In-line milk progesterone profiles to estimate genetic parameters for atypical fertility in cows

Rianne van Binsbergen, Aniek Bouwman, Roel Veerkamp
Fertility in dairy cows

Why fertility?

Breeding goal

- 1 calf / year
- 1 insemination / conception
- No hormonal treatment

Normal reproductive patterns
Normal (‘typical’) reproductive patterns

Commencement of luteal activity (CLA)
Start cyclicity ~ 1 month

Inter-luteal interval (ILI)
Follicular phase ~ 1 week

Luteal phase length (LPL)
Luteal phase ~ 2 weeks
### Atypical reproductive patterns

<table>
<thead>
<tr>
<th>Trait</th>
<th>Definition</th>
<th>Diagram</th>
</tr>
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<tbody>
<tr>
<td><strong>DOVI</strong></td>
<td>Delayed ovulation type I = Prolonged CLA</td>
<td><img src="#" alt="Diagram" /></td>
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<tr>
<td><strong>DOVII</strong></td>
<td>Delayed ovulation type II = Prolonged ILI</td>
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<td><strong>PCLI</strong></td>
<td>Persistent corpus luteum type I = Prolonged LPL (1&lt;sup&gt;st&lt;/sup&gt; cycle)</td>
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<td>Persistent corpus luteum type II = Prolonged LPL (≥2&lt;sup&gt;nd&lt;/sup&gt; cycle)</td>
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<td><strong>LEM</strong></td>
<td>Late embryo mortality = Prolonged LPL (after 1&lt;sup&gt;st&lt;/sup&gt; AI)</td>
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Objective

Investigate atypical reproductive patterns for a large number of cows

- Frequency of atypical patterns on different farms?
- Heritability of atypical fertility traits?
- Genetic correlation with milk production?
Herd Navigator™

- Detects heat by measuring progesterone
- 13 commercial herds (NL) & 1 research herd (NL)
- ~350,000 P4 level records
- 3,380 cows
- June 2012 - March 2016

Intelligent milk-sampling station → Analysis unit → Clear action points for effective management

DeLaval
Frequency atypical patterns (1)

<table>
<thead>
<tr>
<th></th>
<th>DOVI</th>
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<th>PCLI</th>
<th>PCLII</th>
<th>LEM</th>
<th>Total</th>
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<tbody>
<tr>
<td>Freq.</td>
<td>0.17</td>
<td>0.16</td>
<td>0.18</td>
<td>0.13</td>
<td>0.16</td>
<td>0.44</td>
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≥ 1 atypical pattern in 44% of lactations
Frequency atypical patterns (2)

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</tr>
<tr>
<td>Herd A</td>
<td>0.14</td>
<td>0.21</td>
<td>0.05</td>
<td>0.01</td>
<td>0.16</td>
<td>0.28</td>
</tr>
<tr>
<td>Herd B</td>
<td>0.13</td>
<td>0.15</td>
<td>0.17</td>
<td>0.08</td>
<td>0.11</td>
<td>0.37</td>
</tr>
<tr>
<td>Herd C</td>
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<td>0.14</td>
<td>0.12</td>
<td>0.09</td>
<td>0.17</td>
<td>0.37</td>
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<tr>
<td>Herd D</td>
<td>0.03</td>
<td>0.19</td>
<td>0.20</td>
<td>0.14</td>
<td>0.21</td>
<td>0.38</td>
</tr>
<tr>
<td>Herd E</td>
<td>0.16</td>
<td>0.14</td>
<td>0.16</td>
<td>0.12</td>
<td>0.13</td>
<td>0.39</td>
</tr>
<tr>
<td>Herd F</td>
<td>0.17</td>
<td>0.15</td>
<td>0.13</td>
<td>0.08</td>
<td>0.17</td>
<td>0.43</td>
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<td>Herd G</td>
<td>0.21</td>
<td>0.13</td>
<td>0.16</td>
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<td>0.43</td>
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<td>Herd H</td>
<td>0.17</td>
<td>0.19</td>
<td>0.21</td>
<td>0.08</td>
<td>0.22</td>
<td>0.44</td>
</tr>
<tr>
<td>Herd I</td>
<td>0.22</td>
<td>0.11</td>
<td>0.14</td>
<td>0.19</td>
<td>0.59</td>
<td>0.46</td>
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<tr>
<td>Herd J</td>
<td>0.20</td>
<td>0.18</td>
<td>0.27</td>
<td>0.23</td>
<td>0.00</td>
<td>0.50</td>
</tr>
<tr>
<td>Herd K</td>
<td>0.14</td>
<td>0.17</td>
<td>0.26</td>
<td>0.20</td>
<td>0.18</td>
<td>0.50</td>
</tr>
<tr>
<td>Herd L</td>
<td>0.22</td>
<td>0.19</td>
<td>0.20</td>
<td>0.10</td>
<td>0.15</td>
<td>0.52</td>
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<tr>
<td>Herd M</td>
<td>0.24</td>
<td>0.23</td>
<td>0.19</td>
<td>0.05</td>
<td>0.08</td>
<td>0.55</td>
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Atypical patterns shown in all herds
- 28% of lactations atypical in the best herd
- ≥50% of lactations atypical in 5 out of 14 herds

Large differences between herds
Proportion of total variance explained

- Classical fertility: large herd effect
- Atypical fertility: ↑ heritability, ↓ herd effect

- Additive genetic effect (h2)
- Cow effect (permanent environment)
- Herd effect
Genetic correlation with milk yield

-1.0
-0.5
0.0
0.5
1.0

Unfavourable genetic correlation

* only random PE effect for milk yield
Classical fertility vs. Atypical fertility traits

**Classical**
- High number of records
- Unfavourable genetic correlation with milk yield
- Management bias
- Low heritability

**Atypical**
- Lower number of records
- Unfavourable genetic correlation with milk yield
- Less management bias
- Higher heritability
Take home messages

Atypical patterns shown in all herds
• 28% - 55% of lactations
• Large variation

Breeding for atypical fertility traits is promising if enough records available
• Heritability up to 14%
• Less bias by management
## Thresholds atypical fertility

All trait records excl. outliers (> mean + 3*sd)

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<td>Delayed ovulation type II</td>
<td><strong>ILI</strong> ≥ 16 days</td>
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<td>Persistent corpus luteum type I</td>
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Genetic analyses

Linear mixed model in ASReml 4.1
Atypical fertility traits: probit-link function

**Fixed effects**
- Intercept
- Parity class
- Parity class x Calving age
- Year-Season
- Proportion of non-HF genes (5 effects)

**Random effects**
- Additive genetic
  - Pedigree: 31,849 animals
- Permanent environment
  - Cow effect (excl. additive genetic)
- Herd