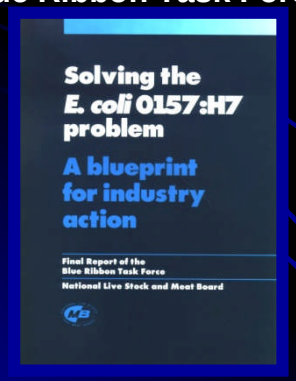
Safety Interventions & Best Practices

Organic acid wash
Acidified sodium chlorite
Steam/thermal pasteurization
Carcass microbial mapping
Steam vacuum
Hide wash

Cattle washing
On farm ecology
Sodium chlorate
Vaccine
Neomycin
Direct fed microbials
Transportation and lairage

1990 1992 1994 1996 1998 2000 2002 2004 2006 2008

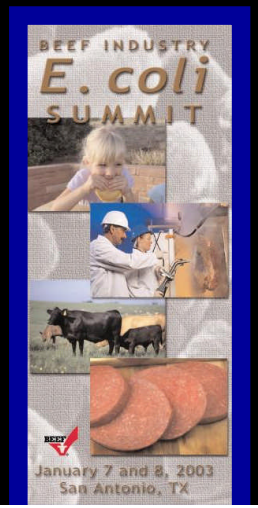
1993
Blue Ribbon Task Force



1997
Founding of BIFSCo

BEEF INDUSTRY BIFSCO FOOD SAFETY COUNCIL

2003
E. coli Summit



Best Practice evolution
and Safety Summits

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BIFSCo cited as model
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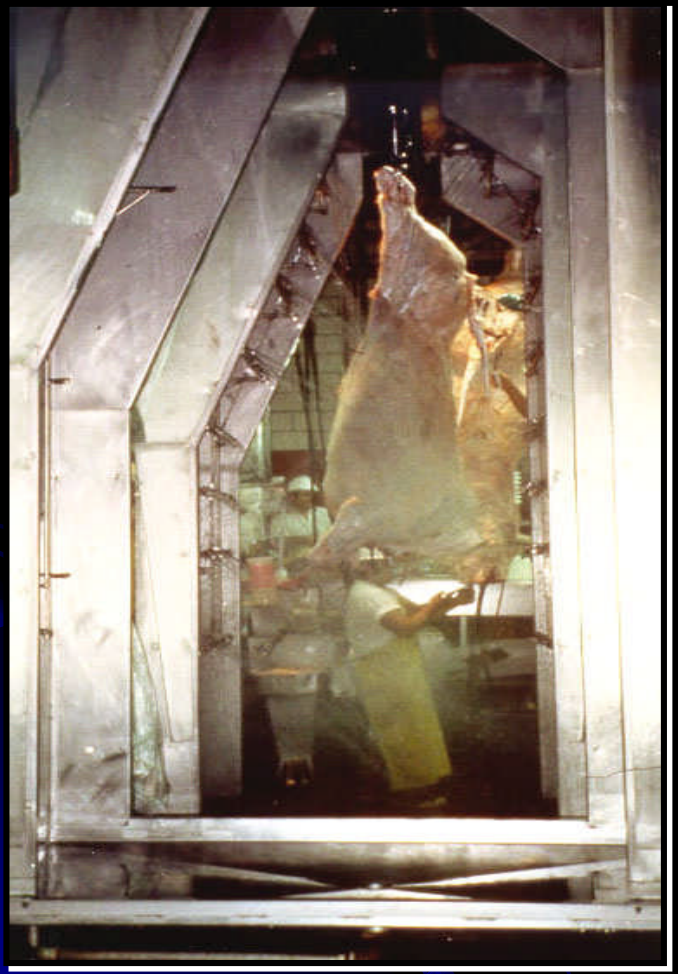
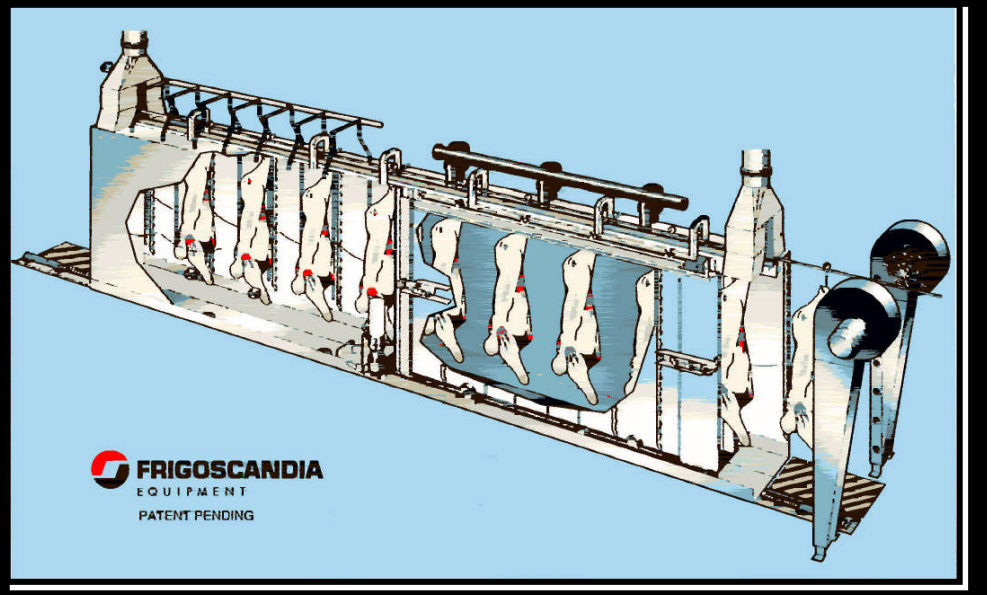
Video of BPs

BEEF

Beef Industry's Commitment to Safety

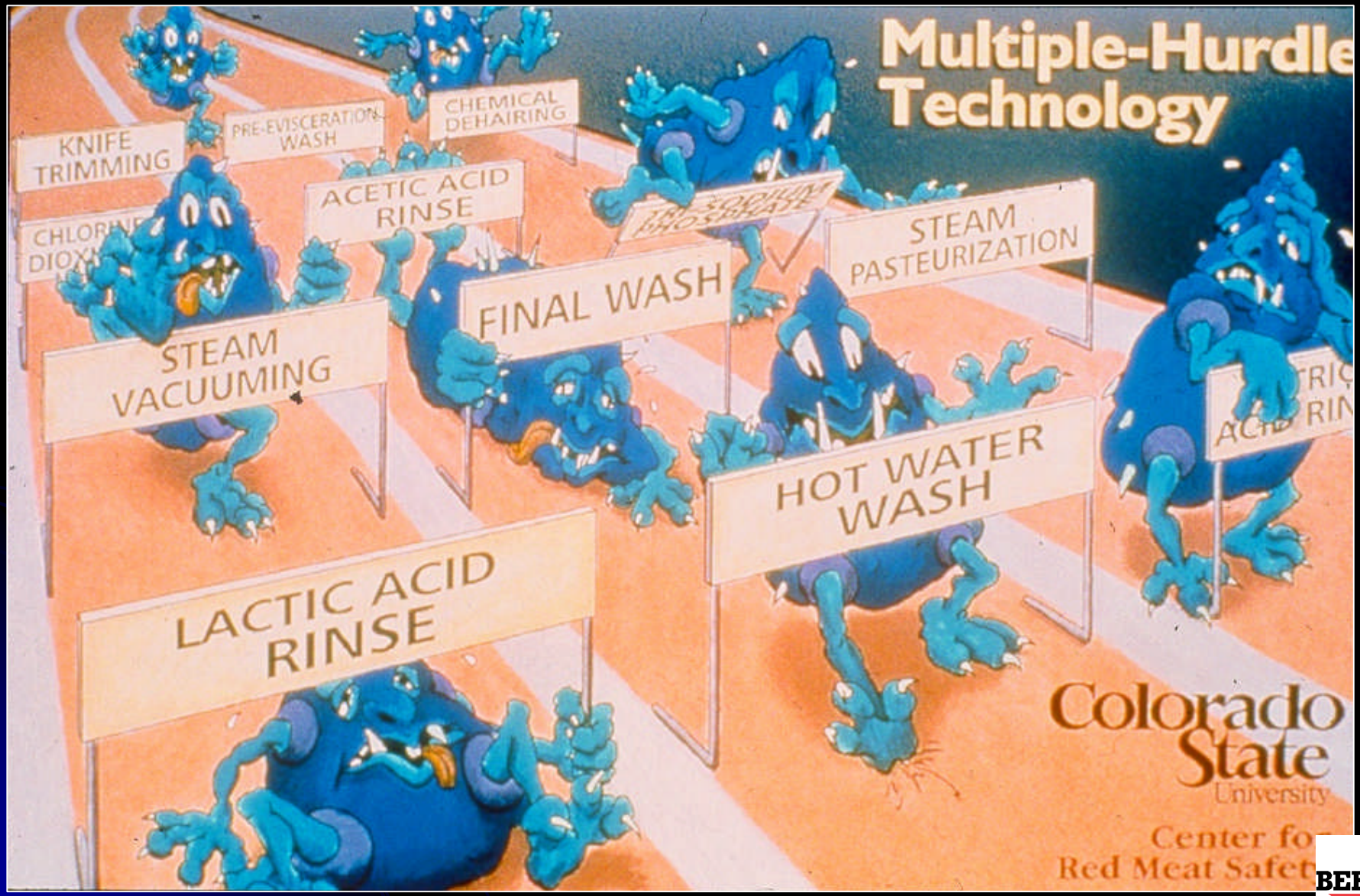
- Interventions (at plant, part of post-harvest)
  - Hide on wash
    - Water
    - Water w/chemical





- Sprays
  - Organic acids - lactic, acetic
  - Acidified sodium chlorite
- Temperature
  - Hot water
  - Steam vacuum
  - Steam pasteurization

Carcass Interventions



Beef Industry's Commitment to Safety

- Many options available
- Industry's dedication to implementation

Beef Industry's Commitment to Safety

- Though post-harvest interventions are successful in minimizing pathogen loads on carcasses some organisms can get through the system.

