Validation of GMACE results based on direct genomic predictions

Dr. Stefan Rensing, Erik Pasman
Vereinigte Informationssysteme Tierhaltung w.V. (vit), Verden

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Data

- gEBV GMACE-Implementation-Run December 2013
  - bulls with GMACE gEBV without DEU information

- compared to

- DEU gEBV November 2013 (= evaluation data sent for GMACE Dec. ‘13)

- Totally 847 bulls in GMACE without DEU info., but DEU info. available
  - thereof with country-of-origin:
    - USA+CAN = 599
    - DFS = 205 (for DFS bulls no SCS/RZS and no longevity)
    - Others = 43
Comparison of GMACE/DEU gEBV

<table>
<thead>
<tr>
<th>Trait</th>
<th>GMACE</th>
<th>gEBV DEU</th>
<th>Diff. GM-DEU</th>
<th>s Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>rel. protein kg</td>
<td>66.2</td>
<td>72.6</td>
<td>-6.3</td>
<td></td>
</tr>
<tr>
<td>protein kg</td>
<td>40.6</td>
<td>41.3</td>
<td>-0.7</td>
<td>7.0</td>
</tr>
<tr>
<td>fat kg</td>
<td>40.4</td>
<td>42.7</td>
<td>-2.3</td>
<td>8.7</td>
</tr>
<tr>
<td>milk kg</td>
<td>1201</td>
<td>1154</td>
<td>48</td>
<td>229</td>
</tr>
<tr>
<td>prod. index (RZM)</td>
<td>119.7</td>
<td>120.5</td>
<td>-0.8</td>
<td>4.9</td>
</tr>
<tr>
<td>rel. RZE</td>
<td>61.7</td>
<td>55.8</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>conf. index (RZE)</td>
<td>118.0</td>
<td>117.6</td>
<td>0.4</td>
<td>4.0</td>
</tr>
<tr>
<td>stature</td>
<td>109.0</td>
<td>109.8</td>
<td>-0.9</td>
<td>3.7</td>
</tr>
<tr>
<td>udder depth</td>
<td>114.2</td>
<td>116.0</td>
<td>-1.8</td>
<td>4.3</td>
</tr>
</tbody>
</table>

- Average GMACE-gEBV very similar to (independent) DEU-gEBV
- In tendency GMACE-gEBV are lower compared to DEU-gEBV

Except milk prod. traits
All traits on relative scale
\( \bar{\phi} = 100 \)
\( S = 12 \)
### Comparison of GMACE/DEU gEBV by country-of-origin

<table>
<thead>
<tr>
<th>Trait</th>
<th>599 USA/CAN bulls</th>
<th>205 DFS bulls</th>
</tr>
</thead>
<tbody>
<tr>
<td>gEBV DEU</td>
<td>Diff. GM-DEU</td>
<td>gEBV DEU</td>
</tr>
<tr>
<td>rel. protein kg</td>
<td>72.5</td>
<td>-4.3</td>
</tr>
<tr>
<td>protein kg</td>
<td>43.1</td>
<td>0.0</td>
</tr>
<tr>
<td>fat kg</td>
<td>46.4</td>
<td>-1.8</td>
</tr>
<tr>
<td>milk kg</td>
<td>1284</td>
<td>75</td>
</tr>
<tr>
<td>prod. index (RZM)</td>
<td>121.8</td>
<td>-0.3</td>
</tr>
<tr>
<td>rel. RZE</td>
<td>55.6</td>
<td>8.2</td>
</tr>
<tr>
<td>conf. index (RZE)</td>
<td>122.7</td>
<td>0.8</td>
</tr>
<tr>
<td>stature</td>
<td>113.6</td>
<td>-1.0</td>
</tr>
<tr>
<td>udder depth</td>
<td>118.5</td>
<td>-2.0</td>
</tr>
<tr>
<td>daug. fert. index (RZR)</td>
<td>109.9</td>
<td>-0.1</td>
</tr>
<tr>
<td>rel. FL cows</td>
<td>44.6</td>
<td>21.5</td>
</tr>
<tr>
<td>first to last cows</td>
<td>105.6</td>
<td>0.9</td>
</tr>
<tr>
<td>rel. NR cows</td>
<td>41.4</td>
<td>10.6</td>
</tr>
<tr>
<td>NonReturn cows</td>
<td>105.6</td>
<td>0.1</td>
</tr>
<tr>
<td>rel. RZS</td>
<td>76.2</td>
<td>-1.8</td>
</tr>
<tr>
<td>SCS (relative)</td>
<td>115.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>rel. Longevity</td>
<td>50.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Longevity (RZN)</td>
<td>123.5</td>
<td>-2.0</td>
</tr>
</tbody>
</table>

