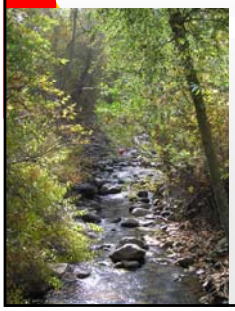
Healthy cattle for healthy environments



Bruce Hoar, DVM, PhD
School of Veterinary Medicine
UC Davis

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Saskatchewan cows in June

3

Saskatchewan cows in January

Healthy cattle for healthy environments

"Good animal management is crucial to the production of healthy, efficiently grown cattle."

5

Costs of disease (pathogens)

- Mortality
  - Value expenses, and disposal
- Morbidity
  - Production, efficiency, cash flow
- Revenue loss
  - Lower weight and value, condemnation
- Seedstock producers
  - Loss market, reputation/goodwill
- Prevention and or treatment
- **Industry impact**
  - **Consumer confidence, export markets**

6

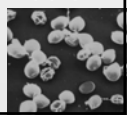
Evaluating trade-offs

Cost to farm	Treatment effectiveness: High	Treatment effectiveness: Low
High	Treat	Prevent
Low	Treat/ignore	Prevent/ignore

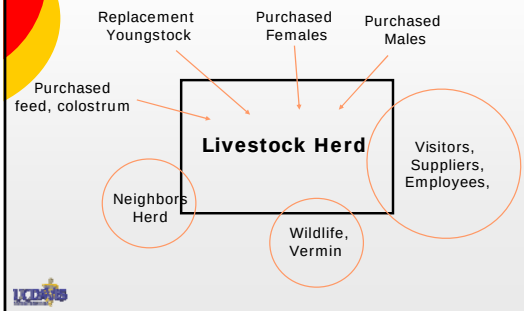
7

What is the goal of an infectious agent?

- **Maintain their existence, propagate**
- Very adaptable
- Short generation times
- Production strategies/tools apply selection pressure



A typical livestock herd



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A "closed" herd does not:

- Buy any genetics or livestock
- Commingle stock (e.g. grazing)
- Buy feeds
- Have any wildlife exposure
- Have any vermin (flies, rodents, birds)
- Have any neighbors with livestock
- Have any bad fences
- Hire livestock haulers
- Have employees who own off-premises livestock
- Take livestock to fairs or shows

10

What is the goal of a herd health program?

Stop disease (pathogen) spread!

Infected animal

Remove infection
Detect and remove
Treat

Stop transmission
Direct (contact)
Indirect (environmental)

Susceptible animal

Enhance resistance
Inherent
Acquired

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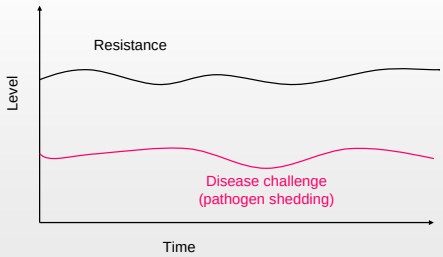
Resistance vs. challenge



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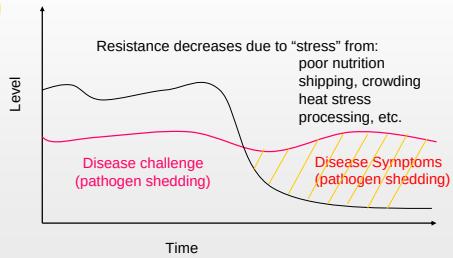
Decreased Resistance



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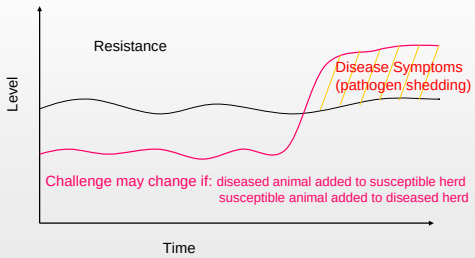
Increased challenge



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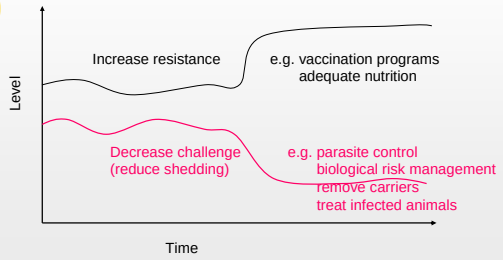
Goal of Herd Health Program



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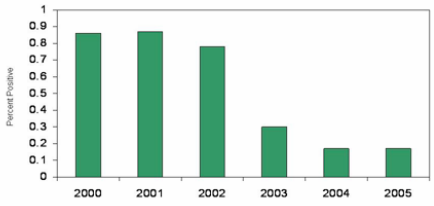
Prevalence of *E. coli* O157:H7 in Ground Beef*



*Results of raw ground beef products analyzed for *E. coli* O157:H7 in federally inspected plants.

Fewer pathogens = healthier product!