- Therefore, there is a need for pre-harvest interventions to further reduce incoming microbial load on cattle

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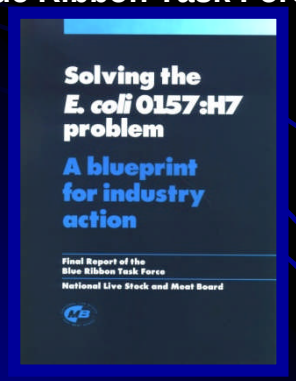

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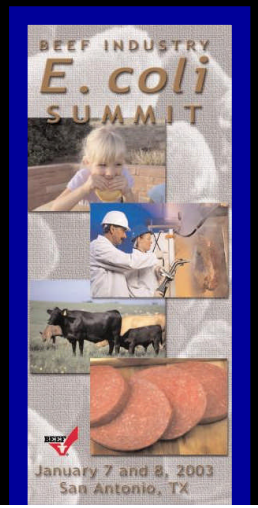

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BEEF

Beef Industry's Commitment to Safety

- Key knowledge learned for pre-harvest
  - Hides
  - Transfer to the carcass

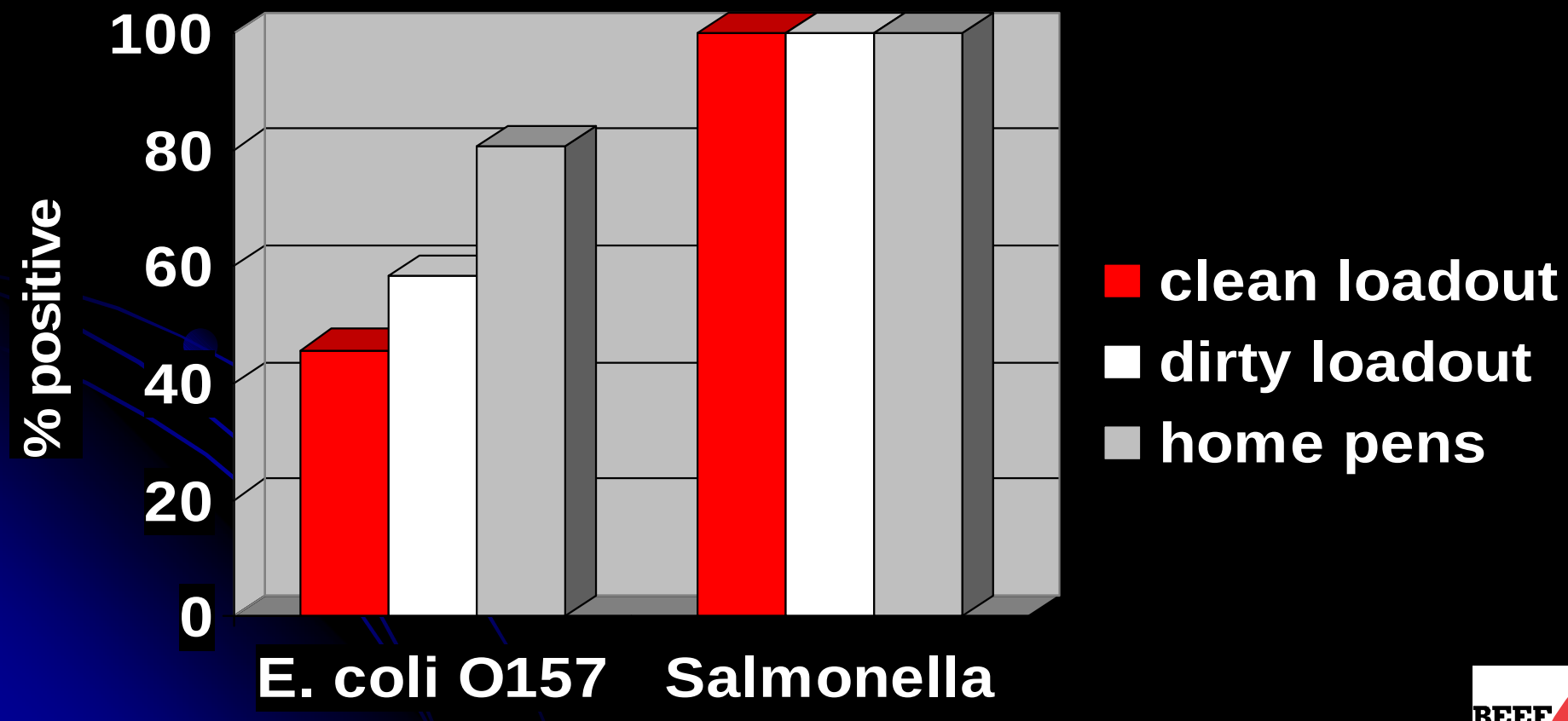
Beef Industry's Commitment to Safety

- Interventions (at plant pre-harvest)
  - Live wash

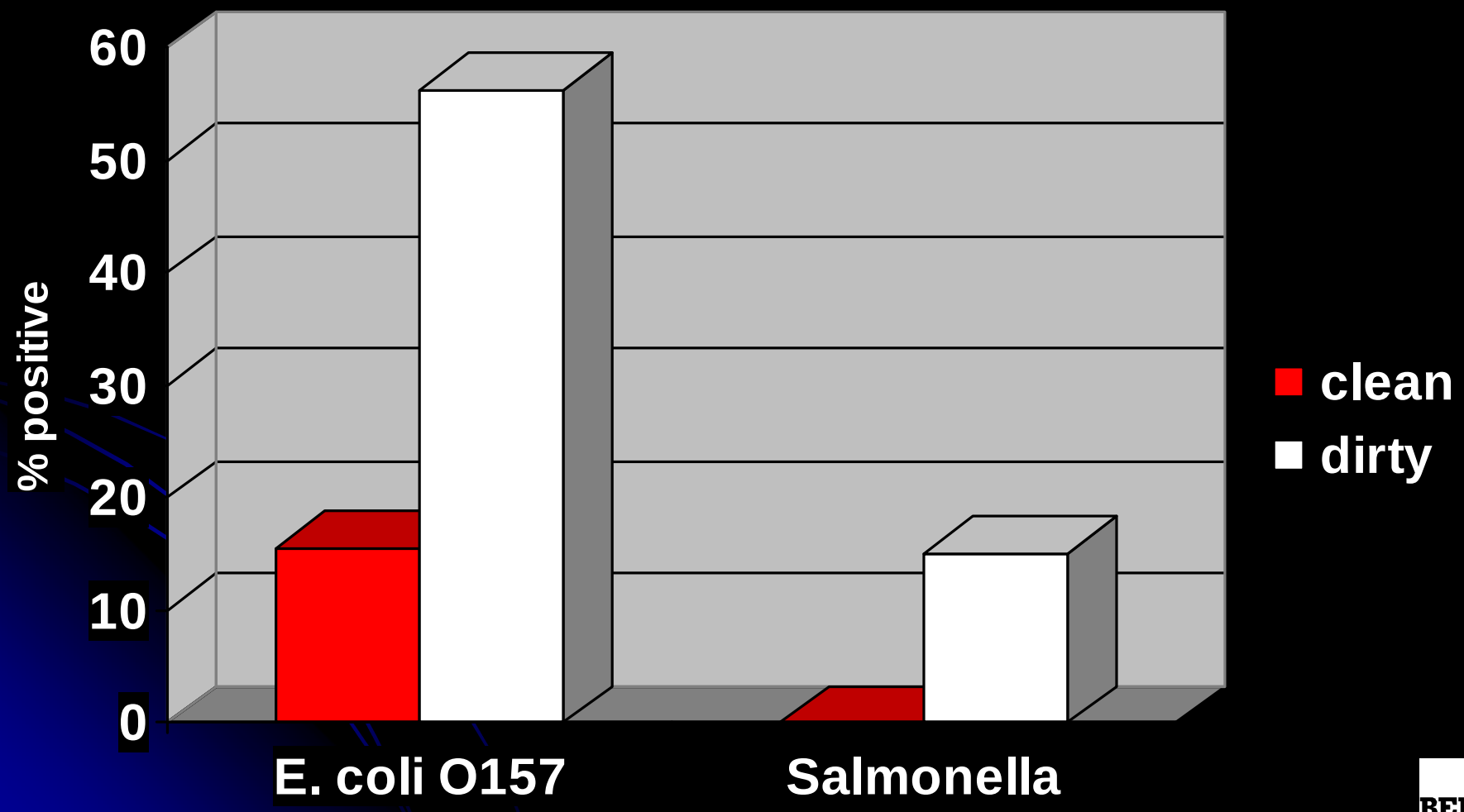
Beef Industry's Commitment to Safety

- Key knowledge for pre-harvest
  - Environment

Prevalence of food-borne pathogens in soil samples collected from beef feedyards



Prevalence of food-borne pathogens in air samples collected from clean loadout areas and dirty, dusty loadout areas in beef feedyards



