Combining Economics and Science in Benefit/Cost Analysis

Erik Lichtenberg
Department of Agricultural and Resource Economics
University of Maryland, College Park

Goals of Food Safety Regulation

- Achieve acceptable level of risk
- With adequate margin of safety against uncertainty
- At lowest possible cost

Tradeoffs

- How much risk is acceptable? (Complete safety not attainable!)
  - Risk to whom? Population risk vs. risk to random individual or individual from susceptible subpopulation?
- How much extra cost to incur guarding against uncertainty?
- Unintended consequences—do actions we take to mitigate one kind of risk increase risk/damage in other dimensions?

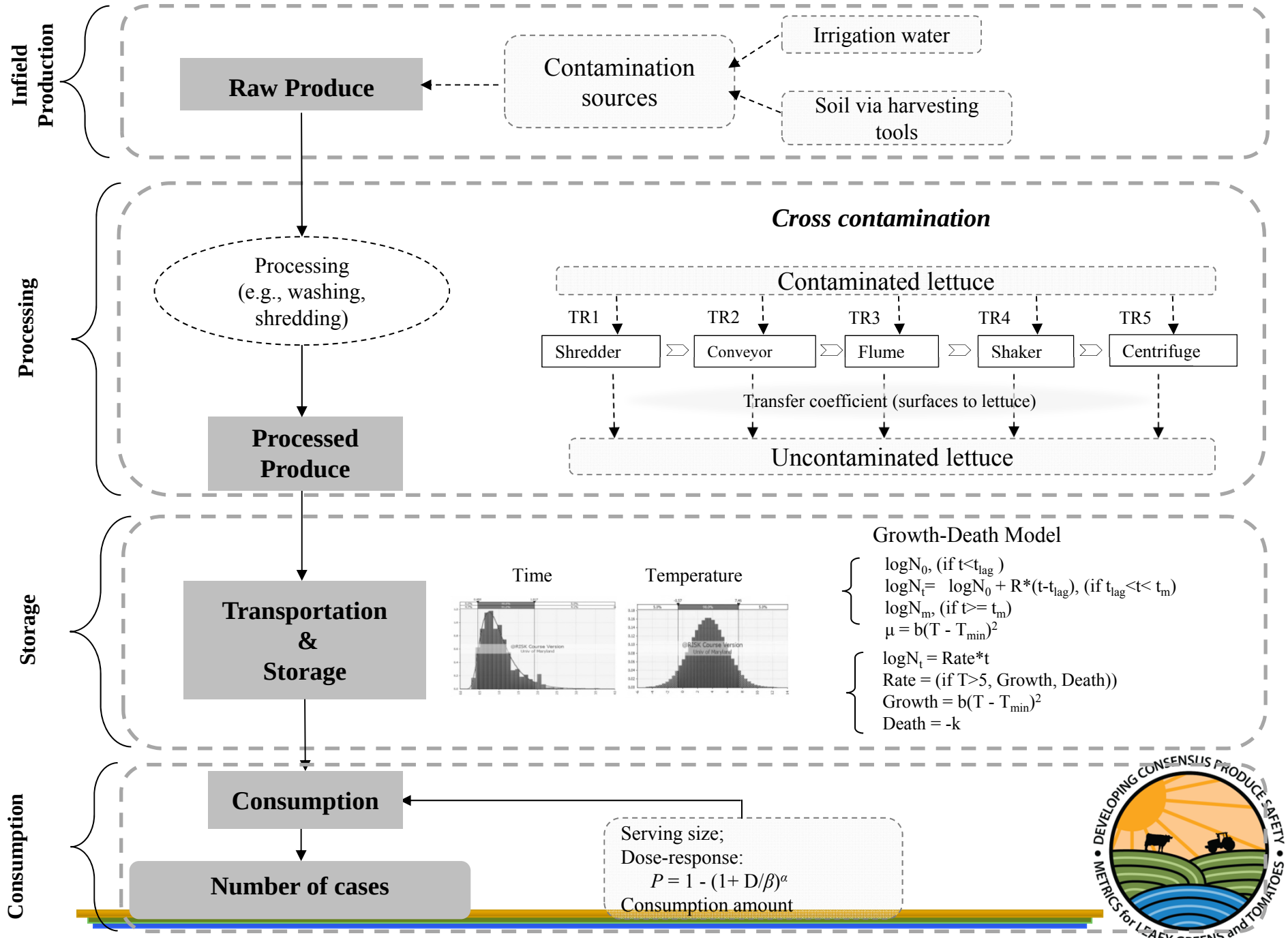
A model of uncertainty-adjusted cost of risk reduction (Lichtenberg and Zilberman)