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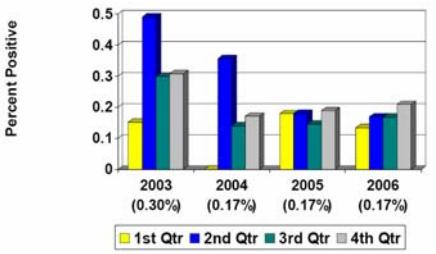
FSIS Raw Ground Beef Testing (All Sources)

Percent Positive *Escherichia coli* O157:H7

Quarterly CY2003 – CY2006 (Figure 2)



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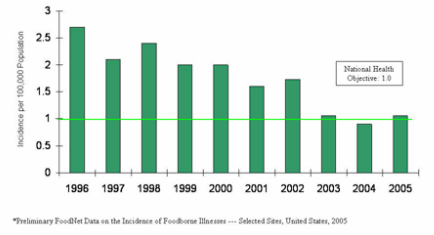
Incidence of Foodborne Illness 1996-2005: *E. coli* O157*



*Preliminary FoodNet Data on the Incidence of Foodborne Illnesses — Selected Sites, United States, 2005

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Conclusions

- Intervention strategies work to reduce meat contamination
- Still see human infections
  - Direct contact with cattle
  - Indirect exposure
    - Contaminated foods (fruits, vegetables)
    - Contaminated water
    - "The environment"

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Disease (pathogen) control strategies

- Eradication
  - "Get rid of it"
- Exclusion / Prevention
  - "Keep it out of here"
- Control
  - "Keep it at an acceptable level"

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Eradication

- The extinction of an infectious agent e.g. smallpox
- Reduction of prevalence to where transmission does not occur
- Reduction of prevalence to where disease ceases to be a major problem
- The *regional* extinction of an infectious agent e.g. Foot and Mouth Disease

21

Eradication

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Prevalence of *E. coli* O157

- Can be found in elk, deer, pigs, horses, dogs, poultry, wild birds, raccoons, flies…
- Overall, prevalence in cattle is extremely high, and widespread geographically.
- Virtually every ranch will have calves that have been exposed.

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Prevalence of *E. coli* O157 in cattle

- Varies with age – higher in young?
- Shedding is transient or intermittent in healthy cattle
- More prevalent in warmer months?
- More in muddy pens

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Prevalence of *C. parvum* in cattle

- Varies with age – higher in young
- Shedding is transient or intermittent in healthy cattle
- More in crowded areas
- Greater if prolonged calving season

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Potential on-farm control methods

1. Exposure reduction strategies
2. Exclusion strategies
3. Direct anti-pathogen strategies

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1. Exposure reduction strategies

"Principle-based husbandry"

- Water quality
  - When water sources are positive, so are cattle.
- Feed hygiene
  - Can affect incidence of *Salmonella*
- Environmental exposure
  - Muddy / wet pens have higher incidence
- Animal density
- Wildlife /pest exclusion (food and water)

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2. Exclusion strategies

- Feed component management
  - Alters GI environment, modify survival of *E. coli* O157:H7???
- Probiotics (direct fed microbials)
  - Mixtures of bacteria and yeasts that alter microbial flora in the host

28

Prevalence of *Escherichia coli* O157:H7 and performance by beef feedlot cattle given *Lactobacillus* direct-fed microbials

- J Food Prot 2003 May; 66(5): 748-754.
- Feeding *L. acidophilus* reduced shedding of *E. coli* O157:H7 in individual animals, decreased number of positive hides at slaughter, decreased number of pens positive
- Body weight gain, feed efficiency, feed intakes not affected

29

3. Direct anti-pathogen strategies

- Hide washing
- Antimicrobial compounds
  - Sodium chlorate? (not approved in U.S.)
  - Neomycin?
- Bacteriophage therapy
- Vaccination

30

Decreased shedding of *Escherichia coli* O157:H7 by cattle following vaccination with type III secreted proteins

- Vaccine 22 (2004) 362-369.
- Vaccination of cattle significantly reduced the prevalence of *E. coli* O157:H7 in a clinical trial conducted in a typical feedlot setting. This strategy could be used to reduce the risk of human disease.

31

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.

- J Food Prot (2007) 2568-2577.
- Vaccinated cattle were 98.3% less likely to be colonized by *E. coli* O157:H7 under conditions of natural exposure.

32

Efficacy of dose regimen and observation of herd immunity from a vaccine against *Escherichia coli* O157:H7 for feedlot cattle.

- J Food Prot (2007) 2561-2567.
- Cattle vaccinated 3 times were less likely to shed *E. coli* O157:H7 than unvaccinated cattle.
- Unvaccinated cattle housed with vaccinated cattle were 59% less likely to shed than cattle in pens not receiving vaccine (herd immunity).

33

Estimation of the basic reproduction ratio (R0) for Shiga toxin-producing *Escherichia coli* O157:H7 (STEC O157) in beef calves

- Epidemiol Infect (2004) 291-295.
- Given the calculated estimate of R0, it is predicted that 65-86% of a herd of calves must be effectively vaccinated to eliminate STEC O157 infection from a herd.