Fecal prevalence for *E. coli* O157:H7

Pen	1	2	3	4	5	6	7	8	9	10	Total
# of Animal	35	36	30	32	30	31	29	32	32	32	319
Sep Feces % Positive	6	6	7	3	7	3	3	6	6	3	5
Oct Feces % Positive	43	67	60	19	83	36	10	47	22	16	40
Nov Feces % Positive	34	61	67	38	67	39	10	72	63	38	49
Dec Feces % Positive	26	42	83	31	43	26	7	38	34	6	34
Jan Feces % Positive	3	8	10	6	23	3	3	19	3	3	8
Feb Feces % Positive	0	0	7	0	17	3	0	6	0	0	3
Mar Feces % Positive	0	0	0	0	10	3	3	6	13	0	3
Apr 04 Feces % Positive	0	0	3	0	3	0	0	3	0	13	2
Apr 18 Feces % Positive	3	0	0	0	0	0	0	0	9	94	11
May 02 Feces % Positive	0	0	0	0	0	3	3	0	19	88	11

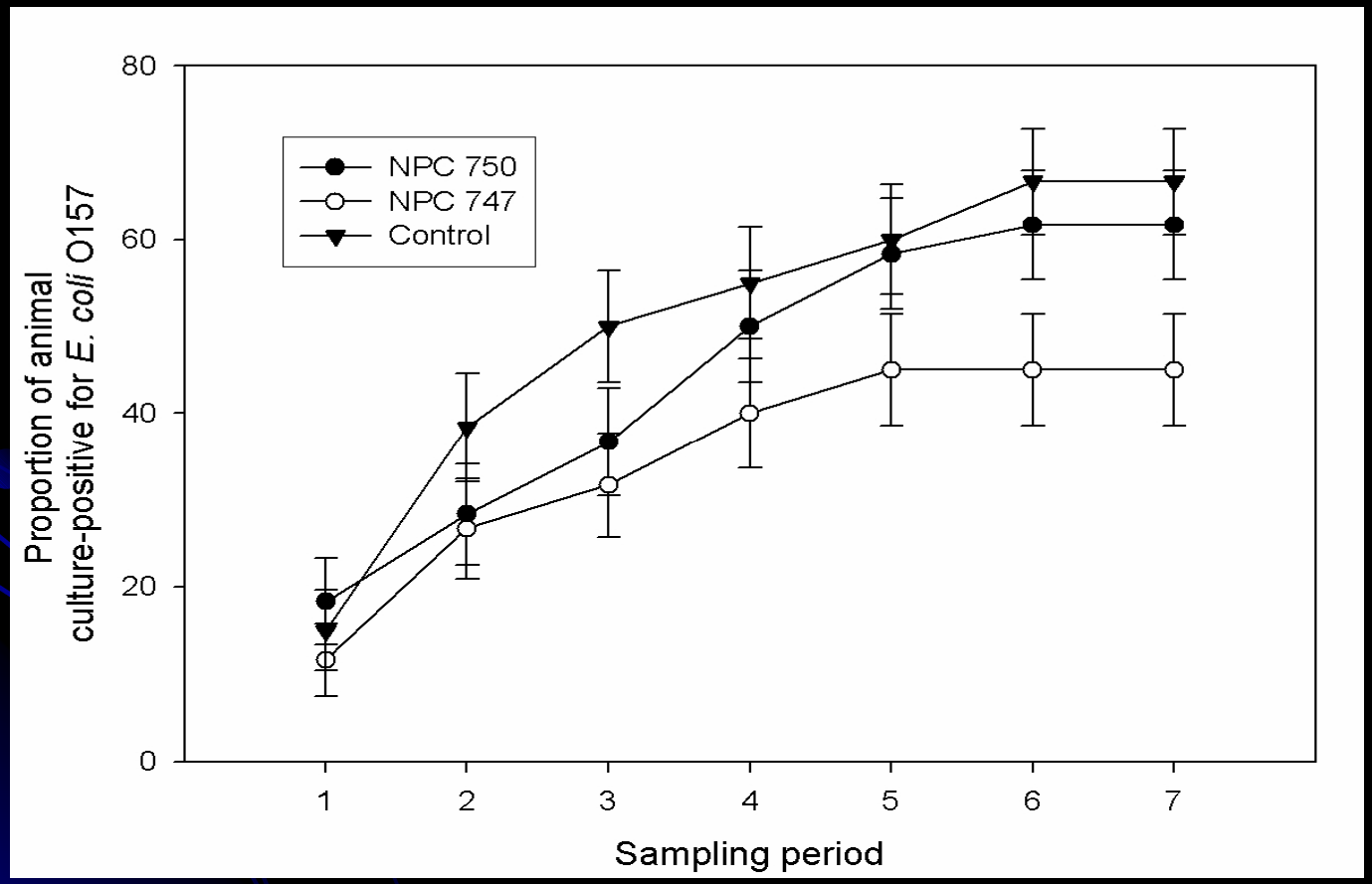
Hide prevalence for *E. coli* O157:H7

Pen	1	2	3	4	5	6	7	8	9	10	Total
# of Animal	35	36	30	32	30	31	29	32	32	32	319
Sep Hide % Positive	37	42	60	66	73	71	79	47	41	28	54
Oct Hide % Positive	89	100	100	94	100	100	100	100	100	100	98
Nov Hide % Positive	91	100	100	100	97	100	97	97	100	100	98
Dec Hide % Positive	49	97	100	100	100	100	86	88	38	84	84
Jan Hide % Positive	3	92	67	16	100	87	52	100	78	47	64
Feb Hide % Positive	3	11	13	9	97	16	3	84	9	3	24
Mar Hide % Positive	0	0	0	0	60	13	3	31	0	0	10
Apr 04 Hide % Positive	0	0	0	0	7	19	14	3	3	97	14
Apr 18 Hide % Positive	66	44	63	56	27	84	59	38	94	100	63
May 02 Hide % Positive	3	17	0	6	3	0	0	6	44	91	17

