RUTGERS
New Jersey Agricultural Experiment Station

Application of Risk-based Approaches to Managing Agricultural Water Quality

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Risk Assessment 101

- **Hazard:** A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.
- **Risk:** A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food.

Hazard vs. risk

- **Hazard**: *Salmonella, Listeria monocytogenes,* splinter, rock, peanut protein, pesticide
- **Risk**: probability and severity
  - One in every 1,000 servings contains 1 cell of ***Organism XYZ***, and one cell has a 1/300 chance of causing diarrhea, a 1/20,000 chance of causing hospitalization, and a 1/500,00 chance of causing death
  - One in 10 servings contains 1 cell of ***Organism ABC***, and one cell has a 1/1,000,000 chance of causing diarrhea, a 1/100,000,000 chance of causing hospitalization, and a 1/1,000,000,000 chance of causing death

Components of Risk Analysis

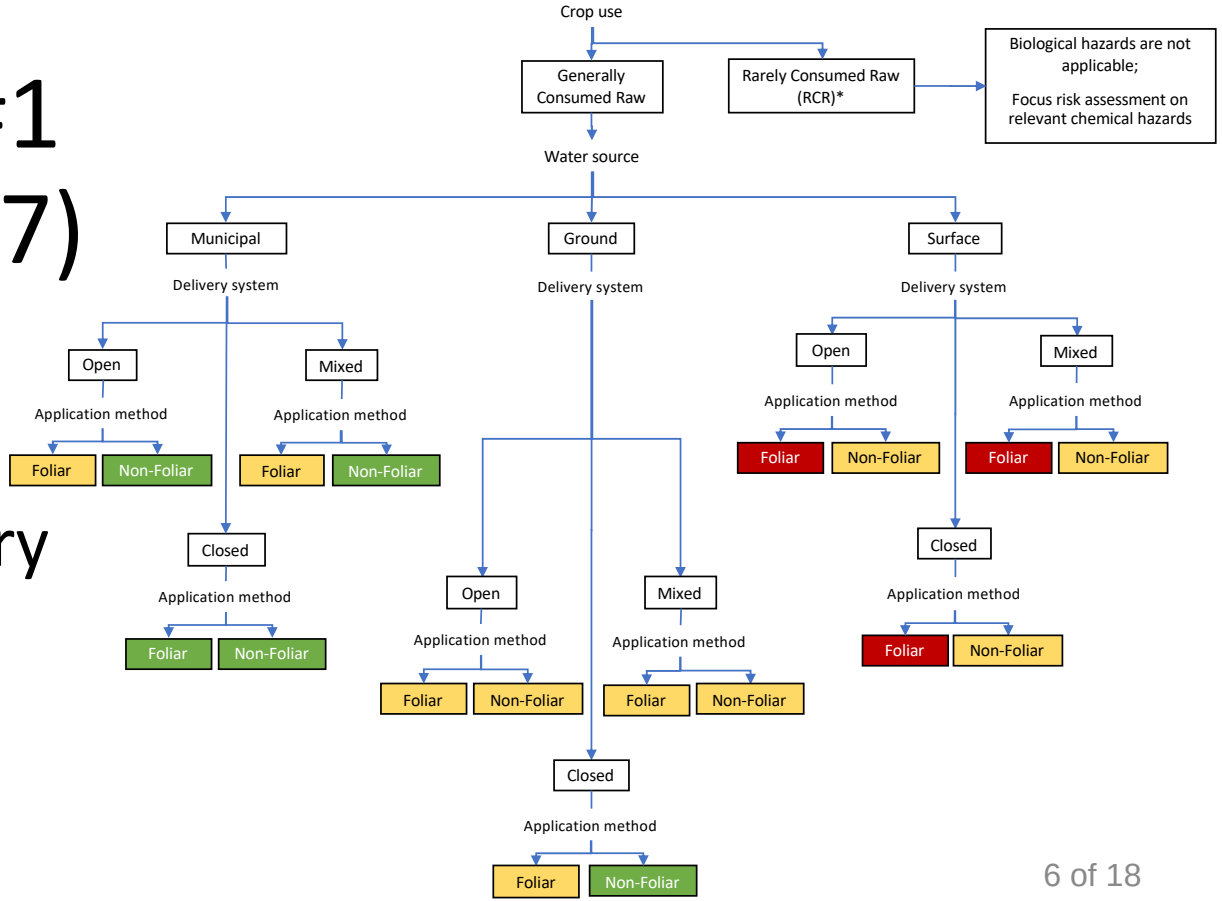
- (Quantitative) Risk Assessment
  - How big is the risk, what factors control the risk?
  - Scientific process
- Risk Management
  - What can we do about the risk?
  - Societal, practical and political process
- Risk Communication
  - How can we talk about the risk with affected individuals?
  - Social and psychological process

