The Power of Frequent Measurement

Andrew Scott on behalf of Rob Orchard
June 2019
Frequency Beats Precision

Key Concepts:

- Day-to-day variation
- Cow-specific bias
Day-to-day Variation

![Graph showing 24h Milk Volume (L) against Day for Cow 171. The graph includes data points and lines representing True volume, True average, On-line analyser, and On-line average.]
Day-to-day Variation

Cow 171

**Volume**

- High variation

**Fat**

- Low variation

**Protein**

**Lactose**

- Low variation
### Day-to-day Variation

<table>
<thead>
<tr>
<th>within cow CV or SD</th>
<th>Mackle 1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (L)</td>
<td>8.9%</td>
</tr>
<tr>
<td>Fat content (g/100mL)</td>
<td>0.27 (5.2%)</td>
</tr>
<tr>
<td>Protein content (g/100mL)</td>
<td>0.12 (3.4%)</td>
</tr>
<tr>
<td>Lactose content (g/100mL)</td>
<td>0.06 (1.3%)</td>
</tr>
<tr>
<td>SCC (&lt;200 kcells/mL)</td>
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</tr>
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<td>SCC (≥200 kcells/mL)</td>
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</table>

## Day-to-day Variation

<table>
<thead>
<tr>
<th></th>
<th>Mackle 1999</th>
<th>Current trial</th>
</tr>
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<tbody>
<tr>
<td>Volume (L)</td>
<td>8.9%</td>
<td>7.0%</td>
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<td>SCC (&lt;200 kcells/mL)</td>
<td>21</td>
<td>61%</td>
</tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Frequency Beats Precision

Key Concepts:

• Day-to-day variation
• Cow-specific bias
Cow-specific Bias

Unacceptable CSB

24h Milk Volume (L)

Day

True volume
True average
On-line analyser
On-line average
Trial Aim

Using a real on-line milk analyser...
...targeting the short-term average of the milk traits...
...we compared two methods

On-line milk analyser
Frequent measurement
...limited by cow-specific bias

Single-day herd test
Precise measurement
...limited by day-to-day variation
On-line Milk Analysers

Saber SCC
- SCC

Saber Milk
- Volume
- Fat
- Protein
- Lactose

Saber Lab
- Volume
- Fat
- Protein
- Lactose
- SCC
Trial Design

- 24-a-side swing-over herringbone
- 14 x Saber Lab (58%)
- 10 x Saber Milk & SCC (42%)

NZ herd of 208 cows

Twice-a-day milking

Herd tests at 20 consecutive milking sessions (10 days)
Volume

Sensor: Individual Test

Sensor: 10-day Average

1-day Herd Test

SDRE 10.6%

SDRE 6.0%
Spearman 0.969

SDRE 6.1%
Spearman 0.976
Fat

Sensor: Individual Test

Sensor test (g/100mL) vs Herd test (g/100mL)

SDE 0.36 g/100mL

Sensor: 10-day average

10-day sensor average (g/100mL) vs 10-day herd test average (g/100mL)

SDE 0.18 g/100mL
Spearman 0.957

1-day Herd Test

1-day herd test (g/100mL) vs 10-day herd test average (g/100mL)

SDE 0.26 g/100mL
Spearman 0.940
Protein

Sensor: Individual Test

Sensor test (g/100mL) vs. Herd test (g/100mL)

Sensor: 10-day Average

10-day sensor average (g/100mL) vs. 10-day herd test average (g/100mL)

1-day Herd Test

1-day herd test (g/100mL) vs. 10-day herd test average (g/100mL)

SDE 0.29 g/100mL
SDE 0.12 g/100mL
SDE 0.09 g/100mL

Spearman 0.934
Spearman 0.973
Lactose

- Sensor: Individual Test
  - SDE 0.18 g/100mL

- Sensor: 10-day Average
  - SDE 0.09 g/100mL
  - Spearman 0.935

- 1-day Herd Test
  - SDE 0.05 g/100mL
  - Spearman 0.957
<table>
<thead>
<tr>
<th>Test Type</th>
<th>SDE (kcells/mL)</th>
<th>SDRE (%)</th>
<th>Spearman Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Test</td>
<td>&lt;200</td>
<td>52%</td>
<td>0.309</td>
</tr>
<tr>
<td>10-day Average</td>
<td>≥200</td>
<td>21%</td>
<td>0.825</td>
</tr>
<tr>
<td>1-day Herd Test</td>
<td>≥200</td>
<td>68%</td>
<td>0.796</td>
</tr>
</tbody>
</table>
Day-to-day Variation Drives Herd Test Precision

<table>
<thead>
<tr>
<th></th>
<th>Single-day Herd Test (SDE or SDRE)</th>
<th>Day-to-day Variation (SD or CV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (L)</td>
<td>6.1%</td>
<td>7.0%</td>
</tr>
<tr>
<td>Fat (g/100mL)</td>
<td>0.26</td>
<td>0.31</td>
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Conclusions

Experimental results consistent with theoretical research

For estimating the cow average

- Single herd test precision was numerically similar to day-to-day variation
- On-line sensor was better than herd test for parameters with high day-to-day variation
- On-line sensor was worse than herd test for parameters with low day-to-day variation
Conclusions

How good is the on-line analyser?

Volume ✓ (as good as a herd test)
Conclusions

How good is the on-line analyser?

- Volume ✓ (as good as a herd test)
- Fat ✓ (better than a herd test)
Conclusions

How good is the on-line analyser?

<table>
<thead>
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<th>Component</th>
<th>Performance</th>
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<tr>
<td>Volume</td>
<td>✔  (as good as a herd test)</td>
</tr>
<tr>
<td>Fat</td>
<td>✔  (better than a herd test)</td>
</tr>
<tr>
<td>Protein</td>
<td>✔  (practically as good as a herd test)</td>
</tr>
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Conclusions

How good is the on-line analyser?

- Volume: ✓ (as good as a herd test)
- Fat: ✓ (better than a herd test)
- Protein: ✓ (practically as good as a herd test)
- Lactose: ✓ (practically as good as a herd test)
Conclusions

How good is the on-line analyser?

- **Volume**: ✓ (as good as a herd test)
- **Fat**: ✓ (better than a herd test)
- **Protein**: ✓ (practically as good as a herd test)
- **Lactose**: ✓ (practically as good as a herd test)
- **SCC**: ✓ (better than a herd test at high SCC)
Conclusions

How good is the on-line analyser?

<p>| | |</p>
<table>
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<tbody>
<tr>
<td>Volume</td>
<td>✓</td>
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<td>Fat</td>
<td>✓</td>
</tr>
<tr>
<td>Protein</td>
<td>✓</td>
</tr>
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<td>Lactose</td>
<td>✓</td>
</tr>
<tr>
<td>SCC</td>
<td>✓</td>
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<td>Timeliness</td>
<td>✓</td>
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