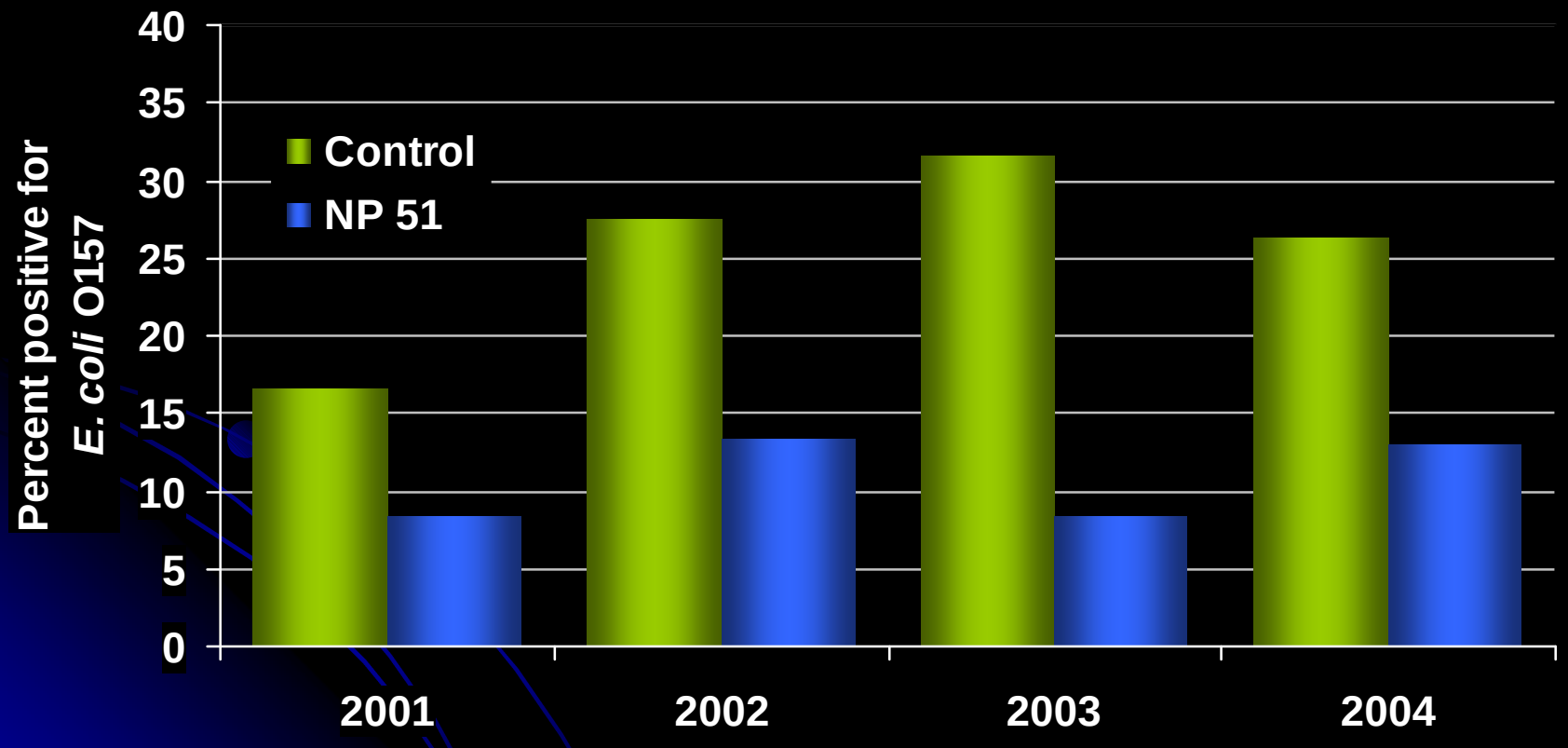
Beef Industry's Commitment to Safety

- Interventions (prior to plant pre-harvest)
  - Direct Fed Microbials
    - Approved for animal health and performance, NOT as a pre-harvest intervention for pathogens

Cumulative proportion of steers that were positive culture-positive for *E. coli* O157:H7 by treatment group and by sampling period.

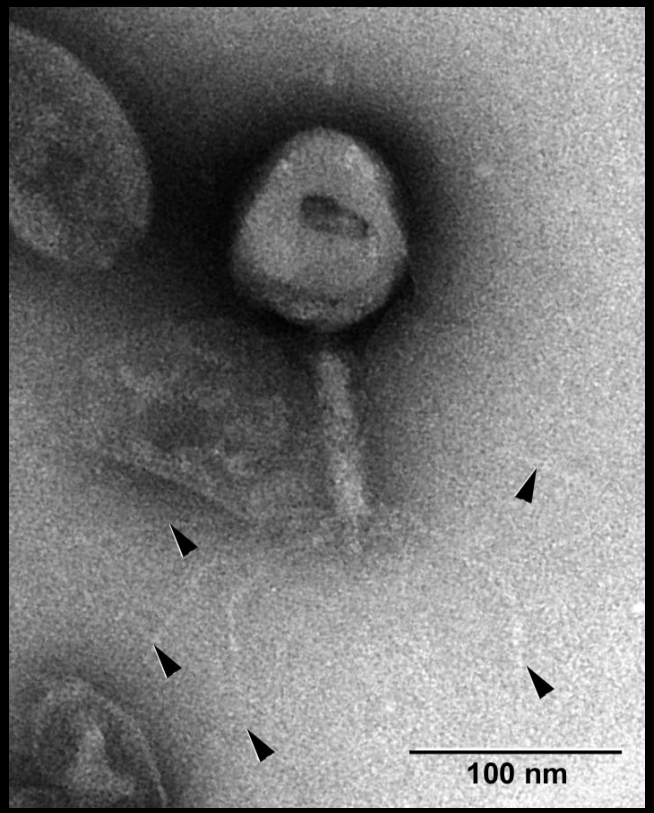


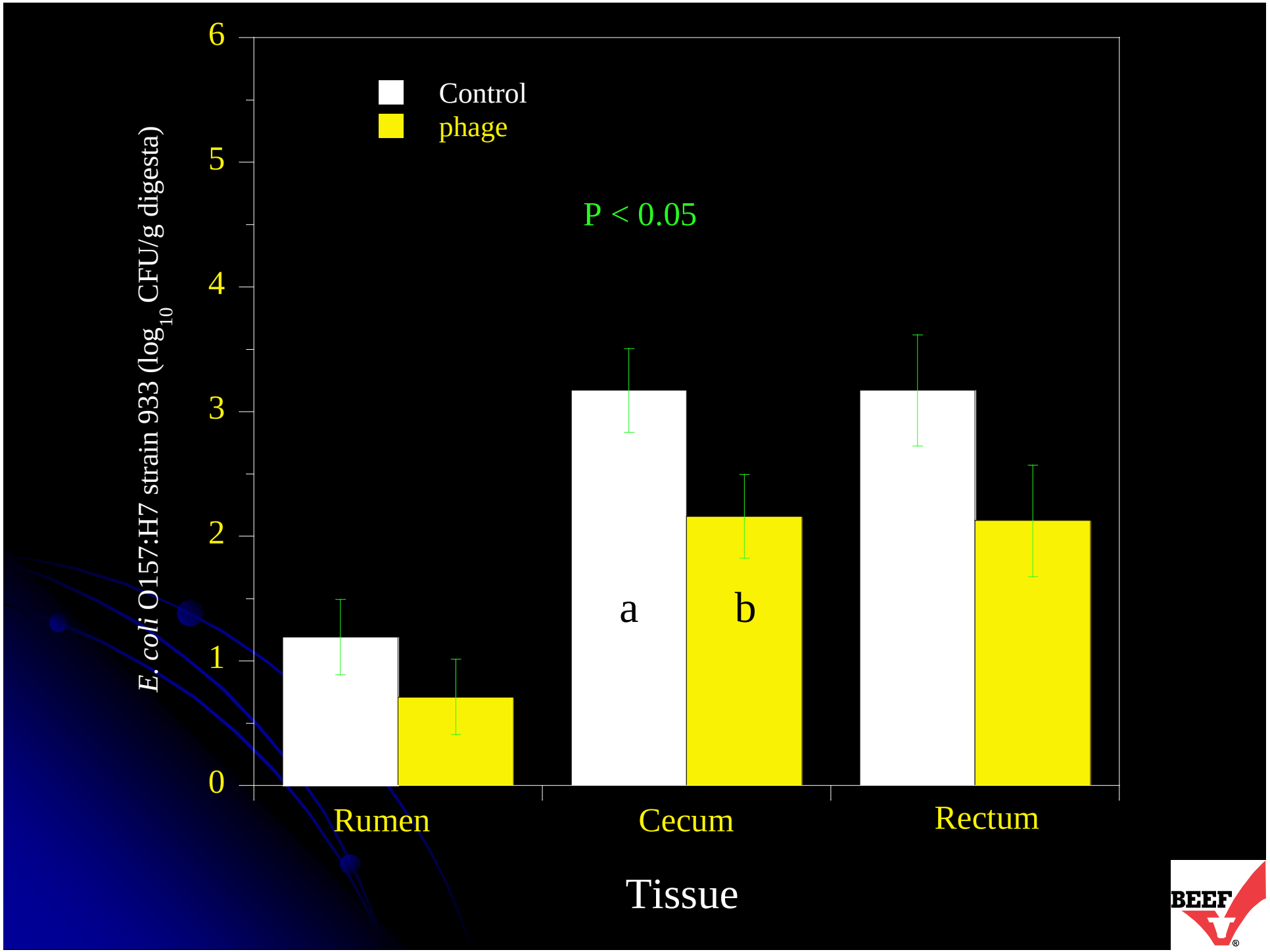
4 Year Cumulative Summary
Reduction of E. coli O157 in Beef Feedlot Cattle Using NP 51



Beef Industry's Commitment to Safety

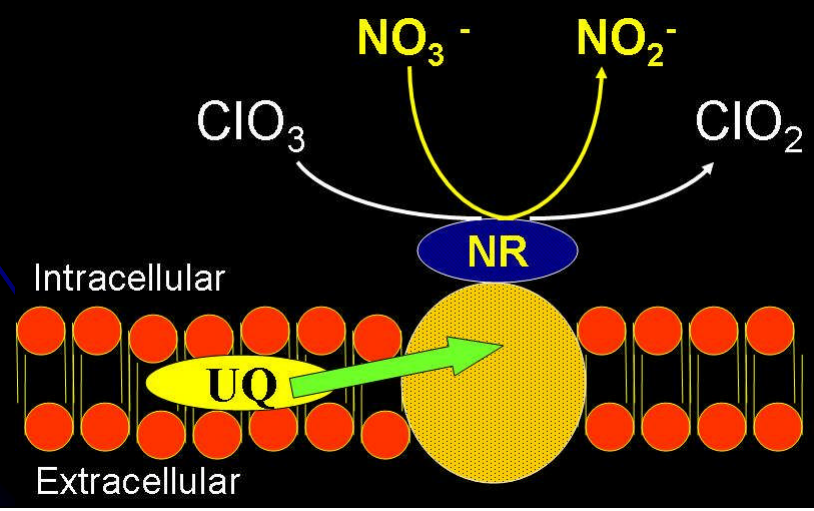
- Interventions (prior to plant pre-harvest)
  - Phages
    - Viruses that target specific bacteria
    - Have been widely used in Eastern Europe in place of antibiotics
    - Invade targeted bacteria, replicate, kill the bacterium, but not other bacteria

