Breeding values for feed intake


*CRV
** Wageningen University & Research
Interest in genetics of feed efficiency

- Feed efficiency
  - Feed important variable cost
  - Environmental/greenhouse gasses
  - “More for less”

- Develop (procedure to predict) feed intake (DMI) breeding values for Dutch bulls and cows
How is feed used?

Available energy
- Production
- Maintenance
- Reproduction
- Health
- Growth

Body energy
Using feed intake data

1. Data on 3200 cows in lactation 1, 2 and 3
   - dry matter intake (DMI)
   - collection of feed intake, milk yield and body weight
   - genotypes (1300 cows + sires of cows)

2. Parameters estimated
   - base for routine evaluation
## Parameters (1)

<table>
<thead>
<tr>
<th>Trait</th>
<th>heritability</th>
<th>Genet. Stdev (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dmi lact 1</td>
<td>0.28</td>
<td>1.24</td>
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<tr>
<td>Dmi lact 2</td>
<td>0.25</td>
<td>1.39</td>
</tr>
<tr>
<td>Dmi lact 3</td>
<td>0.20</td>
<td>1.51</td>
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</tbody>
</table>

Feed intake and response. EHRC meeting 2017
Parameters (2) – genetic correlations

<table>
<thead>
<tr>
<th></th>
<th>dmi1</th>
<th>dmi2</th>
<th>dmi3</th>
<th>milk</th>
<th>fat</th>
<th>protein</th>
<th>body weight</th>
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<td>0.58</td>
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<td>fat</td>
<td></td>
<td></td>
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<td>0.59</td>
<td>0.61</td>
<td>0.91 0.65</td>
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<td>0.10</td>
<td>0.10</td>
<td></td>
</tr>
</tbody>
</table>

Feed intake and response. EHRC meeting 2017
Using feed intake data

1. Data on 3200 cows in lactation 1, 2 and 3
   - collection of feed intake, milk yield and body weight
   - genotypes

2. Parameters estimated
   - base for routine evaluation

3. Model routine evaluation
Model for dry matter intake

\[ DMI = \text{experiment} + \text{year*month} + \text{calving season} + \text{age at calving} + \text{stage of lactation} + \text{breed} + \text{perm. environment} + \text{cow} + \text{error} \]

Cow: usage of pedigree and genotypes

Feed intake and response. EHRC meeting 2017
Using feed intake data

1. Data on 3200 cows in lactation 1, 2 and 3
   - collection of feed intake, milk yield and body weight
   - genotypes

2. Parameters estimated
   - base for routine evaluation

3. Model routine evaluation

4. Compute EBVs using:
   - direct DMI
   - genomic prediction
   - indicators milk production traits and body weight
Computing EBV DMI

Genetic evaluation: observations pedigree genotypes

Genomic equation

genomic breeding values

Breeding values

Indicators
Production
Body weight

breeding values

Feed intake and response. EHRC meeting 2017
Milk vs dry matter intake
Body weight vs dry matter intake
Milk vs body weight
## Results on bulls - Holstein
based on genomics and indicators

<table>
<thead>
<tr>
<th>year of birth</th>
<th>number</th>
<th>rel dmi</th>
<th>EBV dmi</th>
<th>EBV milk</th>
<th>EBV fat</th>
<th>EBV prot</th>
<th>EBV lactose</th>
<th>EBV body weight</th>
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<td>294</td>
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<td>4</td>
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<td>59</td>
<td>0.55</td>
<td>409</td>
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<td>9</td>
<td>19</td>
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<td>345</td>
<td>56</td>
<td>0.60</td>
<td>448</td>
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<td>9</td>
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<tr>
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<td>17</td>
<td>13</td>
<td>23</td>
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</tr>
<tr>
<td>2011</td>
<td>264</td>
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</tr>
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<td>2013</td>
<td>171</td>
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<td>887</td>
<td>34</td>
<td>26</td>
<td>42</td>
<td>15.8</td>
</tr>
</tbody>
</table>

Reliability based on predictors and genomics
-> maximum determined by correlation of predictors with dmi

