EBI & Multi-breed Dairy Genomics

Andrew Cromie, ICBF.
The EBI – Trends & where to next?
Genetic Gain in EBI, by year 1st calving

- Current rate of gain in EBI = ~€10/year.
  -Cumulative has delivered €1.8 bn to Irish dairy industry.
  -Each €10 gain = 61 kg less CO2 eq/lactation (~-1.5%/annum).
  -But, these gains have been “eroded” due to increase in size of cow herd (1.1m cows to 1.5m cows =>+~35%).

- With current rate of gain => EBI of National dairy herd in 2030 will be €230 => 430kt gain (MACC).

- Can we increase rate of gain from current €10/cow/year to €15/cow/year?
Increasing genetic gain

• Where can we achieve improvements;
  • Increased usage of young GS bulls.
  • New traits, e.g., calving, maintenance, beef, age slaughter, health, direct measurement of GHG (GreenBreed).
  • More genotyping => DNA calf reg.
  • More accurate data for genomic predictions.
    • Updating training population to include females & extending to multiple breeds.
    • Blending genomic proofs.
  • Others....

Genetic gain = \frac{i \cdot r \cdot \sigma}{L}

- Intensity
- Accuracy
- Variation
- Generation interval

#ISGC20
Use of “younger” GS bulls.

- Younger GS bulls (3-year old bulls) are €25 ahead of proven bulls (~6 year old bulls) and €70 ahead of stock bulls.
- Trends are same => simple genetic lag re: getting best genes into our dairy population.
- Need to increase usage of younger GS bulls & remove older AI & stock bulls.
  - Even use of teams (~10 bulls) of high EBI bulls is key.
Genomic selection.

Training/Reference population

Phenotypes + ‘000 genotypes

Prediction equation

“SNP key”

Assoc. between genotypes & phenotypes

Genotype + SNP key

Genomic prediction

Selection candidate
## Updating Training Population.

### Milk Traits

<table>
<thead>
<tr>
<th>Animals in training</th>
<th>Breed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Current</td>
<td>10,290</td>
</tr>
<tr>
<td>+ other breed males</td>
<td>10,628</td>
</tr>
<tr>
<td>++ females</td>
<td>10,690</td>
</tr>
</tbody>
</table>

### Calving interval

<table>
<thead>
<tr>
<th>Animals in training</th>
<th>Breed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Current</td>
<td>9,285</td>
</tr>
<tr>
<td>+ other breed males</td>
<td>9,622</td>
</tr>
<tr>
<td>++ females</td>
<td>9,484</td>
</tr>
</tbody>
</table>

- Training population updated with; (i) other breed males, and (ii) females (all dairy breeds).
- System to now routinely add new males/females to training population (as per beef).
- GreenBreed project.
Results – Milk Sub Index.

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>10690</td>
<td>26.29162</td>
<td>38.78305</td>
<td>-120.88</td>
<td>165.86</td>
</tr>
<tr>
<td>Female</td>
<td>19934</td>
<td>35.69475</td>
<td>32.44963</td>
<td>-130.5</td>
<td>180.08</td>
</tr>
<tr>
<td>All</td>
<td>30624</td>
<td>32.41237</td>
<td>35.07861</td>
<td>-130.5</td>
<td>180.08</td>
</tr>
</tbody>
</table>
Results – Fertility Sub Index

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>8591</td>
<td>6.04867</td>
<td>68.75077</td>
<td>-328.02</td>
<td>182.2</td>
</tr>
<tr>
<td>Female</td>
<td>19284</td>
<td>43.4668</td>
<td>47.31685</td>
<td>-183.21</td>
<td>311.36</td>
</tr>
<tr>
<td>All</td>
<td>27875</td>
<td>31.9347</td>
<td>57.48042</td>
<td>-328.02</td>
<td>311.36</td>
</tr>
</tbody>
</table>
Results – Validation.

<table>
<thead>
<tr>
<th>Traits</th>
<th>Validation</th>
<th>EBV</th>
<th>Current GEBV (males in training)</th>
<th>New GEBV (males + females in training)</th>
<th>Relative gain in accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Correlation</td>
<td>0.61</td>
<td>0.68</td>
<td>0.73</td>
<td>20%</td>
</tr>
<tr>
<td>Fat</td>
<td>Correlation</td>
<td>0.43</td>
<td>0.56</td>
<td>0.62</td>
<td>44%</td>
</tr>
<tr>
<td>Protein</td>
<td>Correlation</td>
<td>0.51</td>
<td>0.64</td>
<td>0.68</td>
<td>33%</td>
</tr>
<tr>
<td>SCC</td>
<td>Correlation</td>
<td>0.58</td>
<td>0.62</td>
<td>0.68</td>
<td>17%</td>
</tr>
<tr>
<td>CIV</td>
<td>Correlation</td>
<td>0.37</td>
<td>0.40</td>
<td>0.43</td>
<td>16%</td>
</tr>
</tbody>
</table>

- Validation based on EBV from current evaluation for 262 sires born after 2010 with at least 50 daughters in milk.
- Correlation is improving for all traits => increase accuracy of genomic prediction.
- Internal validation mechanism to assess ongoing improvements in accuracy of training population.
Results – Impact on Active AI Bulls.

- Minimal impact on milk sub-index (+/- €10).
- Considerable impact on fertility sub-index (+/- €40).
Blending genomics.

- Previous based on decision rules, e.g., genomic => daughter proven. Not continuous blending approach => more “stable”.

#ISGC20
Updating Maintenance Sub Index.

• Current maintenance sub index (Cull cow weight PTA * EW).
• New maintenance sub-index (Live-weight PTA * EW).
• Previously Maintenance sub index derived solely from cull cow weights.
  • More cull cow weights than cow live weights. Standard conversion applied, but new research has highlighted important breed differences.
  • Increasing volumes of actual cow live-weight data (1m+) => GreenBreed.
  • Switch to using cow live-weight directly.
Results - Maintenance sub-index.

- JE breed cows losing slightly & Red breed cows gaining slightly.

**Kill-Out%**
- Assumed 45%
- Actual 43%

**Cull Cow Weight**
- Assumed: 200 kg
- Actual: 200 kg

**Assumed Live Weight**
- Assumed: 444 kg
- Actual: 465 kg

**Difference**
- At 43% kill-out, the JE cow has a 21 kg heavier live weight, thus higher maintenance costs.
Results – Overall EBI.

- Changes in genomics, blending, calving & cow maintenance;
  - Little change in ave EBI.
  - r=0.95, so some re-ranking (+/- €50). Due to more accurate training population.
- Gains in reliability (~50%=> ~60%) => more confidence in breeding decisions, especially for young GS bulls.
Take Home Message.

• EBI is working (year on year gains in fat, protein, fertility, survival....).

• Several improvements introduced to dairy genetic evaluations this Spring.
  • New Calving Evaluations, including “risk for use on heifers” trait.
  • New dairy genomics, including females and other dairy breeds.
  • Update of maintenance sub-index.

• Little change in average EBI, but some changes in individual bulls
  • Updated training population => more accurate genetic/genomic evaluations.

• Use teams of high EBI bulls evenly on your herd this Spring.