Proxies for resilience and efficiency

using at-market sensor technologies

Claudia Kamphuis, Yvette de Haas, Wijbrand Ouweltjes
Why Resilience (and Efficiency)

Interest in novel traits that improve health & fitness
   After World War II increase in (milk) production
   Declining health and fertility
   Changed public perception with respect to animal production and welfare

Breeding for Resilience (and efficiency) is hampered
   Lack of (continuous) phenotypic information

Increased adoption of sensor technologies
   High-frequency repeated measurements for individual animals
   Used for monitoring or for detecting specific events
   Not used for phenotyping complex traits
What data were at hand

Data from Dairy Campus

1,800 cows
5,771 lactations between 1995-2016

(Sensor) Data

Activity and Rumination Activity (SCR tags)
Milk yield (conventional / AMS)
Live-weight at/before milking
Health events and inseminations
Step 1 Defining Resilience

Computing a Lifetime Resilience Score

500 plus points for each calving

Age at 1\textsuperscript{st} calving compared to herd mean

1 plus/minus point for each day difference (1\textsuperscript{st} parity)

Calving interval compared to herd mean

1 plus/minus point for each day difference (>1\textsuperscript{st} parity)

Number of inseminations

25 minus points for inseminated culled cows
(last lactation only)

Number of events

1 minus point for each curative treatment day
1 minus point for each day culled before 100 DIM

305-day milk yield

weight 0 (currently lack of reliable data)
## Results Lifetime Resilience scores

1800 cows, 5771 lactations received a score

1518 points on average (31 to 6031 points)

<table>
<thead>
<tr>
<th>Parity</th>
<th>N</th>
<th>Total Resilience score</th>
<th>lac 1</th>
<th>lac 2</th>
<th>lac 3</th>
<th>lac 4</th>
<th>lac 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>315</td>
<td>412</td>
<td>412</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>387</td>
<td>907</td>
<td>497</td>
<td>410</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>385</td>
<td>1401</td>
<td>497</td>
<td>495</td>
<td>409</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>313</td>
<td>1907</td>
<td>497</td>
<td>505</td>
<td>485</td>
<td>421</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>227</td>
<td>2428</td>
<td>498</td>
<td>510</td>
<td>492</td>
<td>496</td>
<td>432</td>
</tr>
<tr>
<td>&gt;=6</td>
<td>173</td>
<td>3266</td>
<td>502</td>
<td>523</td>
<td>508</td>
<td>506</td>
<td>495</td>
</tr>
</tbody>
</table>
Step 2 Defining sensor curve parameters

mikyeld cow 3919 vs. average

absolute production day 40: 50.2kg
Step 2: Defining sensor curve parameters

![Graph showing milk yield comparison]

- **mikyield cow 3919 vs. average**
- Blue line: absolute curve for this cow
- Green line: average absolute curve

**average production day 40:** 40.02 kg
Step 2 Defining sensor curve parameters

Relative production day 40: 125.4%
Step 2 Defining sensor curve parameters

mikyield cow 3919 vs. average

\[ y = 112.8147 - 0.10954 \times d \]
Step 2 Defining sensor curve parameters

Mean and Autocorrelation on relative curve (red line)

Standard deviation, Skewness, and Slope of regression line through relative curve (light blue line)
Step 3 Data analyses

Data preparation

Remove outliers per sensor: mean plus minus 4*std
Compute sensor curve parameters (1-300DIM, and 1-7, 1-60, 61-150, 151-300DIM)

Ordinal logistic regression

H = top 25%, M = middle 50%, L = bottom 25%

Use sensor curve parameters

Per sensor and all sensors simultaneously
Whole lactations and parts of lactation
Cleaned an uncleaned data
Results Ordinal Logistic Regression

Significant parameters simultaneous model (1-300DIM)

Standard deviation of BW, slope of MY
similar to results for uncleaned data (but then also skewness of activity)
not consistent across partial lactations

Predictive performance using significant parameters

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Gold standard</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (L)</td>
<td>Middle (M)</td>
<td>High (H)</td>
<td></td>
</tr>
<tr>
<td>n=90</td>
<td>0.063</td>
<td>0.113</td>
<td>0.042</td>
<td></td>
</tr>
<tr>
<td>n=202</td>
<td>0.132</td>
<td>0.298</td>
<td>0.117</td>
<td></td>
</tr>
<tr>
<td>n=78</td>
<td>0.048</td>
<td>0.135</td>
<td>0.052</td>
<td></td>
</tr>
</tbody>
</table>

Average chance a cow is predicted in the right category is 41.3%

151-300 d lactations slightly better than 1-300d and early partial lactations
To summarize

Limited predictive ability of sensor curve parameters
no difference between cleaned or uncleaned data

Late or entire lactation ‘better’ than early lactation

Variation in significant curve parameters

Improvements
- Other weighing of Lifetime Resilience Score components
- Include parameters previous lactation and dry period
- Efficiency as outcome parameter