Risk based thinking for ag water

- Water source
- Irrigation method
- Time to harvest
- Post-harvest handling
- Commodity differences
- See next two slides

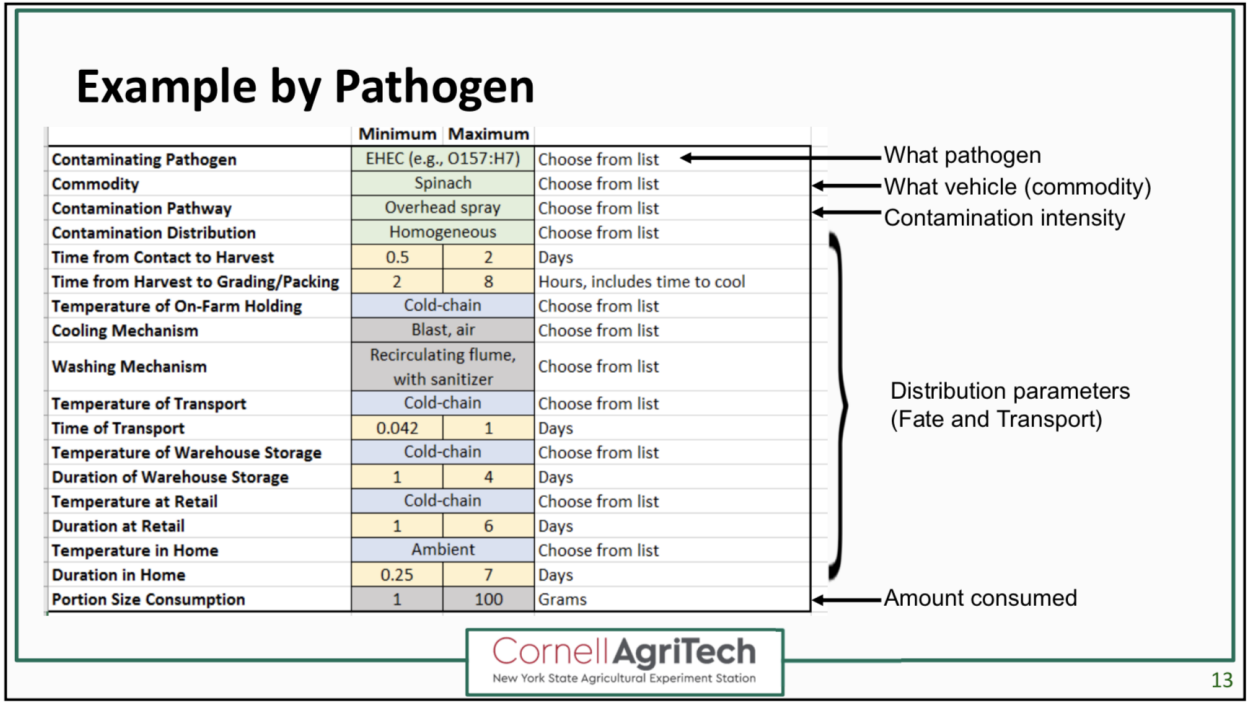
IAFP 2019 flashback #1 (Griep – S47)

- Water risk differs by source, delivery system and application



IAFP 2019 flashback #2 (Stoeckel T1-03)

