Understanding the Microbiology of Hen Housing Systems

Deana R. Jones, PhD
Egg Safety and Quality Research Unit
USDA Agricultural Research Service
Athens, Georgia

Collaborators

- Dr. Ken Anderson
- Dr. Darrin Karcher
- Dr. Jean Guard
- Dr. Richard Gast

Technical Team

- Stephen Norris
- Robin Woodroof
- Patsy Mason
- Garrett Ward
- Bradley Covington

- Tod Stewart
- Cheryl Gresham
- Rupa Guyrana

Research Team

Hen Housing Issues

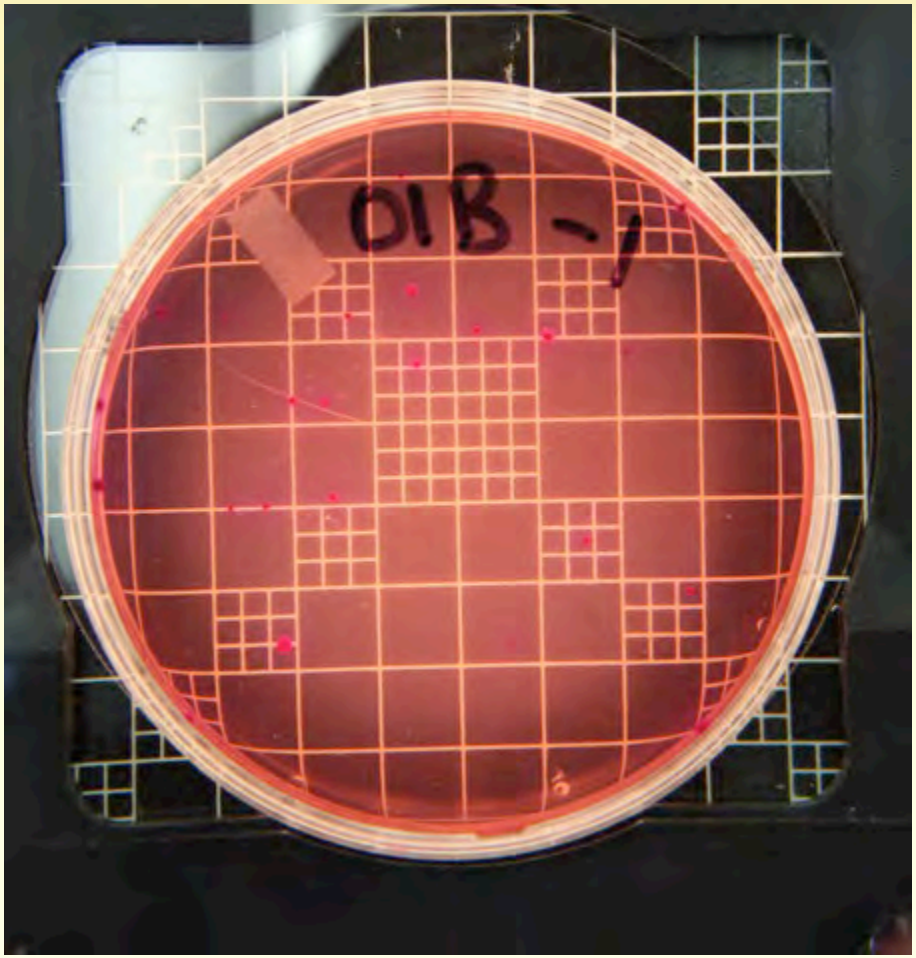
- Quickly emerging for egg industry
- Most research out of Europe
- Differences between US and European egg industry
- Production practices and processing guidelines based on conventional cage
- Desired outcome:
  - Safe, high quality product to consumers

Aerobic Plate Counts

- Indicator of general microbial populations
- Point of comparison
- Higher in presence of dust, feces, feed, and other high surface area contaminants
- 48h incubation

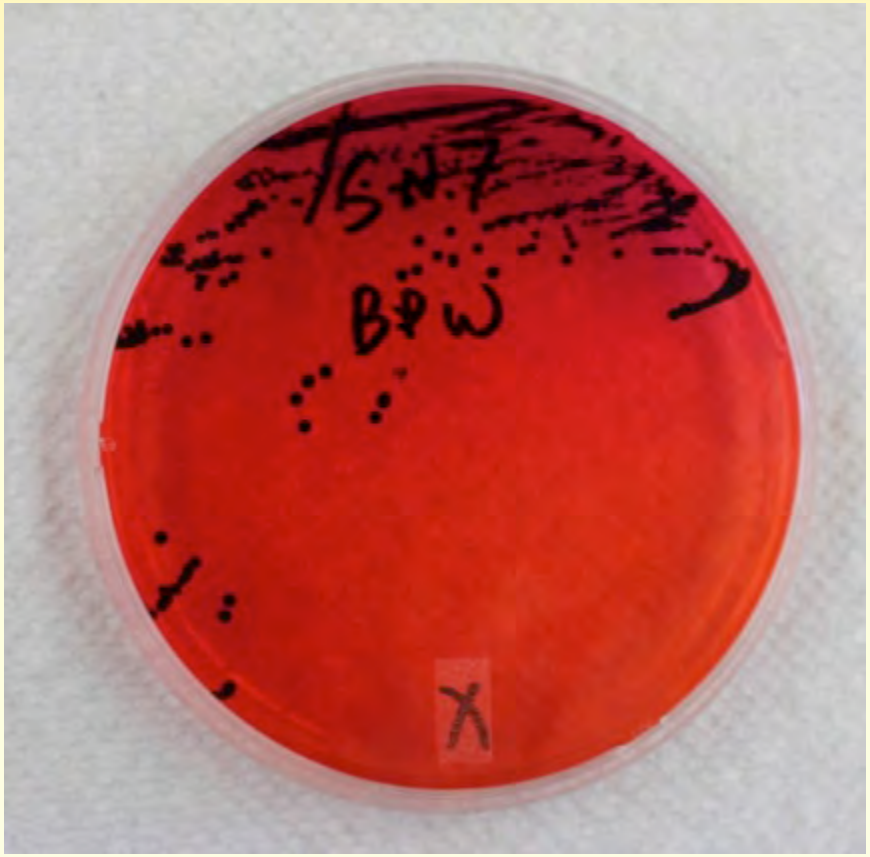
Enterobacteriaceae

- Class containing most human pathogens
- Generally from fecal contamination
- Provide general view of fecal contamination and potential pathogen levels
- 24h incubation



Salmonella

- Pathogen of concern for eggs
- Utilize pre-enrichment
- Culture time: 5 days
- Serotyping:
  - Utilize *dkgB*-linked ISR methodology
  - Developed by Guard (USDA-ARS, ESQRU)

