Genetic Evaluation for Milk Fat Composition in the Walloon Region of Belgium

N. Gengler\textsuperscript{1,2}, S. Vanderick\textsuperscript{1}, V. Arnould\textsuperscript{1}, H. Soyeurt\textsuperscript{1,2}

\textsuperscript{1} Animal Science Unit, Gembloux Agro-Bio Tech, University of Liège (GxABT, ULg) – Gembloux, Belgium
\textsuperscript{2} National Fund for Scientific Research (FRS-FNRS) – Brussels, Belgium
Walloon Region of Belgium:
- collecting fatty acid composition since March 2005
- first experimental on 25 farms
- currently nearly all cows under milk recording
Context

Walloon Region of Belgium:
- collecting fatty acid composition since March 2005
- first experimental on 25 farms
- currently nearly all cows under milk recording

Current data status (April 2010):
864,835 test-days (all-lactation)
Context

Walloon Region of Belgium:
- collecting fatty acid composition since March 2005
- first experimental on 25 farms
- currently nearly all cows under milk recording

Current data status (April 2010):
864,835 test-days (all-lactation), increasing

Next step: development of a genetic evaluation system for milk fat composition
Data and Model

- Previous research done has shown for milk fat composition traits (e.g., Soyeurt et al., 2008):
  - genetic variation and
  - medium to high heritabilities

- Some modelling issues however:
  - repeated records
  - longitudinal traits
  - highly correlated traits
    - with traditional traits (milk, fat, protein)
    - among different fatty acids and fatty acid groups
Data and Model

- Previous research done has shown for milk fat composition traits (e.g., Soyeurt et al., 2008):
  - genetic variation and
  - medium to high heritabilities

- Some modelling issues however:
  - repeated records
  - longitudinal traits
  - highly correlated traits
    - with traditional traits (milk, fat, protein)
    - among different fatty acids and fatty acid groups

More data, but rep. model
Previous research done has shown for milk fat composition traits (e.g., Soyeurt et al., 2008):
- genetic variation and
- medium to high heritabilities

Some modelling issues however:
- repeated records
- longitudinal traits
- highly correlated traits
  - with traditional traits (milk, fat, protein)
  - among different fatty acids and fatty acid groups

Random regression model
Previous research done has shown for milk fat composition traits (e.g., Soyeurt et al., 2008):

- genetic variation and
- medium to high heritabilities

Some modelling issues however:

- repeated records
- longitudinal traits
- highly correlated traits
  - with traditional traits (milk, fat, protein)

Use of historical test-day data
Data and Model

- Previous research done has shown for milk fat composition traits (e.g., Soyeurt et al., 2008):
  - genetic variation and
  - medium to high heritabilities

- Some modelling issues however:
  - repeated records
  - longitudinal traits
  - highly correlated traits
    - among different fatty acids and fatty acid groups

Large number of relevant traits
Data and Model

- Selection of traditional traits
  - based on INTERBULL traits
    - milk, fat, and protein yield

- Selection of milk fat composition traits
  - based on potential place in breeding goal
  - milk pricing
    - saturated fatty acid content (SAT) in milk (g/100g)
  - potentially health related
    - monounsaturated fatty acid content (MONO) in milk (g/100g)
  - prediction from MIR spectral data
    - latest prediction equations
    - developed in RobustMilk 7FP project (Soyeurt et al., 2010)
## Data and Model

- **Only first lactation (for the moment)**

<table>
<thead>
<tr>
<th>Trait*</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILK (kg)</td>
<td>6,749,239</td>
<td>16.96</td>
<td>6.83</td>
</tr>
<tr>
<td>FAT (kg)</td>
<td>6,746,993</td>
<td>0.68</td>
<td>0.29</td>
</tr>
<tr>
<td>PROT (kg)</td>
<td>6,727,524</td>
<td>0.56</td>
<td>0.22</td>
</tr>
<tr>
<td>PFAT (%)</td>
<td>6,746,993</td>
<td>4.02</td>
<td>0.72</td>
</tr>
<tr>
<td>PPROT (%)</td>
<td>6,727,524</td>
<td>3.33</td>
<td>0.40</td>
</tr>
<tr>
<td>SAT (%)</td>
<td>220,397</td>
<td>2.79</td>
<td>0.49</td>
</tr>
<tr>
<td>MONO (%)</td>
<td>220,396</td>
<td>1.15</td>
<td>0.24</td>
</tr>
</tbody>
</table>

