Strategies to combine novel traits across countries: example of heat stress

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\end{itemize}
Novel traits

• INTERBULL:
  • Evaluations for many countries
  • But only for traditional traits
• Novel traits
  • Growing interest
  • Not yet addressed by INTERBULL
• However international collaboration of highest interest but “the king phenotypes” still holds in opposing😊
Novel traits

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  - Evaluations for many countries
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- Novel traits
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- However international collaboration of highest interest but “the king phenotypes” still holds in opposing 😊

➡️ proposal for a strategy applicable to genetic evaluation for novel traits (here heat tolerance)
Novel traits: current situation

Foreign country phenotypic and pedigree data (FOR)

Isolated Foreign evaluation

\[ a_{\text{FORi}} \& \text{REL}_{\text{FORi}} \]

Local country phenotypic and pedigree data (LOC)

Isolated Local evaluation

\[ a_{\text{LOCi}} \& \text{REL}_{\text{LOCi}} \]
Novel traits: free access to raw data

Foreign country phenotypic and pedigree data (FOR)

Local country phenotypic and pedigree data (LOC)

Joint evaluation

\[ a_{\text{FOR}j} \& \text{REL}_{\text{FOR}j} \]

\[ a_{\text{LOC}j} \& \text{REL}_{\text{LOC}j} \]
Novel traits: free access to raw data

Joint evaluation

- Foreign country phenotypic and pedigree data (FOR)
- Local country phenotypic and pedigree data (LOC)

\[ a_{\text{FORj}} \text{ & } REL_{\text{FORj}} \]

\[ a_{\text{LOCj}} \text{ & } REL_{\text{LOCj}} \]
Novel traits: free access to raw data
Novel traits: free access to EBV and REL

- Foreign evaluation
  - $a_{\text{FORi}}$ & $\text{REL}_{\text{FORi}}$

Conversion to local country trait

Local country phenotypic and pedigree data (LOC)
Novel traits: free access to EBV and REL

Foreign evaluation

\[ a_{\text{FORi}} \text{ & } REL_{\text{FORi}} \]

Conversion to local country trait

Bayesian evaluation

\[ a_{\text{LOCb}} \text{ & } REL_{\text{LOCb}} \]

Objective

Ascertainment rankings of individuals in the local country depending on information accessed from foreign country

- **Scenario A:** free access to raw data
  - Local evaluation \textit{vs} Joint evaluation

- **Scenario B:** free access to EBV and REL
  - Bayesian evaluation \textit{vs} Joint evaluation

- Local (Belgium, temperate) and Foreign (Spain, Mediterranean)
- Novel trait: Heat tolerance
Methods

- Spanish (SPA) phenotypic
- BEL and SPA pedigree
- Belgian (BEL) phenotypic

Joint evaluation

\( a_{BELj} \& REL_{BELj} \)
Methods

Spanish (SPA) phenotypic

BEL and SPA pedigree

Belgian (BEL) phenotypic

**Spanish evaluation**

- $a_{SPAi}$ & $REL_{SPAi}$

**Joint evaluation**

- $a_{BELj}$ & $REL_{BELj}$

**Belgian evaluation**

- $a_{BELi}$ & $REL_{BELi}$
Methods

Spanish (SPA) phenotypic

BEL and SPA pedigree

Belgian (BEL) phenotypic

Spanish evaluation

Joint evaluation

Belgian evaluation

\( a_{SPA_i} \) & \( REL_{SPA_i} \)

\( a_{BEL_j} \) & \( REL_{BEL_j} \)

\( a_{BEL_i} \) & \( REL_{BEL_i} \)

Conversion to Belgian trait

- \( a_{SPAb} \) : through SI
- \( REL_{SPAb} : r_g^2 \times REL_{SPA_i} \)

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Methods

Spanish (SPA) phenotypic

BEL and SPA pedigree

Belgian (BEL) phenotypic

Spanish evaluation

Joint evaluation

Belgian evaluation

Bayesian evaluation

Conversion to Belgian trait

* a_{SPA_b} : through SI

* REL_{SPA_b} : r^2 \cdot REL_{SPA_i}

## Data and pedigree

<table>
<thead>
<tr>
<th></th>
<th>Belgium</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb. TD records</td>
<td>900,445</td>
<td>704,330</td>
</tr>
<tr>
<td>Nb. of cows</td>
<td>113,282</td>
<td>81,752</td>
</tr>
<tr>
<td>Milk (Kg/day)</td>
<td>23.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Fat (Kg/day)</td>
<td>0.93</td>
<td>1.02</td>
</tr>
<tr>
<td>Protein (Kg/day)</td>
<td>0.77</td>
<td>0.94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of sires</th>
<th>Within-country</th>
<th>Common across-countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>1,811</td>
<td>369 (56,265 daughters)</td>
</tr>
<tr>
<td>Spain</td>
<td>1,926</td>
<td>369 (36,212 daughters)</td>
</tr>
</tbody>
</table>
Heat-tolerance trait

