Characterization of milk composition and somatic cell count estimates from automatic milking systems sensors

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Introduction

• >11% of milk recorded herds in Canada use AMS
• Increasing rapidly
• Many new installations include sensors for components and/or SCC
• Sampling for MR in AMS can be challenging
• Farmers are requesting that sensor data be considered
• Accuracy needs needs to be characterised for adequate use for
  • Management
  • Performance recognition programs/awards
  • Genetic evaluation
Objective

• The aim of this study was to characterise and compare the results from the AMS sensors and the milk-recording laboratory.
Protocol

- 10 herds with Lely AMS (MQC sensors)
  - Samples taken over a 24-h period
  - Laboratory samples: 24-hr weighted average
  - Comparisons of fat, protein, lactose and SCC from the AMS and the laboratory

- 4 herds with DeLaval AMS (OCC sensors)
  - 1 sample per cow was taken over a 12-h period
  - Comparisons of SCC from the AMS estimation and laboratory

- Samples were analysed in the Valacta laboratory for milk components and SCC (CombiFoss FT+, Foss, Hillerod, DK)
Materials and methods

- Data from the AMS was exported in Microsoft Excel
- Differences were calculated as: $\text{AMS - laboratory results}$
- Mean absolute error (MAE)
- Concordance correlation coefficient (CCC)
- Bland Altman analysis

- The CCC and the Bland Altman analyses quantify the agreement and the reliability between two quantitative measurements, and help establishing the validity of a new technique (Kwiecien et al., 2011; Giavarina, 2015).

R program version 3.4.1
(R Development Core Team, 2017)
Results

Bulk tank vs AMS

Herd C (CCC = 0.43)

Herd D (CCC = 0.74)
## Results

Mean differences and SD of milk components generated for the ten herds by the Lely AMS and the milk recording laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>% Fat</th>
<th>% Protein</th>
<th>% Lactose</th>
<th>Fat yield (kg/d)</th>
<th>Protein yield (kg/d)</th>
<th>SCC (cells/mL)</th>
<th>Linear score</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS</td>
<td>3.76</td>
<td>3.19</td>
<td>4.65²</td>
<td>1.63</td>
<td>1.40</td>
<td>71³</td>
<td>2.11</td>
</tr>
<tr>
<td></td>
<td>(0.57)</td>
<td>(0.21)</td>
<td>(0.11)</td>
<td>(0.40)</td>
<td>(0.33)</td>
<td>(145)</td>
<td>(0.87)</td>
</tr>
<tr>
<td>Laboratory</td>
<td>3.81</td>
<td>3.19</td>
<td>4.68</td>
<td>1.67</td>
<td>1.39</td>
<td>133</td>
<td>2.11</td>
</tr>
<tr>
<td></td>
<td>(0.55)</td>
<td>(0.28)</td>
<td>(0.16)</td>
<td>(0.40)</td>
<td>(0.30)</td>
<td>(340)</td>
<td>(1.68)</td>
</tr>
<tr>
<td>Differences</td>
<td>-0.05</td>
<td>-0.001</td>
<td>-0.04</td>
<td>-0.04</td>
<td>0.01</td>
<td>-61</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.23)</td>
<td>(0.1)</td>
<td>(0.23)</td>
<td>(0.10)</td>
<td>(255)</td>
<td>(1.56)</td>
</tr>
<tr>
<td>MAE⁴</td>
<td>0.38</td>
<td>0.18</td>
<td>0.09</td>
<td>0.17</td>
<td>0.08</td>
<td>99</td>
<td>1.31</td>
</tr>
</tbody>
</table>

¹Geometric mean of the last three milkings (x1000)
²Data available only for seven farms
³Data available only for six farms
⁴Means absolute error
Results - Components

Mean absolute difference: 0.50%  Mean absolute difference : 0.23%
Results - Components

CCC (average 10 herds)

- Fat, %
  - Robot Fat, % vs. Lab Fat, %
  - CCC: 0.61
  - (95% CI 0.55 - 0.66)

- Protein, %
  - Robot Protein, % vs. Lab Protein, %
  - CCC: 0.59
  - (95% CI 0.54 - 0.64)

- Lactose, %
  - Robot Lactose, % vs. Lab Lactose, %
  - CCC: 0.69
  - (95% CI 0.64 - 0.74)
Results by DIM Categories

Categories of DIM:

DIM 1: DIM ≤ 100
DIM 2: DIM between 101 and 200
DIM 3: > 201 DIM

\[ P > 0.01 \]
\[ SE = 0.04 \]

\[ P > 0.01 \]
\[ SE = 0.02 \]
Results

By herd

Differences among herds were larger for fat than for protein percentage (MAE = 0.47 to 0.28%)
Results

CCC between milk fat percentages from the AMS sensors and the laboratory analysis of the 10 farms

A: CCC: 0.74 (95% CI 0.5 - 0.88)
B: CCC: 0.64 (95% CI 0.52 - 0.73)
C: CCC: 0.43 (95% CI 0.23 - 0.59)
D: CCC: 0.74 (95% CI 0.57 - 0.85)
E: CCC: 0.62 (95% CI 0.39 - 0.77)
F: CCC: 0.45 (95% CI 0.17 - 0.66)
G: CCC: 0.66 (95% CI 0.33 - 0.85)
H: CCC: 0.48 (95% CI 0.2 - 0.69)
I: CCC: 0.66 (95% CI 0.37 - 0.83)
J: CCC: 0.59 (95% CI 0.44 - 0.77)
Results - SCC
Results - SCC

CCC (average 10 farms)
Results

CCC (average 4 herds) DeLaval SCC

Differences between the SCC (x1000) were \(-66 \pm 364\) (MAE = 101)
Results

CCC (by herd) DeLaval SCC

Z

CCC: 0.84
(95% CI 0.8 - 0.88)

Y

CCC: 0.95
(95% CI 0.95 - 0.96)

W

CCC: 0.93
(95% CI 0.89 - 0.95)

X

CCC: 0.98
(95% CI 0.97 - 0.98)
Discussion

Calibration

• One hypothesis to explain the large inter-herd variations may be the way producers calibrate the sensors.
  • Calibration of the Lely AMS sensors can be done in two ways:
    1) At the cow level: using the results of the DHI
    2) At the herd level: using the results of the bulk tank

• Units of the two methods are different in Canada
  • DHI is in kg/100kg or percentage
  • Bulk tank is in kg/hl or kg/100 litres.
    • Systematic bias of approx. 3% (kg/hl ≈ kg/100 kg x 1.03)
    • Plus, an additional bias of approx. 0.98 % for lactose (bulk tank include lactose and other solids.

• Frequency at which the calibration is made ????
Outlook

• Further work to understand the impact of the calibration frequency and protocol
• Need to identify source of sensor data in central databases
• Evaluate value for genetic evaluation and other usages
• Establish routine data quality checks
Thank you

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