- Risk is different with different factors

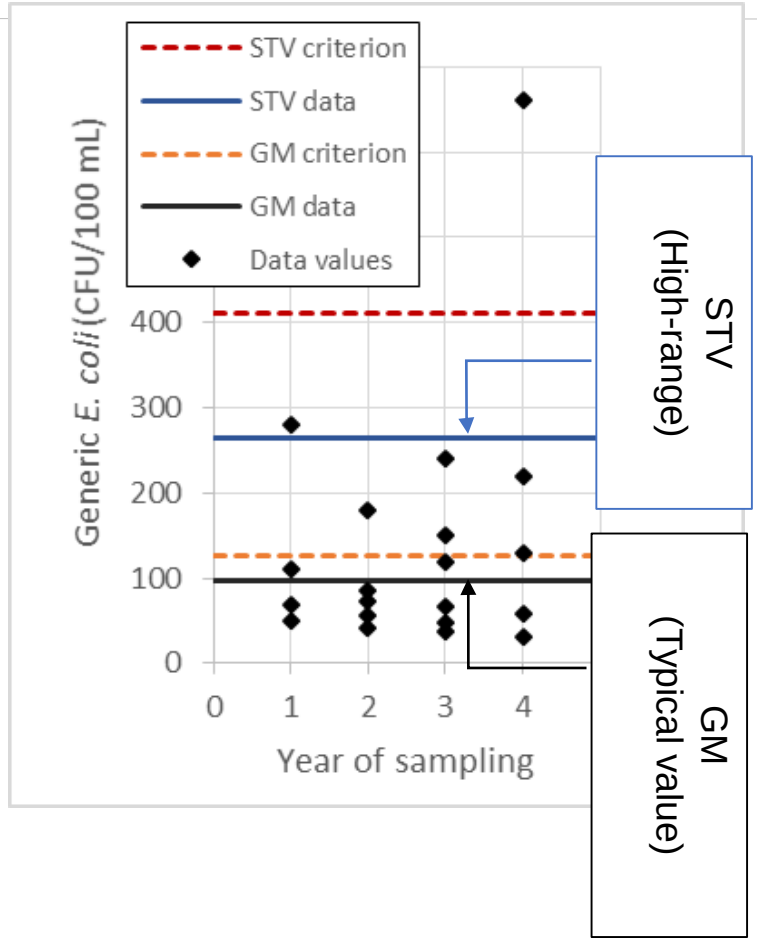


Indicator, index and surrogate

- Indicators of…
  - Pathogens, hygiene or sanitation, quality, process control, spoilage
- Index organisms are indicators of pathogens
- Surrogates
  - Non-pathogenic organisms with characteristics that correlate with pathogen growth or survival

Geometric Means and Statistical Threshold Values

- Tests used to calculate GM and STV to compare to water quality criteria in the FSMA Produce Safety Rule
  - GM log-scale average, “typical” value
  - STV measures variability - estimated “high range” value (~ 90th percentile)