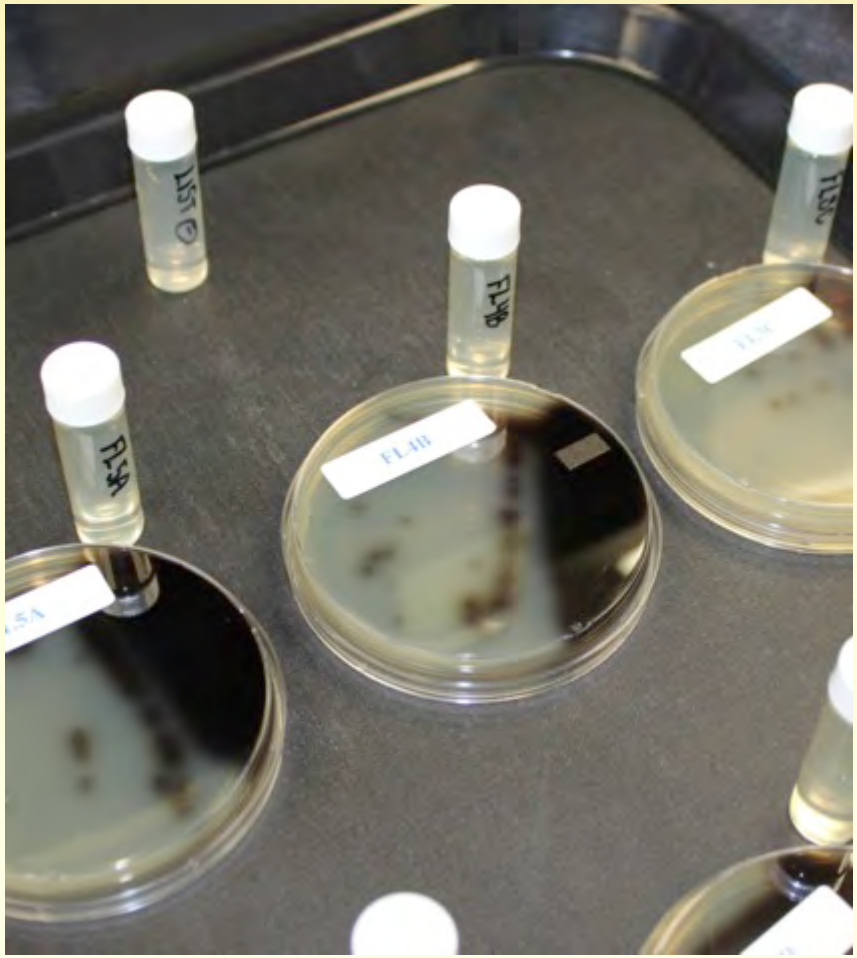


Campylobacter

- Human pathogen
- Associated with feces
- Concern for animal agriculture
- 72h incubation
- Latex agglutination for confirmation

Listeria

- *L. monocytogenes* human pathogen
- Can survive in refrigerated temperatures
- Can infiltrate processing facilities
  - Very difficult to eradicate
- 6 days incubation
- Serotyping via biochemical test strips

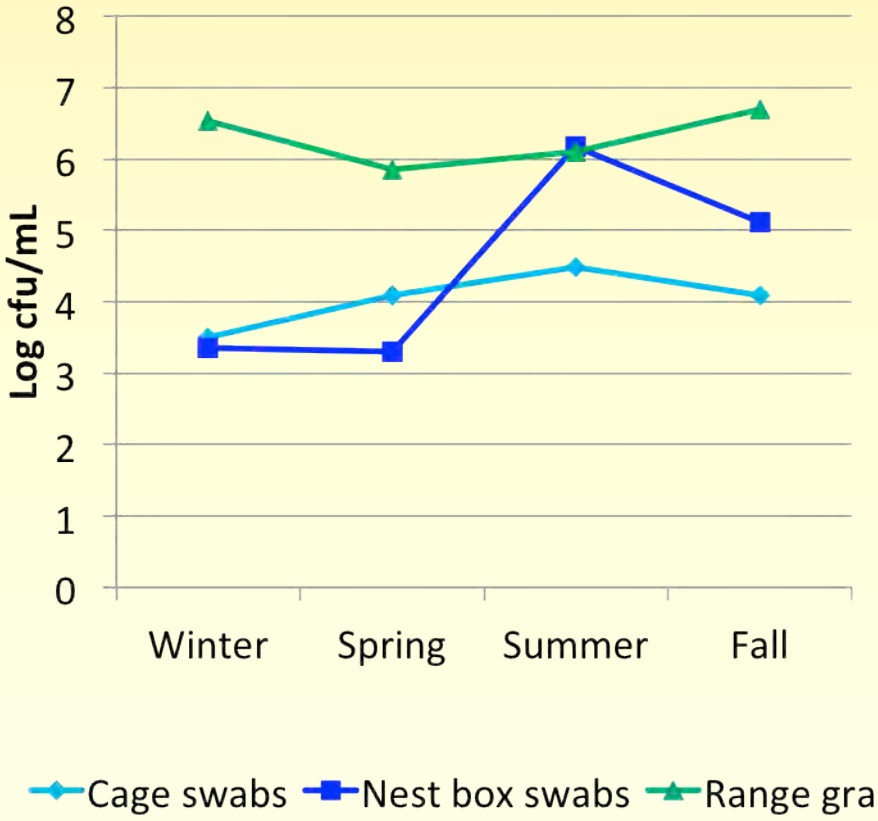


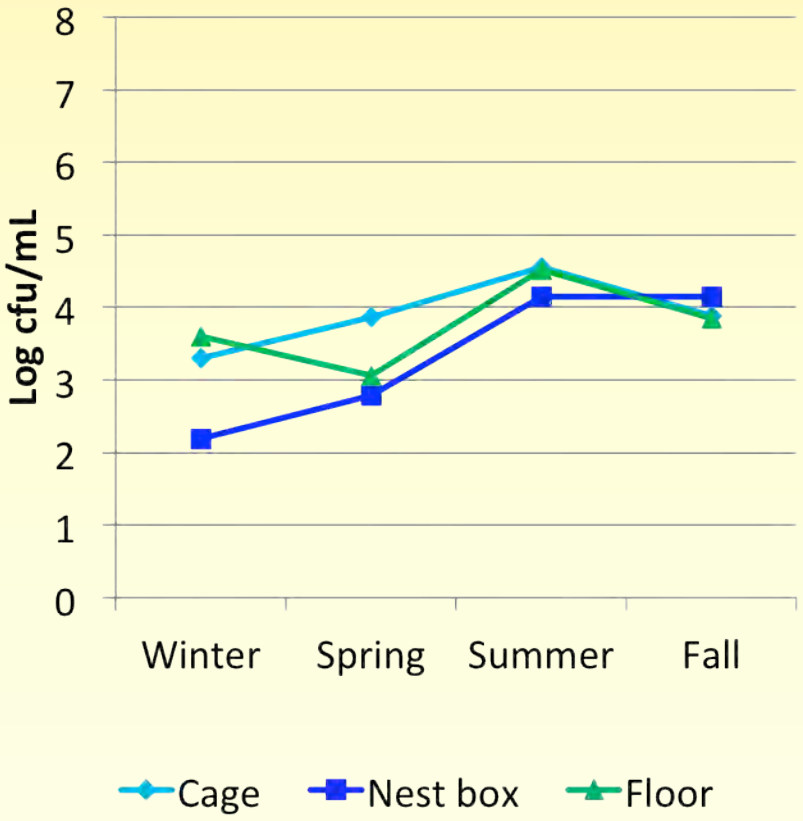
Housing System Microbial Impact Comparisons

