Jeffrey Bewley, PhD, Extension Dairy Specialist

Amanda Stone, Randi Black, Barbara Wadsworth, Di Liang, Karmella Dolecheck, Matthew Borchers, Lauren Mayo, Nicky Tsai, Maegan Weatherly, Melissa Cornett, Samantha Smith, Megan Hardy, Jenna Klefot, Juha Hietaoja, Barbara Wolfger, Elizabeth Eckelkamp, Savannah Meade, Joey Clark, Denise Ray
The use of automated, mechanized technologies toward refinement of dairy management processes, or information collection.
Happy Cows via Technology?
Areas to Monitor a Dairy Cow

- Methane emissions
- Respiration
- Feed intake
- Chewing activity
- Heart rate
- Lying/standing behavior
- Animal position/location
- Hoof Health
- Mobility
- Milk content
- Fatness or Thinness
- Temperature
- Rumination/pH
- Mastitis
Ideal Technology

• Explains an underlying biological process
• Can be translated to a meaningful action
• Cost-effective
• Flexible, robust, reliable
• Simple and solution focused
• Information readily available to farmer
• Commercial demonstrations
So Many Options!!!!
Precision Dairy Farming Benefits

• Improved animal health and well-being
• Increased efficiency
• Reduced costs
• Improved product quality
• Minimized adverse environmental impacts
• More objective
SCR HR Tag for Milk Fever Detection

Milk fever identified on 8/11/11

Amanda Stone et al. , Unpublished Data
SCR Rumination Time

Klebsiella Mastitis Identified on 11/7/12

Minutes Ruminating per Day

Date

Amanda Stone et al., Unpublished Data
**Agis Health Alert**


Stone et al., Unpublished Data
IceQube Lying Time

Stone et al., Unpublished Data
DVM Systems Temperature and Milkline Individual Quarter Conductivity

Temperature (° Fahrenheit)

- **Temperature spike started on 6/30/11**
- **Klebsiella mastitis identified on 7/10/11**
- **Electrical Conductivity Alert on 7/5/11**
Estrus Detection
Estrus Detection

- Efforts in the US have increased dramatically
- Satisfaction closely tied to reproductive performance before investment
- Only catches cows in heat
- Balanced approach with selective hormone intervention
- Tag management, data management, and algorithms matter

GEA Rescounter II
SCR HR Tag/AI24
DairyMaster MooMonitor/SelectDetect
BouMatic HeatSeeker II
AFI Pedometer +
Track a Cow
Comparison of timed artificial insemination and automatic activity monitoring as reproductive management strategies in three commercial dairy herds

K.A. Dolecheck, W.J. Wilvia, G. Heersche Jr., C.L. Wood, K.J. McQuerry, and J.M. Bewley
Study Cows

• Three commercial Holstein herds in Kentucky
• No clinical metabolic diseases
• Veterinary check
  – Normal ovarian activity
• Body condition score ≥ 2.50

Dolecheck et al., 2014
Cow Treatment Allocation

- 90 d study period
  - No visual estrus detection
- Balanced for
  - Parity (primiparous or multiparous)
  - Predicted milk yield (above or below herd average)

Dolecheck et al., 2014
Timed Artificial Insemination (TAI)

- Combination of G7G, Ovsynch, and Resynch

- Up to three services (maximum possible in 90 d)

G7G Ovsynch

- PGF$_{2\alpha}$
- GnRH
- 2 d

- GnRH
- 7 d

- GnRH
- 7 d

- PGF$_{2\alpha}$
- GnRH
- 56 h

Resynch

- GnRH
- 7 d

- PGF$_{2\alpha}$ if open
- 56 h

- GnRH
- Pregnancy Diagnosis

- AI

Dolecheck et al., 2014
Automated Activity Monitoring (AAM)

• AfiTag Pedometer™ Plus (Afimilk®, Kibbutz Afikim, Israel)
  – Number of steps, rest time, rest bouts
  – “Cows to be bred” report

• Veterinary examination determined hormone intervention (PGF$_{2\alpha}$ or GnRH) if no alert was created for a cow for > 32 days

Dolecheck et al., 2014
Time to First Service

- Time to first service was significantly lower for TAI bred cows (15 d); the difference was greatest in Herd C

![Graph showing time to first service (d past VWP) for different treatments and herds, with significant differences indicated by letters a, b, and c, and a p-value of 0.01.](image)
• Service interval was shorter in AAM cows than TAI cows and shortest in primiparous AAM cows