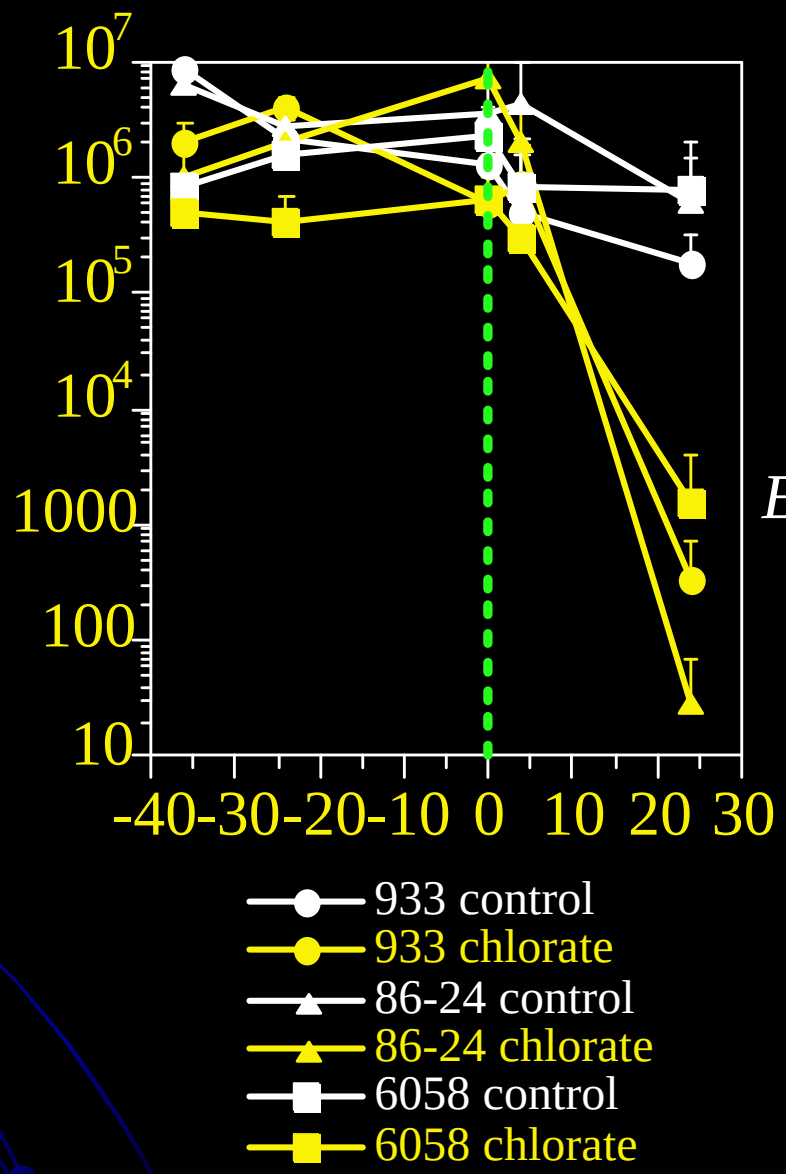



6
5
4
3
2
1
0
Control
phage
P < 0.05
a
b
E. coli O157:H7 strain 933 (log10 CFU/g digesta)
Rumen
Cecum
Rectum
Tissue

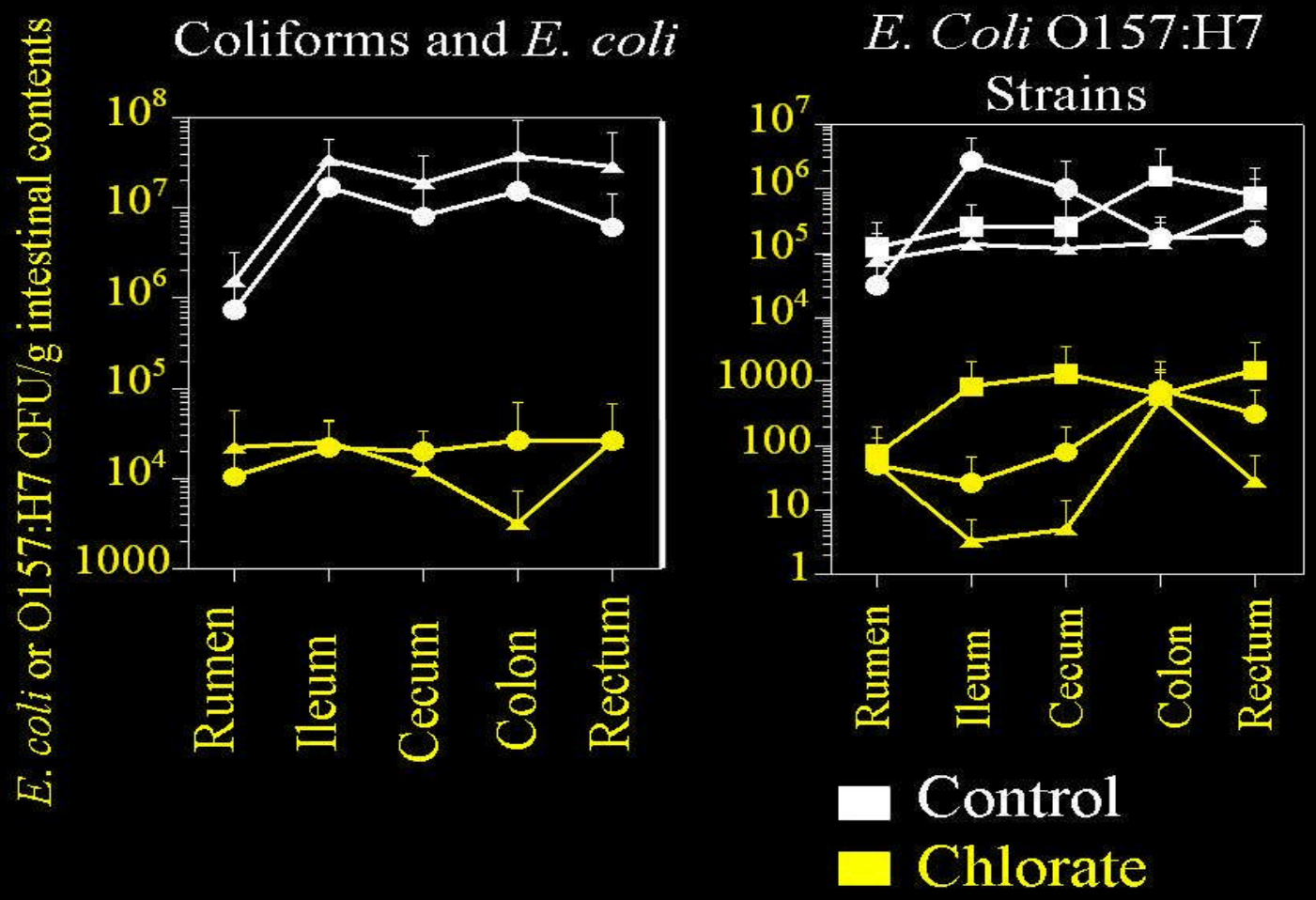
Beef Industry's Commitment to Safety

- Interventions (prior to plant pre-harvest)
  - Sodium chlorate
    - Phages target and invade specific bacteria
    - Chlorate kills bacteria that have the enzyme nitrate reductase only
    - Kills *E. coli* O157:H7 and *Salmonella* but not other bacteria