### Notes:
- φ = number countries in GMACE: USA/CAN 4.3; DFS 1.9
  - SCS and longevity for DFS bulls not available in GMACE implementation run Dec. 2013
- In tendency GMACE-gEBV are more similar to (independent) DEU-gEBV for USA/CAN bulls compared to DFS bulls

### Except milk prod. traits
All traits on relative scale

φ = 100
S = 12
Comparison of GMACE/DEU gEBV

- GMACE: 119.7
- DEU: 120.5
- Diff.: -0.8
- Deviation: ± 4.9

No systematic over- or under-estimation for milk production traits
  - In tendency lower GMACE-gEBV for high bulls
Comparison of GMACE/DEU gEBV by country-of-origin

Production index RZM

- **DEU-gEBV**: 121.8
- **n countries**: 4.3
- **Diff.**: -0.3
  - **deviation**: ± 5.1

- **DEU-gEBV**: 117.3
- **n countries**: 1.9
- **Diff.**: -2.0
  - **deviation**: ± 3.9

- GMACE-gEBV from USA/CAN bulls realistic (even high bulls)
- DFS bulls in average lower as DEU-gEBV, especially high bulls
Comparison of GMACE/DEU gEBV

- GMACE: 118.0
- DEU: 117.6
- Diff.: +0.4

- Deviation: ± 4.0
- In average across all conformation traits similar GMACE-gEBV compared to DEU-gEBV
  - but bigger differences per single conformation trait:
    - Diff.-stature: -0.9
    - Diff.-udder depth: -1.9

RZE = conformation index
Scale: Ø=100, s=12
Comparison of GMACE/DEU gEBV by country-of-origin

Overall conformation index RZE

- **DEU-gZW**: 122.7
- **n countries**: 4.3
- **Diff.**: +0.8  **deviation**: ± 4.3

- **DEU-gZW**: 103.2
- **n countries**: 1.9
- **Diff.**: -0.5  **deviation**: ± 3.2

GMACE-gEBV of USA/CAN bulls in average slightly higher as DEU-gEBV
- For low bulls more pronounced, high bulls very similar gEBV

DFS bulls in average slightly lower gEBV from GMACE compared to DEU-gEBV
- but same tendency as USA/CAN bulls i.e. low bulls overestimated, high bulls slightly underestimated
Comparison of GMACE/DEU gEBV

- No GMACE SCS for DFS bulls → results dominated by 599 USA/CAN bulls
- $\overline{\text{GMACE}}: 114.5 \hspace{1cm} \overline{\text{DEU}}: 114.9 \hspace{1cm} \text{Diff.: } -0.4$
- $\overline{\text{deviation}} : \pm 4.9$
- No systematic higher GMACE-gEBV for high bulls for SCS/RZS

RZS = SCS relative reversed
Scale: $\varnothing=100$, $s=12$
Comparison of GMACE/DEU gEBV

- No GMACE longevity for DFS bulls → results dominated by 599 USA/CAN bulls
- $\bar{\text{GMACE}}: 120.9$  $\bar{\text{DEU}}: 122.9$  $\text{Diff.:} -2.0$  $\text{deviation:} \pm 5.6$
- GMACE-gEBV for longevity are systematic lower compared to DEU-gEBV
  - in German validation in practice some overestimation of DEU-gEBV is observed, too
  - $\Rightarrow$ GMACE-gEBV are realistic

RZN = longevity
Scale: $\bar{\text{}}=100$, $s=12$
Summary

- **GMACE seems to work**
  - GMACE-gEBV (without DEU info) show good accordance with independent DEU-gEBV
    - even for high USA/CAN sire of sons
Thank you for attention!
Summary

