Genetic evaluations based on data from automatic milking systems

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ICAR Conference, Berlin, May 2014
Norwegian dairy farming

• Larger herds with automatic milking systems (AMS)
• 1/3 of the dairy cows are in AMS herds
  \(\approx 1200\) milking robots
• Within a few years will AMS be the dominating dairy production system in Norway.
Automatic milking systems (AMS)

- Vast amounts of data are recorded daily
- Objective, frequent and accurate measures of many traits
- How can we best make use of these data?
Aim

• First genetic analysis of Norwegian AMS data
• Estimate heritability and predict breeding values for milkability in Norwegian Red.
AMS data

• 46 herds with DeLaval milking robots
• Minimum 2 years of data from each herd
• Information from >6000 cows and > 2 mill daily records

• Data for genetic analyses
  – Records from 6 to 305 days after calving
  – Lactation 1-7
  – Norwegian Red A.I. sire
Milkability

**MILKABILITY** = Milk yield per total time spent in the milking robot; kg milk per minute “box time”

Box time = actual milking time
  + time used for preparation and attachment of teat cups
  + the time the cow uses before she decide to leave the robot

• A combined measure of milking speed / milk flow and how efficient the cow is when visiting the milking unit
• Directly associated with the capacity of the milking robot
Distribution of milk yield per minute spent in the milking robot

Overall mean:
1.5 kg milk per minute box time

95 % were within the interval 0.7 – 3.3.
Trait definition

- Daily milkability (one observation per cow per day)
- Mean milkability from day 30 to 60
- Lactation mean milkability from day 6 to 305

Table 1. Summary statistics of milkability traits (kg milk per minute box time)

<table>
<thead>
<tr>
<th></th>
<th>Daily</th>
<th>Mean d 30-60</th>
<th>Lactation mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of observations</td>
<td>1,597,156</td>
<td>6,808</td>
<td>8,046</td>
</tr>
<tr>
<td>No of cows</td>
<td>4,835</td>
<td>4,264</td>
<td>4,787</td>
</tr>
<tr>
<td>Milkability, mean kg/min</td>
<td>1.47</td>
<td>1.48</td>
<td>1.44</td>
</tr>
</tbody>
</table>
Factors affecting milkability

- Days in milk
- Lactation number
- Herd
- Year and season
- Milking frequency
- Milk yield
- Box time also affected by cow behavior
Milkability by days in milk for first- and later lactations
Model

• Repeatability models
  – assumed to be the same trait across lactations
• Univariate linear animal models
  – fixed effects of herd-year, month-year of calving, and age at calving by lactation number.
    • For daily milkability: effect of DIM
      – random effects of animal and permanent environment

• Variance components estimated using DMU
  (Madsen & Jensen, 2007)
Heritability

Table 2. Estimated variance components, with their standard error (SE) and the corresponding heritability and repeatability of daily-, mean day 30-60 -, and lactation mean milkability.

<table>
<thead>
<tr>
<th>Variance component</th>
<th>Milkability trait (kg milk per minute box time)</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
<td>Mean day 30-60</td>
<td>Lactation mean</td>
<td></td>
</tr>
<tr>
<td>Animal</td>
<td>0.033 (0.004)</td>
<td>0.037 (0.005)</td>
<td>0.033 (0.004)</td>
<td></td>
</tr>
<tr>
<td>Permanent environment</td>
<td>0.073 (0.004)</td>
<td>0.050 (0.004)</td>
<td>0.046 (0.004)</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>0.198 (0.0002)</td>
<td>0.038 (0.001)</td>
<td>0.035 (0.001)</td>
<td></td>
</tr>
<tr>
<td><strong>Heritability</strong></td>
<td><strong>0.11</strong></td>
<td><strong>0.30</strong></td>
<td><strong>0.29</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td><strong>0.35</strong></td>
<td><strong>0.70</strong></td>
<td><strong>0.69</strong></td>
<td></td>
</tr>
</tbody>
</table>
Heritability

• Mean milkability day 30 to 60: 0.30
• Lactation mean milkability: 0.29

• Current genetic evaluation of milking speed for Norwegian Red
  – Trait: milking speed scored in 3 categories (slow, medium, fast)
  – Heritability: 0.19

• More precise phenotypes gives higher heritability and more accurate breeding values.
Breeding values for milkability

EBV for milkability (day 30-60) for cows with data (left panel) and AI sires with daughters in the dataset
## Rank correlations EBV milkability

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Mean d 30-60</td>
<td>0.87</td>
<td>0.88</td>
</tr>
<tr>
<td>Lactation mean</td>
<td>0.98</td>
<td></td>
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</tbody>
</table>
Milkability

- Directly associated with the capacity of the milking robot
- Interesting trait for breeding more efficient cows for AMS
- Genetic improvement of milkability would be beneficial also in other production systems
  - Milking speed and aspects of cow behavior

**MILKABILITY** = Milk yield per total time spent in the milking robot; kg milk per minute “box time”
New traits

• The cow meet different challenges in the AMS herds
• The breeding program should be adjusted accordingly with respect to traits, trait definitions and weights in the total merit index
• Measures related to milking and cow traffic recorded in AMS that can be used to define new behavior and milking efficiency traits
Conclusion

• Data from AMS can be used for genetic evaluations
• Data routinely recorded in AMS provide information on new traits that can supplement or replace current traits in genetic evaluation