Feasible Production Targets in Pasture-based AMS Farms
Utsumi S., Straub H., Bronson J. and Nieman C.

Automatic milking systems (AMS)

- > 11,000 units world-wide (2010); > 500 North America; >15 in Michigan (2012)
- 50-60% new milking units in Europe are AMS
- New concept integrating voluntary milking of individual cows with the automation of all steps of the milking process

Cleaning  Attachment  Milking  Disinfection
Challenge 1: seasonal grazing

Alternatives:
- Low input seasonal dairies? (cash flow, productivity, overall efficiency)
- Higher input dairies combining winter feeding plus grazing the remainder of the year

<table>
<thead>
<tr>
<th>Season</th>
<th>Confinement</th>
<th>Pasture-based</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean temp., °C</td>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>Mean precip., mm</td>
<td>77</td>
<td>46</td>
</tr>
</tbody>
</table>

Challenge 2: High Producing Cows

Graphs showing milk production and body weight changes over dim.
Robotic Milking Management: What milking frequency and density of cows per stall?

Goal: Optimize milking frequency per cow and number of cows per AMS to maximize milk yield per unit of milking time and milk production per robot.

Milk = a + b*(1-Exp(-c*interval))

Milking frequency?

Maximum milk/box time was 3.5-4 lb/minute regardless of the feeding system.
Milk yield per cow?

<table>
<thead>
<tr>
<th></th>
<th>FS</th>
<th>Milkings</th>
<th>Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>170</td>
<td></td>
<td>83</td>
</tr>
<tr>
<td>PMR_PC</td>
<td>172</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>PMR</td>
<td>175</td>
<td></td>
<td>55</td>
</tr>
</tbody>
</table>

Number of Cows?
KBS approach to Precision Grazing Management in pasture-based AMS

- Maximize forage utilization and conversion
  - Per area (stocking rate – growth rate)
  - Per cow (Forage intake)
  - Per lactation (Extending the grazing season)

- Maximize milk production from grass
  - Per area
  - Per cow
  - Per lactation

- Cow traffic
  - Milking frequency
  - Milking interval
  - Milking distribution
C-Dax Pasture growth rate – Forage Utilization 2010-2011

Average Growth Rate$_{March-November}$: 27.9 kg/d = SR$_{560-30\%Conc.}$ of 2.3 cows/ha

Pregrazing = 2400 lb/acre
Pregrazing = 1600 lb/acre
Ryegrass/white clover

Pregrazing 2000 lb/acre
Residual = 1200 lb/acre

Growth rate = 65 lb/acre/day
Growth rate = 25 lb/acre/day

Complementary Forage Systems...the next step.

By August 30, Forage Rape produced about 4,200 lb DM/acre and growth rate since emergency (July 20th) was 102 lb/acre. This was two times the growth rate of irrigated pasture (60 lb/acre) during same period.

Annual forage crops? Will they improve forage production and efficiency (water/nutrients) in pasture-based systems?
Traffic of cows through the AMS and achievement of distributed milkings in a day is critical.

This requires a proper milking barn design and pasture facility layout to facilitate animal movements in the system.
Traffic Management & Milking Intervals

Range:
- **Minimum interval**: minimum number of milkings per day and expected milk shield (high control!)
- **Maximum interval**: affected by cow traffic (Lower control?)

Traffic management in a two-way (A-B) grazing systems (12-h allocations)

Pasture: two mixtures; Ryegrass/White Clover & Orchardgrass/Fescue/Alfalfa/Clovers
System-based research on AMS and Grazing

- Two stocking rates
  - High: 3.8 cows/ha (1.5 cows/acre)
  - Low: 2.5 cows/ha (1 cow/acre)

- Two feeding system
  - Pasture & Conc only
  - PMR_PC (pasture/TMR) & Conc.

- Two genotypes
  - USAH: USA Holstein
  - NZF: New Zealand Friesian
Farmlet characteristics: Diet Composition (Grazing Season Only)

High Stock-High Feed (1.5 cow acre)
- Pasture: 12 kg DM (27 lb) (53%)
- Haylage: 4 kg DM (9 lb) (17%)
- Corn: 3 kg DM (7 lb) (14%)
- Pellet: 3 kg DM (7 lb) (14%)

Total Intake: 22 kg DM (49 lb)

Low Stock-Low Feed (1 cow/acre)
- Pasture: 16 kg DM (36 lb) (78%)
- Corn: 3 kg DM (7 lb) (16%)
- Pellet: 1 kg DM (2 lb) (6%)

Total Intake: 20.5 kg DM (46 lb)
Stocking rate, feeding system and feeding system on forage utilization

Forage utilization kg/ha/year

Grazed paddock #

Stocking rate, feeding system and growth rates (GR)

Growth rate, kg/ha d-1

Grazed paddock #

PMR Feeding: 36 lb DM TMR/ha, 9.5 lb/cow or 4.3 kg/cow

Difference between the GR need and actual average GR is PMR supplementation
Yield, body weight, activity and rumination

KBS- High-High

KBS- Low-Low

Yield, milking frequency and AMS efficiency

KBS- High-High

KBS- Low-Low

Similar efficiency with the two diets 3.5-4 lb/min of BoxTime
Milk speed is a critical component of AMS efficiency

**KBS- High-High**

\[ y = 0.8757x - 0.1595 \]

\[ R^2 = 0.9173 \]

**KBS- Low-Low**

\[ y = 0.6686x + 0.2283 \]

\[ R^2 = 0.9207 \]

Conclusion: increases in milk speed may offer opportunities to further improve robotic milking efficiency in pasture-based diets.