- GMACE seems to work
  - GMACE-gEBV (without DEU info) show good accordance with independent DEU-gEBV
    - even for high USA/CAN sire of sons
Comparison of GMACE/DEU gEBV

- GMACE: 110.7
- DEU: 110.6
- Diff.: +0.1

- Deviation: ± 4.3

RZR is almost always a mix from GMACE- and DEU-gEBV (not all countries have the 5 IB traits)

- But bigger differences per single trait:
  - Diff.-NRc: +0.8
  - Diff.-FLc: +0.9

RZR = Daug. Fert. index
Scale: ∅=100, s=12
Comparison of GMACE/DEU gEBV by country-of-origin

SCS = RZS (reversed relative scale)

- DEU-gEBV: 115.3
- n countries: 4.3
- Diff.: -0.5  deviation: ± 5.0

DFS: no GMACE SCS
Comparison of GMACE/DEU gEBV by country-of-origin

**Longevity RZN**

- **DEU-gZW: 123.5**
- **n countries: 4.3**
- **Diff.: -2.0 \( \phi \) deviation: \( \pm 5.6 \)

- GMACE-gEBV longevity are systematic as lower compared to DEU-gEBV as is in German validation in practice
- GMACE-gEBV are realistic

- **DFS: no GMACE longevity**
Comparison of GMACE/DEU gEBV by country-of-origin

Daughter fertility index RZR

- Average DEU-gEBV: 109.9
- Average n countries: 4.3
- Difference: -0.1
- Standard deviation: ± 4.3
- Difference-NRC: +0.1
- Standard deviation: ± 5.6
- Difference-FLC: +0.9
- Standard deviation: ± 5.3

- Average DEU-gEBV: 114.7
- Average n countries: 1.9
- Difference: -0.7
- Standard deviation: ± 4.2
- Difference-NRC: +1.7
- Standard deviation: ± 4.5
- Difference-FLC: +0.7
- Standard deviation: ± 4.1

GMACE-gEBV are almost always a mix of IB- + DEU-gEBV

Single fertility traits: overall slightly higher GMACE-gEBV compared to DEU-gEBV
- Problem of DEU-evaluation, or of GMACE (DEU fert. gEBV have low reliability)?
Evaluation of GMACE-Pilot-Runs MP50 and GP50 December 2013

Vereinigte Informationssysteme Tierhaltung w.V. (vit), Verden
Genetic Evaluation Devision
Background and data

- IB used same national data as for implementation-run Dec. 2013
  - But with pilot runs all animals are distributed
    - Implementation-run: ca. 22,000 A.I. bulls
    - Pilot-runs: ca. 95,000 males (A.I. bulls + selection candidates)

- Two pilot-runs:
  - GP50: reliability weighted 50% national rel., 50% theoretical rel. (size reference pop.)
  - MP50: reliability weighted + MACE variance instead of genomic variance
  - Background:
    - no international harmonization of national calculation of gEBV reliability
    - Some countries with small reference population seem to calculate relatively high reliabilities
    - Parameters from MACE may not be correct for GMACE

- Evaluation/comparison:
  - With implementation-run i.e. only A.I. bulls that were in implementation-run
  - Only HOL bulls
Comparison of GMACE/DEU gEBV

