Animal Health Economics

“The discipline that aims to provide a framework of concepts, procedures and data to support the decision-making process in optimizing animal health management.”

Dijkhuizen, 1992, Modeling animal health economics, Wageningen Agricultural University
Industry Level Costs

• Mastitis costs the U.S. dairy industry about $1.7 to 2 billion annually

• SO WHAT!?!?!
Historic View

• “Cost of disease”
• Used for policy decisions to support importance of disease for research
• Limited to direct costs (i.e. production)
• Ignore global economic effects of disease reduction
• Generally over-predictions
• Reduce credibility in the minds of farmers
Primary Economic Impacts of Animal Disease

1. Reduction in level of marketable outputs
2. Reduction in (perceived or actual) output quality
3. Waste or higher use of inputs
4. Resource costs associated with disease prevention and control

Primary Economic Impacts of Animal Disease

5. Human health costs associated with diseases (zoonoses) or disease control

6. Negative animal welfare impacts associated with disease

7. International trade restrictions due to disease and its control

Private Versus Public Costs

• Private (farmer) costs easiest to estimate
• Public or society costs require models of entire economic systems
• Society costs may outweigh private costs
• Private cost estimates motivate change
• Society benefits from these changes
Animal Health Economics Research

• Quantifying the financial effects of disease

• Developing methods for optimizing decisions when individual animals, herds, or populations are affected

• Determining costs and benefits of disease control measures
Definitions

$C = L + E$

- **Costs ($C$):** represent all economic effects of disease
- **Loss ($L$):** benefit is taken away (discarded or unrealized milk, feelings/stress from death)
- **Expenditure ($E$):** extra inputs into production (drug costs, preventative measures)

The Loss Expenditure Frontier

- **Maximum Loss**
- **Minimum Level of Losses Attainable for Given Expenditure**
- **Economic Optimum**
- **Technical Optimum**
- **Technical Limit**

Loss-Expenditure Frontier Example

• Subclinical mastitis costs (£172.7 million annually in 1988)
• If everyone operated at the economic optimum, costs would be £159.6 million
• Thus, disease cost could be reduced by £23.1 million by using most efficient procedures

Costs of Mastitis

• Milk production losses
• Drugs
• Discarded milk
• Veterinary services
• Labor
• Product quality losses
• Materials and investments
• Diagnostics
• Culling
• Other diseases

What affects these costs?
Costs of Mastitis

- Parity
- Days in milk
- Value of the cow
- Price of milk
- Treatment
- Pathogen type
- Cure rate
- Multiple Cases
Challenges in Estimating Mastitis Economics

- Variation by country or region
  - Milk quota vs. Free market
  - Varying pricing strategies
  - Costs of drugs/veterinary services
- Changes in milk quality premiums
- Time value of money
- Difficult to obtain estimates for models
- Pathogen variation
- Farm variation
# Milk Production Losses (Lactation)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Mean Loss (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houben et al (1993)</td>
<td>31-128</td>
</tr>
<tr>
<td>Myllys and Rautala (1995)</td>
<td>32.8</td>
</tr>
<tr>
<td>Pedraza (1991)</td>
<td>749</td>
</tr>
<tr>
<td>Rajala-Schultz and Grohn (1999)</td>
<td>110-348</td>
</tr>
<tr>
<td>Houben et al (1993)</td>
<td>144-448</td>
</tr>
<tr>
<td>Wolf and Jahnke (1990)</td>
<td>205</td>
</tr>
<tr>
<td>Rajala-Schulz and Grohn (1999)</td>
<td>220-300</td>
</tr>
<tr>
<td>Firat (1996)</td>
<td>231</td>
</tr>
<tr>
<td>Pedraza (1991)</td>
<td>734</td>
</tr>
<tr>
<td>Rajala-Schultz and Grohn (1999)</td>
<td>387-509</td>
</tr>
<tr>
<td>Hoblet et al (1991)</td>
<td>75-206</td>
</tr>
<tr>
<td>Lescourret and Coulon (1994)</td>
<td>313</td>
</tr>
</tbody>
</table>

Seegers et al., 2003, *Vet. Research* 34:475-491
Cost of Culling

- Oversimplified methodology: difference between slaughter value and cost of replacement
- Correct methodology: retention pay-off
- Retention pay-off is the difference between:
  - The predicted future income of the animal in question
  - The predicted future income of her potential replacement
- Requires the use of simulation and/or dynamic programming
## Risk of Culling

<table>
<thead>
<tr>
<th>Reference</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaudeau et al (1994)</td>
<td>1.5</td>
</tr>
<tr>
<td>Beaudeau et al (1995)</td>
<td>1.3-4.0</td>
</tr>
<tr>
<td>Grohn et al (1998)</td>
<td>1.9-3.0</td>
</tr>
<tr>
<td>Rajala-Schulz et al (1999)</td>
<td>1.4-2.6</td>
</tr>
<tr>
<td>Beaudeau et al (1995)</td>
<td>1.2-1.7</td>
</tr>
</tbody>
</table>