* FAT = fat yield, PROT = protein yield, PFAT = fat content, PPROT = protein content, SAT = saturated fatty acid content in milk and MONO = monounsaturated fatty acid content in milk
Heritabilities (diagonal) and genetic correlations (above) expressed on a lactation base

<table>
<thead>
<tr>
<th>Trait</th>
<th>MILK</th>
<th>FAT</th>
<th>PROT</th>
<th>SAT</th>
<th>MONO</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILK (kg)</td>
<td>0.31</td>
<td>0.57</td>
<td>0.83</td>
<td>-0.42</td>
<td>-0.31</td>
</tr>
<tr>
<td>FAT (kg)</td>
<td>0.33</td>
<td>0.70</td>
<td>0.50</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>PROT (kg)</td>
<td>0.26</td>
<td></td>
<td>-0.11</td>
<td></td>
<td>-0.11</td>
</tr>
<tr>
<td>SAT (%)</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>MONO (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.51</td>
</tr>
</tbody>
</table>
Heritabilities (diagonal) and genetic correlations (above) expressed on a lactation base

<table>
<thead>
<tr>
<th>Trait</th>
<th>MILK (kg)</th>
<th>FAT (kg)</th>
<th>PROT (kg)</th>
<th>SAT (%)</th>
<th>MONO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILK (kg)</td>
<td>0.31</td>
<td>0.57</td>
<td>0.83</td>
<td>-0.42</td>
<td>-0.31</td>
</tr>
<tr>
<td>FAT (kg)</td>
<td>0.33</td>
<td>0.70</td>
<td>0.50</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>PROT (kg)</td>
<td>0.26</td>
<td>-0.11</td>
<td>-0.11</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>SAT (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>MONO (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.51</td>
<td></td>
</tr>
</tbody>
</table>
Expressing Results?

- **Two potential components** could contribute to selection objective
  - milk pricing: SAT
  - health related: MONO

- However underlying problem:
  - both traits highly correlated to major traits

- Two consequences:
  1. Risk of deleterious effects on current selection objectives
  2. EBV of SAT and MONO expressing differences in MILK, FAT and PROTEIN
Expected EBV for saturated fatty acid content (SAT) in milk predicted from EBV for milk, fat and protein.
Expected EBV for monounsaturated fatty acid content (MONO) in milk predicted from EBV for milk, fat and protein
Expressing Results

- **Idea** expressing relative differences
- Computation of new “traits” (indexes)
  - milk pricing: dUNSAT
  - health related: dMONO
Expected EBV for monounsaturated fatty acid content (MONO) in milk predicted from EBV for milk, fat and protein
Expressing Results

- **Idea** expressing relative differences
- Computation of new “traits” (indexes)
  - $d\text{MONO} = \text{MONO} - E(\text{MONO}|\text{MILK, FAT, PROTEIN})$
Expressing Results

- **Idea** expressing relative differences
- Computation of new “traits” (indexes)
  - \( \text{dM} \text{ONO} = \text{MONO} - E(\text{MONO}|\text{MILK, FAT, PROTEIN}) \)
  - \( \text{dUN} \text{SAT} = -(\text{SAT} - E(\text{SAT}|\text{MILK, FAT, PROTEIN})) \)
Expressing Results

