Genetic evaluation for saved feed and methane emission

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Gert Pedersen Aamand, NAV
Outline

• Feed Saved
  • Plan for a genetic evaluation (Gert)
  • Maintenance (Rasmus)
  • Feed intake (research farm data, and CFIT) (Jan)
  • Reliability – what can we expect? (Gert)

• Methane
  • Registration, genetics, impact on climate (Jan)
The overall aim

$\text{EBV}^{(\text{Saved Feed})} = V_1 \times \text{EBV(Maintenance)} + V_2 \times \text{EBV(Metabolic)}$

- Key data is cow weights from practice
- Key data is Feed intake from Research farms data and CFIT
# Preliminary plan for publication of NAV Breeding values for Feed Saved

<table>
<thead>
<tr>
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<tr>
<td>May 2019</td>
<td>$EBV_{maintenance}$</td>
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<td>All 3 breeds</td>
</tr>
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<td>$EBV_{metabolic}$</td>
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<td>HOL, (RDC)</td>
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*Means also genomic breeding values

*EBV for feed saved will not be included in NTM in 2019, but can be given as an extra information trait*
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**EBV for feed saved will not be included in NTM in 2019, but can be given as an extra information trait**
The overall aim

\[ \text{EBV}_{\text{(Saved Feed)}} = \text{V}_1 \times \text{EBV}_{\text{(Maintenance)}} + \text{V}_2 \times \text{EBV}_{\text{(RFI)}} \]
The core trait

- **Metabolic body weight** \( (MBW = \text{body weight}^{0.75}) \)
- ~1 kg dry matter to maintain 100 kg body weight (~30% of the total energy requirement for a dairy cow)
Data sources

- A small proportion of the cows have scale/tape measurements (only in DNK and FIN)
- A larger proportion has conformation data
- Genetic correlation with body weight
Tape measurements (FIN data)

- Voluntary measurements in 25 % of the Finnish herds (~10% of the cows in Finland)
- Measured once per lactation (mostly) from 1990 and onwards
- Data from RDC and HOL
  - 700,000 cows in 1\textsuperscript{st} parity
  - 440,000 cows in 2\textsuperscript{nd} parity
  - 150,000 cows in 3\textsuperscript{rd} parity
AMS scale (DNK data)

- Number of 1\textsuperscript{st} parity cows
  - 59,000 HOL (2008-2018)
  - 4,400 RDC (2011-2018)
  - 3,800 JER (2011-2018)

- Repeated trait
  - Mean lactation body weight is calculated
  - Precorrection necessary
Conformation – indicator traits

- Conformation traits recorded in Denmark, Finland and Sweden
  - Stature, body depth, chest width
- Currently evaluated in NAV
  - 79,000 HOL 1st parity cows in 2017
  - 34,000 RDC 1st parity cows in 2017
  - 13,500 JER 1st parity cows in 2017
Genetic evaluation

Multiple-trait model with following traits:

- Metabolic body weight 1\textsuperscript{st} parity (MBW 1)
- Metabolic body weight 2\textsuperscript{nd} parity (MBW 2)
- Metabolic body weight 3\textsuperscript{rd} parity (MBW 3)
- Conformation traits from 1\textsuperscript{st} parity (indicator)
  - Stature
  - Body depth
  - Chest width
Heritabilities

- Tape is based on Finnish field data (RDC & HOL)
- Scale is based on Danish AMS data (HOL)

<table>
<thead>
<tr>
<th></th>
<th>Tape</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBW 1</td>
<td>0.46</td>
<td>0.58</td>
</tr>
<tr>
<td>MBW 2</td>
<td>0.51</td>
<td>0.55</td>
</tr>
<tr>
<td>MBW 3</td>
<td>0.56</td>
<td>0.54</td>
</tr>
</tbody>
</table>

- Approximately at the same level
Genetic correlations
- Between MBW traits
  • Based on 284 primiparous cows (Luke’s research herd Jokioinen)
    • MBW – tape
    • MBW – lac_avg (lactation average, similar to Danish AMS trait)
      • Genetic correlation >0.93
Genetic correlations
- Between MBW traits

- Based on Finnish field data (RDC & HOL)

<table>
<thead>
<tr>
<th>Traits</th>
<th>1\textsuperscript{st} parity</th>
<th>2\textsuperscript{nd} parity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2\textsuperscript{nd} parity</td>
<td>0.98</td>
<td>0.96</td>
</tr>
<tr>
<td>3\textsuperscript{rd} parity</td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

- The same trait across parities
Genetic correlations
- Between MBW 1 and indicator traits

• Between MBW in 1st parity and indicator traits

<table>
<thead>
<tr>
<th>HOL</th>
<th>Stature</th>
<th>Body depth</th>
<th>Chest width</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBW 1</td>
<td>0.65</td>
<td>0.51</td>
<td>0.59</td>
</tr>
</tbody>
</table>
Conclusion

• Strong genetic correlation between tape and AMS scale measurements

• MBW is a highly heritable trait

• MBW the same trait in different parties

• Conformation traits are good indicator traits
Perspectives

• Camera technology looks promising for prediction of body weight

• Some large herds might install scales for management purposes

• Use slaughter weight – not included to keep the evaluation simple
Residual feed intake (metabolic efficiency)

- What does it mean?

