Developments in multi-source genetic evaluations for beef cattle: a BREEDPLAN perspective

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Agricultural Business Research Institute

- ABRI is a commercial company:
  - founded in 1970
  - based UNE, Armidale (AUS)

- primary business → to provide a diverse range of agribusiness information services to livestock industries, worldwide:
  - integrated pedigree & performance database (ILR2)
  - genetic analyses (BREEDPLAN)
  - breed registry services
  - extension services
  - multi-species
International Livestock Registry Registry 2

- world-leading breed registry software
- multi-species system
- used by >190 breed associations
- > 40 million animals recorded
- “global language”
ILR2 – global language for beef cattle

- standardised PED, PERF, GENO extracts → for genetic analysis
- storage of cross-reference information → building global XREF files
- automated → no need for involvement of office staff
BREEDPLAN® software is developed by the Animal Genetics & Breeding Unit, a joint venture of the University of New England and NSW Department of Primary Industries, with support from Meat & Livestock Australia.

**BREEDPLAN®**

**Growth**
- Birth weight
- Weaning weight
- Yearling weight
- Final weight
- Mature Cow weight
- Maternal growth

**Fertility**
- Gestation length
- Scrotal size
- Days to calving

**Scan**
- Eye muscle area
- Rib fat
- Rump fat
- IMF%

**Carcase**
- Carcase weight
- Carcase EMA
- Carcase fat
- Retail beef yield %
- IMF%

**Additional**
- Net feed intake
- Flight time
- Shear force
- % normal sperm
- Camera (carc) traits

**Calving ease**
- Docility
- Structural traits
## Multi-source BREEDPLAN developments

<table>
<thead>
<tr>
<th>Breed</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hereford</td>
<td>AUS, NZ, CAN, UK, NAM, UY, AR</td>
</tr>
<tr>
<td>Brahman</td>
<td>AUS, RSA, NAM, USA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Breeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Brahman</td>
</tr>
<tr>
<td></td>
<td>Santa Gertrudis</td>
</tr>
<tr>
<td></td>
<td>Droughtmaster</td>
</tr>
<tr>
<td></td>
<td>Belmont Red</td>
</tr>
</tbody>
</table>
Multi-country BREEDPLAN: approach

- **Each country:**
  - standardised extracts (ILR2)
  - estimate trait-specific parameters:
    - adjustment factors: AOC, AOD, sex-specific
    - variance components: $V_A, V_M, V_C, V_{SXH}, V_E$

- **Multi-country model:**
  - estimate across-country correlations, per trait
  - multi-country COVAR matrix:
    - pooled variances (weighted by effective phenotypes)
    - correlations (derived from most comprehensive data set)
  - model includes:
    - sire x herd interactions
    - allowance for heterogeneity of variance
    - comprehensive genetic groupings: country, year, “other breed”
  - single “multi-country” expression per trait
## Multi-country BREEDPLAN

<table>
<thead>
<tr>
<th>Trait</th>
<th>Hereford-7</th>
<th>Brahman-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight</td>
<td>1,749,276</td>
<td>795,466</td>
</tr>
<tr>
<td>Weaning weight</td>
<td>2,229,446</td>
<td>540,945</td>
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<tr>
<td>Yearling weight</td>
<td>1,374,949</td>
<td>260,690</td>
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<tr>
<td>Final weight</td>
<td>769,455</td>
<td>234,152</td>
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<tr>
<td>Mature cow weight</td>
<td>128,461</td>
<td>60,079</td>
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<tr>
<td>Scrotal circumference</td>
<td>243,519</td>
<td>52,922</td>
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<tr>
<td>Scan EMA</td>
<td>469,172</td>
<td>45,814</td>
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<tr>
<td>Scan RIB</td>
<td>471,333</td>
<td>43,474</td>
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<tr>
<td>Scan IMF</td>
<td>270,090</td>
<td>-</td>
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<tr>
<td>Total records</td>
<td>7,705,701</td>
<td>2,033,542</td>
</tr>
</tbody>
</table>
Multi-country BREEDPLAN: approach

Single country:

- Current national COVAR
- Country VAR, multi-country CORR
- Multi-country COVAR

Multi-country:

- Multi-country COVAR

Validate assumptions
Results

Animal is a Published Sire, Birth Wt. (kg) <= 2.2, 200 Day Wt. (kg) >= 20, 400 Day Wt. (kg) >= 28, 600 Day Wt. (kg) >= 38,

<table>
<thead>
<tr>
<th>Primary Country</th>
<th>Birth Wt. (kg)</th>
<th>200 Day Wt. (kg)</th>
<th>400 Day Wt. (kg)</th>
<th>600 Day Wt. (kg)</th>
<th>Mat. Cow Wt. (kg)</th>
<th>Milk (kg)</th>
<th>Scrotal Size (cm)</th>
<th>Eye Muscle Area (sq.cm)</th>
<th>Rib Fat (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>+2.1</td>
<td>+22</td>
<td>+35</td>
<td>+55</td>
<td>+60</td>
<td>+4</td>
<td>+1.8</td>
<td>+2.6</td>
<td>-0.4</td>
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<tr>
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<td>+22</td>
<td>+34</td>
<td>+38</td>
<td>+44</td>
<td>+4</td>
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<td>+0.4</td>
<td>-0.1</td>
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<td>+34</td>
<td>+44</td>
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<td>+1</td>
<td>+2.3</td>
<td>+1.5</td>
<td>+0.5</td>
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<tr>
<td>Australia</td>
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<td>+44</td>
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<td>+4</td>
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<td>South Africa</td>
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<td>Namibia</td>
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<td>+28</td>
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<tr>
<td>USA</td>
<td>+2.1</td>
<td>+21</td>
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<td>+39</td>
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<tr>
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<td>+28</td>
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<tr>
<td>USA</td>
<td>+1.9</td>
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<td>+35</td>
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<td>+2</td>
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<tr>
<td>Australia</td>
<td>+1.1</td>
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<td>+45</td>
<td>+42</td>
<td>+2</td>
<td>+2.7</td>
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<td>+41</td>
<td>+2</td>
<td>0.0</td>
<td>+4.6</td>
<td>-0.5</td>
</tr>
</tbody>
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Breed Avg. EBVs: +2.1  +16  +21  +29  +34  +3  +0.4  +2.0  -0.2
Multi-breed BREEDPLAN developments
Northern Tropical BREEDPLAN analysis
Current considerations:

- **Multi-country:**
  - cross-validation studies
  - inclusion of additional traits
  - transition to genomics (ssGBLUP)

- **Multi-breed:**
  - breed association structures
  - structured multi-breed herds
  - technical considerations
    - >1 (co)variance matrix?
    - implications for ssGBLUP
Thank you