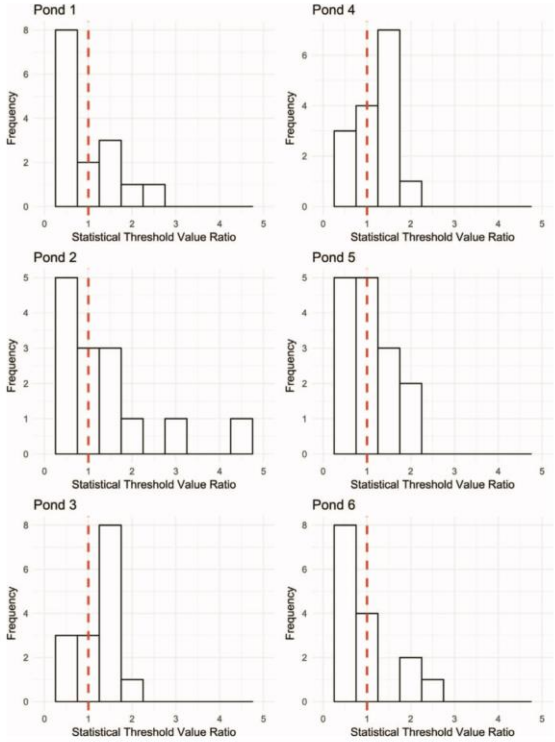


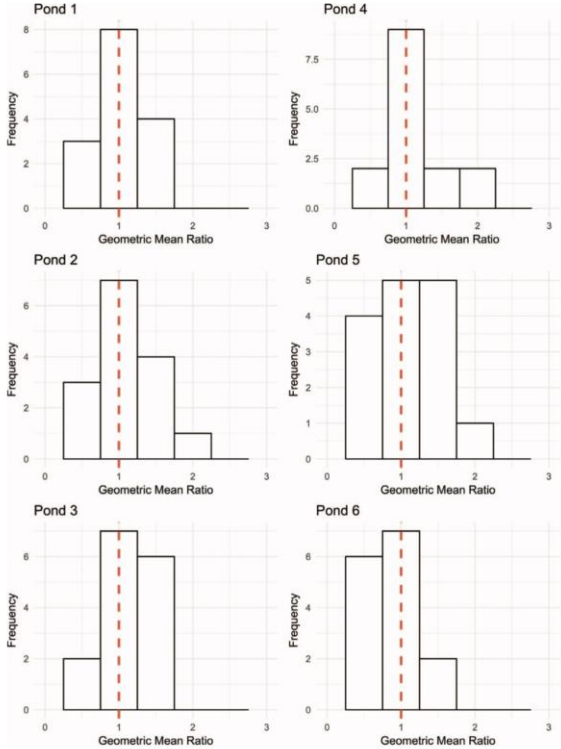
Havelaar et al, JFP 2017

- Compared data from 6 ponds to ask “would sample GM and STV work as estimates”?
  - Compare “truth” from 90 samples/pond vs.
    - 10 sets of 20 random samples
    - 5 sets of 20 evenly spaced samples
- Evaluated the ratio of the estimates (20 samples) to the “truth” (90 samples)
- If the ratio is ~1 then estimates are “good”
- If <1 = underestimate risk, if >1 overestimate risk

