Building up a reference population for new (and old) traits

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The reliability of the DGV depends on:

- The heritability of the trait or the reliability of the EBV for the bulls
- The number of genotyped animals with phenotypic records
- The number of markers (3K, 50K, HD)
- Linkage disequilibrium

DGV = Direct Genomic Value, EBV = Estimated Breeding Value
Linkage disequilibrium

Allele $Q$ is favorable
The reliability of the index

In this study

The reliability of the DGV

$$\text{The reliability of the index} = \text{Relationship} + \text{Linkage disequilibrium}$$

DGV = Direct Genomic Value
The reliability of the index

In reality

The reliability of the index = Relationship

The reliability of the DGV = Relationship* × Linkage disequilibrium

* That can be explained by markers

DGV = Direct Genomic Value
Recording of new traits

- New (often functional) traits
- New traits are probably only recorded on a smaller part of the population
- Fewer bulls get daughters with phenotypic records
Recording on a large scale

- Every year the reference population is added:
  - **B30**: 30 bulls with 500 daughters
  - **B30_C2000**: 30 bulls with 500 daughters and 2000 cows with phenotypic records
  - **B30_TB170**: 30 bulls with 500 daughters and 170 test bulls with 100 daughters
General assumptions

- Heritability of 0.05
- 38,000 informative markers (50K)
- Turbo scheme – the bulls are used for breeding purposes as soon as they reach sexual maturity
The reliability of the DGV if the new trait is recorded on a large scale
# Cows versus (test) bulls when $h^2 = 0.05$

<table>
<thead>
<tr>
<th>Reliability</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulls with 500 daughters</td>
<td>414</td>
<td>1,150</td>
<td>12,000</td>
</tr>
<tr>
<td>Test bulls with 100 daughters</td>
<td>1,340</td>
<td>3,730</td>
<td>39,000</td>
</tr>
<tr>
<td>Cows</td>
<td>57,700</td>
<td>160,500</td>
<td>1,680,000</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
</tr>
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<td>-------------</td>
<td>------</td>
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<td>------</td>
</tr>
<tr>
<td>Bulls with 500 daughters</td>
<td>73</td>
<td>204</td>
<td>2.100</td>
</tr>
<tr>
<td>Test bulls with 100 daughters</td>
<td>333</td>
<td>925</td>
<td>9,700</td>
</tr>
<tr>
<td>Cows</td>
<td>7,100</td>
<td>19,700</td>
<td>205,000</td>
</tr>
</tbody>
</table>
Recording on a small scale

- Every year the reference population is added:
  - **C4000**: 4000 cows with phenotypic records
  - **B30_D133**: 30 bulls with 133 daughters
- $h^2 = 0.05$
- 38,000 informative markers
- Turbo scheme
The reliability of the DGV if the new trait is recorded on a small scale
Recommendations for new traits

- Lower reliability of the DGV for new functional traits
- Great value of including more animals in the reference population than the elite bulls
Assumptions

- The existent reference population gives 60% DGV-reliability
- Stop for collection of phenotypes for both cows and bulls.
Reliability depends on both LD and genetic relationship

An illustration
Reliability drops when phenotypes are missing

Modified after Calus et al., 2010
Reasons

- From gen. 2 to gen. 3: The animals themselves are not included in the reference population.
- From gen. 3 to gen. 4: The animals are less related to the reference population.
The reliability drops, when phenotypes are missing (Nordic results)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Sire included in the reference population</th>
<th>Sire not included in the reference population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertility</td>
<td>0.41</td>
<td>0.33</td>
</tr>
<tr>
<td>Protein</td>
<td>0.41</td>
<td>0.36</td>
</tr>
<tr>
<td>Udder health</td>
<td>0.44</td>
<td>0.34</td>
</tr>
</tbody>
</table>

$L^2_{DGV,EBV}$

Lund et al., 2009
Conclusion

- Registrations are continuing necessary
  - To achieve high DGV-accuracy for "new" traits
  - To sustain/enhance DGV-accuracy for "old" traits
- Still recommended to progeny test bull for strengthening the reference population
- Acceptable accuracy for DGV’s for new traits are achieved as fast as possible with cows in the reference population
- Genomic test strategy is dependent on test price (males versus females)
Practical considerations with use of GenVikPlus (GV+) bulls

Morten Kargo

The on farm challenge is the lowered accuracy (compared to proven bulls)
## True breeding value (TB) versus EBV

<table>
<thead>
<tr>
<th>EBV</th>
<th>+ 25 NTM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>50%</td>
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<tr>
<td></td>
<td>60%</td>
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<td>70%</td>
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<td></td>
<td>80%</td>
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<tr>
<td></td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>95%</td>
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<tr>
<td><strong>TB, min</strong></td>
<td>+6</td>
</tr>
<tr>
<td></td>
<td>+7</td>
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<td></td>
<td>+9</td>
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<td>+11</td>
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<td>+13</td>
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<td>+15</td>
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<td>+18</td>
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<td></td>
<td>+20</td>
</tr>
<tr>
<td><strong>TB, max</strong></td>
<td>+44</td>
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<tr>
<td></td>
<td>+43</td>
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<tr>
<td></td>
<td>+41</td>
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<td>+39</td>
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<td>+37</td>
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<td>+35</td>
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<tr>
<td></td>
<td>+32</td>
</tr>
<tr>
<td></td>
<td>+30</td>
</tr>
</tbody>
</table>

**Average accuracy**

**High Accuracy**

- Accuracy: 30% - 50%
- TB, min: +6 - +11
- TB, max: +44 - +41
NTM accuracy on group mean of GV+ bulls depending on group size

AC Sørensen
The expected NTM level for the best GV+ bulls

The dotted lines are 95% confidence intervals

AC Sørensen
The expected NTM level for the best progeny tested bulls

The dotted lines are 95% confidence intervals
GV+ bulls versus progeny tested bulls

AC Sørensen
Value of using GV+ bulls instead of "traditional" progeny tested bulls

- On average the difference is 15 NTM units (Holstein)

- Economic advantage using GV+ bulls for 100 heifers/cows instead of traditional tested bulls is approximate 7,000 – 8,500 Euro
Disadvantages

- Lowered reliability of parent average for young animals
- No problem for dairy producers focusing on groups of animals
- A problem for breeders focusing on single animals
Challenges

- Stop focusing on single animals – also in the presentation of GV+ bulls
- GV+ bulls must be considered as a group of bulls
- In small herds use only 2-3 doses per GV+ bull
Practical recommendations regarding bull use for dairy farmers

- Use 75% GV+ bulls and 25% test bulls
- Have intermediate aims – it is a big change for some dairy farmers
Practical considerations regarding Sires of sons

- 50% GV+ bulls and 50% progeny tested bulls as sires of sons. The argument is based on risk and inbreeding considerations.
Practical considerations – Overall conclusion

- Use of GV+ bulls as sires of cows are in the long term free of risk, and therefore recommended
- There is a risk using only GV+ bulls as sires of sons
  - Is something missed – we are new in the area
  - Inbreeding
- Given today’s knowledge: continue progeny testing
- Remember breed differences