E. coli O157:H7 in cows

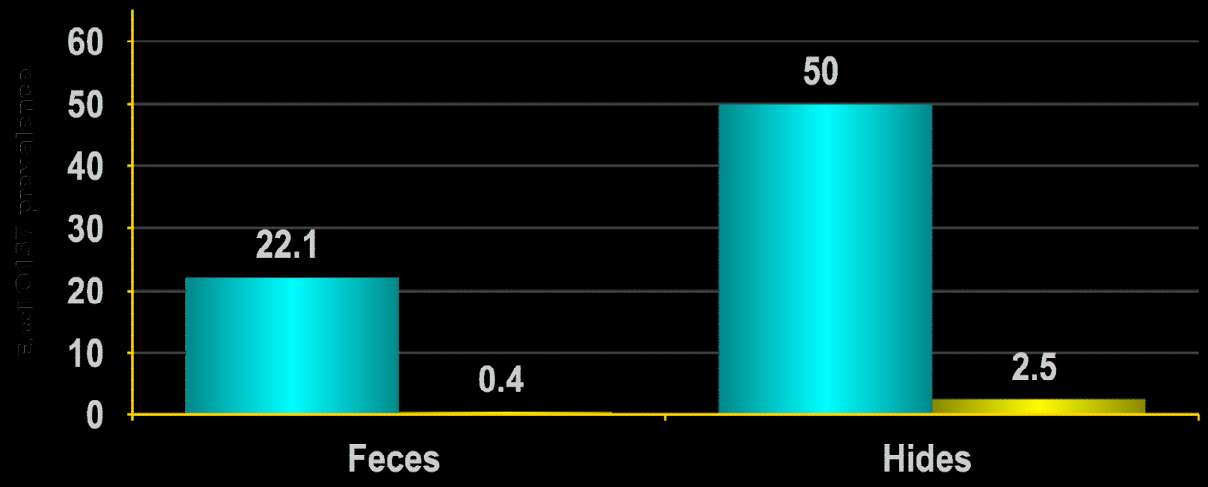


Sodium chlorate reduces O157:H7 populations in experimentally infected cows

Did not change rumen or gut function

Beef Industry's Commitment to Safety

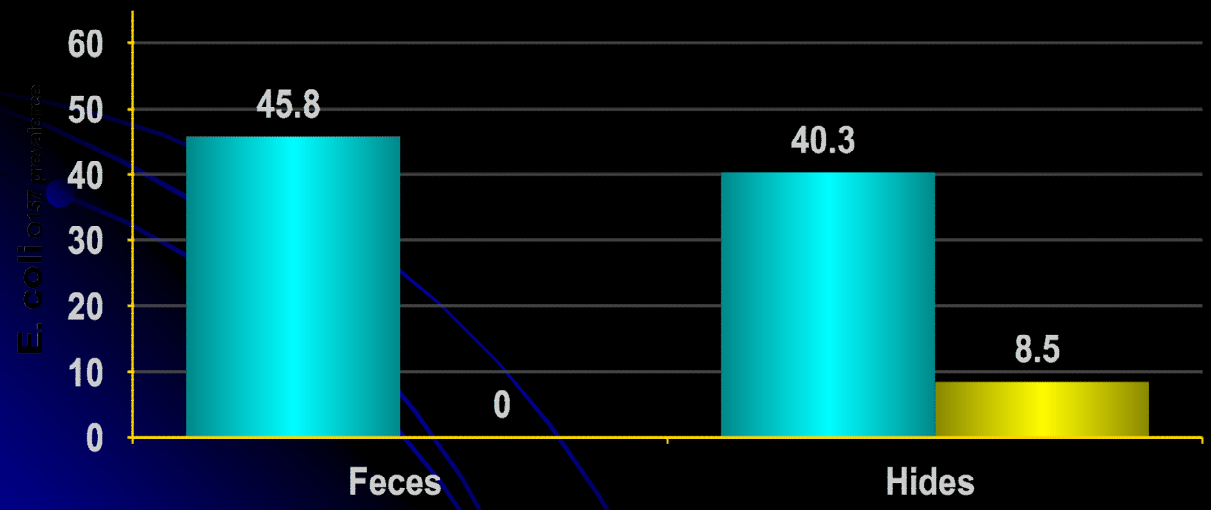
- Interventions (prior to plant pre-harvest)
  - Neomycin
    - Labeled for use in cattle
    - 'treatment and control of colibacillosis (bacterial enteritis) caused by *Escherichia coli*'
    - In-feed and in-water preparations
    - 10 mg/lb/day for up to 14 days
    - 1-day withdrawal period