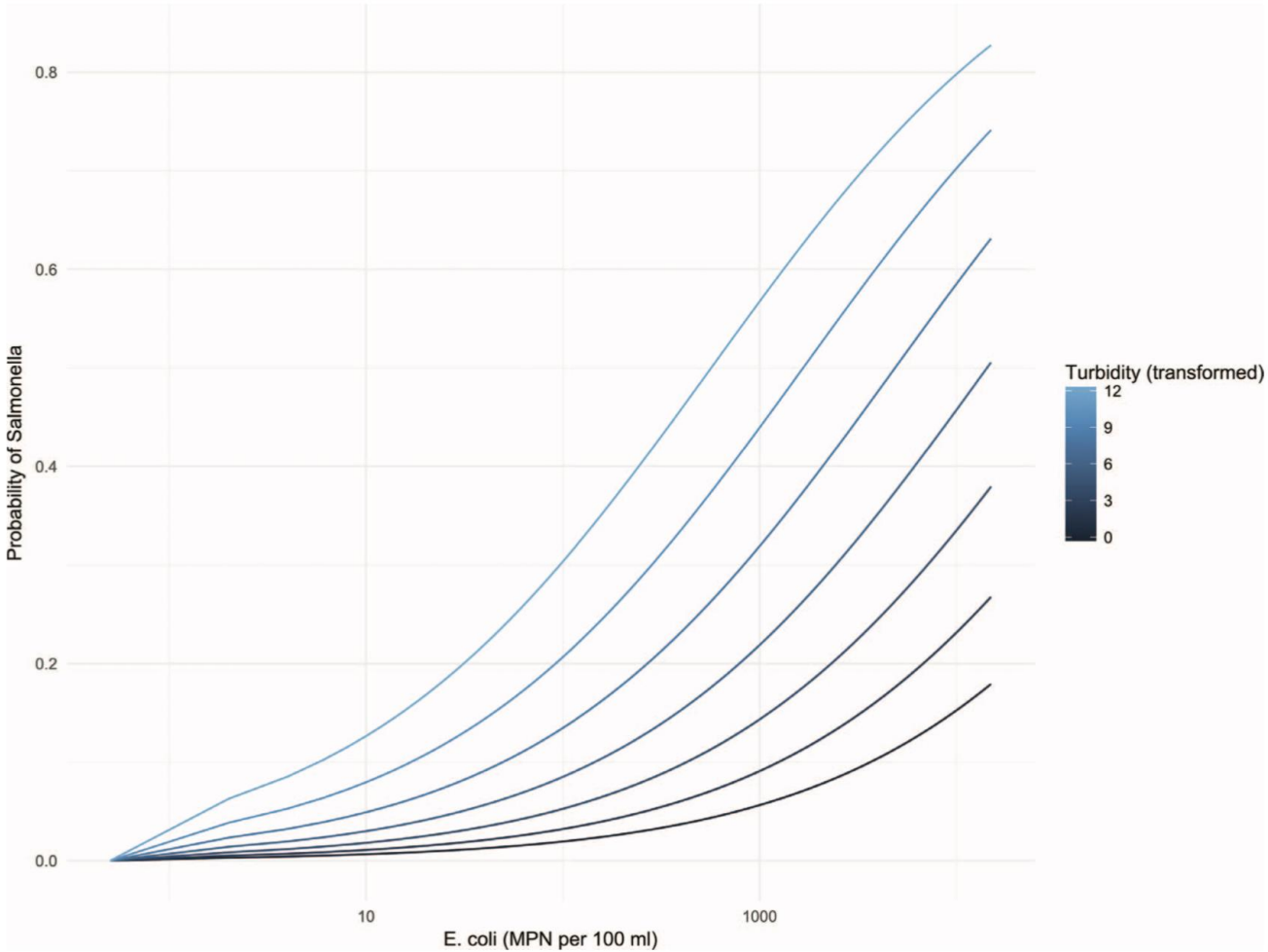
STV and GM ratios

- STV by pond on left
- GM by pond on right
- Some over, some under





- Some good news?