- Feed intake corrected for energy sinks:
  - Yield level
  - Body weight
  - Body weight chance
  - ...

Nordisk Avlsværdi Vurdering • Nordic Cattle Genetic Evaluation
## Database on Holstein

<table>
<thead>
<tr>
<th>Country</th>
<th># cows</th>
<th>DMI records</th>
<th>Yield records</th>
<th>Weight records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>900</td>
<td>58,000</td>
<td>58,000</td>
<td>56,000</td>
</tr>
<tr>
<td>Canada</td>
<td>500</td>
<td>28,000</td>
<td>33,000</td>
<td>3,000</td>
</tr>
<tr>
<td>USDA</td>
<td>700</td>
<td>20,000</td>
<td>20,000</td>
<td>9,000</td>
</tr>
<tr>
<td>CHE</td>
<td>100</td>
<td>800</td>
<td>2,000</td>
<td>1,100</td>
</tr>
<tr>
<td>UK</td>
<td>2,300</td>
<td>125,000</td>
<td>156,000</td>
<td>5,000</td>
</tr>
<tr>
<td>AUS</td>
<td>600</td>
<td>2,100</td>
<td>2,100</td>
<td>2,100</td>
</tr>
</tbody>
</table>

4,500 total cows with feed intake data
3,300 total cows genotyped
Research farm data

- Different diets and experiments
- Different production environments
- Hardly correlations of 1 between countries
Cattle Feed Intake
CFIT
System setup
Example of feed intake from a visit

Blue is higher

Red is deeper

Removed 14.39 l
Added 10.75 l
Total 3.64 l

Total is difference between red and blue
97 Jersey cows (19 cameras) measured for 14 days
Two consecutive milk recordings were used
Results

- Repeatability between weeks 0.84
- Repeatability between days 0.65
- $r_{FI, ECM} = 0.65$
Installation and test in 4 herds
Analysis on live data including live weight prediction
Dialogue with farmers on interface
Alarm diagnostics – when and when not
Economic benefits of having records
## Status and plans installation

<table>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of herds with CFIT</strong></td>
<td>1 JER</td>
<td>2 JER, 1 HOL, 1 RDC</td>
<td>2 JER, 2 HOL, 2 RDC</td>
<td>5 JER, 10 HOL, 5 RDC</td>
</tr>
<tr>
<td><strong>Number of 1. lact cows with CFIT</strong></td>
<td>40 JER</td>
<td>100 JER, 100 HOL, 50 RDC</td>
<td>150 JER, 200 HOL, 150 RDC</td>
<td>600 JER, 1200 HOL, 600 RDC</td>
</tr>
<tr>
<td><strong>Number of cows in total with CFIT</strong></td>
<td>100 JER</td>
<td>400 JER, 400 HOL, 200 RDC</td>
<td>600 JER, 800 HOL, 600 RDC</td>
<td>3000 JER, 6000 HOL, 3000 RDC</td>
</tr>
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## Reference population size, Jan. 2019

<table>
<thead>
<tr>
<th>Breed</th>
<th>Category</th>
<th>Maintenance* (weight data)</th>
<th>Metabolic (feed intake data)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Phenotypes</td>
<td>Genotypes*</td>
</tr>
<tr>
<td>Holstein</td>
<td>Bulls &gt;10 daughters</td>
<td>2,500</td>
<td>2,500</td>
</tr>
<tr>
<td></td>
<td>Cows</td>
<td>300,000</td>
<td>2,500</td>
</tr>
<tr>
<td>RDC</td>
<td>Bulls &gt;10 daughters</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>Cows</td>
<td>635,000</td>
<td>4500</td>
</tr>
<tr>
<td>Jersey</td>
<td>Bulls &gt;10 daughters</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Cows</td>
<td>3,800</td>
<td>&lt;200</td>
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*estimates;  ** genotypes on about 2/3 of the cows
How reliable will the Saved Feed breeding values be?

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<td>Bull with 20 daughters having data</td>
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<td>30%</td>
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<td>Jersey lower</td>
<td>HOL&gt;RDC&gt;(Jersey) CFIT</td>
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Methane emission

- Climate debate every day in all news media
- Anti-animal production agenda
- Agriculture is a part of the contribution to GHG emission
- Agriculture is also a part of the solution – but not all the solution!
Measuring
Results

• Data on Holstein (+3000 cows) and Jersey (+1200 cows)
• Heritability ~20%
• Genetic correlations (inaccurate)
  • Between Methane and Yield - positive (unfavorable)
  • Between Methane and other NTM traits - no unfavorable
Results

• Data collection in research projects still ongoing

• Quantification methods are equivalent to respiration chamber data but can be improved
Relationship between methane and DMI
Implementation?

- Possibilities for genetic ranking
- VERY low initial reliabilities (~10%)
- Routine recordings to get more data and make documentation
- Cost approx. 20 Euro per cow