**Milk Production and Feed Intake**

**KBS-High-High** had greater feed intake and milk production per cow as we expected, but the AMS milking efficiency and overall stall occupancy was similar between the two groups.
Feed Conversion Efficiency and Productivity

Similar feed conversion efficiency between groups but **KBS High-High** resulted in greater productivity of butter fat per area.

Effect of stocking rate and feeding system on the distribution of voluntary milkings in a AMS (Nieman, 2012)
Effect of Stocking Rate and Feeding System on Milking Intervals in a AMS

Genotype x Feeding system Hypothesis

USH: 1400 lb  NZF: 950 lb
Effect of Stocking rate and Feeding system on the performance of two contrasting genotypes (Nieman, 2012)

<table>
<thead>
<tr>
<th>Variable</th>
<th>High¹</th>
<th>Low²</th>
<th>P &lt; *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US³</td>
<td>NZ⁴</td>
<td>US</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>27.24a</td>
<td>14.46b</td>
<td>28.6a</td>
</tr>
<tr>
<td>FPCM⁵, kg/d</td>
<td>24.87a</td>
<td>15.22b</td>
<td>26.37a</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kg/d</td>
<td>0.8a</td>
<td>0.48b</td>
<td>0.89a</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kg/d</td>
<td>0.97a</td>
<td>0.65b</td>
<td>1.01a</td>
</tr>
<tr>
<td>ADG, kg</td>
<td>9.05a</td>
<td>3.04b</td>
<td>13.16a</td>
</tr>
<tr>
<td>Milking Freq.⁸</td>
<td>2.38a</td>
<td>2.22b</td>
<td>2.65a</td>
</tr>
<tr>
<td>Milking Interval⁹</td>
<td>10.48ab</td>
<td>11.23a</td>
<td>9.23b</td>
</tr>
<tr>
<td>Refusals/d¹⁰</td>
<td>0.89b</td>
<td>1.53ab</td>
<td>1.83a</td>
</tr>
</tbody>
</table>

¹ (Low) Low Stocking Rate; ² (High) High Stocking Rate; ³ (USH) United States Holstein; ⁴ (NZF) New Zealand Friesian; ⁵ Genotype

Effect of Stocking rate and feeding system on the intake and feed conversion of two genotypes (Nieman, 2012)

<table>
<thead>
<tr>
<th>Variable</th>
<th>High¹</th>
<th>Low²</th>
<th>P &lt; *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US³</td>
<td>NZ⁴</td>
<td>US</td>
</tr>
<tr>
<td>Tot. Intake, kg</td>
<td>22.65 a</td>
<td>16.35b</td>
<td>21.99 a</td>
</tr>
<tr>
<td>Conc. Pellet, kg</td>
<td>4.56 a</td>
<td>2.45 b</td>
<td>4.43 a</td>
</tr>
<tr>
<td>Conc. Corn, kg</td>
<td>0.79 a</td>
<td>0.95 a</td>
<td>1.15 a</td>
</tr>
<tr>
<td>Forage Intake, kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(haylage + pasture)</td>
<td>17.3 a</td>
<td>12.95 b</td>
<td>16.41 a</td>
</tr>
<tr>
<td>FCE⁶</td>
<td>1.21 a</td>
<td>1.04 b</td>
<td>1.26 a</td>
</tr>
<tr>
<td>Total intake, %BW⁷</td>
<td>3.99 a</td>
<td>4.2 a</td>
<td>3.93 a</td>
</tr>
</tbody>
</table>

¹ (Low) Low Stocking Rate; ² (High) High Stocking Rate; ³ (USH) United States Holstein; ⁴ (NZF) New Zealand Friesian; ⁵ Genotype; ⁶ Feed conversion efficiency
Effect of Breed on distribution of voluntary milkings in a AMS (Nieman, 2012)

Conclusion: breeds complemented each other by utilizing the milking stall more evenly and efficiently

Conclusion Remarks

Design and manage your AMS-pasture dairy around realistic and clear production goals per AMS, per area and per cow
Acknowledgements

• Pasture Executive Committee: Dr. Kay Gross, Dr. Janice Swanson (Dr. Karen Plaut), Dr. Douglas Bhuler, Dr. Dr. John Baker, Dr. Michael Hamm, Dr. Stephen Lovejoy

• KBS dairy staff: Jim Bronson, Rob Ashley, Mat Haan, Rick Lawrence, Shannon Kimbrue, Larry Langshaw, Mat Pixley, Rob Lawrence, Dan Carlson, Jennifer Lawrence and Sara Holm

• Lab team: Kate Steensma (MS), Christine Nieman (MS), Anais Fauchille (PURPAN, France), Thelma Mohamad (Andrews Univ.), Priscilla Montenegro (EARTH, Costa Rica), Sophie Rieux (PURPAN, France), Dr. Jairo Mora Delgado (Assoc. Prof. Tolima Univ., Colombia), Jhony Flores (EARTH), Luke Petersen (UCDavis)

Thank you !