34

USDA Grants Conditional License To *E. coli* Vaccine

Canadian biopharmaceutical company, Bioniche Life Sciences Inc., has received USDA notice that the latest data for its *E. coli* O157:H7 cattle vaccine "meets the 'expectation of efficacy' standard" and is eligible for a conditional license, providing the firm develops a plan that would collect sufficient data to move the product to full licensure.

35

Prevalence of *E. coli* O157:H7 in cattle and beef from the feedlot to the cooler

- J Food Protection Dec 2006 pp. 2824 – 2826
- 1,328 samples, *E. coli* O157:H7 found in:
  - 24.7% of fecal pats from feedlot floor
  - 14.7% of hides
  - 27.6% of colon samples
  - 10.1% of carcasses before evisceration
  - 1.4% of carcasses after evisceration
  - 0.3% of carcasses after final decontamination

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Prevalence of *E. coli* O157:H7 in cattle and beef from the feedlot to the cooler

- If feedlot floor had <20% positive samples, then *E. coli* O157:H7 found in:
  - 5% of hides
  - 7.5% of colon samples
  - 6.3% of carcasses before evisceration
  - 0% of carcasses after evisceration
  - 0% of carcasses after final decontamination

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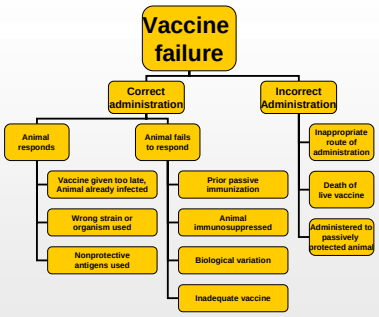

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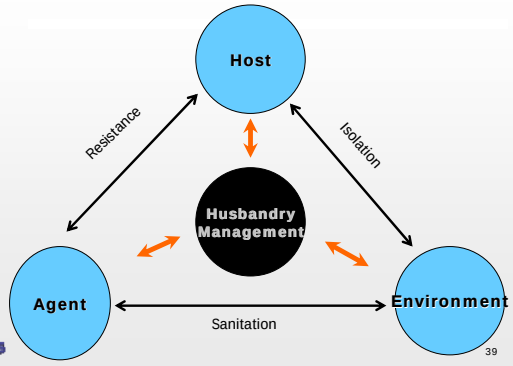
Concepts of host-agent interaction



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Infections are multifactorial

- Pathogen exposure
- Strain variation
- Environmental conditions
- Management conditions
- Nutritional state
- Immune status

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Agent factors

- Dose
- Environmental survivability
- Virulence
- Infectivity
- Toxicity

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Host factors

- Innate resistance
- Previous exposure
- Passive immunity
- Vaccination status
- Age
- Gender
- Behavior
- Production/pregnancy status

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Environmental factors

- Stocking density/Herd size
- Geographical distribution/density of herds
- Animal movement between groups, herds, regions, etc.
- Environmental conditions/hygiene
- Housing
- Nutritional status
- Climate/climatic changes

Risk management - HACCP

- ***Hazard Analysis Critical Control Points***
- Risk factor = something that influences the likelihood of an event
- Goal: minimize factors that increase disease risk, maximize factors that decrease risk
- Factors we can influence are called "control points"

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Risk factors for diarrhea

- Viruses, bacteria, etc
  - **Control point = appropriate vaccination**
- Failure of Passive Transfer
  - **Control point = closely monitor calving**
- Bad weather
  - **Control point = shelters, wind breaks**

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A biological risk management program: A-RITS

- A = Assessment
  - Evaluate specific diseases of concern
  - Assess likelihood of exposure, potential impact on herd, options for control measures

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A biological risk management program: A-RITS

- R = Resistance
  - Vaccination protocol
  - Adequate nutrition, minimize stress
  - Purchase animals of known status
  - On-site testing / surveillance
  - Necropsy all dead animals

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A biological risk management program: A-RITS

- I = Isolation
  - Minimize movement / commingling
  - Separation by age / production group
  - Fences
  - Appropriate isolation / quarantine area
  - Hospital pen?

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A biological risk management program: A-RITS

- T = Traffic control
  - Stop or minimize contamination of animals, feed, equipment
  - Loading facilities on perimeter of facility
  - Dead animal removal area
  - Vehicle cleaning area

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A biological risk management program: A-RITS

- S = Sanitation
  - Disinfection and cleanliness of people and equipment
  - Prevent fecal-oral contamination
  - Remove organic material
  - Different equipment for feed and manure
  - Establish disinfection protocols

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Summary

- There are no “silver bullets” to eliminate pathogens

- Pathogen control is possible by a number of routes – use as many as you can to help produce healthy cattle in healthy environments

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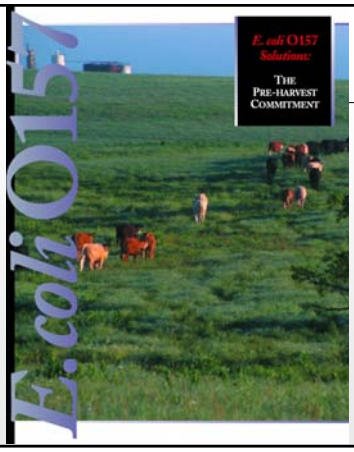

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