- Eggs:
  - Shell and shell membrane pools
  - Egg content pools
- Environmental:
  - Swabs
    - Initially utilized sterile PBS; switched to evaporated milk
  - Physical samples
    - Grass cuttings from forage area
    - Samples of alternative nestbox bedding materials
    - Fresh fecal droppings

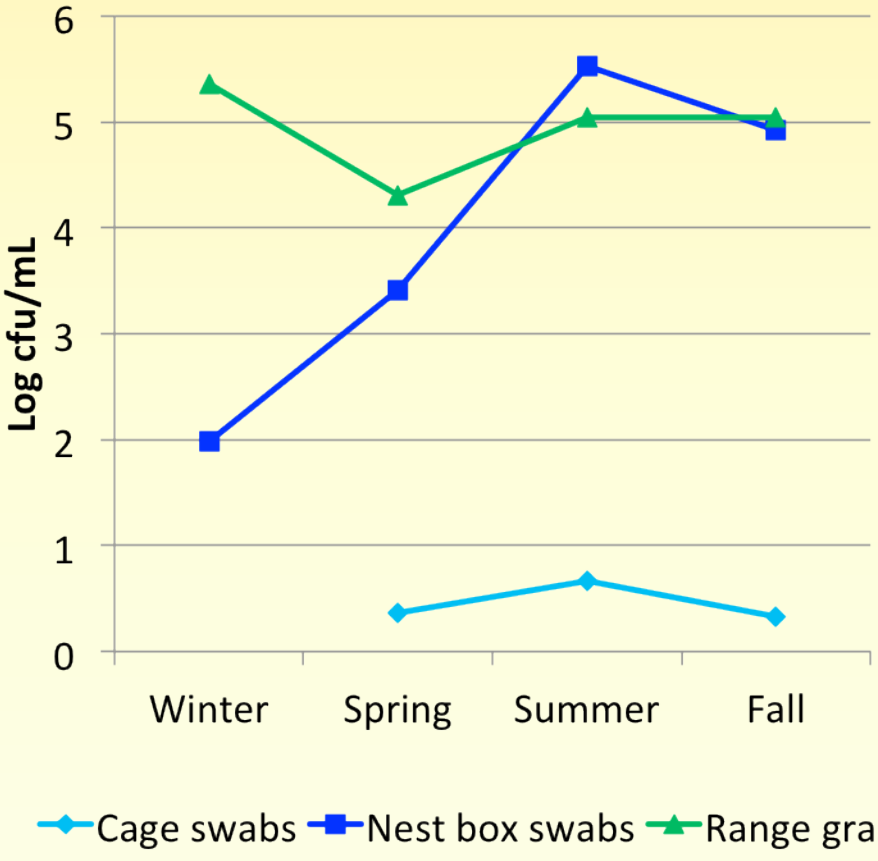
Conventional Cage and Free Range Production Systems

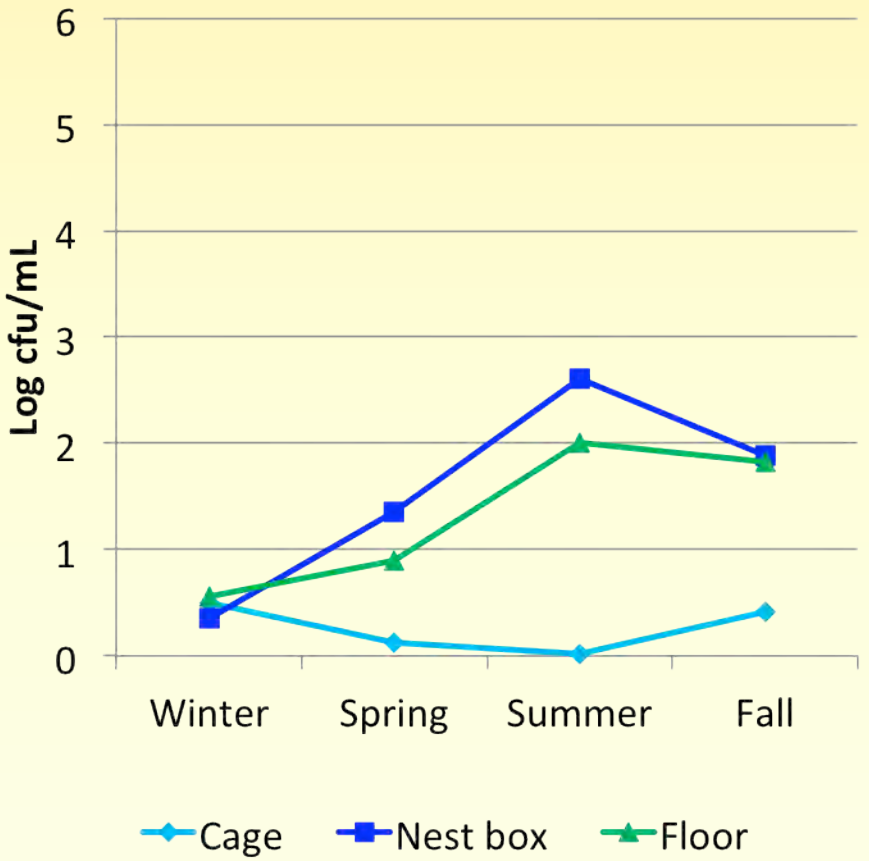
Effect of Season on Aerobic Plate Count Levels