Service interval (d)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Parity</th>
<th>Service interval (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAI</td>
<td>Primiparous</td>
<td>42.0</td>
</tr>
<tr>
<td>TAI</td>
<td>Multiparous</td>
<td>42.3</td>
</tr>
<tr>
<td>AAM</td>
<td>Primiparous</td>
<td>25.6</td>
</tr>
<tr>
<td>AAM</td>
<td>Multiparous</td>
<td>31.8</td>
</tr>
</tbody>
</table>

\[ P < 0.01 \]
Rate of Pregnancy

- No significant difference

Hazard Ratio = 0.97
$P = 0.78$

Proportion of Non-pregnant cows

Dolecheck et al., 2014
<table>
<thead>
<tr>
<th>Parameter</th>
<th>n</th>
<th>TAI</th>
<th>AAM</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>First service conception rate (%)</td>
<td>539</td>
<td>41.5 ± 3.2</td>
<td>41.7 ± 3.5</td>
<td>0.97</td>
</tr>
<tr>
<td>Repeat service conception rate (%)</td>
<td>293</td>
<td>41.5 ± 4.4</td>
<td>49.9 ± 5.3</td>
<td>0.12</td>
</tr>
<tr>
<td>Services per pregnancy</td>
<td>356</td>
<td>1.58 ± 0.06</td>
<td>1.55 ± 0.06</td>
<td>0.70</td>
</tr>
<tr>
<td>Pregnancy loss (%)</td>
<td>397</td>
<td>10.5 ± 2.3</td>
<td>7.1 ± 2.0</td>
<td>0.20</td>
</tr>
<tr>
<td>Days open (d past VWP)</td>
<td>356</td>
<td>31.3 ± 1.9</td>
<td>35.3 ± 2.0</td>
<td>0.13</td>
</tr>
<tr>
<td>Proportion pregnant at 90 d (%)</td>
<td>543</td>
<td>67.5 ± 3.1</td>
<td>68.3 ± 3.2</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Dolecheck et al., 2014
What Are the Limitations of Precision Dairy Farming?
PDF Reality Check

- Maybe not be #1 priority for commercial dairy producers (yet)
- Many technologies are in infancy stage
- Not all technologies are good investments
- Economics must be examined
- People factors must be considered
Technology Pitfalls

- “Plug and play,” “Plug and pray,” or “Plug and pay”
- Technologies go to market too quickly
- Not fully-developed
- Software not user-friendly
- Developed independently without consideration of integration with other technologies and farmer work patterns
Technology Pitfalls

• Too many single measurement systems

• Lack of large-scale commercial field trials and demonstrations

• Technology marketed without adequate interpretation of biological significance of data

• Information provided with no clear action plan
• Be prepared for little things to go wrong

• Be careful with early stage technologies

• Need a few months to learn how to use data

• Data integration is challenging
How Many Cows With Condition Do We Find?

Example: 100 estrus events

80 Estrus Events Identified by Technology

20 Estrus Events Missed by Technology

Example: 100 estrus events
How Many Alerts Coincide with an Actual Event?

90 Alerts for Cows Actually in Heat

10 Alerts for Cows Not in Heat

Example: 100 estrus events
What’s the Sweet Spot?

• Cost of missed event
  – High for estrus
  – Lower for diseases?

• Cost of false positive
  – Low for estrus
  – High for mastitis

• Farm dependent
The Book of David: Cow People Benefit Most
Why Have Adoption Rates Been Slow?

Rebecca Russell, 2013
Reason #1. Not familiar with technologies that are available (N = 101, 55%)
Reason #2. Undesirable cost to benefit ratio
(N = 77, 42%)
Reason #3. Too much information provided without knowing what to do with it
(N = 66, 36%)
Reason #4. Not enough time to spend on technology
(N = 56, 30%)
Reason #5. Lack of perceived economic value (N =55, 30%)
Reason #6. Too Difficult or Complex to Use (N =53, 29%)
Reason #7. Poor technical support/training (N =52, 28%)
Reason #8. Better alternatives/easier to accomplish manually
(N = 43, 23%)
Reason #9. Failure in fitting with farmer patterns of work (N = 40, 22%)
Reason #10. Fear of technology/computer illiteracy (N =39, 21%)
Reason #11. Not reliable or flexible enough
(N = 33, 18%)
Reason #99. Wrong College Degree
(N = 289, 100%)
Precision Dairy Technologies: A Producer Assessment