- Minimize cost of actions aimed at different components of the risk generation process.
- Safety-first constraint specifying acceptable risk, weight on uncertainty about risk.
  - Weight on uncertainty = margin of safety.
- Varying acceptable risk level, margin of safety → uncertainty-adjusted cost curve for risk reduction.
- "Optimal" regulation requires comparing uncertainty-adjusted cost with uncertainty-adjusted benefit.
  - Margin of safety needs to be specified as well.

Implications of Cost-Minimizing Policy

- Attractiveness of any regulatory action depends on a combination of 3 factors:
  - Cost of action;
  - Reduction in expected risk;
  - Reduction in uncertainty about risk (which depends on absolute level of uncertainty as well as marginal reduction in uncertainty).
- May be optimal to use a portfolio of policies—some specializing in reducing risk on average, others in reducing uncertainty about risk.

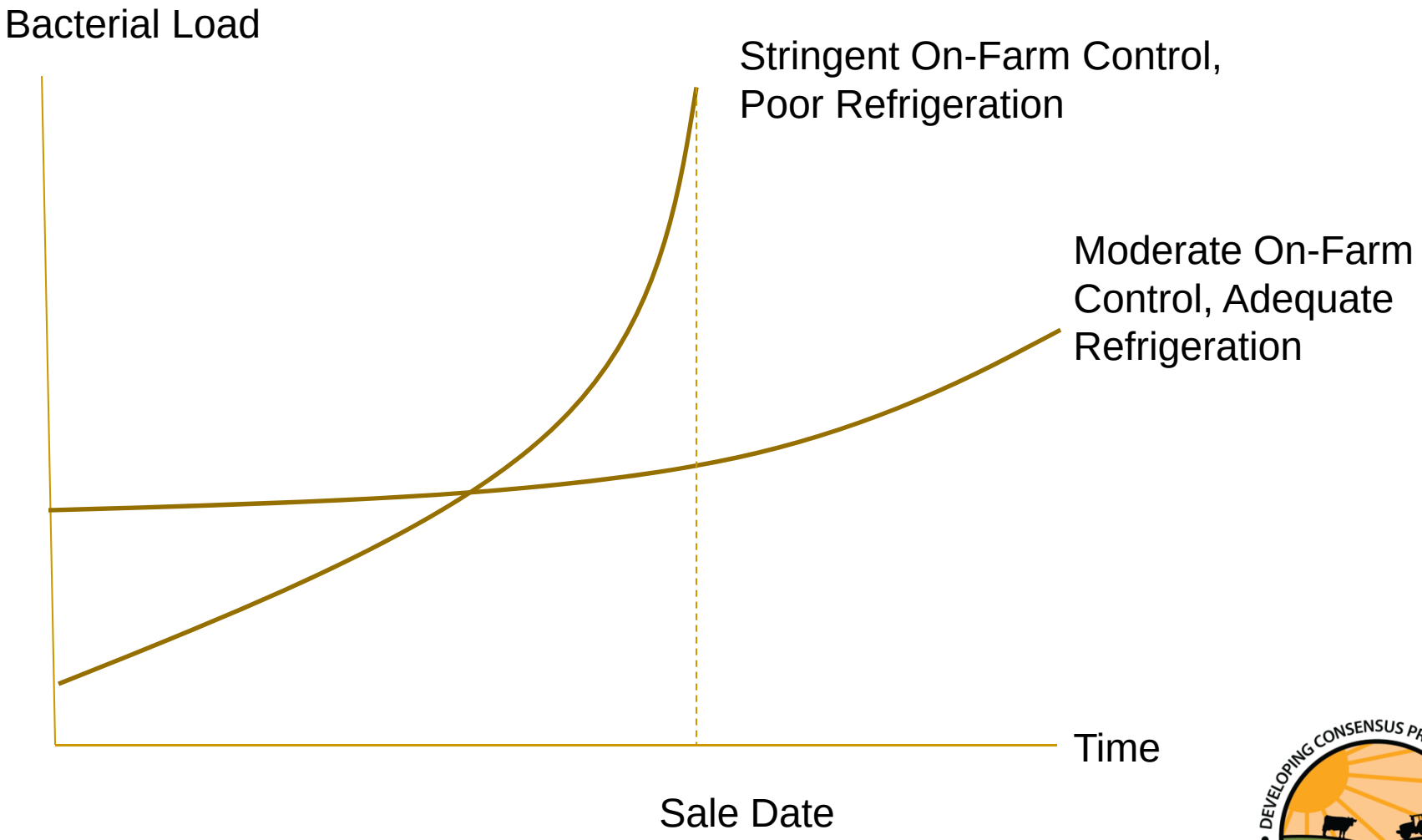
Example: Microbial Contamination of Leafy Greens (Hao and Pradhan, Danyluk and Schaeffer)


