When to Use Gender-Biased Semen: Economics

Victor E. Cabrera, DCRC Nov. 13-14 & 19-20, 2009
Introduction

• Gender-biased = sexed semen = sex-sorted semen

• Sexed semen = ↑ Female Calf Ratio

• Sexed semen economically attractive

• Sexed semen = ↓ Fertility

• Consequently, sexed semen has an increased proportion of females, but with a lower CR
Introduction

• Decision should be based on careful economic analysis

• A number of other factors impact the economics

• Sexed semen could be used with any open cow

• However, it seems to be more appropriated for virgin heifers

• Wisconsin dairy producers are using it with virgin heifers in first and second services
Objectives

- Propose a methodological framework to evaluate systematically the economics of sexed semen
- Document the latest biological and economic parameters to perform the evaluation
- Assess the economic value of sexed semen on heifers
- Transform the analysis framework into a user-friendly decision support system
• Partial budgeting of survival curves using net present values (NPV) to estimate the economic value (EV) of sexed semen programs

• Partial budgeting = additional revenues, additional costs, revenues foregone, reduced costs

• NPV = Fair comparison between conventional sexed semen programs

• EV = Difference of sexed and conventional semen
• Assumption 1: The reproductive program starts on 14-mo old heifers (420 d age)

• Assumption 2: Producers will attempt up-to 5 consecutive reproductive services on virgin heifers (Kuhn et al., 2006)

• Treatments: Sexed semen used in 1, 2, 3, 4, and 5 consecutive services.

• Control: Conventional semen
• Calculation of the EV:

\[ EV = NPV(X) - NPV(NX) \]

• Calculation of the NPV:

\[
NPV = \sum_{s=1}^{5} (\delta_s)(NPV_s) + (\delta_5)(HC - HR)(1 - PP_5)
\]

\( HC \) = heifer cull value; \( HR \) = value of a 20-mo pregnant heifer; \( PP_5 \) = proportion of pregnant heifers after the fifth service, \( \delta \) discount
Methodological Framework

- Calculation of the NPV after each service:

\[
NPV_s = CR'_s \times (CV - DC) - (1 - PP_s) \times MC - AIC
\]

- \( CR' \): conception rate achieved in service \( s \)
- \( CV \): Calf value dependent on heifer sex ratio
- \( DC \): Estimated dystocia cost
- \( MC \): Non-pregnant heifer maintenance
- \( AIC \): Cost of semen dose
• Survival curves calculated by conditional probabilities:

\[ PP_1 = CR_1' = CR_1 \]

\[ PP_s = PP_{s-1} + (1 - PP_{s-1}) \times CR_s \quad \text{for } s = 2 \text{ to } 5 \]

\[ CR_s' = PP_s - PP_{s-1} \quad \text{for } s = 2 \text{ to } 5 \]

• Concept of “Overall EV”:

\[
\text{Overall EV} = \left( \sum_{t=1}^{5} \sum_{CR=1}^{3} \text{EV}_{t,CR} \right) / (5 \times \text{trt} \times 3 \times CR)
\]
- Conventional CR: 34% (low), 56% (avg.), 83% (high) (DeJarnette et al., 2009)

- Sexed semen CR: 80% of the conventional semen (DeJarnette et al., 2009)

- Decrease in CR: 2.5% points additional service (Kuhn et al., 2006)

- Conv. heifer calf rate: 46.7% (Silva del Rio et al., 2007)

- Sexed semen heifer calf rate: 89% (DeJarnette et al., 2009)
Economic Parameters

- **Premium paid for sex-sorted semen dose: $30**
  (Olynk and Wolf, 2007)

- **Female/Male calf value: $562 / $48**
  (Wisconsin USDA Market Report, 2008)

- **Dystocia cost: $28.53**
  (Dematawewa and Berger, 1997)

- **Male/Female dystocia cost: 1.57, $34.91 / $22.15**
  (Martinez et al., 1983)
## Other Economic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conventional and Sexed Semen</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance ($/d)</td>
<td>2.4</td>
<td>Zwald et al., 2007</td>
</tr>
<tr>
<td>Weight of a 20-mo non-pregnant heifer (kg)</td>
<td>505</td>
<td>NRC, 2001</td>
</tr>
<tr>
<td>Salvage value of 20-mo non-pregnant heifer ($/kg)</td>
<td>1.79</td>
<td>Wisc. USDA (2008)</td>
</tr>
<tr>
<td>Value of 20-mo pregnant heifer ($)</td>
<td>1,200</td>
<td>Wisc. USDA (2008)</td>
</tr>
<tr>
<td>Interest rate (%/yr)</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>
Analyses

- Calculation of Overall EV for baseline conditions
- Break-even
- Sensitivity
- Scenarios
- Optimal treatment
Results & Discussion

- Sexed semen justified for the first service for any CR (Overall EV = $30.10/heifer)

