Finances and returns for robotic dairies

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Introduction- Robotic milker usage is growing quickly

- According to estimates there are over 35,000 robotic milking systems (RMS) worldwide
- Sales of milking robots are growing rapidly with 5,180 units sold in 2014 (IFR Statistical Dept, 2015)
- Initially farms in countries with high milk prices, high labor costs and high yielding cows installed RMS (Lind et al., 2000)
- Improved lifestyle is the number one reason for installing robots
- Profitability of robotic milking systems must be considered
Potential AMS Advantages

Provides Data

- Milk production etc
- Over 100 measurements at every milking
- Timely decision making

Other benefits:

- Consistent milking routine
- Higher skilled labor
- Never late for work
- Never needs training
- Doesn’t need scheduling or holidays off
Potential challenges

• “Plug and play,” “Plug and pray,” or “Plug and pay”

• Low Return on Investment? (compared to what?)

• Obsolescence

• Repair costs

Adapted from Bewley, 2015
Outline

- Comparing profitability of robotic systems to parlor systems
  - Herd size effect
  - Milk production effect
  - Labor effect

- Keys to optimizing robot efficiency

http://z.umn.edu/RobotParlor
Cost/Value (small farms)

- Expensive – compared to what???
- Family dairy looking to expand
- Trade offs
  - labor (hired and family)
  - capital investment
  - lifestyle
- Choices:
  - low cost parlor – hired/family labor
  - modern parlor – hired/family labor
  - AMS – family labor
Cost/Value (larger farms)

- Do you need a new parlor?
- How much is the information worth?
- 2X vs 3X vs robot milking
- How much time is spent hiring, training and managing labor?
- Future labor availability
- Trade offs (what devil do you want to deal with?)
  - labor (hiring, training and managing)
  - repair costs
  - on call 24/7
  - trickier feeding management
Conventional farms have greater margin than robot farms

<table>
<thead>
<tr>
<th>Item</th>
<th>Robot</th>
<th>Conv</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross margin over direct costs</td>
<td>$231,542</td>
<td>$232,519</td>
<td>0.754</td>
</tr>
<tr>
<td>Total nonaccountable costs</td>
<td>$79,614</td>
<td>$65,025</td>
<td>0.002</td>
</tr>
<tr>
<td>Contractor labor</td>
<td>$21,783</td>
<td>$15,361</td>
<td>0.004</td>
</tr>
<tr>
<td>Utilities</td>
<td>$10,337</td>
<td>$8,788</td>
<td>0.021</td>
</tr>
<tr>
<td>Mach &amp; Equip maint &amp; ins</td>
<td>$28,088</td>
<td>$24,411</td>
<td>0.136</td>
</tr>
<tr>
<td>Land, Bldg, maint &amp; ins</td>
<td>$7,404</td>
<td>$5,371</td>
<td>0.104</td>
</tr>
<tr>
<td>Avail for overhead &amp; profit</td>
<td>$151,198</td>
<td>$167,494</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Bijl et al, 2007, JDS, 90:239-248
On a FTE-basis, robots have greater margin than conventional farms

<table>
<thead>
<tr>
<th>Item</th>
<th>Robot</th>
<th>Conv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows/FTE</td>
<td>74</td>
<td>59</td>
</tr>
<tr>
<td>Total revenues/FTE</td>
<td>$206,378a</td>
<td>$164,250b</td>
</tr>
<tr>
<td>Total costs/FTE</td>
<td>$57,796</td>
<td>$48,463</td>
</tr>
<tr>
<td>Margin on dairy production/FTE</td>
<td>$148,582a</td>
<td>$115,787b</td>
</tr>
<tr>
<td>Gross margin/FTE</td>
<td>$163,056a</td>
<td>$127,939b</td>
</tr>
<tr>
<td>Avail for overhead &amp; profit/FTE</td>
<td>$101,372</td>
<td>$88,429</td>
</tr>
</tbody>
</table>


\[a, b\) Difference within row \((P < 0.05)\]
FinBin Data indicates that robot farms have higher costs, but greater milk production per cow and FTE

<table>
<thead>
<tr>
<th>Item</th>
<th>Robot</th>
<th>Conv</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk/cow, lb</td>
<td>23,532</td>
<td>21,526</td>
<td>+2006</td>
</tr>
<tr>
<td>Milk per FTE, lb</td>
<td>2,206,100</td>
<td>1,542,900</td>
<td>+663,200</td>
</tr>
<tr>
<td>Feed cost/cwt milk</td>
<td>$9.57</td>
<td>$10.25</td>
<td>-$0.68</td>
</tr>
<tr>
<td>Direct cost/cow/yr</td>
<td>$3,261</td>
<td>$3,189</td>
<td>+$72</td>
</tr>
<tr>
<td>Overhead cost/cow/yr</td>
<td>$898</td>
<td>$558</td>
<td>+$340</td>
</tr>
<tr>
<td>Net Return/cow/yr</td>
<td>$406</td>
<td>$483</td>
<td>-$77</td>
</tr>
<tr>
<td>Dep + Int/cow/yr</td>
<td>$547</td>
<td>$253</td>
<td>+$249</td>
</tr>
</tbody>
</table>