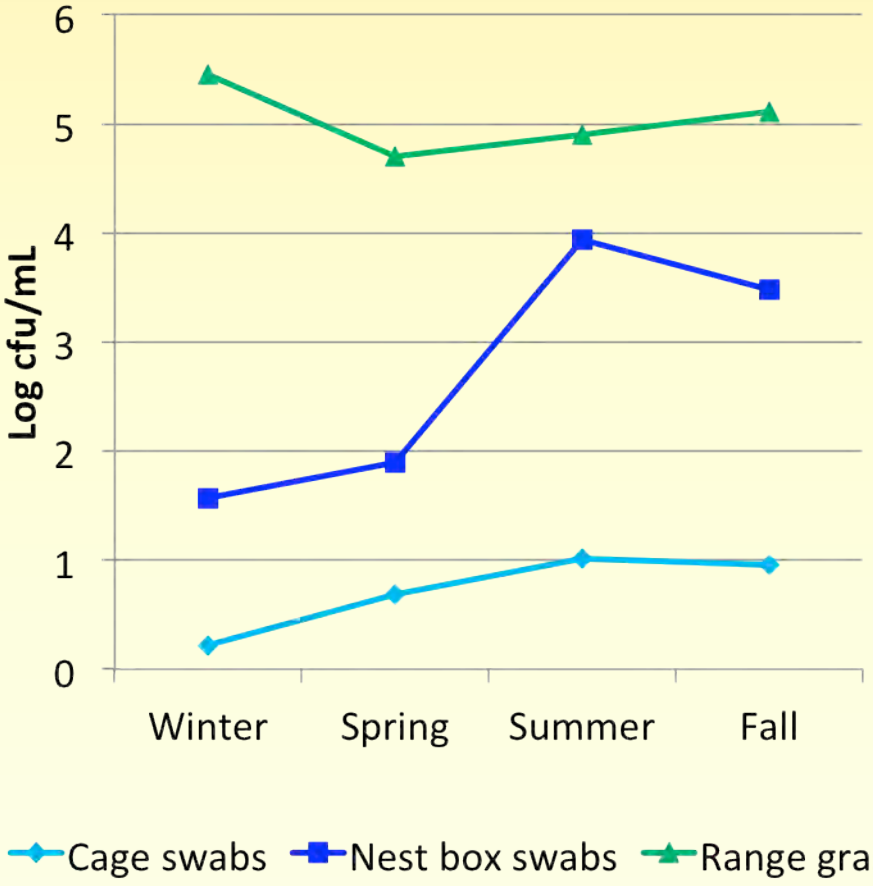


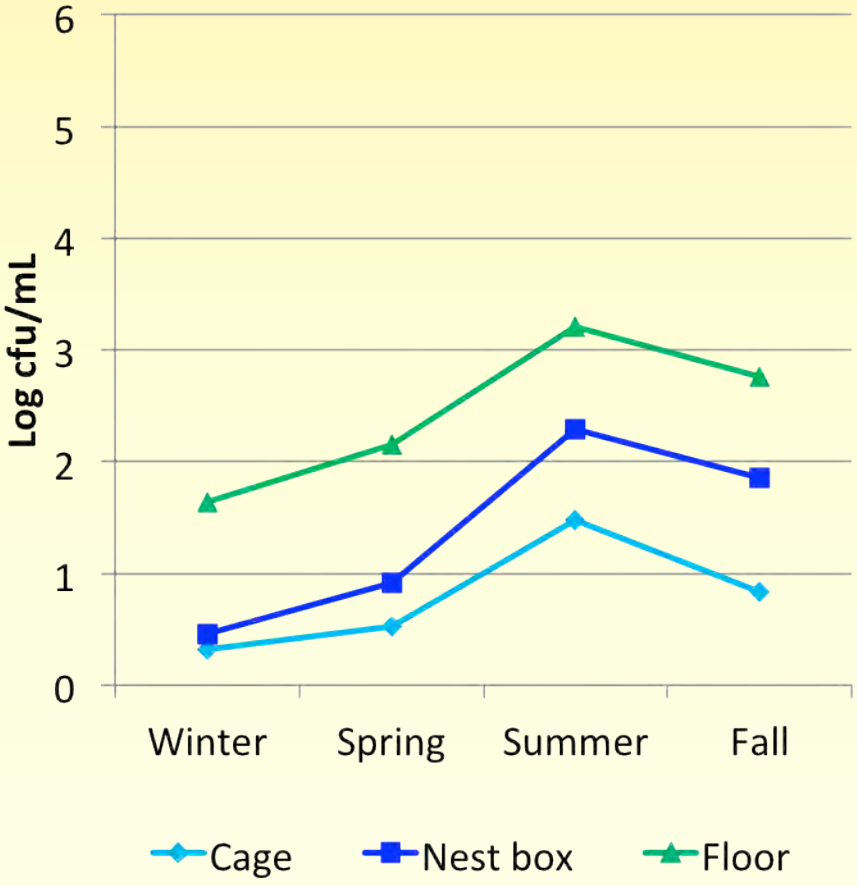
Effect of Season on Coliform Levels





Effect of Season on Yeast and Mold Levels





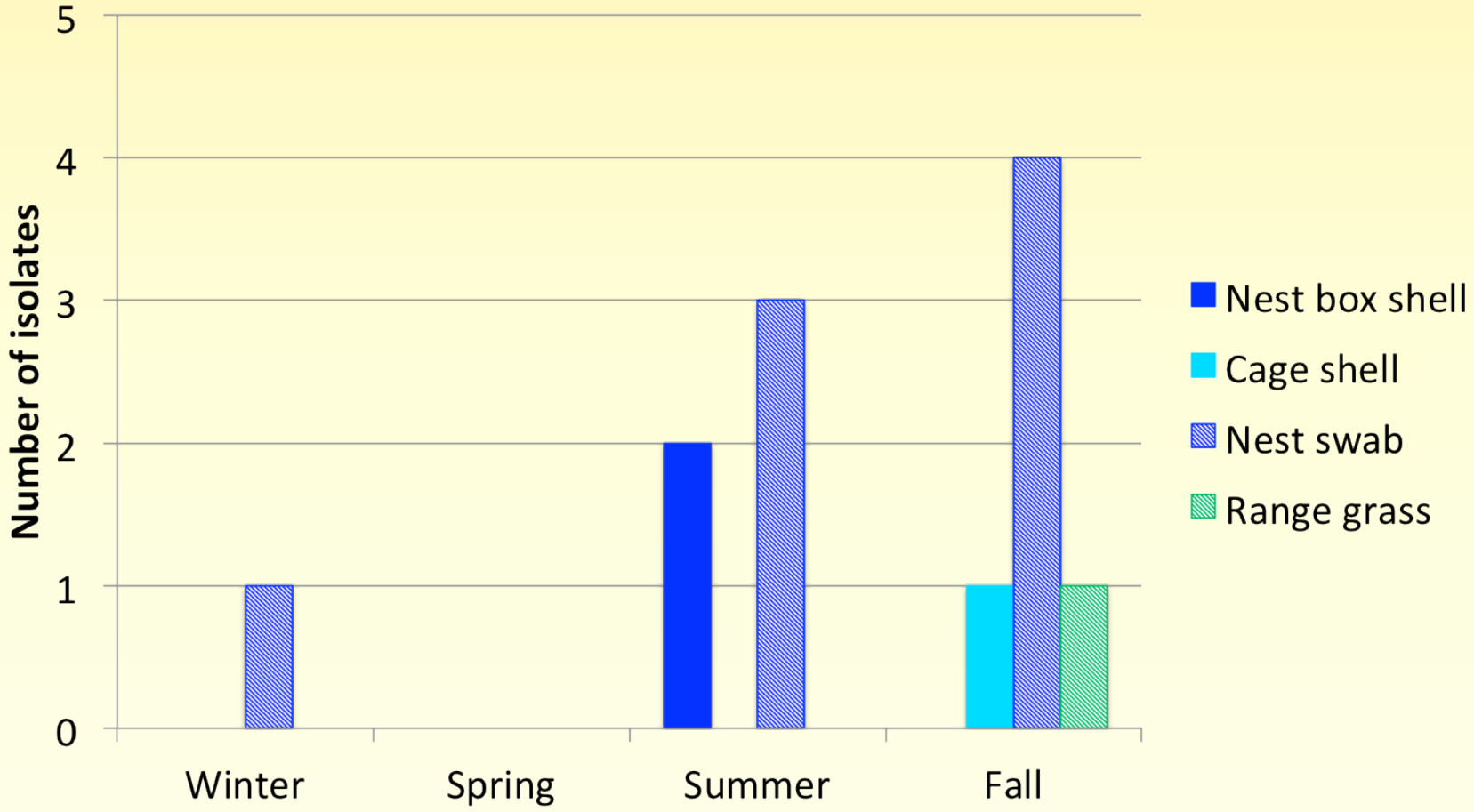
Summary of Results

- Contents pools from all treatments were extremely low for all populations
- Dust from caged environment appears to increase aerobic bacterial levels on shells
- Cage eggs had substantially lower counts for coliform and yeast and mold