Infield Production
Raw Produce
Contamination sources
Irrigation water
Soil via harvesting tools
Processing
Processing (e.g., washing, shredding)
Processed Produce
Cross contamination
Contaminated lettuce
TR1
TR2
TR3
TR4
TR5
Shredder
Conveyor
Flume
Shaker
Centrifuge
Transfer coefficient (surfaces to lettuce)
Uncontaminated lettuce
Storage
Transportation & Storage
Time
Temperature
Growth-Death Model
$logN_0$, (if $t<t_{lag}$)
$logN_t = logN_0 + R*(t-t_{lag})$, (if $t_{lag}<t<t_m$)
$logN_m$, (if $t>=t_m$)
$\mu = b(T - T_{min})^2$
$logN_t$ = Rate*t
Rate = (if T>5, Growth, Death))
Growth = $b(T - T_{min})^2$
Death = -k
Consumption
Consumption
Number of cases
Serving size;
Dose-response:
$P = 1 - (1+ D/\beta)^{\alpha}$
Consumption amount
DEVELOPING CONSENSUS PRODUCE SAFETY METRICS for LEAFY GREENS and TOMATOES

Water Testing

- Studies from SCRI Food Safety Metrics:
  - Bacterial survivorship = 1-2 days.
  - Contamination more likely from soil splashed onto surface by rainfall.
- Implication: Frequent irrigation water testing may be very cost-ineffective (low reduction in risk on average and uncertainty about risk).

Tradeoffs and Incentives I



Tradeoffs and Incentives II

- Food safety as a team production problem—multiple agents contribute, separate contributions hard to separate.
- Product testing, record-keeping at each stage of supply chain can be used to "break up" the team, apportion liability in case of outbreak—at least to some extent.
- Equivalent to certification as means of mitigating adverse selection, moral hazard problems.

Tradeoffs and Incentives III

- At which stages of the supply chain does testing reveal useful information?
- How accurate does testing need to be—from either perspective?
  - If bacterial loads are low, probability of false negative will be high unless sample size is large.
  - But large sample size may be too punitive economically, especially for small growers.
- How much care should final consumers be required to exercise (moral hazard effect)?

Heterogeneity

- Costs, risk levels may vary among agents.
- Regulatory actions that are cost-effective for some size farms are not cost-effective for others.
- Example: Irrigation water, product testing for large versus small growers.
  - Preliminary results from Mid-Atlantic grower data imply elasticities of scale (crop acres) in testing = 0.43 (leafy greens), 0.80 (tomatoes).
  - Maximum tomato acres = 36X average, testing cost per acre = 49% of average.
  - Maximum leafy green acres = 12.5X average, testing cost per acre = 24% of average.
  - Small growers sell almost everything direct—not team production.
  - Higher costs, lower exposure from small growers ⇒ testing requirements likely <u>not</u> to be cost-effective.

Unintended Consequences

- Guarding against intrusion of wildlife → elimination of riparian vegetation, increase in erosion and elimination of habitat.
- Can these effects be foreseen? If so, how should they be incorporated?

Final Thoughts

- Team nature of production, difficulty of separating contributions of different agents make it difficult to harness market forces to ensure adequate food safety.
  - A complication: Victims may also bear some responsibility.
- Need to evaluate tradeoffs between cost, acceptability of risk, aversion to uncertainty.
  - Regulatory actions that have low levels of risk reduction and do little to mitigate uncertainty are likely not cost effective.
  - Cost effective regulations may be more stringent for some than others—not necessarily a level playing field across the supply chain or with a sector (e.g., scale). That may raise political problems.
- Combined economic/scientific analysis (e.g., SCRI Food Safety Metrics project) can help winnow out actions that are strictly dominated. But acceptability of risk, adequacy of margin of safety are social/policy decisions.