• Lack of direct measurements of heat tolerance
• Therefore indirect heat tolerance (HT) traits:
  – Modeling reaction of performance of an individual under heat \( \Rightarrow \) reaction norm
  – “Heat” expressed as Temperature-Humidity-Index (THI)
  – Regressing performances on THI
  – Regression coefficients define HT traits
Reaction norm models

- Single- (within-) and bi-variate (across-country) models

\[ y = Xb + Q_{HT} Wt + Q_{HT} (Zp + Za) + e \]

- \( Q_{HT} \) matrix of 2\(^{nd} \) order Legendre polynomials on standardized THI scale [-1,1]

- Fixed effects:
  - \( b = \) Herd x Test-day, Lactation stage, Age at calving x Season of calving
  - \( t = \) Fixed regression (mean) THI effect

- Random effects:
  - \( p = \) Random regressions for Permanent Environment THI effects
  - \( a = \) Random regressions for Additive Genetic THI effects
Results: Milk yield

1,104 sires with Spanish daughters but without Belgian daughters

- Intercept
  - Joint evaluation
    - Local Belgian
    - Joint evaluation
  - 1st order LP
    - $r_s = 0.667$
  - 2nd order LP
    - $r_s = 0.920$
    - $r_s = 0.912$
Results: Milk yield

1,104 sires with Spanish daughters but without Belgian daughters

rs = 0.667

rs = 0.978

rs = 0.920

rs = 0.992

rs = 0.912

rs = 0.997

1st order LP

2nd order LP

Intercept

Bayesian evaluation

Joint evaluation

Local Belgian
Results: Milk yield

369 sires with common daughters (36,212) in Spain and (56,265) in Belgium

**Local Belgian**

**Joint evaluation**

- Intercept: \( r_s = 0.957 \)
- 1st order LP: \( r_s = 0.993 \)
- 2nd order LP: \( r_s = 0.993 \)
Results: Milk yield

369 sires with common daughters (36,212) in Spain and (56,265) in Belgium
## Results: all traits

- Comparisons with the joint evaluation for the 1,104 sires with only Spanish daughters

<table>
<thead>
<tr>
<th>Traits</th>
<th>Evaluations</th>
<th>Rank correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Intercept</td>
</tr>
<tr>
<td>Milk</td>
<td>Local Belgian</td>
<td>0.667</td>
</tr>
<tr>
<td>Milk</td>
<td>Bayesian</td>
<td>0.978</td>
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<tr>
<td>Fat</td>
<td>Local Belgian</td>
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<td>Fat</td>
<td>Bayesian</td>
<td>0.980</td>
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<td>Protein</td>
<td>Local Belgian</td>
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<tr>
<td>Protein</td>
<td>Bayesian</td>
<td>0.977</td>
</tr>
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## Results: all traits

- Comparisons with the joint evaluation for the 369 sires with Spanish and Belgian daughters

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<tr>
<th>Traits</th>
<th>Evaluations</th>
<th>Intercept</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; order</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Local Belgian</td>
<td>0.957</td>
<td>0.993</td>
<td>0.993</td>
</tr>
<tr>
<td></td>
<td>Bayesian</td>
<td>0.967</td>
<td>0.993</td>
<td>0.996</td>
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<tr>
<td>Fat</td>
<td>Local Belgian</td>
<td>0.958</td>
<td>0.996</td>
<td>0.992</td>
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<td></td>
<td>Bayesian</td>
<td>0.981</td>
<td>0.996</td>
<td>0.992</td>
</tr>
<tr>
<td>Protein</td>
<td>Local Belgian</td>
<td>0.959</td>
<td>0.995</td>
<td>0.988</td>
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Conclusions

- Rankings of Bayesian evaluations more similar to rankings of the joint evaluation

- This strategy showed the interest to integrate external information from exporting countries when access to raw data not possible

- Bayesian integration can accommodate several external information sources, ongoing research includes also Luxembourg and Slovenia

- Flexibility of Bayesian integration adapted well to situation of novel trait “heat-tolerance”

- Further development of Bayesian integration towards multi-trait use will allow avoiding conversion step
Thank you for your attention

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