Precision Dairy Farming: What Have We Learned?

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The Future
NEXT EXIT
Technological Transformation

• Extension of other industries
• New dairy industry demands
  – Animal well-being
  – Consumer demands
  – Environmental pressure
  – Labor challenges
  – Economic competition
Cow Challenge Solutions

1. Finding cows in heat
2. Finding and treating lame cows
3. Finding and treating cows with mastitis
4. Catching sick cows in early lactation
5. Understanding nutritional status of cows
   a. Feed intake
   b. Body condition (fat or thin)
   c. Rumen health (pH/rumination time)
Happy Cows via Technology?
The use of automated, mechanized technologies toward refinement of dairy management processes, or information collection.
Areas to Monitor a Dairy Cow

- Fatness or Thinness
- Temperature
- Respiration
- Rumination/pH
- Feed intake
- Methane emissions
- Heart rate
- Chewing activity
- Lying/standing behavior
- Animal position/location
- Milk content
- Mobility
- Hoof Health
- Mastitis
## UK Coldstream Dairy Monitoring Capabilities

<table>
<thead>
<tr>
<th>Technology</th>
<th>Parameter(s) Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>SmartBow</td>
<td>Position, Movement</td>
</tr>
<tr>
<td>VelPhone</td>
<td>Calving Time, Vaginal Temperature</td>
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<tr>
<td>Alanya</td>
<td>Temperature, Lying Time, Activity, Locomotion, Behavior</td>
</tr>
<tr>
<td>AfILab</td>
<td>Fat, Protein, Lactose</td>
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<tr>
<td>Pedometer Plus</td>
<td>Lying Time, Steps</td>
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<tr>
<td>HR Tag</td>
<td>Rumination Time, Neck Activity</td>
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<tr>
<td>Track-a-Cow</td>
<td>Lying Time, Time at Feedbunk</td>
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<tr>
<td>Mastiline</td>
<td>Somatic Cell Count</td>
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<tr>
<td>CowManager Sensoor</td>
<td>Rumination Time, Feeding Time, Ear Skin Temperature, Activity</td>
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<tr>
<td>IceQube</td>
<td>Lying Time, Steps, Locomotion</td>
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<tr>
<td>Anemon</td>
<td>Vaginal Temperature, Estrus</td>
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<td>TempTrack</td>
<td>Reticulorumen Temperature</td>
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<tr>
<td>FeverTag</td>
<td>Tympanic Temperature</td>
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<tr>
<td>AccuBreed</td>
<td>Mounting Activity</td>
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<tr>
<td>CowScout</td>
<td>Leg Activity</td>
</tr>
</tbody>
</table>

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Precision Dairy Farming Benefits

- Improved animal health and well-being
- Increased efficiency
- Reduced costs
- Improved product quality
- Minimized adverse environmental impacts
- More objective
So Many Options!!!!
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
Technological Transformation

Associated Challenges
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
Murphy’s Law

Anything that can go wrong, will go wrong.
Sheldon's Friendship Flowchart (as Modified by Wolowitz)

Place Phone Call

Home

Would You Like to Share a Meal

No

Leave Message

What Is the Response?

No

Wait for Callback

Yes

Dine Together?

What Is the Response?

No

Do You Enjoy a Hot Beverage?

Yes

Case: Tea

Coffee

Cocoa

Have Tea

Have Coffee

Have Cocoa

Begin Friendship

Partake in Interest

Recreational Activities! Tell Me One of Your Interests?

n = No

ESC

n = 3

No

Do I Share That Interest?

Yes

Why Don't We Do That Together?
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
Labour and skills support

Management enhancement

Positive

Negative

Knowledge silos
Reducing skills and capability
Staff intimidated by IT

Wrong data, wrong decisions
Data overload
Overconfidence due to precise data
Poor connectivity between systems

Callum Eastwood, 2014
Accuracy and Precision
Sensitivity and Specificity

**Sensitivity** (true positive rate): alert with an observed mastitis case

\[
\text{Sensitivity} = \frac{\text{true positives}}{\text{true positives} + \text{false negatives}}
\]

**Specificity** (true negative rate): no alert with no mastitis

\[
\text{Specificity} = \frac{\text{true negatives}}{\text{true negatives} + \text{false positives}}
\]
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?

Example: 100 estrus events

90 Alerts for Cows Actually in Heat

10 Alerts for Cows Not in Heat
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
1331 had *Strep uberis* isolated from her LF and RF quarters on 11/29/11

Amanda Sterrett et al., Unpublished Data
SCR Rumination Time

Klebsiella Mastitis Identified on 11/7/12

Amanda Sterrett et al., Unpublished Data
Percent of cows above and below Z-score thresholds and varying alert time windows from udder quarters from clinical, subclinical, and mastitis-free cows

<table>
<thead>
<tr>
<th>Z-score threshold</th>
<th>Observation window (d)</th>
<th>Variable monitored</th>
<th>Subclinical mastitis</th>
<th>Clinical mastitis</th>
<th>No mastitis detected</th>
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<tr>
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<td></td>
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<td>% Above</td>
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RU = rumination time, NA = neck activity, and MY = milk yield.
From Purdue to Poor Due

Did I get the wrong PhD?
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%)
What do producers consider before purchasing one of these technologies?

Matthew Borchers, 2014
Consideration #1.
Benefit: cost ratio
(4.57 ± 0.66)
Consideration #2
Total investment cost
\((4.28 \pm 0.83)\)
Consideration #3. Simplicity and ease of use

\(4.26 \pm 0.75\)
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)
Important Parameter #3 Daily milk yield
(4.72 ± 0.62)
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
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