Seegers et al., 2003, *Vet. Research* 34:475-491
Mortality

• *E. coli* and *Klebsiella sp.* more likely to cause death
• Estimated to be around 0.2%

Seegers et al., 2003, *Vet. Research* 34:475-491
Average Premium/Deduction for Varying SCC Levels

## Mastitis Costs (Per Case)

<table>
<thead>
<tr>
<th>Study</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaneene (1990)</td>
<td>$35.54</td>
</tr>
<tr>
<td>Miller (1990)</td>
<td>$40.00</td>
</tr>
<tr>
<td>Sischo (1990)</td>
<td>$27.32</td>
</tr>
<tr>
<td>Hillerton (1992)</td>
<td>$357.02</td>
</tr>
<tr>
<td>McInerney (1992)</td>
<td>$129.99</td>
</tr>
<tr>
<td>Miller (1993)</td>
<td>$38.00</td>
</tr>
<tr>
<td>Reinsch (1997)</td>
<td>$3.64</td>
</tr>
<tr>
<td>Kossaibati (1997)</td>
<td>$366.45</td>
</tr>
<tr>
<td>Fourichon (2001)</td>
<td>$33.24</td>
</tr>
</tbody>
</table>
Facts and Perception

- Dutch study
- Costs of mastitis calculated for 64 farms
- Farmer’s assessed losses at €78 ($123) per cow per year
- Modeled losses at €140 ($220) per cow per year
- To improve adoption of mastitis control techniques, true farm-specific losses must be shown

Huijps et al., 2008, Journal of Dairy Research 75 113:-120
Treatment of Chronic Subclinical Intramammary Infections

- Compared 3-day versus 8-day lactation treatment to no treatment

Which is more profitable?

Treatment of Chronic Subclinical Intramammary Infections

- Compared 3-day versus 8-day lactation treatment to no treatment
  - 3 day-Net profit of €11.62 ($15.13)
  - 8 day-Net profit of €-21.83 (-$28.42)

National Mastitis Council Estimated Annual Losses Due to Mastitis

Losses per cow in herd:
- Reduced production, $121.65, 65%
- Discarded milk, $10.45, 6%
- Extra Labor, $1.14, 1%
- Treatment, $7.36, 4%
- Veterinary Services, $2.72, 1%
- Replacement cost, $41.73, 23%

Total = $184.40 (2010 = $259)

Stochastic Modeling

- Randomness considered
- Don’t always know *exact* inputs
- Culling and death risks vary by stage of lactation
- Prices vary
- Negative impact of disease varies
- Use published estimates within a distribution (5%, mean, 95%)
- Draw from distribution across a series of simulations
- Obtain an estimate with consideration of variation
Let’s Roll the Dice

<table>
<thead>
<tr>
<th></th>
<th>Simulation 1</th>
<th>Simulation 2</th>
<th>Simulation 3</th>
<th>Simulation 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Price</td>
<td>$22</td>
<td>$10</td>
<td>$15</td>
<td>$18</td>
</tr>
<tr>
<td>Corn Price</td>
<td>$2</td>
<td>$6</td>
<td>$4</td>
<td>$5</td>
</tr>
<tr>
<td>Alfalfa Price</td>
<td>$100</td>
<td>$220</td>
<td>$175</td>
<td>$157</td>
</tr>
<tr>
<td>Mastitis incidence</td>
<td>30%</td>
<td>25%</td>
<td>38%</td>
<td>42%</td>
</tr>
<tr>
<td>Milk losses (lbs per lactation)</td>
<td>50</td>
<td>800</td>
<td>200</td>
<td>1400</td>
</tr>
</tbody>
</table>

- We can roll the dice hundreds or thousands of times.
- Goal: What do things look like on average, when times are bad, and when times are good.
Mastitis Costs - Lactation=1

Min.=$133.65
Mean=$205.95
Max.=$315.86

Culling: $82.70
Days Open: $18.33
Discard Milk: $34.14
Labor: $1.50
Death: $6.49
Lost Milk: $20.00

Bewley et al. 2008
Mastitis Costs - Lactation ≥ 2

Min. = $111.73
Mean = $163.28
Max. = $250.73

Bewley et al. 2008
Tornado Diagram for Stochastic Factors Affecting Mastitis Cost (P≥2)

- Milk Price: $13.03
- Milk Loss: $10.55
- Feed Cost: -$5.41
- Replacement Price: $4.76
- Milk Discarded: $4.27
- Days Open: $2.80
- Labor (Hours): $1.97
- Veterinary and Drug: $1.84
- Slaughter Price: -$1.33

Bewley et al. 2008
Tornado Diagram with Additional Variables

@RISK Student Version
For Academic Use Only

Baseline = 190.47
Conclusions

• Mastitis has a major impact on dairy farm profitability

• No consensus as to the magnitude of this impact

• Impact varies by mastitis pathogen

• Impact varies by specific country and farm conditions

• Most of the impact of mastitis is “invisible”
Benefits of Increased Efforts in Animal Health Economics

- Economics motivate change
- Improved product quality
- Improved farmer well-being
- Improved animal well-being
- Reduction in societal costs of controlling animal disease