Global worming in the dairy aspect

Sensor base cooling reduced heat stress in dairy cows

Harel Levit, Shlomi Goldshtein, Yehoshav Ben Meir, Alona Kleinjan-Elazary, Eran Gershon, Severino Pinto, Joshuah Miron, Ilan Halachmi
**Agenda:**

1. Project goals
2. Background
3. Sensor base cooling results
4. Conclusions and discussion
Project goals:

1. Study the individual cow heat stress response – sensor based

2. Transforming rumen temperature to vaginal temperature (Statistic model)

3. Design sensor base cooling method for forced cooling purposes (production/welfare)
Background:

Background:


Our threshold:

1. Body temperature over 39°C
2. Respiration over 80 per min
3. Feeding duration and DMI decreases in order to maintain normal thermoregulation. (Tian et al. 2016).

(Curtis, 1981)
Background:

Cooling management in Israel

1. Base on environmental temperature (THI)

2. Normal routine- time base (3-8)
Materials and Methods

2016: 8 cooling vs. 5 cooling per day

2017: Sensor-based cooling vs. pre-defined cooling (3 cooling)

1. ARO, Volcani, research dairy barn

2. (2016) 24 Holstein cows, 14 days
   (2017) 30 Holstein cows, 3 months

3. Data:
   • Rumen temperature (Reticulum bolus)
   • Vaginal temperature (i-button logger, cider)
   • Eating behavior (KG, duration)
   • Thermal humidity index (temperature, humidity, radiation, wind)
   • Severino Pinto ATB Germany (respiration, rectal temperature, HRV)

Cooling session: 1 min. shower and 4 min. fan x 9 times = 45 min
Materials and methods – algorithm (2016)

How to “exchange” vaginal with bolus temperatures?

\[
\sum_{i=1}^{n} [y_i - (\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij})]^2 + \lambda \sum_{j=1}^{k} |\beta_j| = \|Y - X\beta\|_2^2 + \lambda \|\beta\|_1
\]

- Cow: 3304
- RMSE: 0.128

Average Root Mean Square Error = 0.162°C

Borrowed from Shlomi Goldshtain
Master work
Materials and methods:
Vaginal temperature (2016)

Differences in two groups for three days

Vaginal temperature \( \text{C}^\circ \)

Day

0 0 1 1 1 1 1 2 2 2 3 3 3
Materials and methods:
Rumen VS vaginal temperature (2016)

Aggregate sensors differences along the day in the 8 cooling group

- V.temp
- B.temp
- Cooling

Temperature (°C) vs. Time in the day

0  20  40  60  80  100  120  140
Materials and Methods

sensor validation

Two different manufactures - in the lab
Two different bolus manufactures in a single cow

Materials and Methods

sensor validation

Repeat in 6 cows

0.3°C difference
Result: Animal response to sensor-based cooling changes (2017)
The preferred sensor-based cooling regime (2017)

- Green - THI
- Blue - time base
- Black - sensor base
Animal response to crossover experiment (2017)

Green - THI
Blue - sensor base
Black - time base
## Production performance

<table>
<thead>
<tr>
<th>Trait</th>
<th>TB (3 cooling)</th>
<th>SB (8 cooling)</th>
<th>SEM</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, kg/d</td>
<td>44.7</td>
<td>44.7</td>
<td>0.37</td>
<td>0.99</td>
</tr>
<tr>
<td>Milk Fat, %</td>
<td>3.46</td>
<td>3.72</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>Milk Protein, %</td>
<td>3.15</td>
<td>3.26</td>
<td>10.0</td>
<td>0.001</td>
</tr>
<tr>
<td>Milk Lactose, %</td>
<td>4.89</td>
<td>4.83</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>ECM, kg/d</td>
<td>41.3</td>
<td>42.8</td>
<td>0.30</td>
<td>0.001</td>
</tr>
<tr>
<td>FCM 4%, kg/d</td>
<td>41.0</td>
<td>42.7</td>
<td>0.30</td>
<td>0.001</td>
</tr>
<tr>
<td>ECM/DMI</td>
<td>1.59</td>
<td>1.53</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>RFI, kg DM/d</td>
<td>1.03</td>
<td>1.03</td>
<td>0.01</td>
<td>0.93</td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Milk solids (fat, protein) were more affected then the milk volume
<table>
<thead>
<tr>
<th>Trait</th>
<th>TB</th>
<th>SB</th>
<th>SEM</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3 cooling)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMI, kg/d</td>
<td>26.4</td>
<td>28.4</td>
<td>0.19</td>
<td>0.001</td>
</tr>
<tr>
<td>Eating rate, g DM/min.</td>
<td>131.6</td>
<td>142.6</td>
<td>1.72</td>
<td>0.001</td>
</tr>
<tr>
<td>Eating time, min./d</td>
<td>200.6</td>
<td>199.1</td>
<td>2.46</td>
<td>0.112</td>
</tr>
<tr>
<td>Valid visits/d</td>
<td>9.31</td>
<td>7.69</td>
<td>0.06</td>
<td>0.001</td>
</tr>
<tr>
<td>Visit duration, min.</td>
<td>23.7</td>
<td>28.1</td>
<td>0.33</td>
<td>0.001</td>
</tr>
<tr>
<td>Visit size, kg DM</td>
<td>2.83</td>
<td>3.80</td>
<td>0.05</td>
<td>0.001</td>
</tr>
<tr>
<td>Lying, Min./d</td>
<td>558.8</td>
<td>563.9</td>
<td>6.74</td>
<td>0.598</td>
</tr>
<tr>
<td>Pedometer, Steps/h</td>
<td>97.9</td>
<td>136.5</td>
<td>2.46</td>
<td>0.001</td>
</tr>
<tr>
<td>Body Weight, kg</td>
<td>639.6</td>
<td>656.4</td>
<td>2.54</td>
<td>0.001</td>
</tr>
<tr>
<td>Rumination, min./d</td>
<td>393.4</td>
<td>487.6</td>
<td>95.4</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Conclusion Exp. 2017:

- Higher milk solids
- Higher feed consumption
- Change in eating behavior
- Change in production
- Better thermoregulation
  (Av. 38.6°C)

Effective tool to manage the dairy’s cooling regime and ease cow’s heat stress.
Acknowledgment:

- This experiment was funded by the EU OptiBarn project and the Israeli Dairy Board.
- I thank ARO dairy team for their help.
- I thank SmaxTect – ProjectBar for the boluses.

For further information:

**Harel Levit**  
harelle@volcani.agri.gov.il

**Prof. Ilan Halachmi**  
halachmi@volcani.agri.gov.il
Discussion