Feed intake and response. EHRC meeting 2017
## Extra direct information dmi

Only genomic information

<table>
<thead>
<tr>
<th>Birth year</th>
<th>Number bulls with extra dmi info</th>
<th>Average effect extra dmi info</th>
<th>Average effect reliability extra dmi info</th>
<th>Stdev effect extra dmi info</th>
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<tbody>
<tr>
<td>2006</td>
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<td>-0.02</td>
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<td>5</td>
<td>0.19</td>
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<tr>
<td>2011</td>
<td>132</td>
<td>-0.10</td>
<td>5</td>
<td>0.17</td>
</tr>
<tr>
<td>2012</td>
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<td>5</td>
<td>0.16</td>
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<tr>
<td>2013</td>
<td>110</td>
<td>-0.10</td>
<td>4</td>
<td>0.16</td>
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</tbody>
</table>

0.17 is about 12% of genetic stdev

Feed intake and response. EHRC meeting 2017
Breeding goal – effect on selection response

- Breeding goal represented by NVI = Total Merit Index

- **Current NVI contains:**
  - Production index (Inet)
  - Udder health index
  - Fertility index
  - Calving traits index
  - Conformation U + F&L

- **Alternative NVI:**
  - Inet with DMI
  - Udder health index
  - Fertility index
  - Calving traits index
  - Conformation U + F&L
Breeding goal – effect on selection response (2)

- Current Inet:
  \[ \text{Inet}_{2015} = 0.3 \text{ lactose} + 2.1 \text{ fat} + 4.1 \text{ protein} \]
  weights milk components = price paid by factory – feed cost

- Inet with dmi*:
  \[ \text{Inet}_{\text{dmi}} = 0.5 \text{ lactose} + 2.7 \text{ fat} + 5.4 \text{ protein} - 60.2 \text{ kg dmi} \]
  weights milk components = price paid by factory
  weight dmi = cost feed (energy)

\[ \text{Inet}_{\text{dmi}} \] direct relationship with maintenance (size/efficiency of cow)

* Production EBV = kg/305 days
  dmi EBV = kg /day

Feed intake and response. EHRC meeting 2017
## Results on bulls – Holstein: earnings!

<table>
<thead>
<tr>
<th>Year of Birth</th>
<th>Number</th>
<th>EBV DMI</th>
<th>EBV Milk</th>
<th>EBV Fat</th>
<th>EBV Prot</th>
<th>EBV Lactose</th>
<th>Current Inet</th>
<th>Inet with DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>444</td>
<td>0.11</td>
<td>239</td>
<td>-1</td>
<td>2</td>
<td>13</td>
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<td>2007</td>
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<tr>
<td>2008</td>
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<td>409</td>
<td>10</td>
<td>9</td>
<td>19</td>
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<td>2010</td>
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<td>34</td>
<td>26</td>
<td>42</td>
<td>€ 191</td>
<td>€ 157</td>
</tr>
</tbody>
</table>

Earning less as no increase of production went together with increase feed intake, more than only needed for production.
Inet vs Inet with dry matter intake

- Correlation: 0.95
- Spread difference: 36 euro -> 30% of genetic st.dev.

Feed intake and response. EHRC meeting 2017
Effect on selection: dmi part of TMI

Feed intake and response. EHRC meeting 2017

Feed intake and response. EHRC meeting 2017
Next step: Feed intake for maintenance

- **DMI EBV** = feed intake for production AND maintenance (kg/day)

  Remove feed for production

- **EBV Feed for maintenance**
  - Body weight
  - Activity
  - Digestion of feed

  - **EBV Feed per day** (kg/day)
  - **EBV Feed Cost for Maintenance per lactation** (eur/lactation)

Farmer can see how much extra feed or extra feed cost is needed to keep a cow.

Feed intake and response. EHRC meeting 2017
Feed for maintenance vs body weight
Adding feed intake to breeding goal:

A. Increase of feed intake in relation with
   - Milk, fat and protein yield increase
   - Less increase in body weight

Or

B. Produce more milk with the same size of cow

Or

C. Produce more milk from the same amount of feed

Which option depends on how much weight in TMI on production and on feed intake
Summary

- Dry matter intake EBVs available, based on
  - 3200 cows and indicators
  - genomic prediction available

- DMI part of breeding goal NVI
  - more efficient (in euro’s)
  - no effect on health

- More data collected coming years
  - Increase of reliability genomic prediction

- End result: more efficient cow