- **Idea** expressing relative differences
- **Computation of new “traits”** (indexes)
  - \( d_{\text{MONO}} = \text{MONO} - E(\text{MONO}|\text{MILK, FAT, PROTEIN}) \)
  - \( d_{\text{UNSAT}} = -(\text{SAT} - E(\text{SAT}|\text{MILK, FAT, PROTEIN})) \)
- **Expressed on a standardized scale**
- **Genetic parameters** for \( d_{\text{UNSAT}} \) and \( d_{\text{MONO}} \)
  - Genetic correlation: 0.93
  - \( h^2 \): \( d_{\text{UNSAT}} \) 0.21 and \( d_{\text{MONO}} \) 0.42
## Results and Discussion

**EBV for evaluated and expressed traits (sires REL ≥ 0.50)**

<table>
<thead>
<tr>
<th>Trait</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk (kg)</td>
<td>1844</td>
<td>450</td>
<td>424</td>
<td>0.78</td>
<td>0.14</td>
</tr>
<tr>
<td>FAT (kg)</td>
<td>1929</td>
<td>16.1</td>
<td>16.6</td>
<td>0.80</td>
<td>0.13</td>
</tr>
<tr>
<td>PROT (kg)</td>
<td>1780</td>
<td>18.9</td>
<td>11.9</td>
<td>0.77</td>
<td>0.14</td>
</tr>
<tr>
<td>SAT (%)</td>
<td>1949</td>
<td>0.005</td>
<td>0.207</td>
<td>0.82</td>
<td>0.12</td>
</tr>
<tr>
<td>MONO (%)</td>
<td>1583</td>
<td>0.008</td>
<td>0.053</td>
<td>0.75</td>
<td>0.14</td>
</tr>
<tr>
<td>dUNSAT (rEBV)</td>
<td>1904</td>
<td>-1.02</td>
<td>0.69</td>
<td>0.80</td>
<td>0.13</td>
</tr>
<tr>
<td>dMONO (rEBV)</td>
<td>1583</td>
<td>0.34</td>
<td>0.62</td>
<td>0.80</td>
<td>0.11</td>
</tr>
</tbody>
</table>
Results and Discussion

**Correlation of EBV for milk composition traits with official EBV**

<table>
<thead>
<tr>
<th>Trait*</th>
<th>MILK</th>
<th>FAT</th>
<th>PROT</th>
<th>PFAT</th>
<th>PPROT</th>
<th>SCS</th>
<th>LONG</th>
<th>FFERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td>-0.56</td>
<td>0.34</td>
<td>-0.31</td>
<td>0.95</td>
<td>0.60</td>
<td>-0.04</td>
<td>-0.12</td>
<td>0.19</td>
</tr>
<tr>
<td>MONO</td>
<td>-0.48</td>
<td>0.33</td>
<td>-0.20</td>
<td>0.86</td>
<td>0.64</td>
<td>-0.03</td>
<td>-0.08</td>
<td>0.14</td>
</tr>
<tr>
<td>dUNSAT</td>
<td>-0.01</td>
<td>-0.04</td>
<td>0.05</td>
<td>-0.02</td>
<td>0.12</td>
<td>0.06</td>
<td>-0.11</td>
<td>0.03</td>
</tr>
<tr>
<td>dMONO</td>
<td>0.26</td>
<td>0.07</td>
<td>0.26</td>
<td>-0.21</td>
<td>-0.07</td>
<td>0.05</td>
<td>0.07</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

* Individual traits represent official EBVs computed during routine genetic evaluations or provided by INTERBULL. For more details please refer to [http://www.elinfo.be](http://www.elinfo.be). FFERT = female fertility, SCS = somatic cell score, LONG = longevity.
## Results and Discussion

