Economics of using genomic selection at the farm level

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Introduction – GS in dairy cattle

- Genomic selection (GS) may increase $\Delta G$ in breeding program
  - Sires of sires
  - Bull dams
  - Sires of dams

- $\Delta G$ “reaches” commercial farms with some time lag
  - Lag > generation interval of females
Impact of using GS for choosing heifers for replacement

![Diagram showing genetic level over time for breeding program and typical dairy herd, with a time lag indicated.](image-url)
Further use of GS at the herd level?

- Selection response for dams of cows pathway is negligible

- Perhaps GS can be used to select replacement heifers
Using GS for replacement

- Economic benefit comes through selecting better heifers

- “One-time-only” effect
  - Reduces time lag (temporarily) for $\Delta G$ to reach herd
  - If heifer is culled, the benefit disappears
  - Impact on $\Delta G$ at population level (DD pathway) is negligible
Impact of using GS for choosing heifers for replacement

- breeding program
- herd with continuous GS
- typical dairy herd

Genetic level vs. years
Impact of using GS for choosing heifers for replacement

- Breeding program
- Herd with continuous GS
- "One time only GS" herd
- Typical dairy herd
Objective

Investigate:
- Economic impact of GS for replacement
- Compared to replacement based on parent average
- Derive break-even cost for genotyping
Impact of GS for replacement - Scenarios

Commercial herd:

- 100 cows
- Number of heifers available = 15 - 40
- Replacement rate 15 - 30%
- Survival female calves = 80%
- Use of conventional or sexed semen (SS)
  - SS doubles number of heifers available (30 – 80)
- Proportion of heifers genotyped
  - All
  - Pre-selection based on parent average (PA)
Impact of GS for replacement - Parameters

\[ R = i \times \rho \times \sigma_H \]

- \( R \) = response in Euros
- \( i \) = selection intensity
- \( \rho \) = accuracy of selection, not EBV accuracy (Bijma, 2011)
- \( \rho_{PA} = 0.15; \rho_{GS} = 0.7 \)
- \( \sigma_H \) = SD breeding goal = 300 Euro (de Roos, 2011)
  - 100 Euro per SD per lactation × 3 lactations
- Additional response:
  \[ R = i \times (\rho_{GS} - \rho_{PA}) \times \sigma_H \]
Break-even cost genotyping - conventional semen

Heifers available

Replacement rate (%)
Two-stage selection

- Stage 1: pre-selection based on parent average
- Stage 2: selection using GS
Two-stage selection

- Reduce genotyping costs by pre-selection based on parent average

What is (relative) impact on:
- Total genotyping costs
- Additional revenues due to GS

Using replacement rate = 15%;

<table>
<thead>
<tr>
<th>Scenario</th>
<th>#heifers available</th>
<th>Proportion selected</th>
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</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>30</td>
<td>50%</td>
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<tr>
<td>Sexed</td>
<td>60</td>
<td>25%</td>
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</table>
Impact pre-selection

- Break-even cost of genotyping:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>All genotyped</th>
<th>Pre-selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Sexed</td>
<td>63</td>
<td>105</td>
</tr>
</tbody>
</table>

=> GS for replacement easier affordable with pre-selection
Discussion

- Using GS at the level of the dams yields additional benefits (not considered here):
  - “Avoid” conceiving calves with low breeding value
  - Perhaps use a beef bull instead

- Response to GS (for replacement) $\propto (\rho_{GS} - \rho_{PA})$

- We used $\rho_{PA} = 0.15$ & $\rho_{GS} = 0.7$
  - $\rho_{GS} = 0.5$ yields a 36% lower benefit
  - $\rho_{GS} = 0.9$ yields a 36% higher benefit
Conclusions

- GS for replacement of heifers is beneficial, provided:
  - There is some room for selection
  - Genotyping costs are $\sim<50$ Euro

- Use of sexed semen (SS) increases potential benefit
  - Increased costs for SS were not considered

- Pre-selection based on PA is beneficial
  - By reducing genotyping costs
  - Especially when using sexed semen