<table>
<thead>
<tr>
<th>Reproductive Program (Number of Sexed Semen Services)</th>
<th>Low CR (34%)</th>
<th>Average CR (56%)</th>
<th>High CR (83%)</th>
<th>Conventional CR for positive EV %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.5</td>
<td>49.3</td>
<td>100.0</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>-3.4</td>
<td>57.8</td>
<td>111.6</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>-23.1</td>
<td>46.4</td>
<td>96.1</td>
<td>41</td>
</tr>
<tr>
<td>4</td>
<td>-48.9</td>
<td>24.7</td>
<td>71.7</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>-78.5</td>
<td>-2.7</td>
<td>43.9</td>
<td>58</td>
</tr>
</tbody>
</table>
## Results & Discussion

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Overall EV ($/hfr)</th>
<th>Break-Even CR (%)</th>
<th>Number of Consecutive Services Positive EV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low CR (34 %)</td>
</tr>
<tr>
<td>Baseline</td>
<td>30.10</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>X Semen CR at 85 %</td>
<td>46.40</td>
<td>31</td>
<td>2</td>
</tr>
<tr>
<td>X Semen CR at 75 %</td>
<td>12.50</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>X Semen 95 % heifer ratio</td>
<td>52.40</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>X Semen 78 % heifer ratio</td>
<td>-10.90</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>Male calf value at $0</td>
<td>45.20</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Female calf value at $700</td>
<td>69.30</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Female calf value at $280</td>
<td>-50.10</td>
<td>59</td>
<td>0</td>
</tr>
<tr>
<td>Premium X semen at $40</td>
<td>1.1</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>Premium X semen at $20</td>
<td>59.1</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Dystocia cost at $42.8</td>
<td>32.40</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Dystocia cost at $14.27</td>
<td>27.70</td>
<td>31</td>
<td>1</td>
</tr>
</tbody>
</table>

* *Required CR for positive EV with 1 X semen service*
### Results & Discussion

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<th>Low CR (34 %)</th>
<th>Average CR (56 %)</th>
<th>High CR (83 %)</th>
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</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>1) X Semen CR at 85 %</td>
<td>1</td>
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<td>2) X Semen CR at 75 %</td>
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<td>3) X Semen to have 95 % heifer Calves</td>
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<td>2</td>
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<tr>
<td>4) X Semen to have 78 % heifer Calves</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>5) Male calf value at $0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6) Female calf value at $700</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>7) Female calf value at $280</td>
<td>None</td>
<td>None</td>
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<tr>
<td>8) Dystocia cost at $42.8</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>9) Dystocia cost at $14.27</td>
<td>1</td>
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<tr>
<td>10) X semen premium $40</td>
<td>None</td>
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<td>2</td>
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<td>11) X semen premium $20</td>
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<td>1) and 3)</td>
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<td>3) and 6)</td>
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Results & Discussion

![Graph showing expected value (EV) of heifers for different semen types and services. The graph compares conventional unsexed semen with sexed semen services. The expected values are represented in dollars with axes ranging from 30% to 85% and $0 to $120. The graph includes lines for 1 service sexed semen, 2 services sexed semen, and 3 services sexed semen, with each line representing different costs and expected values.]

- Conventional Unsexed-Semen CR
- 1 Service Sexed-Semen
- 2 Services Sexed-Semen
- 3 Services Sexed-Semen
• Maintenance cost ($2.4/d): -$1/+$0.1
• Salvage value ($1.79/kg): -$1/+$0.1
• Pregnant heifer value ($1,200): -2.84/+$100
• Dystocia cost ($28.53): +$1.44/+$10
• Premium of sexed semen ($30): -$14.50/+$5
• Discount rate (12%): -$0.1/+10%
Conclusions

• Gender-biased or sexed-semen has a higher economic value than conventional semen

• The single most important factor is the current or expected conventional semen heifer CR:
  • If the CR is between 31 and 44%, the optimal is to use sexed-semen for only first service
  • If the CR is above 44%, the optimal would be to use sexed-semen for the 2 first services
Conclusions

• Other important parameters in the decision: CR of sexed-sexed semen (+); expected proportion of female calves (+); female calf value (+); premium of sexed-semen (-)

• Other parameters will only have limited impact on the decisions
Conclusions

• Some other considerations:
  • Greater incidence of stillbirths
  • Longer gestation period
  • Faster genetic improvement possibilities
  • Implications for farm herd expansion
  • Decreased bio-security risks
  • Implications for US herd expansion
• Results not applicable for all farm and market conditions

• Every farm is different

• Market conditions are permanently changing

• Challenge: Provide the same analysis as a decision support system for practitioners or final users

• Spreadsheets are good and popular, but sometimes could deter users for a series of reasons
• Decision support system should be:
  • Visually attractive
  • Interactive
  • Robust
  • Preferably online
  • Self-contained
  • Scenario-driven

• Decision support system should have:
  • Secured calculations. Users characterize their situation by defining parameters
  • Clear instructions
  • Technical support available
Thanks

http://www.uwex.edu/ces/dairymgt/