Genotype–Environment Interactions of Bulls used in Expanding Herds

Sinead McParland
Genotype*Environment (G*E) Interaction

- Daughter performance varies according to her environment
  - Rescaling or reranking of sires

- High vs low concentrate input (Cromie et al., 1997)
- Large vs small herds (Hayes et al., 2003)
- High vs low temperature humidity (Hayes et al., 2003)
- Grazing vs confined production (Kearney et al., 2004)
A changing dairy industry

- Milk quota abolition has led to significant changes in European milk production
  - Previous limiting factor on milk production
  - Cows not yielding to full genetic potential
  - Farms not utilised to full potential

- Food Harvest2020
  - Strategy document published by Irish DAFM
  - Set target of increased milk output by 50% by 2020
    - Volumes increased by 10% by 2014
Calves born from dairy or beef dams (Ireland)

Source: AIM bovine statistics report
http://www.agriculture.gov.ie
Average herd size in Ireland

Source: AIM bovine statistics report
http://www.agriculture.gov.ie
Is there an impact of dairy expansion?

- Nationally, dairy herds are expanding

- Expanding vs Static herds
  - Lower milk yield, higher fat & protein %
  - Better reproductive rates
  - Lower average parity number
  - Higher rates of AI

Does bull performance differ in herds of different size, or herds differing in rate of expansion?

*Jago and Berry, 2011*
Materials & Methods 1) Herd Characterisation

- National data base of milk recorded cows 2010 – 2014, inclusive
  - Spring calving herds retained
  - Only herds present for all 5 years retained
- Linear robust regression to quantify rate of expansion
  - Static $(-/+b; p>0.05)$
  - Contracting $(-b; p<0.05)$
  - Expanding $(+b; p<0.05)$
    - Slowly $(+3.1 \text{ cows / year})$
    - Rapidly $(+8.7 \text{ cows / year})$
- Predicted herd size in 2012
  - Small (46.5 cows), Medium (72.6 cows), Large (125.3 cows)
Materials & Methods 2) Data & Analysis

- Sire PTA from December 2011 national genetic evaluation obtained (http://www.icbf.com)
  - PTA deregressed
  - Retained if reliability >50%

- Holstein–Friesian cows calving for first time in 2012 or after
- Predicted 305-day yields (Biological extremes removed)

- Linear mixed models ASReml
  - Test for sire PTA * herd classification (expansion or size)
  - Test for sire PTA * parity
  - Herd class, parity, sire PTA, [HYS calving]
## Data Summary

<table>
<thead>
<tr>
<th></th>
<th>Avg Cows</th>
<th>No Recs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>47</td>
<td>38,756</td>
</tr>
<tr>
<td>Medium</td>
<td>73</td>
<td>67,485</td>
</tr>
<tr>
<td>Large</td>
<td>125</td>
<td>115,431</td>
</tr>
<tr>
<td>Static</td>
<td>0</td>
<td>125,652</td>
</tr>
<tr>
<td>Slow</td>
<td>3</td>
<td>36,517</td>
</tr>
<tr>
<td>Rapid</td>
<td>9</td>
<td>59,503</td>
</tr>
</tbody>
</table>
RESULTS
Did daughters perform as expected?

<table>
<thead>
<tr>
<th></th>
<th>Milk (kg)</th>
<th>Fat (kg)</th>
<th>Prot (kg)</th>
<th>Fat (%)</th>
<th>Prot (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.59</td>
<td>0.61</td>
<td>0.48</td>
<td>0.79</td>
<td>0.73</td>
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</tbody>
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## Daughter Performance

<table>
<thead>
<tr>
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<th>Fat (kg)</th>
<th>Prot (kg)</th>
<th>Fat (%)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>5,777&lt;sup&gt;A&lt;/sup&gt;</td>
<td>232.6&lt;sup&gt;A&lt;/sup&gt;</td>
<td>202.1&lt;sup&gt;A&lt;/sup&gt;</td>
<td>4.06&lt;sup&gt;A&lt;/sup&gt;</td>
<td>3.51&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Med</td>
<td>5,834&lt;sup&gt;B&lt;/sup&gt;</td>
<td>236.9&lt;sup&gt;B&lt;/sup&gt;</td>
<td>204.5&lt;sup&gt;B&lt;/sup&gt;</td>
<td>4.10&lt;sup&gt;B&lt;/sup&gt;</td>
<td>3.52&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Large</td>
<td>5,705&lt;sup&gt;C&lt;/sup&gt;</td>
<td>234.8&lt;sup&gt;C&lt;/sup&gt;</td>
<td>201.3&lt;sup&gt;A&lt;/sup&gt;</td>
<td>4.16&lt;sup&gt;C&lt;/sup&gt;</td>
<td>3.54&lt;sup&gt;C&lt;/sup&gt;</td>
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The Irish Agriculture and Food Development Authority
### Sire use across herd categories

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<tr>
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<th>Fat (%)</th>
<th>Prot (%)</th>
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</thead>
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<tr>
<td>Small (47)</td>
<td>177&lt;sup&gt;A&lt;/sup&gt;</td>
<td>12.8&lt;sup&gt;A&lt;/sup&gt;</td>
<td>10.5&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.11&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.09&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Med (73)</td>
<td>201&lt;sup&gt;B&lt;/sup&gt;</td>
<td>13.5&lt;sup&gt;B&lt;/sup&gt;</td>
<td>11.2&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.11&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.09&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Large (125)</td>
<td>207&lt;sup&gt;C&lt;/sup&gt;</td>
<td>14.1&lt;sup&gt;C&lt;/sup&gt;</td>
<td>11.6&lt;sup&gt;C&lt;/sup&gt;</td>
<td>0.12&lt;sup&gt;C&lt;/sup&gt;</td>
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<tr>
<td>Small (47)</td>
<td>0.67&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.66&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.52&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.84&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.76&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Med (73)</td>
<td>0.62&lt;sup&gt;A&lt;/sup&gt;</td>
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<td>0.51&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.82&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.74&lt;sup&gt;A&lt;/sup&gt;</td>
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<td>Large (125)</td>
<td>0.58&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.55&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.46&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.75&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.72&lt;sup&gt;B&lt;/sup&gt;</td>
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Note: Values with different superscript letters (A, B, C) indicate significant differences.
Conclusion

- Irish dairy herds are undergoing expansion
- Cows performed closest to their genetic potential in
  - Small & medium sized herds
  - Herds which were slowly expanding (<3 cows / year)
- Genetic correlations among classes of expansion / herd size will indicate if differences are due to rescaling or reranking
Thank you for your attention

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