Detection of early lactation ketosis by rumination and other sensors

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Outline

• Introduction
• Hypothesis
• Objectives
• Material & Methods
• Results
  ▫ Basic statistics
  ▫ Model Development - Calibration – Validation
• Discussion
• Conclusion
Introduction

- **Past**: livestock management decisions based only on human observation
Introduction

- **Last decades**: dairy farming → intensive production systems
Introduction

- Dairy farming in Israel
  - Israeli-Holstein
  - ~ 11500 kg milk/cow/year
Introduction

• Cow health
  ▫ All cows: Routine check 5 to 12 days after calving
  ▫ One main vet organization: 99 % cows
  ▫ Records collected on national level

• Many sensors
Introduction

• Large quantity of data signals in herd management software

• Many sensors - specific purposes
  → Give sensor data biological meaning

• GAP: combination sensor data hardly explored
Introduction

• Ketosis
  ▫ Early lactation
  ▫ 15 % of the cows in Israel

• Costs:
  ▫ Veterinarian
  ▫ Treatment
  ▫ Lost milk yield
  ▫ Labour
Hypothesis

• Ketosis$=\Delta$ behaviour and performance

• Sensors
  ▫ Ruminating time
  ▫ Neck activity
  ▫ Milk yield
Objectives

• Identifying post-calving ketosis by:
  ▫ Behavioural data (ruminating time, neck activity)
  ▫ Performance data (milk yield)

• Build model that can be applied in commercial farms as part of the herd management software
Material & Methods

• Sensor: HR-Tag (SCR Engineers Ltd)
  ▫ Cow Identification
  ▫ Ruminating time (min/2h)
  ▫ Neck activity (activity index/2h)
Material & Methods

• Data collection:
  ~ 2000 cows – commercial herds
  ▫ Big kibbutz farm: 1100 cows
  ▫ 4 smaller kibbutz farms: ca. 300 cows/farm

• Daily data – 2h data

• Start in November 2010
Material & Methods

• Golden standard: veterinarian
  ▫ Routine check 5 to 12 days after calving

• Procedure
  ▫ Ketosis → Ketostix test (measuring AcAc in urine)

• Treatment
  ▫ Drenching with propylene glycol
  ▫ Intravenous infusion in severe cases
Material & Methods

- Based on health reports and lactation curves:
  - Healthy cows
  - Ketotic cows
  - Excluded:
    - Cows with other health problems (metritis, mastitis, lameness, ...)
    - Cows without Ketostix test results
    - Cows with unexplained drop in milk yield
Preliminary Results - Rumination

Healthy: 45 cows
Ketotic: 45 cows
Preliminary Results - Neck Activity

Activity (activity index / 2h)

Healthy: 45 cows

Ketotic: 45 cows
Preliminary Results - Milk yield

Healthy: 45 cows

Ketotic: 45 cows
Objectives

- Identifying post-calving ketosis by:
  - Behavioural data (ruminating time, neck activity)
  - Performance data (milk yield)

- Build model that can be applied in commercial farms as part of the herd management software
Model: Development

• Stepwise logistic regression model
  ▫ Probability of being sick
    • \( f(z) = (1 + e^{-z})^{-1} \)
    • \( z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \)
  ▫ 2 model outcomes:
    • 0 – Healthy
    • 1 – Ketotic

• Variables: Ruminating Time, Neck Activity and Milk Yield
Model: Calibration

- 45 healthy and 45 ketotic cows

<table>
<thead>
<tr>
<th>Detected value</th>
<th>Reference value</th>
<th>Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketotic</td>
<td>37</td>
<td>5</td>
</tr>
<tr>
<td>Healthy</td>
<td>8</td>
<td>40</td>
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</tbody>
</table>
Model: Validation

- Ketotic: 89 cows
- Healthy: 144 cows
## Model: Validation

- **144 healthy and 89 ketotic cows**

<table>
<thead>
<tr>
<th>Days to diagnosis</th>
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<td>Sick</td>
<td>Healthy</td>
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<td>-2</td>
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<td>Healthy</td>
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<td>25</td>
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## Model: Validation

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<thead>
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<tr>
<td>1</td>
<td>83 %</td>
</tr>
<tr>
<td>2</td>
<td>70 %</td>
</tr>
<tr>
<td>3</td>
<td>91 %</td>
</tr>
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<td>4</td>
<td>67 %</td>
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<td>5</td>
<td>77 %</td>
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</tbody>
</table>

![Map with numbered locations](image)
Discussion

• Existing farm data
• Exact timing of disease is unsure
• After diagnosis and treatment: recovery

• Misclassified cases ~
  ▫ Subclinical ketosis (53 %)
  ▫ Environmental conditions
  ▫ Management practices
  ▫ …

• Improvements
  ▫ Other types of models (survival models, tree based models)
  ▫ Other sensors
Conclusion

• Ketosis $\Rightarrow$ behaviour and performance

• A model can be build

• Practical application: herd management software $\rightarrow$ automatic list of cows at risk for ketosis

Thank you!

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