U of MN Finbin [www://finbin.umn.edu](http://finbin.umn.edu), data from 2011-2015
# Assumptions consistent across all scenarios

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chore labor rate</td>
<td>$16.00/hour</td>
</tr>
<tr>
<td>Management labor rate</td>
<td>$25.00/hour</td>
</tr>
<tr>
<td>Milk Price</td>
<td>$7.71/kg ($17.00/cwt)</td>
</tr>
<tr>
<td>Cost per kg/DM</td>
<td>$0.050/kg ($.011/lb)</td>
</tr>
<tr>
<td>Loan interest rate</td>
<td>5%</td>
</tr>
<tr>
<td>Equity interest rate</td>
<td>5%</td>
</tr>
<tr>
<td>Weighted avg cost of capital</td>
<td>3%</td>
</tr>
<tr>
<td>Loan term on barn</td>
<td>20 year</td>
</tr>
<tr>
<td>Loan term on robot</td>
<td>10 year</td>
</tr>
</tbody>
</table>
240 cow scenario assumes 4 robots and D8 parlor

**Investment**¹
- Robot (4) $2,400,000
- Parlor (D8) $1,352,000

**Milking Labor**
- Robot (45 m/r/d) 2.5 hr/d
- Parlor (64 c/hr) 2X - 16 hr/d 3X – 24 hr/d

¹Includes new barn cost
Four robot system compared to D8 Parlor

Net Annual Impact (Robot – Parlor)

1% wage inflation  2% wage inflation  3% wage inflation

14589  17765  21328

5967  10987  16445

240 cows 2X milking  240 cows 3X milking

Robot milk per cow +5 lb/day for 2x milking and -2.0 lb/d for 3X milking

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1500 cow scenario assumes 25 robots and D24 parlor

**Investment**
- Robot (25)  
  $13,750,000
- Parlor (D24)  
  $6,786,000

**Milking Labor**
- Robot (45 min/RMS/d)  
  16.75 hr/d
- Parlor (200 c/hr)  
  81.2 hr/d
Net annual income for a 1500 milking cow dairy - 25 robots compared to D24 parlor

Net Annual Impact (Robot – Parlor)

1% wage inflation

Robot -2.0 lb m/c/d $162,672

Robot +0 lb m/c/d $147,542

2% wage inflation

Robot -2.0 lb m/c/d $111,210

Robot +0 lb m/c/d $96,080

3% wage inflation

Robot -2.0 lb m/c/d $80,672

Robot +0 lb m/c/d $60,571
Breakeven labor rate for 1500 milking cow dairy - 25 robots compared to D24 parlor

- **1% wage inflation**: Robot -2.0 lb m/c/d - $32.30; Robot +0 m/c/d - $27.23
- **2% wage inflation**: Robot -2.0 lb m/c/d - $29.59; Robot +0 m/c/d - $24.95
- **3% wage inflation**: Robot -2.0 lb m/c/d - $27.05; Robot +0 m/c/d - $22.91
Milk production and wage inflation affect annual impact

25 robot system compared to D24 Parlor
Affect of labor and lifespan on annual profitability per robot for 4 robot system

<table>
<thead>
<tr>
<th>Robot lifespan (years)</th>
<th>8</th>
<th>10</th>
<th>13</th>
<th>15</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected Milking Labor (min/robot/d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>($9045)</td>
<td>($6223)</td>
<td>($3475)</td>
<td>($2167)</td>
<td>($1103)</td>
</tr>
<tr>
<td>45</td>
<td>($9526)</td>
<td>($6717)</td>
<td>($3989)</td>
<td>($2694)</td>
<td>($1644)</td>
</tr>
<tr>
<td>60</td>
<td>($10,489)</td>
<td>($7706)</td>
<td>($5016)</td>
<td>($3748)</td>
<td>($2725)</td>
</tr>
</tbody>
</table>

Projected Milking Labor (min/robot/d) for different robot lifespans and labor requirements:
- **2 lb/cow/d decrease in milk yield**
- **No change in milk yield**
- **2 lb/cow/d increase in milk yield**

New robot investment only – no new barn investment
Affect of production and useful life on annual profitability for 4 robot system

10 year robot useful life (3 robot installations)
- Robot +4 lb milk/cow/d
- Robot +6 lb milk/cow/d
- Robot +10 lb m/cow/d