- Nest box eggs had the highest levels of all monitored populations during summer followed by fall

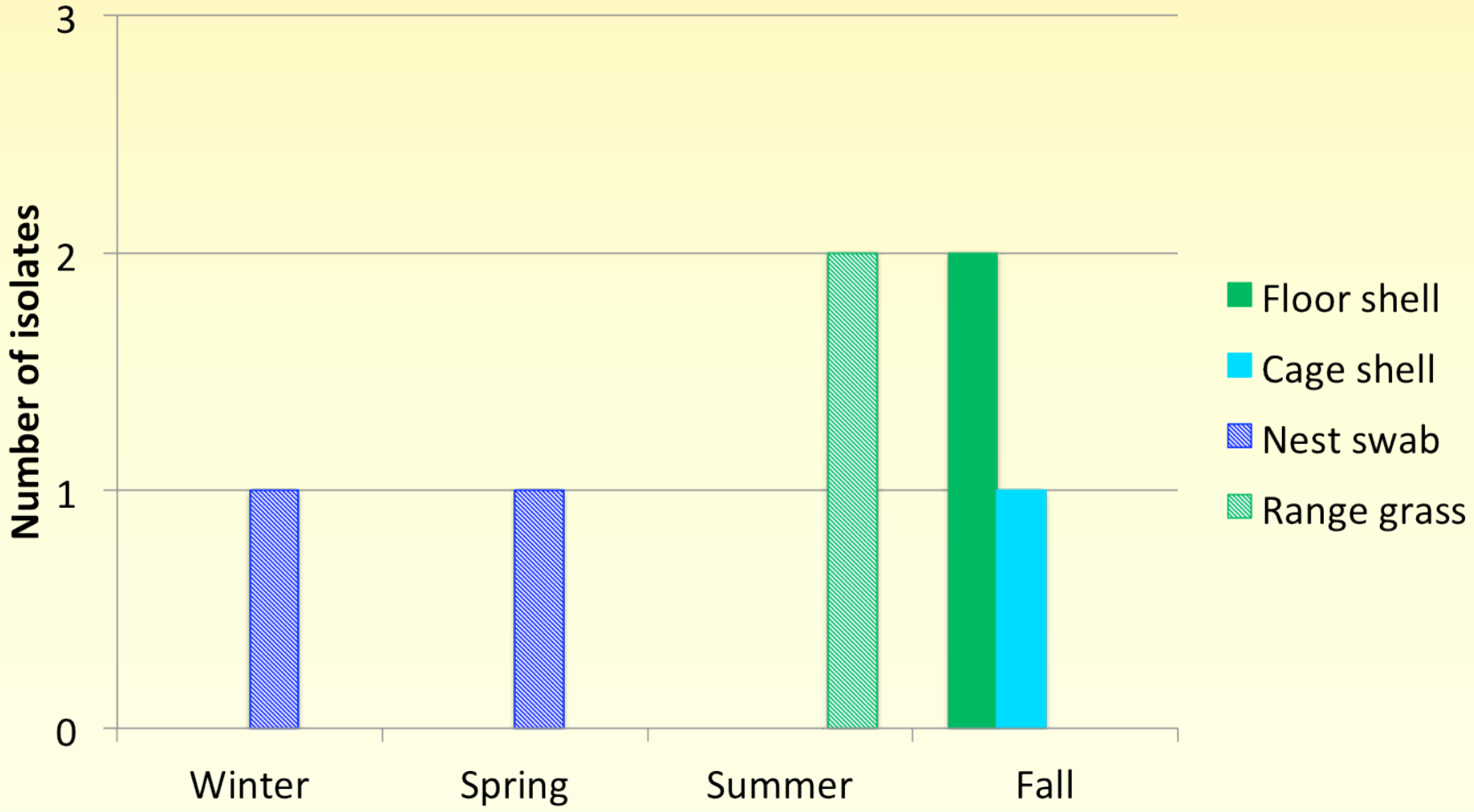
Summary of Results

- Cage swabs and range grass aerobic levels remained fairly consistent across seasons
- Range grass coliform and yeast and mold levels were consistently high throughout all seasons
- Summer and fall nest box swabs were elevated for all populations monitored

