Automated Daily Analysis of Milk Components and Cow Behavior

Developing New Applications in The Dairy Herd

36th ICAR Session and Interbull Meeting 16-20 June 2008
Why Applications are Needed?

- Herd size increasing
- Sensors range and diversity is rising

=> Quantity of data increasing (resolution & innovative)

- Benefit for the end users? Applications

⇒ Research for developing applications is needed
Applicative Research in Firms
What are The Options?

- Applicative research ? R&D
- Research team – Experts
- Academic institutes and Research centers
Two New Advanced Sensors

- Afilab™ - Milk analyzer
- Pedometer+™ - Behavior meter
Milk Analyzer (Afilab™)

- Measures milk solids (fat, protein, lactose)
- Indication – SCC, Blood
- Technology – Optical characteristics of light scattering off matter
- On-line, In-line (each stall)
- Concept – amplifying laboratory periodically tests
Field Study - Material & Methods

S.A.E. Research Application Team (Schcolnik et. al.)

- Large commercial dairy farm (~800 milking cows)
- Analyzer data were recorded for each cow every milking
- Milk samples collected once a week – analyzed for solids and SCC - Israeli Milk Central Laboratory (Combi Milkoscan™, Foss)
- Blood samples for BHBA thrice weekly - fresh cows (1-21 DIM)
- Statistic analysis - JMP® 6, SAS
Derived Applications

- Control nutritional status – herd and groups
- Individual feeding
- Predictions (diagnosis) metabolic diseases
- Follow ups dairies’ milk payment
- Retrospective analysis
- Milk separation based on its quality
- Early detection of mastitis (under research)
Control nutritional status

- Milk components utilized with herd health program? rapid detection nutritional changes -> metabolic and reproduction problems (Eicher, 2004)

![Graph showing fat percentage changes from May to July](chart-fat.png)

-0.05% to 0.28%

![Graph showing protein percentage changes from May to July](chart-protein.png)

0.01% to 0.05%

Scholnik et al, 2007
• High importance – Management where supplement of additional concentrate feeding is needed (pasture, fresh cows, non homogenous groups)

NRC 2001 formula:

$$DMI_{(kg/day)} = (0.372*FCM^{0.75} + 0.0968*BW)*(1-e^{-0.192*(wol+3.67)})$$
Predictions (diagnosis) Metabolic Diseases

- Correlation between metabolic diseases and milk components

- Ketosis (NEB) – Fat/Protein Ratio (FPR) > 1.35-1.50 (Heuer et. al., 1999)

- SARA – FPR < 1.0 or more then 10% with fat < 2.5% (Tomaszewski and Cannon, 1993; Nordlund et. al., 2004)
Predictions of Ketosis – Through FPR

<table>
<thead>
<tr>
<th>FPR</th>
<th>BHBA &gt; 1.4 (31.3%*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensitivity (%)</td>
</tr>
<tr>
<td>&gt;1.2</td>
<td>59.3</td>
</tr>
<tr>
<td>&gt;1.4</td>
<td>33.3</td>
</tr>
<tr>
<td>&gt;1.6</td>
<td>11.1</td>
</tr>
<tr>
<td>&gt;1.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>

* % of cases with BHBA above threshold

Schcolnik et. al., 2007
Predictions of Ketosis – Multifactorial Approach

<table>
<thead>
<tr>
<th>FPR cut off</th>
<th>Model FPR + 3 SHI*2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensitivity</td>
</tr>
<tr>
<td>1.30</td>
<td>73.0</td>
</tr>
<tr>
<td>1.35</td>
<td>69.6</td>
</tr>
<tr>
<td>1.40</td>
<td>60.9</td>
</tr>
</tbody>
</table>

* SHI – “Sound Health Indicators”
2 Model FPR + activity, conductivity and urea (** 3/48, 125, 8.7, 17)

Livshin et. al., 2008
Milk Separation Based on Quality

- Separation based on Protein%, SCC, presence of Blood

![Diagram showing blood concentration over milking progress time](image)

- High Prot %
- Low fat %
- Good Quality Milk
- Blood, SCC
• Early Detection of Mastitis

- Correlation between udder health and milk components
- Lactose and conductivity two of the most promising parameters (Pyorala, 2003)