<table>
<thead>
<tr>
<th>Variable</th>
<th>gZW DEU</th>
<th>Implem.</th>
<th>s Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ncou_prod</td>
<td>847</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RZM</td>
<td>120,50</td>
<td>-0,76</td>
<td>4,89</td>
</tr>
<tr>
<td>mkg</td>
<td>1153,55</td>
<td>47,88</td>
<td>228,58</td>
</tr>
<tr>
<td>fkg</td>
<td>42,66</td>
<td>-2,25</td>
<td>8,68</td>
</tr>
<tr>
<td>ekg</td>
<td>41,31</td>
<td>-0,70</td>
<td>6,95</td>
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<tr>
<td>ncou_prod</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>RZE</td>
<td>117,57</td>
<td>0,44</td>
<td>4,02</td>
</tr>
<tr>
<td>gro</td>
<td>109,84</td>
<td>-0,88</td>
<td>3,68</td>
</tr>
<tr>
<td>eti</td>
<td>116,05</td>
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<td>4,30</td>
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<td>ncou_prod</td>
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<td></td>
</tr>
<tr>
<td>RZS</td>
<td>114,91</td>
<td>-0,41</td>
<td>4,93</td>
</tr>
<tr>
<td>RZN</td>
<td>122,91</td>
<td>-1,99</td>
<td>5,58</td>
</tr>
<tr>
<td>ncou_prod</td>
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<tr>
<td>RZR</td>
<td>110,62</td>
<td>0,10</td>
<td>4,32</td>
</tr>
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<td>flc</td>
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<td>5,29</td>
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<td>ncou_prod</td>
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<tr>
<td>nrc</td>
<td>105,02</td>
<td>0,78</td>
<td>4,98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GP50</th>
<th>s Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>47,12</td>
<td>227,65</td>
</tr>
<tr>
<td>-2,31</td>
<td>8,63</td>
</tr>
<tr>
<td>-0,77</td>
<td>6,87</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>MP50</th>
<th>s Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1,49</td>
<td>4,59</td>
</tr>
<tr>
<td>28,50</td>
<td>218,43</td>
</tr>
<tr>
<td>-3,52</td>
<td>8,28</td>
</tr>
<tr>
<td>-1,67</td>
<td>6,50</td>
</tr>
</tbody>
</table>

- Only small differences for average gEBV and average deviation
Comparison of GMACE/DEU gEBV

- **Diff.: -0.76**  
  \( \emptyset \) deviation: \( \pm 4.89 \)

- **GP50**: rel. + variance
  - Diff.: -0.82  \( \emptyset \) deviation: \( \pm 4.83 \)

- **MP50**: only rel. changed
  - Diff.: -1.49  \( \emptyset \) deviation: \( \pm 4.59 \)

RZM = production index
Scale: \( \emptyset = 100, s = 12 \)
Comparison of GMACE/DEU gEBV

- **MP50**: only rel. changed
  - Diff.: -0.41
  - $\varnothing$ deviation: $\pm 4.93$

- **GP50**: rel. + variance
  - Diff.: -0.39
  - $\varnothing$ deviation: $\pm 4.94$

- **MP50**: only rel. changed
  - Diff.: -1.16
  - $\varnothing$ deviation: $\pm 4.57$

**RZS** =

SCS relative reversed

Scale: $\varnothing=100, s=12$
Comparison of GMACE/DEU gEBV

- **Implementation-run**
  - Diff.: +0.44
  - $\bar{\phi}$ deviation: $\pm 4.02$

- **GP50: rel. + variance**
  - Diff.: +0.18
  - $\bar{\phi}$ deviation: $\pm 3.82$

- **MP50: only rel. changed**
  - Diff.: -0.28
  - $\bar{\phi}$ deviation: $\pm 3.50$

RZE = conformation index
Scale: $\bar{\phi}$=100, s=12
Comparison of GMACE/DEU gEBV

- **MP50**: only rel. changed
  - Diff.: -1.99
  - $\bar{\sigma}$ deviation: ± 5.58

- **GP50**: rel. + variance
  - Diff.: -2.68
  - $\bar{\sigma}$ deviation: ± 5.30

- **MP50**: only rel. changed
  - Diff.: -3.0
  - $\bar{\sigma}$ deviation: ± 5.13

RZN = longevity
Scale: $\bar{\sigma}$=100, s=12
Additional aspects

- **What reliability is (more) correct?**
  - National reliability
  - or theoretical reliability

- DEU-rel. for SCS are relatively higher compared to international SCS-rel.
  - But from validation in practice with now almost 2,000 A.I. bulls with >100 daughters we know that this high reliability seems even under-estimated

- DEU-rel. for daughter fertility are relatively low
  - But from validation in practice with now almost 2,000 A.I. bulls with >100 daughters we know that this relatively low reliability seems correct
Conclusions

- No clear indication that modification of reliability towards “theoretical” reliability gives better (=more realistic) results across all countries and traits

- The single effect of using genomic variance is hard to derive from these pilots because it is only available in conjunction with changed reliabilities

- **⇒ IB should stay with the procedure in implementation-runs**
- **⇒ and accelerate harmonization of national calculation of reliabilities**