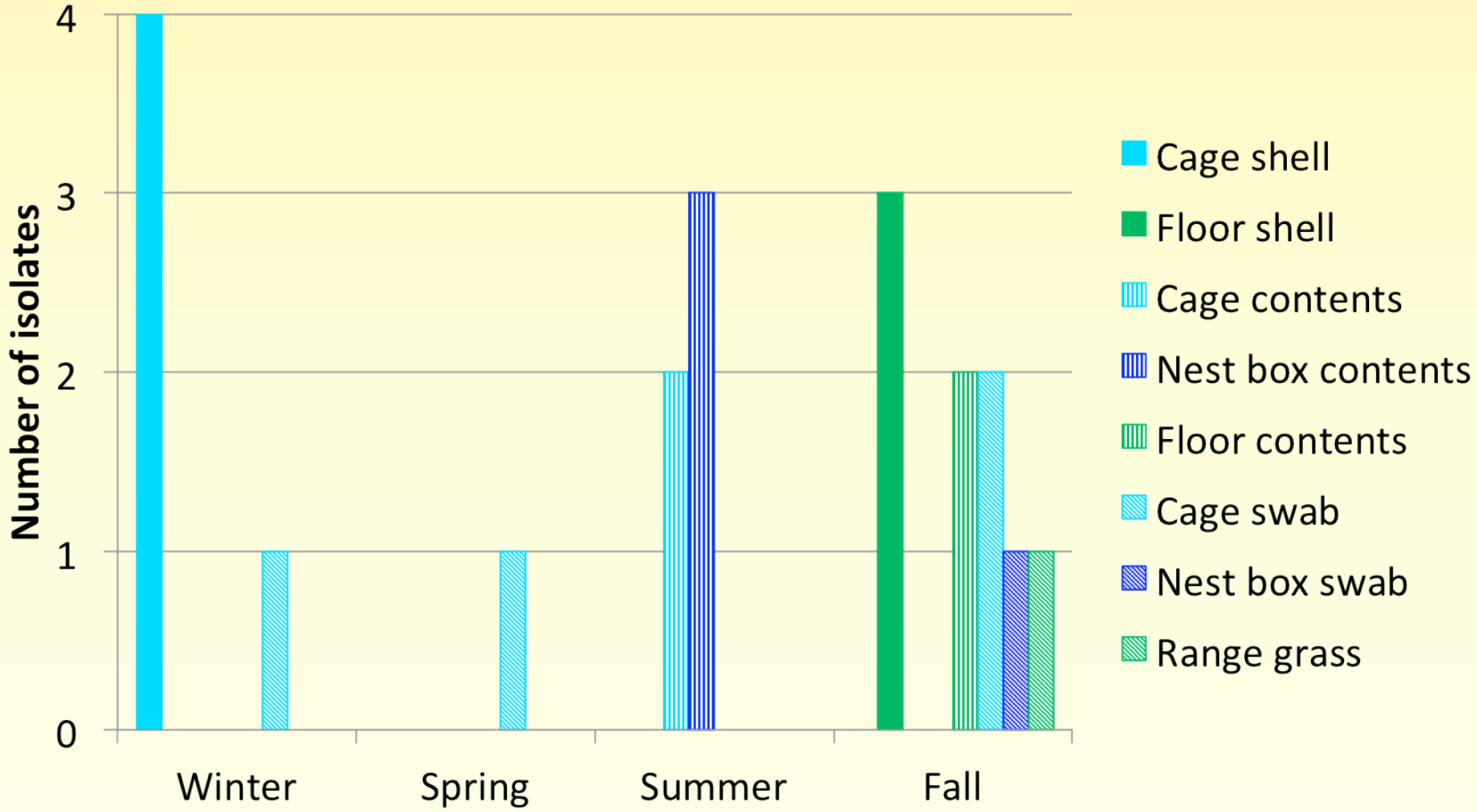
Effect of Season on the Prevalence of *Campylobacter*



Effect of Season on the Prevalence of *Listeria*



Effect of Season on the Prevalence of *Salmonella*



Salmonella ssp. Detected

- Eighteen *S.* Typhimurium
- *S.* Javiana
  - Floor egg shell
- *S.* Enteritidis
  - Range grass
- One PCR failure – not serotyped

Summary of Results

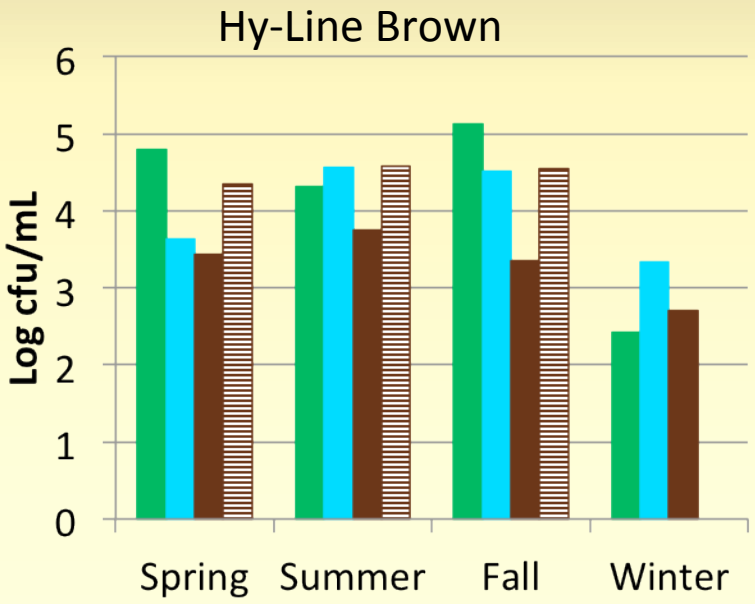
- Significantly greater prevalence of *Campylobacter* in the nest box environment than range grass or cage swabs
- No significant difference in the prevalence of *Listeria* amongst treatments
- No significant difference in the prevalence of *Salmonella* amongst treatments