Mastitis – Case Report – Commercial Moshav Farm

![Graph showing lactose, milk, conductivity, and SCC over time]
Derived Applications

- Control nutritional status – herd and groups
- Individual feeding
- Predictions (diagnosis) metabolic diseases
- Follow ups dairies’ milk payment
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Behavior Meter (Pedometer+™)

- Records - activity (steps/hr), Lying time, Lying bouts
- Technology – 3 dimensional sensor
- Concept – determine routine behavior of the animal and pinpoint exceptions
- Animal Welfare & Comfort indication
<table>
<thead>
<tr>
<th>Study 1</th>
<th>Study 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Commercial dairy farm (550 MC)</td>
<td>• Volcani Center dairy farm</td>
</tr>
<tr>
<td>• 1\textsuperscript{st} trial – lying behavior (12 MP)</td>
<td>• 14 cows prior calving</td>
</tr>
<tr>
<td>• 2\textsuperscript{nd} trial – two different barns – free stall vs. no stall (8\times2 PP)</td>
<td>• 5 kg concentrates feed (1kg\times5) using CCSF</td>
</tr>
<tr>
<td>• 3\textsuperscript{rd} trial – changed over 4 cows from each group</td>
<td>• Activity, lying and feeding behavior – recorded last 7 days prior calving</td>
</tr>
<tr>
<td>• Student T-test</td>
<td>• T-test (each day vs. previous day)</td>
</tr>
</tbody>
</table>
Derived Applications

- Animal Welfare & Comfort assessment
- Detecting calving time of dairy cows
- Heat detection under unfavorable condition (tie stall, heat stress)
- Define the optimal stocking density
### Animal Welfare & Comfort Assessment

*Lying time (mean ± SD) in between milking diurnal intervals of 8 cows in no stalls barn and in free stall barn*  
(activity = 100%) = stable parameter

<table>
<thead>
<tr>
<th>Time interval</th>
<th>Lying Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No stall barn</td>
<td></td>
</tr>
<tr>
<td>Morning (04:00-12:00)</td>
<td>157±42 (29.4*)</td>
</tr>
<tr>
<td>Noon (12:00-20:00)</td>
<td>118±50 (22.1)</td>
</tr>
<tr>
<td>Night (20:00-04:00)</td>
<td>258±51 (48.4)</td>
</tr>
</tbody>
</table>

* % from daily lying time

From Livishin et. al., 2005
Animal Welfare & Comfort Assessment

Heat Stress (During Israeli Summer) – Case Report – Lying behavior Vs. Activity Whole Group Level – Commercial Moshav Farm
## Animal Welfare & Comfort Assessment

### Evaluation of housing management

**Changing of Lying Time (minutes) after transferred between 2 different housing barns**

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 1</th>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning (04:00-12:00)</td>
<td>No stall</td>
<td>Free stall</td>
<td>Free stall</td>
<td>No stall</td>
</tr>
<tr>
<td></td>
<td>153±41*&lt;sup&gt;a&lt;/sup&gt;</td>
<td>126±55</td>
<td>120±39*</td>
<td>178±55&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*<sup>p<0.01 of the same cows when transferred from one barn to the other</sup>

<sup>a</sup><sup>p<0.01 between groups (4 cows) inhabiting different barns within period</sup>

From Livishin et. al., 2005
Detecting Calving Time

- Cows behavior change prior to calving
  - Activity/Lying ratio in the last 7 days prior to calving
- Calving parameters
- Help
- Attention

* P< 0.01 day -1 vs. day -2

* P< 0.01 day -1 vs. day -2

Maltz and Antler, 2008

![Graph showing changes in activity and lying ratio](image)
Heat Detection in Unfavorable condition

Heat Detection – Case Report – Changing only in Lying Behavior

Maltz et. al.
Derived Applications

- Animal Welfare & Comfort assessment
- Detecting calving time of dairy cows
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Applications Derived from Interactions of Sensors

- Interaction between large range of data from varied sensors (Milk meter, Weight scale, Self feeders)
- Developing innovative models
- Developing new applications and improving established ones
- **Early** detection and **specify** of health, fertility and welfare problems
Summary

- Modern farm - Herd size increasing? Amount and range of data increasing
- Sophisticated applications are needed
- Applied research is required
- Two new advanced sensors were developed by S.A.E. Afikim

- The sky is the limit