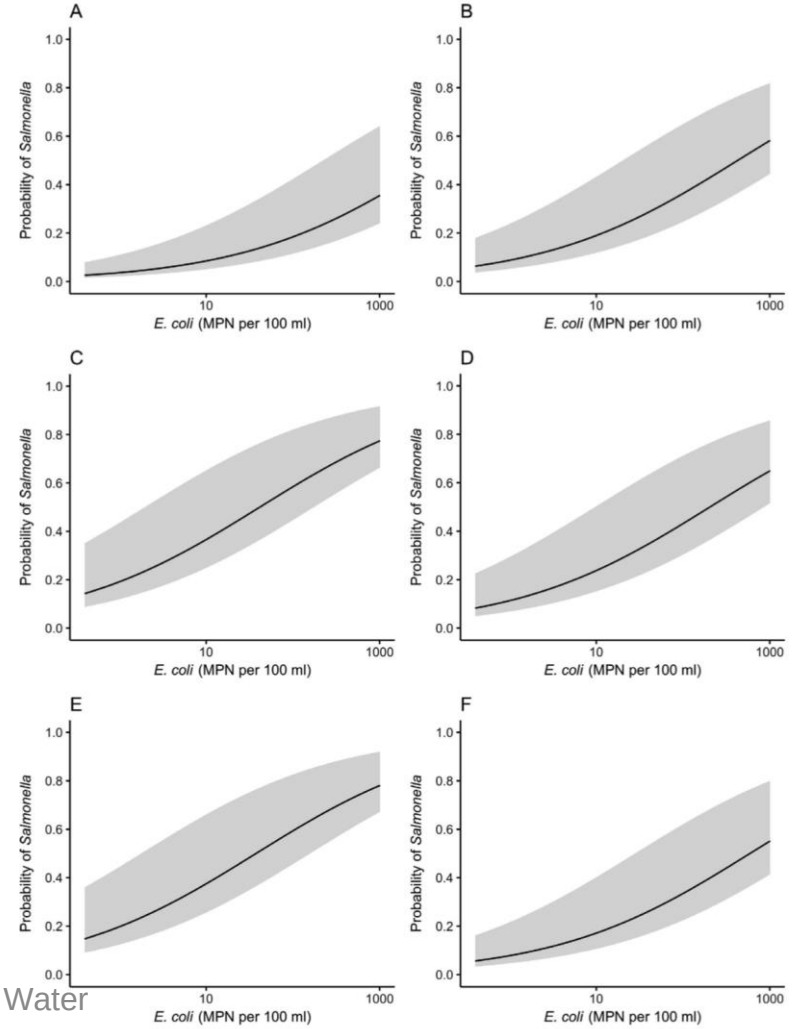


Truitt et al., JFP 2018

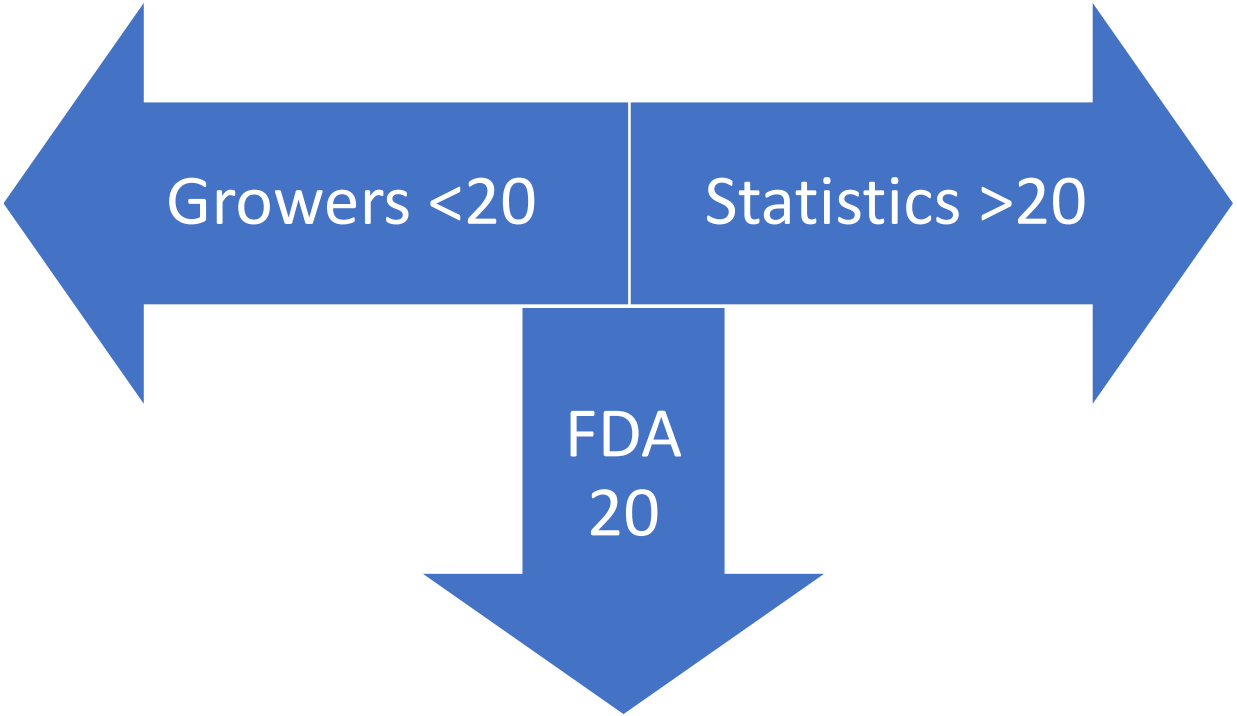
- Strawn lab, VA Eastern Shore, some author overlap with Havelaar, 2017
- Water samples (1 L) from 20 agricultural ponds in 2015 and 2016 growing seasons
- Total aerobic bacteria, total coliforms, and *Escherichia coli* enumerated
- Samples (250 mL) enriched for *Salmonella*
- Seventeen of the 20 ponds met the FSMA PSR standards for ag water
- Three ponds did not
  - because the statistical threshold value exceeded the limit
- Salmonella was detected in 19% of water samples in each year

Results

- p(Sal) = f(E. coli, Total)
- Farm C and E, ↑ *Salmonella* vs. farm A
  - These farms had “culls” located near some ponds
  - Culls attracted birds, rodents, etc.