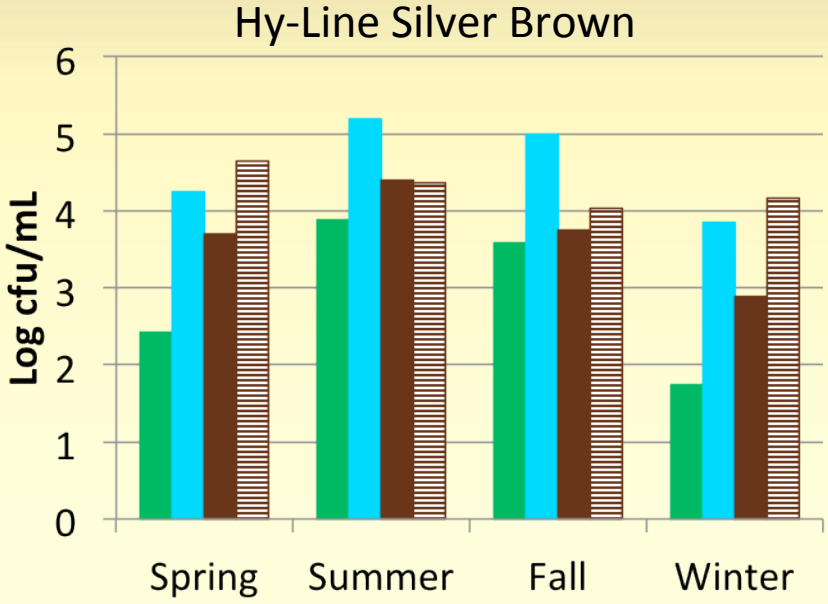
Summary of Results

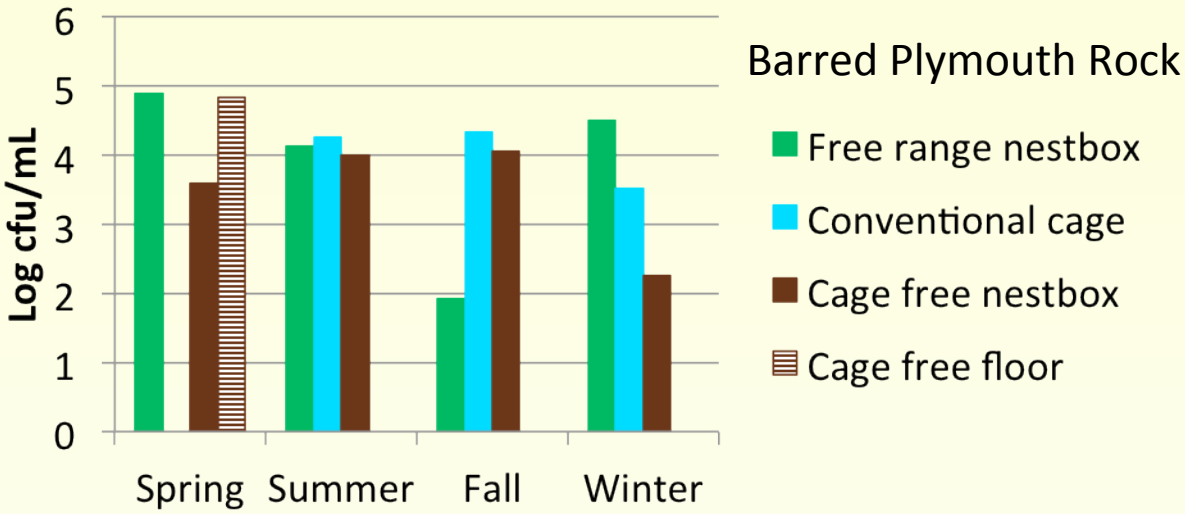
- Twenty-one *Salmonella* isolates were detected
- Eighteen were *S.* Typhimurium
- One each of *S.* Javiana and *S.* Enteritidis
- *Salmonella* Enteritidis was detected in the production environment (range grass), but not in or on any eggs