Matthew R. Borchers and Jeffrey M. Bewley
University of Kentucky
Department of Animal and Food Sciences
What do producers consider before purchasing one of these technologies?
Consideration #1.
Benefit: cost ratio
(4.57 ± 0.66)
Consideration #2
Total investment cost
(4.28 ± 0.83)

Matthew Borchers, 2014
Consideration #3. Simplicity and ease of use

$(4.26 \pm 0.75)$

Matthew Borchers, 2014
What parameters do producers find most useful in technologies?
Important Parameter #1. Mastitis
(4.77 ± 0.47)
Important Parameter #2
Standing heat
(4.75 ± 0.55)

Matthew Borchers, 2014
Important Parameter #3 Daily milk yield

(4.72 ± 0.62)

Matthew Borchers, 2014
Economic Considerations

- Need to do investment analysis
- Not one size fits all
- Economic benefits observed quickest for heat detection/reproduction
- If you don’t do anything with the information, it was useless
- Systems that measure multiple parameters make most sense
- Systems with low fixed costs work best for small farms
- Investment decisions for PDF technologies
- Flexible, partial-budget, farm-specific
- Simulates dairy for 10 years
- Includes hundreds of random values
- Measures benefits from improvements in productivity, animal health, and reproduction
- Models both biology and economics
NPV establishes what the value of future earnings from a project is in today's money.
Investment Analysis of Automated Estrus Detection Technologies

K.A. Dolecheck, G. Heersche Jr., and J.M. Bewley
University of Kentucky
Investment Analysis of Heat Detection Technologies

Heat detection is a major concern on many dairies today. Recently, technologies used to monitor activity levels and other cow parameters have been applied to manage heat detection.

This net present value tool can be used to compare up to 3 different heat detection technologies in order to determine which might work best economically on a specific dairy.

To use, change herd and technology information in the input tabs and then review the outcome in the "Results" and "Before vs. After" tabs.

Developed by Karmella Dolecheck and Jeffrey Bewley
Animal & Food Sciences Department
University of Kentucky College of Agriculture

Dashboard available at: www2.ca.uky.edu/afsdairy/HeatDetectionTechnologies
Putting your mouse over any of the buttons will give you a description of what information to insert.

**Herd Size**
- Min: 0
- Max: 10000
- Current Value: 170

**Cull Milk Yield (lbs/d)**
- Min: 0
- Max: 50
- Current Value: 35

**Milk Yield (lbs/d)**
- Min: $0.00
- Max: $40.00
- Current Value: 70.5

**Culling Rate**
- Min: 0
- Max: 50
- Current Value: 37.6

**Milk Price ($/cwt)**
- Min: 0
- Max: 50
- Current Value: 19.52

**Days in Milk Do Not Breed**
- Min: 0
- Max: 500
- Current Value: 300

**Feed Cost ($/lb DM)**
- Min: $0.00
- Max: $1.00
- Current Value: 0.09

**Voluntary Waiting Period**
- Min: 0
- Max: 100
- Current Value: 58.7

**Replacement Cost**
- Min: 0
- Max: 5000
- Current Value: 2280.67

**Current Heat Detection Rate**
- Min: 0
- Max: 100
- Current Value: 44.4

**Cull Cow Value ($/lb)**
- Min: 0
- Max: 1.5
- Current Value: 0.75

**Current 1st Service Conception Rate**
- Min: 0
- Max: 100
- Current Value: 43.5

Dashboard available at: www2.ca.uky.edu/afsdairy/HeatDetectionTechnologies
Dashboard available at: www2.ca.uky.edu/afsdairy/HeatDetectionTechnologies
Customer Service is Key

- More important than the gadget
- Computer literacy
- Not engineers
- Time limits
- Failure of hardware and software

"Can I return these?...They're nice and all, but they just scare the snot out of me."
Cautious Optimism

• Critics say it is too technical or challenging
• We are just beginning
• Precision Dairy won’t change cows or people
• Will change how they work together
• Improve farmer and cow well-being

“Opportunity is missed by most people because it is dressed in overalls and looks like work.” - Thomas Edison
Path to Success

• Continue this rapid innovation

• Maintain realistic expectations

• Respond to farmer questions and feedback

• Never lose sight of the cow

• Educate, communicate, and collaborate
Future Vision

• New era in dairy management
• Exciting technologies
• New ways of monitoring and improving animal health, well-being, and reproduction
• Analytics as competitive advantage
• Economics and human factors are key
Questions?

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