O157 Reduction in Prev

- Feces – 98.2%
- Hides – 95%

Theuninck - Cargill



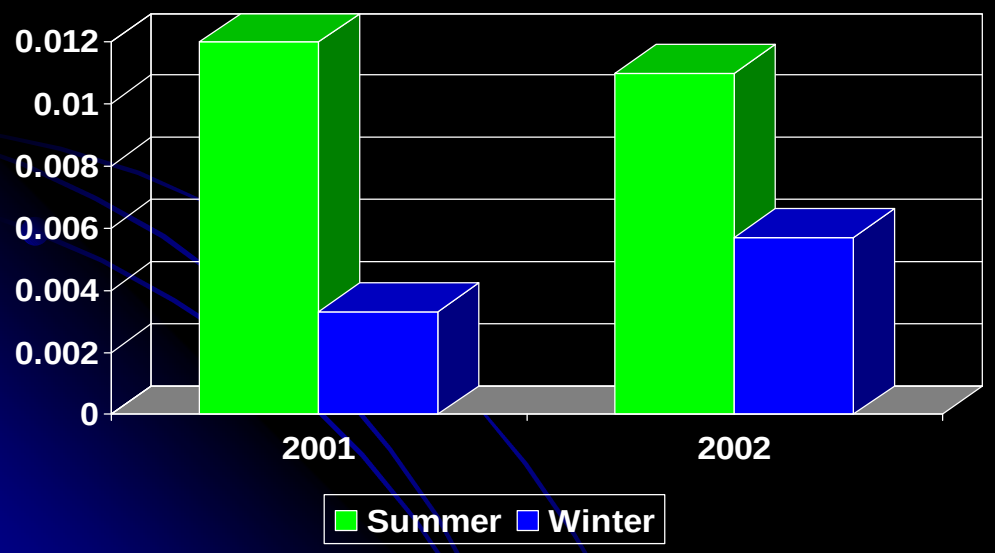
O157 Reduction in Prev

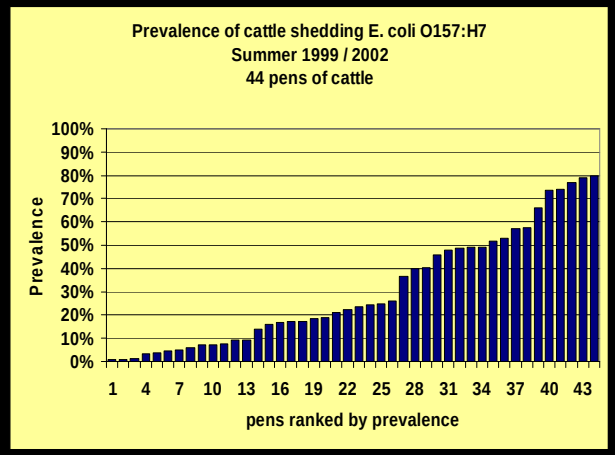
- Feces – 100%
- Hides – 78.9%

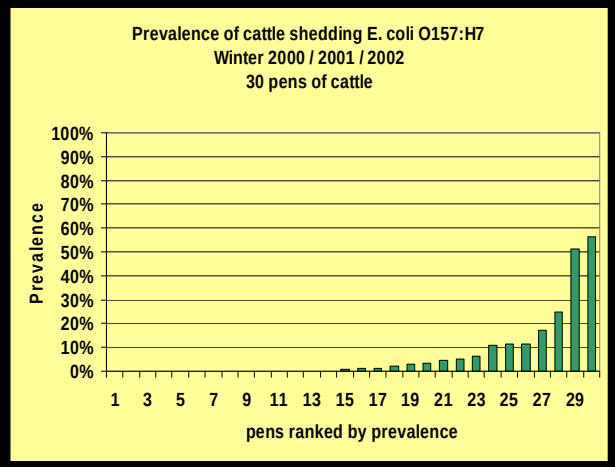
Belk - CSU

Beef Industry's Commitment to Safety

- Interventions (prior to plant pre-harvest)
  - Vaccines

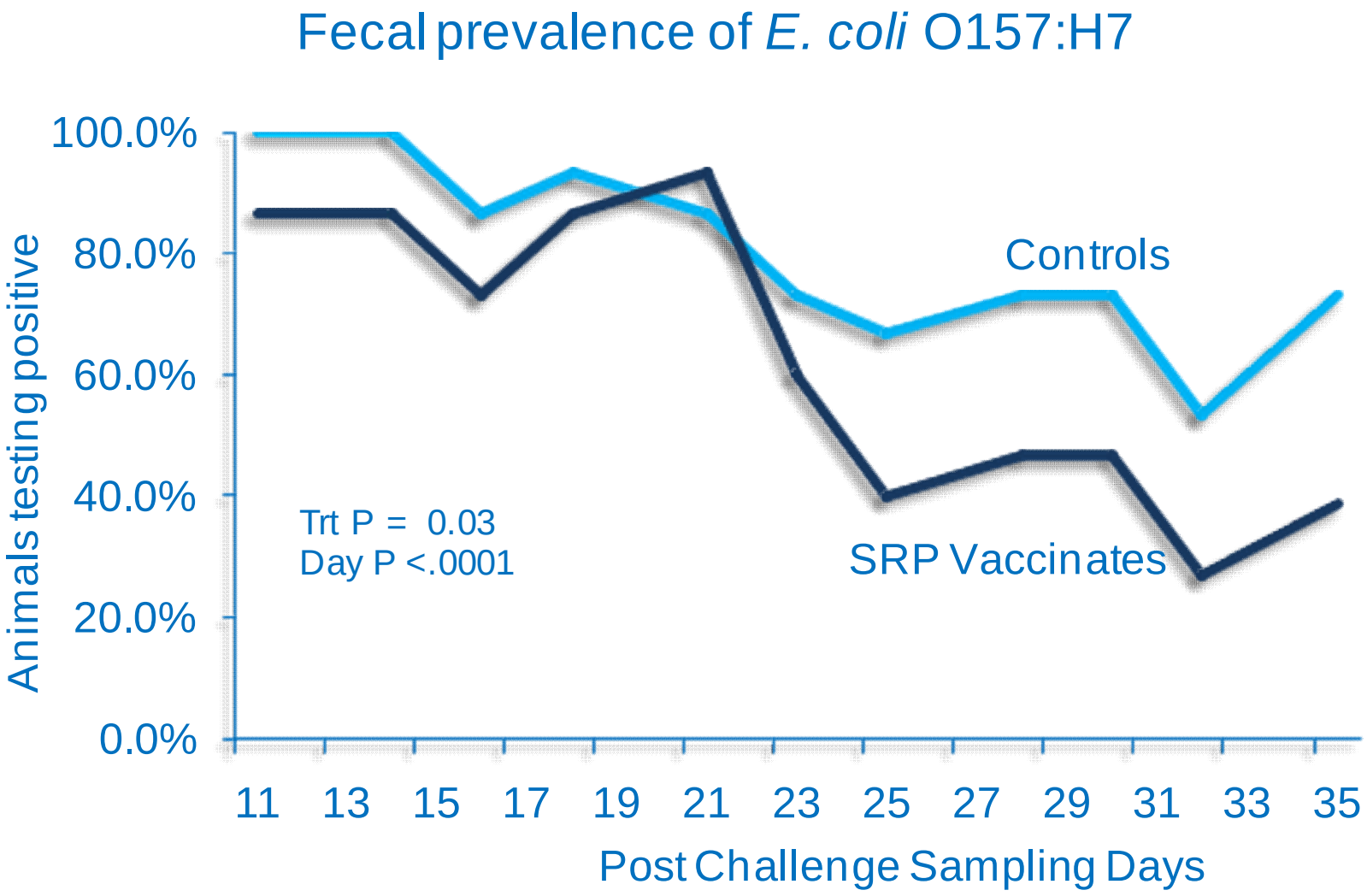




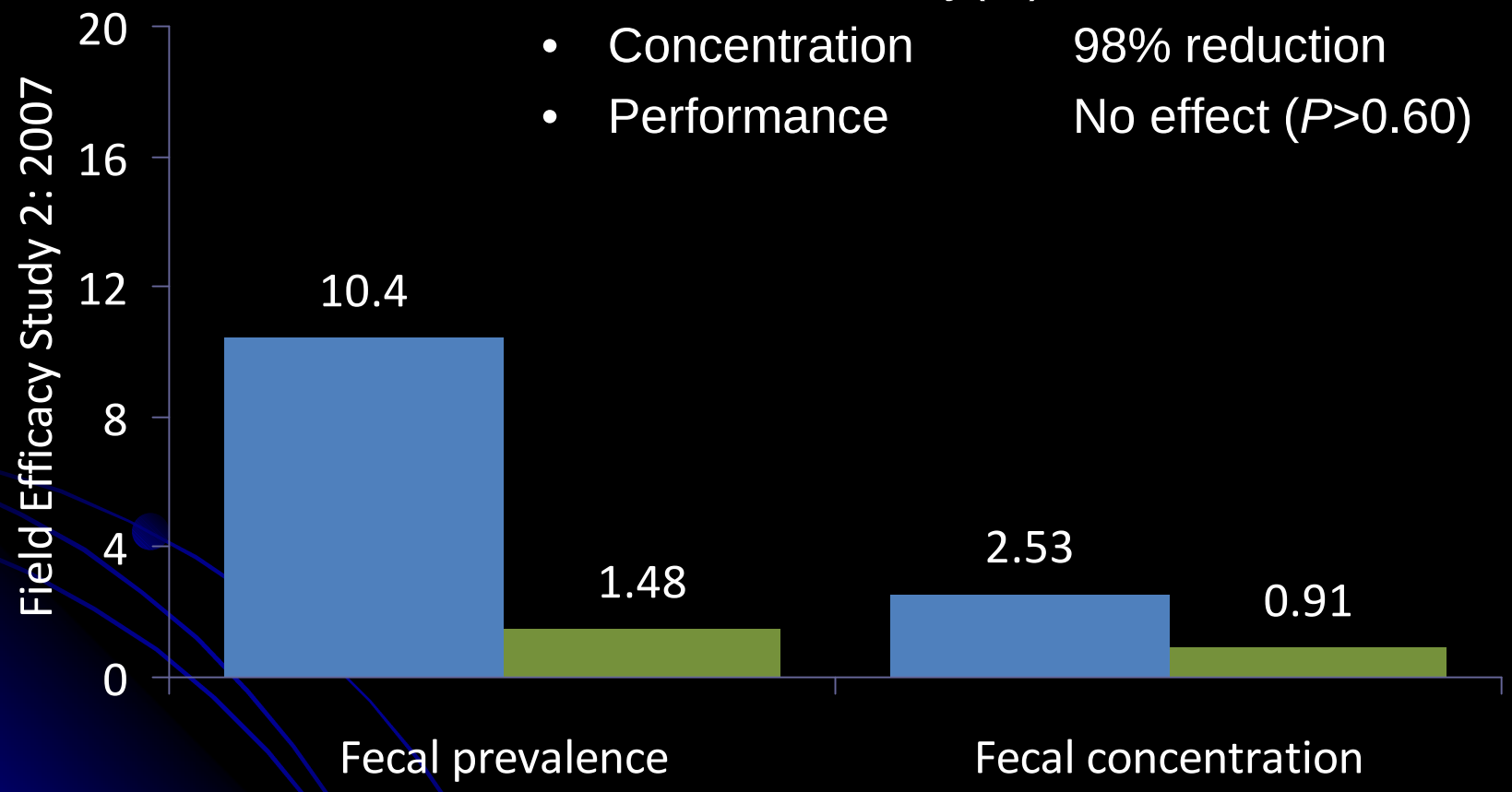


http://www.fsis.usda.gov/OPHS/ecoltest.htm

Challenge Study



Measure of effect	Magnitude
• Vaccine Efficacy(%)	86% reduction
• Concentration	98% reduction
• Performance	No effect (*P*>0.60)



Both comparisons associated with $P \leq 0.02$

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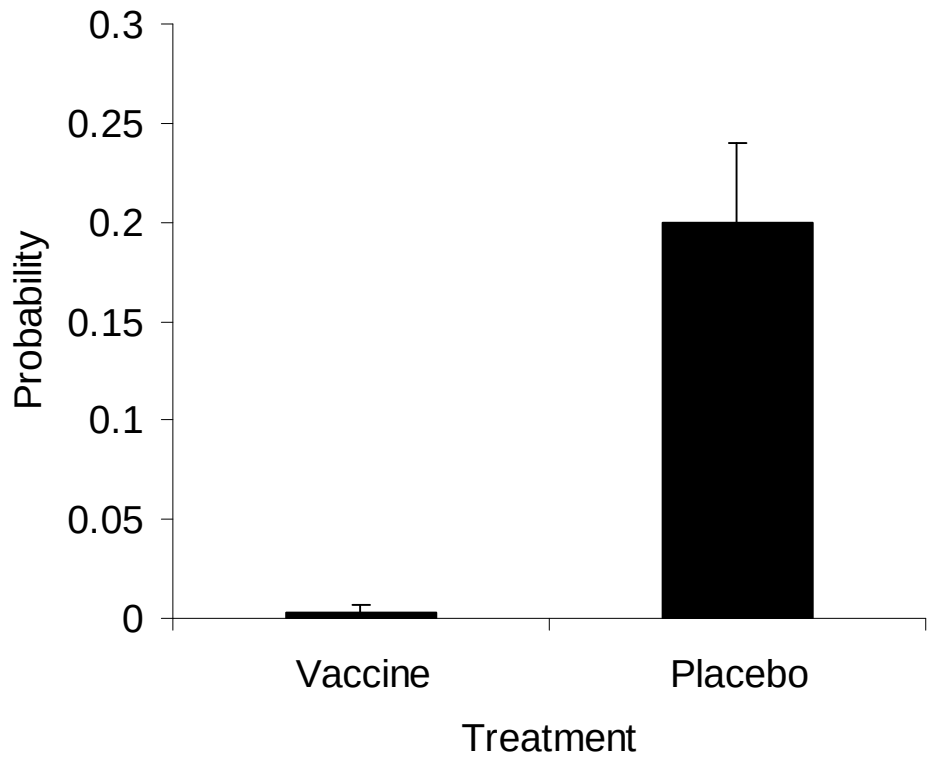
Effect of a Vaccine Product Containing Type III Secreted Proteins on the Probability of *Escherichia coli* O157:H7 Fecal Shedding and Mucosal Colonization in Feedlot Cattle†

R. E. PETERSON,[1] T. J. KLOPFENSTEIN,[1] R. A. MOXLEY,[2] G. E. ERICKSON,[1] S. HINKLEY,[2] G. BRETSCHNEIDER,[2] E. M. BERBEROV,[2] D. ROGAN,[3] AND D. R. SMITH[2]*

"The most important finding of this study was that vaccinated cattle were less likely to be colonized at the TRM."

"Vaccinated cattle were 98.3 percent less likely to be colonized by *E. coli* O157:H7 in TRM (odds ratio = 0.014, $P<0.0001$)."