Laying Hen Strains and Various Production Systems

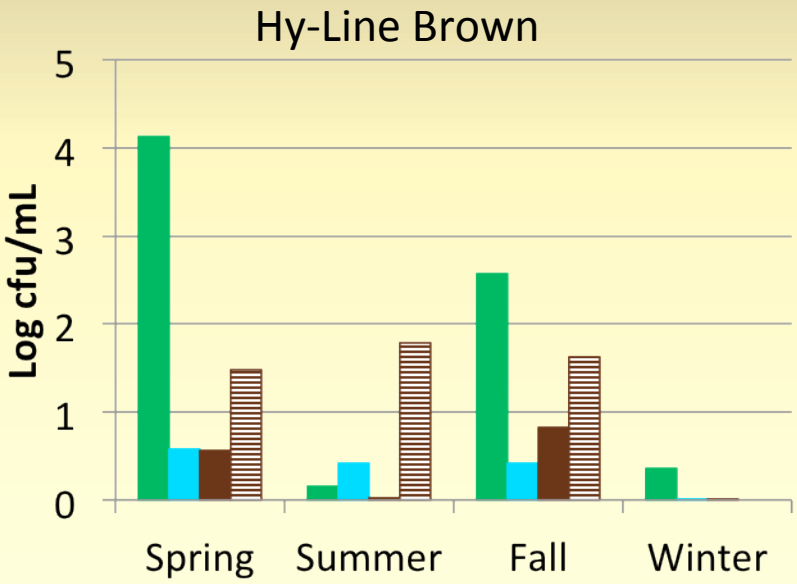
Shell Emulsion Aerobic Plate Counts

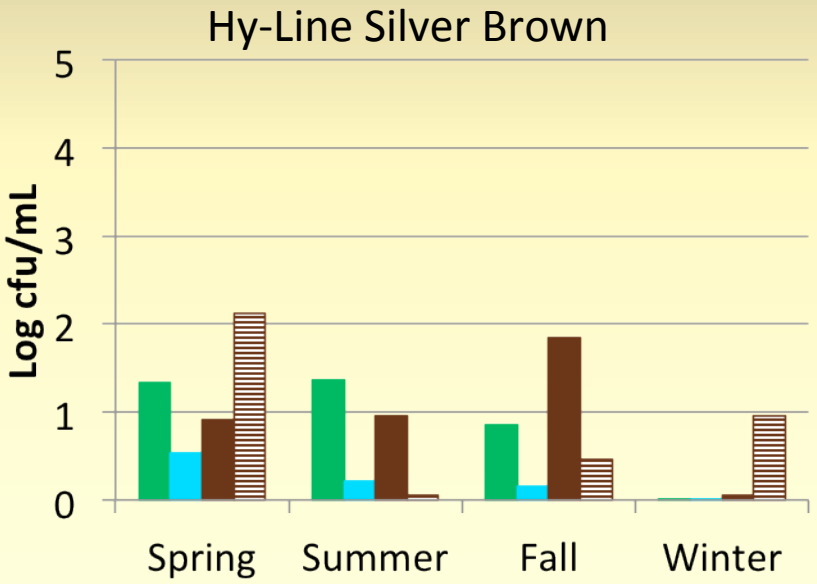


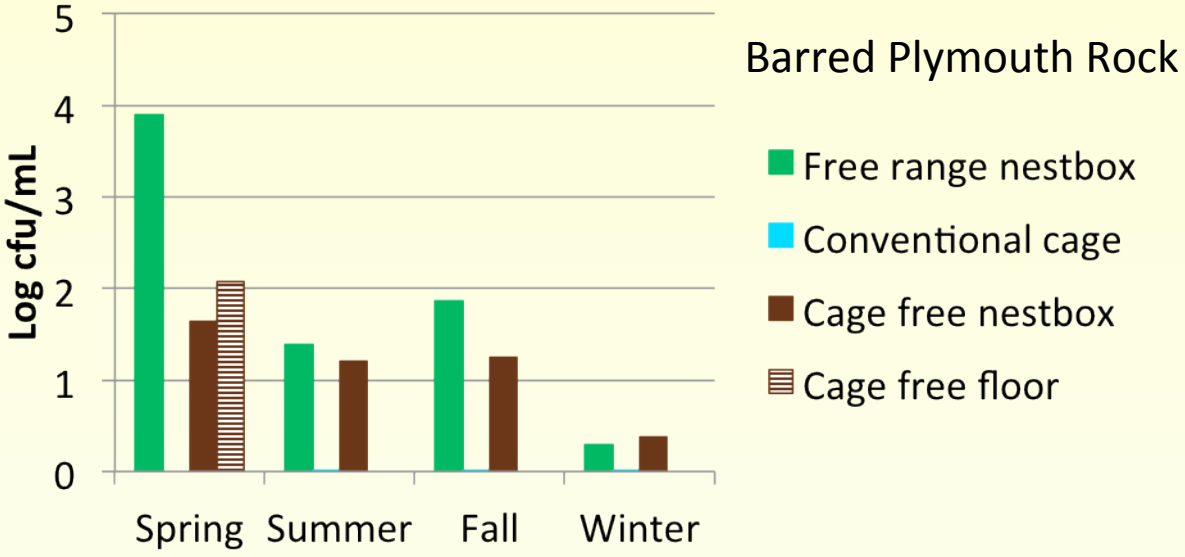




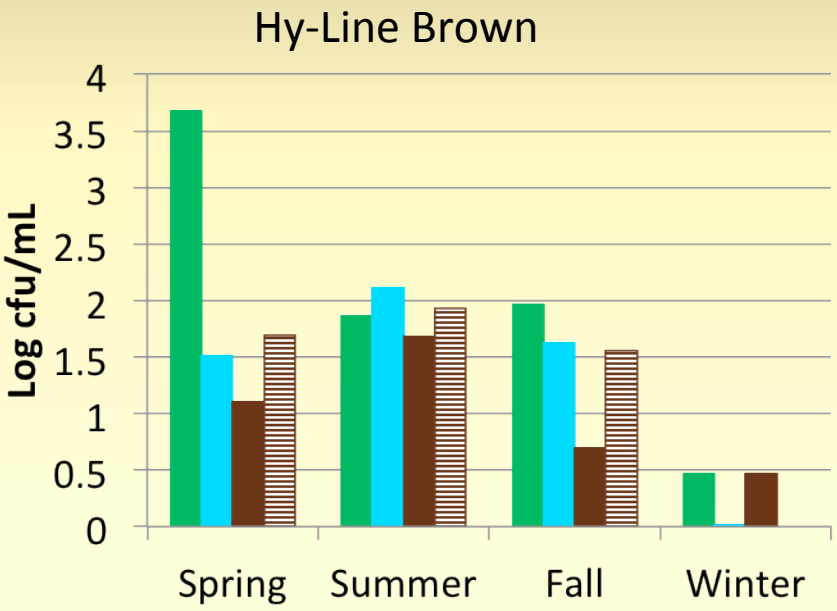
Shell Emulsion *Enterobacteriaceae* Counts

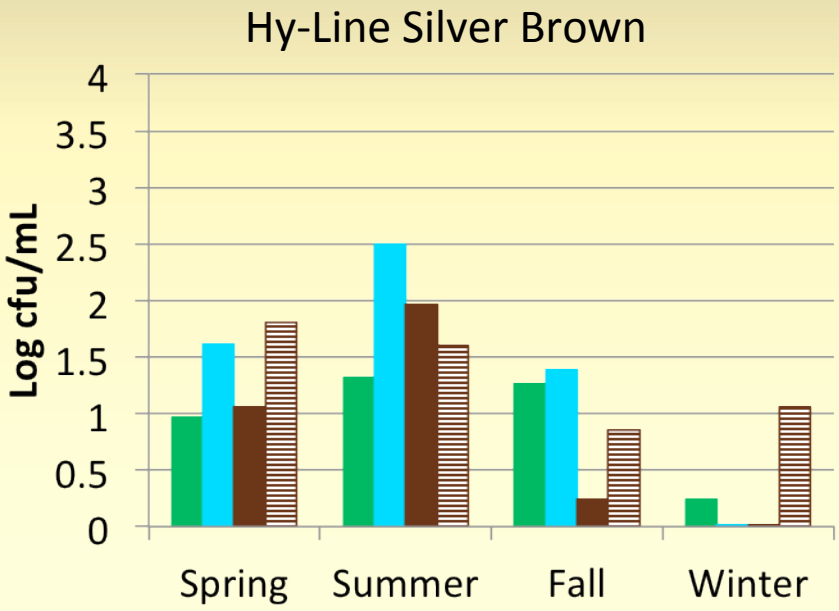


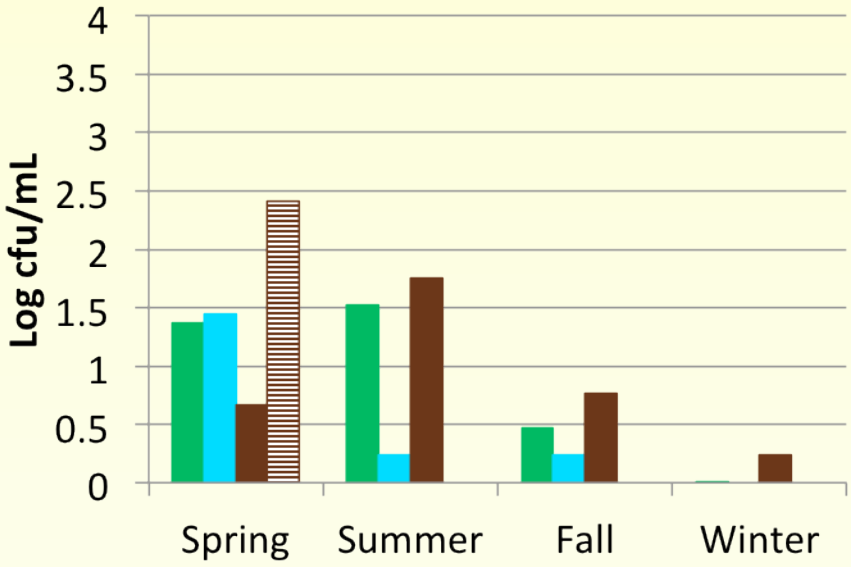




Shell Emulsion Yeasts and Molds Counts







Barred Plymouth Rock

- Free range nestbox
- Conventional cage
- Cage free nestbox
- Cage free floor

Discussion

- As was seen before, season appears to affect microbial levels
- As was seen before, conventional cage eggs have overall highest level of aerobic organisms associated with the shell
- Altering nest box design appears to have influenced the production of free range floor eggs

Summary of Results

- No pathogens detected in egg contents
- No *Listeria* detected
- Three *Salmonella* isolates were found
  - All Group B
  - All from cage free production
  - Each found in a separate sampling period

Summary of Results

- *Campylobacter* was detected in three sampling periods
- Six isolates were detected
  - All three strains produced eggs externally contaminated
- Four of the isolates came from the cage free environment
  - One isolate from free range
  - One isolate from conventional cage

Discussion

- Floor eggs continue to be microbial concern
  - Should floor eggs be excluded from consumer eggs?
  - Do we know enough to make this decision?
- The strains of laying hen produced eggs of varying microbial quality
  - Will some strains produce eggs of higher microbial quality?
  - Are breeders considering production system/egg microbial quality in selection process?
  - Is this necessary?

Next?

- Continue to compare microbiological impact of housing systems
- Housing system impact on the colonization of laying strains with *Salmonella*
- Molting of alternative housing systems and food safety
- Understanding microbiological impacts of organic production

Deana.Jones@ars.usda.gov
706.546.3486