How much to test?



Risk Analysis, Vol. 15, No. 3, 1995

Cost to save a life

- Red arrow (no brainer)
- Risk management (not easy)

Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness

Tammy O. Tengs,[1] Miriam E. Adams,[2] Joseph S. Pliskin,[3,6] Dana Gelb Safran,[4]

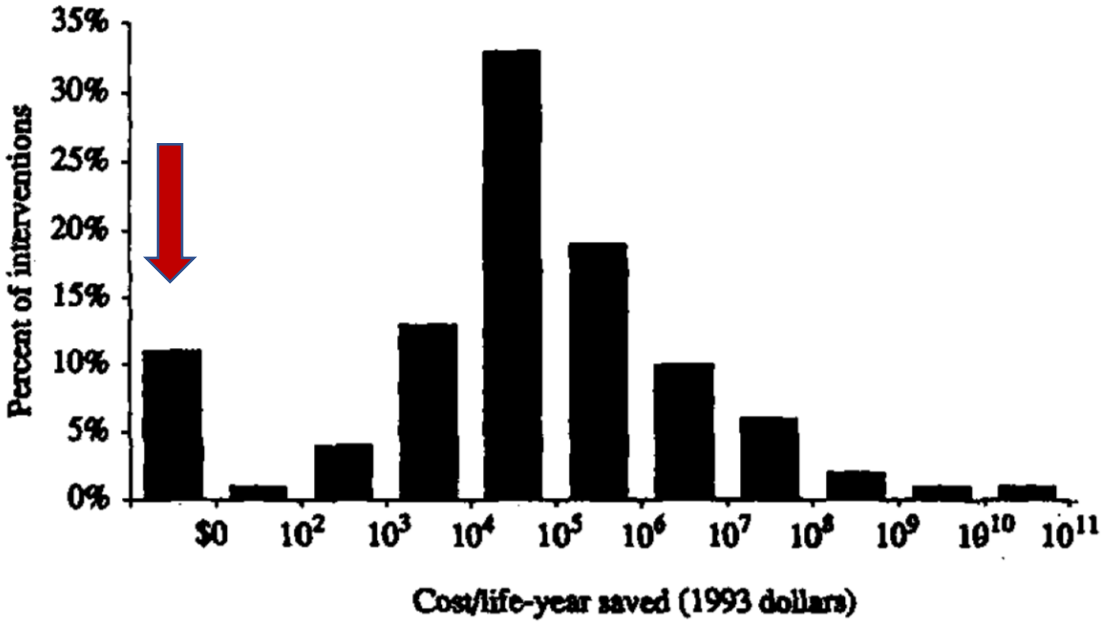


Fig. 1. Distribution of cost/life-year saved estimates (n = 587).

FDA economic analysis on testing

We believe that the cost of testing is justified based on the significant risk that agricultural water poses as a source of contamination and foodborne illness. FDA estimates that agricultural water provisions, as written in the final rule, will cost approximately $37 million dollars annually, which represents an average cost to a single farm of approximately $1,058 per year.

The agency anticipates the final rule will bring about a reduction of over 60 percent in the risk of contamination from agricultural water, or a reduction of about 20 percent in the total number of foodborne illnesses associated with produce, with a corresponding reduction of $477 million in the costs of foodborne illnesses.

Where do we go from here?

- Risk differs by source, delivery and application
  - Risk based thinking says: use this
- Testing can reduce risk
  - Risk based thinking says: use this
- Testing can tell you stuff (e.g. cull piles)
  - Risk based thinking (and common sense) say: use this!
  - One really high count might be allowed… but might be telling you something!
- Risk assessment vs. risk management
  - No such thing as “safe”
  - Try to reduce risk
- Be proactive – don’t wait for FDA