15 year robot useful life (2 robot installations)
- Robot +4 lb milk/cow/d
- Robot +6 lb milk/cow/d
- Robot +10 lb m/cow/d

Net Annual Impact

- $8,000
- $6,000
- $4,000
- $2,000
- $0
- $2,000
- $4,000
- $6,000
- $10,000

New robot and barn investment – 30 year barn life
Milk per robot
Farms averaged over 2 tons of milk per robot

Average = 4,325
Net Annual impact by milk yield per robot\(^1\)

Net Annual Impact compared to 4000 lb/robot/d

Net Annual Impact compared to 4000 lb/robot/d

\(^1\)Net annual impact per robot compared to 4000 lb/robot/d
High milk per robot is possible

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Milk Yield last 24hrs</th>
<th>Avg Yield Per Day Last 7 days</th>
<th>Milk Yield To Tank Last 24hrs</th>
<th>Avg Yield To Tank Per Day Last 7 days</th>
<th>Avg. Yield / Milking Last 24h</th>
<th>Milkings Last 24hrs</th>
<th>Divert Milking Last 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMS 1</td>
<td>6778.9</td>
<td>6399.7</td>
<td>6778.9</td>
<td>6388.2</td>
<td>39.9</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>VMS 2</td>
<td>6148.9</td>
<td>5915.7</td>
<td>6148.9</td>
<td>5830.9</td>
<td>41.3</td>
<td>149</td>
<td></td>
</tr>
<tr>
<td>VMS 3</td>
<td>6492.4</td>
<td>6131.8</td>
<td>6492.4</td>
<td>6131.8</td>
<td>40.1</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>VMS 4</td>
<td>6871.5</td>
<td>6319.4</td>
<td>6871.5</td>
<td>6255.0</td>
<td>40.4</td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>
A major factor affecting high yield per robot is high yield per cow.

There is a significant correlation between yield per cow and yield per RMS ($r = 0.83$)
Visits per day, milking speed cows per robot and concentrate per cow is associated with more milk per robot.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking visits per day</td>
<td>746.3</td>
</tr>
<tr>
<td>Milking speed</td>
<td>387.0</td>
</tr>
<tr>
<td>Cows per RMS unit</td>
<td>70.8</td>
</tr>
<tr>
<td>Concentrate per cow</td>
<td>92.8</td>
</tr>
</tbody>
</table>

Salfer and Endres, unpublished
## Milking time, speed

<table>
<thead>
<tr>
<th></th>
<th>Milking time (minutes)</th>
<th>Milking speed (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>5.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Minimum</td>
<td>4.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Maximum</td>
<td>6.3</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Salfer and Endres, unpublished
Residual feed, alley scraping and stall surface is associated with less milk per robot.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual feed per cow</td>
<td>-177.5</td>
</tr>
<tr>
<td>Alley scraping</td>
<td>-460.5</td>
</tr>
<tr>
<td>Stall surface</td>
<td>-394.6</td>
</tr>
</tbody>
</table>

Salfer and Endres, unpublished
Keys to increasing milk per robot

- High milk production per cow
  - Fetch early lactation cows more frequently to maximize lactation potential
  - Well balanced diets and excellent transition cow program
  - High reproductive efficiency
  - Excellent cow comfort
  - Low somatic cell count

- Minimize box time per cow
  - Cows that attached fast
  - Cows that milk fast
  - Carefully thought out milking permission settings
    - Each 5 seconds more/milking = one less cow

- Minimize free time
  - May increase the number of fetch cows in free flow systems
Reduced box time per cow

- Select for cows that milk and attach fast
- Keep RMS equipment in top working condition
- Singe udders
- Trim tail switches
Milk per cow
Milkings per day, milking speed, concentrate and exit lane length is associated with more daily milk per cow.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking visits per day</td>
<td>14.8</td>
</tr>
<tr>
<td>Milking speed</td>
<td>7.5</td>
</tr>
<tr>
<td>Concentrate per cow</td>
<td>2.0</td>
</tr>
<tr>
<td>Length of exit lane</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Salfer and Endres, unpublished
Residual feed and failed milkings is associated with less daily milk per cow.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual feed per cow</td>
<td>-4.4</td>
</tr>
<tr>
<td>Failed milking visits/cow</td>
<td>-1.1</td>
</tr>
</tbody>
</table>

Salfer and Endres, unpublished
Summary

Main management factors affecting profitability include:

- Milk production per robot
- Milk production increases compared to other milking systems
  - Trading manual to more productive management labor
- Labor savings compared to other milking system option
Summary

Other factors include:

- Robot useful life
- Wage inflation
This material is based upon work supported by USDA-NIFA under Award Number 2015-49200-24226.