### Correlation of EBV for milk composition traits with official EBV

<table>
<thead>
<tr>
<th>Trait*</th>
<th>MILK</th>
<th>FAT</th>
<th>PROT</th>
<th>PFAT</th>
<th>PPROT</th>
<th>SCS</th>
<th>LONG</th>
<th>FFERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td>-0.56</td>
<td>0.34</td>
<td>-0.31</td>
<td>0.95</td>
<td>0.60</td>
<td>-0.04</td>
<td>-0.12</td>
<td>0.19</td>
</tr>
<tr>
<td>MONO</td>
<td>-0.48</td>
<td>0.33</td>
<td>-0.20</td>
<td>0.86</td>
<td>0.64</td>
<td>-0.03</td>
<td>-0.08</td>
<td>0.14</td>
</tr>
<tr>
<td>dUNSAT</td>
<td>-0.01</td>
<td>-0.04</td>
<td>0.05</td>
<td>-0.02</td>
<td>0.12</td>
<td>0.06</td>
<td>-0.11</td>
<td>0.03</td>
</tr>
<tr>
<td>dMONO</td>
<td>0.26</td>
<td>0.07</td>
<td>0.26</td>
<td>-0.21</td>
<td>-0.07</td>
<td>0.05</td>
<td>0.07</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

* Individual traits represent official EBVs computed during routine genetic evaluations or provided by INTERBULL. For more details please refer to [http://www.elinfo.be](http://www.elinfo.be). FFERT = female fertility, SCS = somatic cell score, LONG = longevity.
Results and Discussion

- **Correlation of EBV for milk composition traits with official indexes**

<table>
<thead>
<tr>
<th>Index</th>
<th>V€L</th>
<th>V€T</th>
<th>V€F</th>
<th>V€G</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td>0.00</td>
<td>-0.15</td>
<td>-0.10</td>
<td>-0.08</td>
</tr>
<tr>
<td>MONO</td>
<td>0.08</td>
<td>-0.10</td>
<td>-0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>dUNSAT</td>
<td>0.04</td>
<td>0.01</td>
<td>-0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>dMONO</td>
<td>0.19</td>
<td>0.07</td>
<td>0.06</td>
<td>0.16</td>
</tr>
</tbody>
</table>

* For more details please refer to [http://www.elinfo.be](http://www.elinfo.be).

V€L = subindex ‘milk’, V€T = subindex ‘type’, V€F = subindex ‘functionality’
V€G = global index
Results and Discussion

- **Correlation of EBV for milk composition traits with official indexes**

<table>
<thead>
<tr>
<th>Index</th>
<th>V€L</th>
<th>V€T</th>
<th>V€F</th>
<th>V€G</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td>0.00</td>
<td>-0.15</td>
<td>-0.10</td>
<td>-0.08</td>
</tr>
<tr>
<td>MONO</td>
<td>0.08</td>
<td>-0.10</td>
<td>-0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>dUNSAT</td>
<td>0.04</td>
<td>0.01</td>
<td><strong>-0.10</strong></td>
<td>0.09</td>
</tr>
<tr>
<td>dMONO</td>
<td>0.19</td>
<td>0.07</td>
<td>0.06</td>
<td><strong>0.16</strong></td>
</tr>
</tbody>
</table>

* For more details please refer to [http://www.elinfo.be](http://www.elinfo.be).

V€L = subindex ‘milk’, V€T = subindex ‘type’, V€F = subindex ‘functionality’
V€G = global index
Conclusions

- First results **genetic evaluation system for milk fat composition** in the Walloon Region of Belgium:
  - still under development
  - only current status

- Chosen traits showed:
  - high heritabilities
  - genetic variability

- With still limited data:
  - **1904 sires**: EBV with REL ≥ 0.50 for dUNSAT
  - **1583 sires**: EBV with REL ≥ 0.50 for dMONO
Perspectives

- Adding more data:
  - currently 500,000 records added every year

- Going to a multi-lactation model:
  - better use of existing data from later lactations

- Adding new traits:
  - additional fatty acids

- Integration of external information:
  - different possibilities to be explored to integrate MACE EBV for MILK, FAT and PROT

- Genomic selection:
  - specific situation well suited to use one step approach (Aguilar et al., 2010)
Thank you for your attention!

Study supported by:

- Ministry of Agriculture of the Walloon Region of Belgium (SPW – DGARNE)
- National Fund for Scientific Research (F.R.S. – FNRS)
- RobustMilk a FP7 KBBE-2007-1 EU Project