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Efficacy of Dose Regimen and Observation of Herd Immunity from a Vaccine against *Escherichia coli* O157:H7 for Feedlot Cattle†

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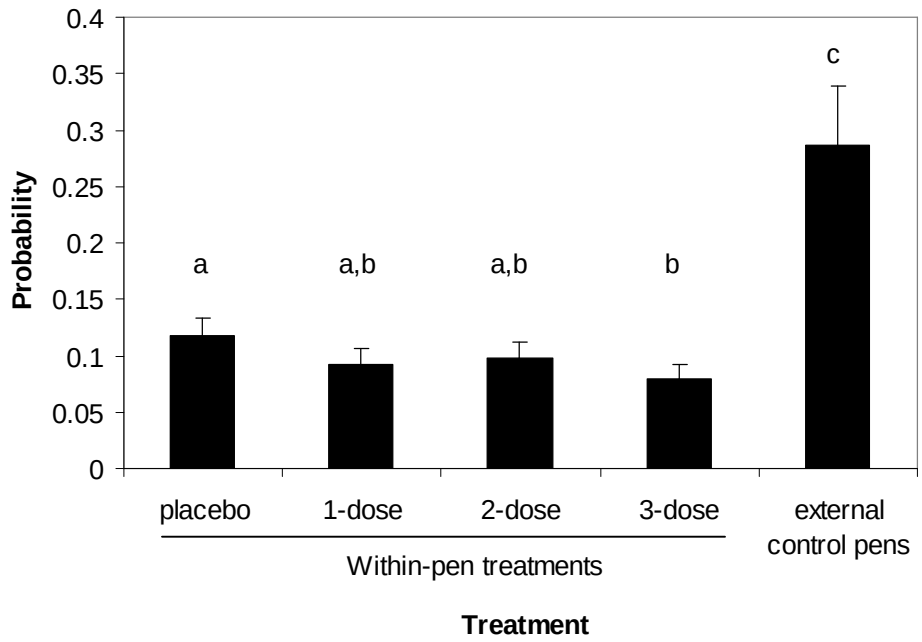
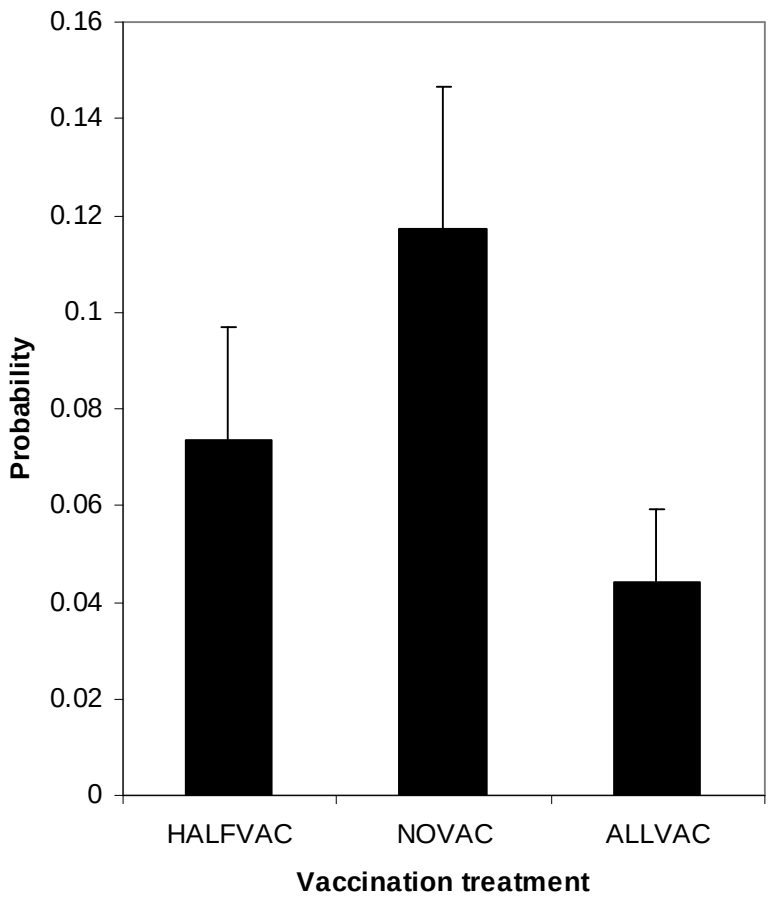
Vaccine efficacy of receiving one, two, or three doses of vaccine was 68, 66, and 73% respectively, compared with cattle in pens not receiving vaccine.

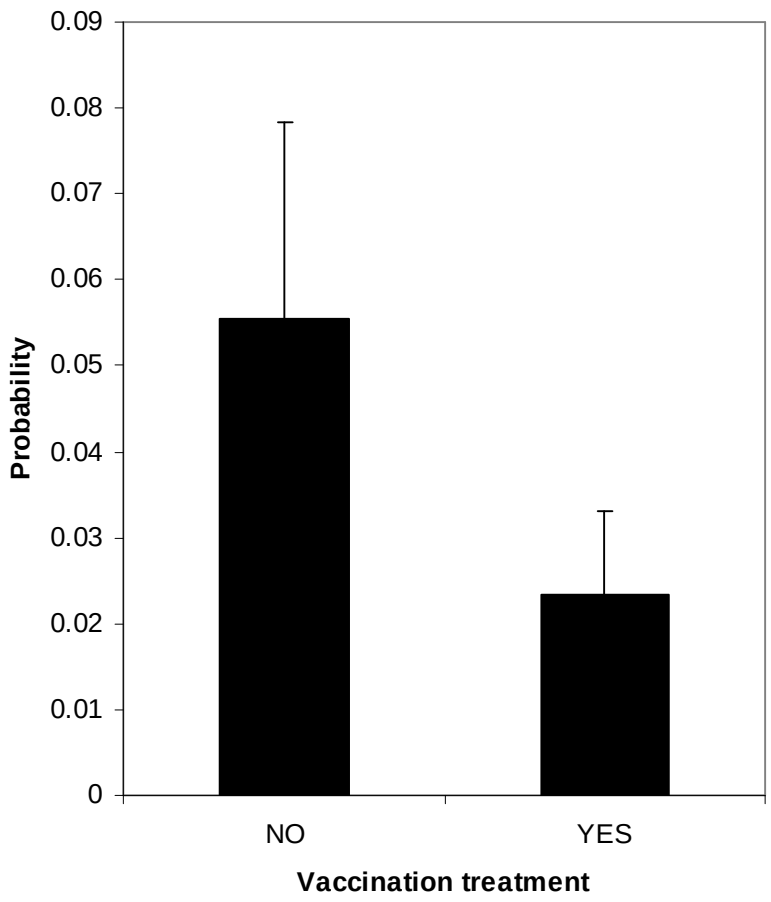
Unvaccinated cattle housed with vaccinated cattle were 59% less likely to shed *E. coli* O157:H7 than cattle in pens not receiving vaccine, likely because they benefited from herd immunity.



Cattle in the vaccinated region were 62% less likely to shed *E. coli* O157:H7 than cattle in the unvaccinated region (p=0.002)



Within commingled pens vaccinated cattle were 58% less likely to shed *E. coli* O157:H7 than unvaccinated cattle (p=0.005)



Beef Industry's Commitment to Safety

- Prevalence
  - What was available
  - Expensive
  - Labor intensive
  - Sensitivity
- Load/quantification
  - Now available and used
  - Allows for routine testing and quantification
  - More cost efficient
  - Sensitivity

Beef Industry's Commitment to Safety

- Interventions, both pre- and post-harvest are vital parts of a system of hurdles in beef production and processing

- No "silver-bullet", and because of the multi-hurdle system, one intervention does not have to be

Decontamination

- These procedures **cannot** be applied to replace…
  - Good manufacturing practices such as:
    - Equipment hygiene during production
    - Employee hygiene and hand washing
    - Sanitation – before, during and after operations
  - Proper chilling:
    - proper time & temperature
    - product and carcass spacing to insure air flow
  - Continuous employee training for proper technique

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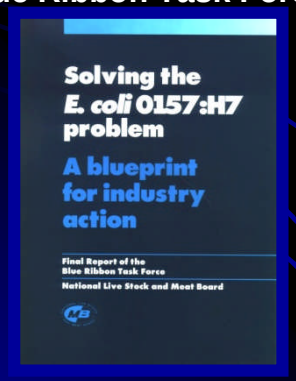

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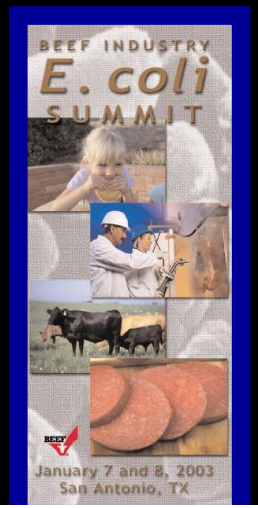

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- Avenues of implementation
  - BIFSCo
    - Beef Industry Safety Summit
    - Executive Summary
  - Best Practices
  - www.bifsco.org
  - www.beefresearch.org

Interventions for a Beef Safety System

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