Nordic Total Merit Index (NTM)

Proteje meeting 18th May 2010 - Paris

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Nordic Cattle Genetic Evaluation

Denmark
40,000 RDM
362,000 HF
58,000 Jersey

Sweden
138,000 SRB
157,000 HF

Finland
156,000 FAY
71,000 HF
NAV

Established 01.01.2002 by:

Faba breeding
Swedish Dairy Association
Danish Cattle
Nordic Cattle Genetic Evaluation
- history

- 2002 - Established
- 2002 – Development has started
- 2005 – first EBVs published – type, milk ability, temperament and fertility
- 2006 – Yield and mastitis
- 2007 – Calving
- 2008 – Other diseases and NTM(Nordic Total Merit)
- 2009 – Growth
- 2010 - Longevity
Genetic evaluation

Joint ranking of animals
- Expressed on rolling "cow base" – mean 100
- Expressed with a standard deviation of 10

Joint EBVs a basis for a joint TMI
Process – joint Nordic breeding goal

Economic basis 2007
(Best possible estimates for the current economic situation in Finland, Sweden and Denmark)

+ Expectations for the future – traits getting bigger/smaller value 5-10 years ahead

= Joint Nordic Breeding Goal
Total Merit Index

- Most efficient way to weigh economic important traits together
- Maximizes genetic/economic progress
Total Merit Indices - history

- **1975-1985** TMI- introduced in Nordic countries including production and functional traits
- **1985-2007** TMI’s in Nordic countries gradually improved more traits – better methods
- **1990-2000** TMI – based on few traits popular in many countries
- **2008** Joint Nordic TMI – called NTM
- **Today** – everyone see the need for having a TMI including all economic important traits
Economic values

The value of one unit improvement in the trait – keeping the remaining traits constant

- Future production circumstances 5 – 10 years ahead
Nordic Total Merit Index (NTM)

Three step procedure:

1) Economic values for single traits 2007-2008
   44 single traits – single conformation traits not included
   • Based on “current” situation (Spring 2007) !!

2) Breeding goal adjustments 2008
   Input from breed organisations and others on
   • Perspective for the future
   • “Non-economic” value

3) Implementation in practice ultimo 2008
Economic basis - survey of traits analysed

- Yield: Milk, Protein and Fat production
- Beef production: Net daily gain, EUROP form score
- Calving traits: Calf vitality and calving ease
- Fertility: Periods Calving to 1st AI, 1st to last, Number of AI’s
- Udder health: Frequency of mastitis and SCC
- Other health traits: Metabolic, Feet & legs, reproductive diseases
- Longevity
  - Conformation: Body, Feet& legs, Udder
  - Milking speed, Temperament
Method: Economic profit model

- Deterministic data simulation (Excel – farm accounting)
- Results expressed as: Marginal profit per cow per year
- Many assumptions: Economic, technical, biological
Method: Economic profit model

Strengths
- Transparency – interactions can be understood
- Possible to run many alternatives
Method: Economic profit model

Shortcomings

- Insufficient modelling of cow culling process
- All cow replacement costs attached to longevity
  “repaired” by transfer of value from longevity
Production scenarios (countries) and breed groups

<table>
<thead>
<tr>
<th>Country</th>
<th>RDC</th>
<th>Holstein</th>
<th>Jersey</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNK</td>
<td>RDM</td>
<td>HOL</td>
<td>JER</td>
</tr>
<tr>
<td>SWE</td>
<td>SRB</td>
<td>HOL</td>
<td></td>
</tr>
<tr>
<td>FIN*</td>
<td>AYS</td>
<td>HOL</td>
<td></td>
</tr>
</tbody>
</table>

* For Finland both a southern and northern scenarios was considered
Production scenarios and breed groups

Basic levels per breed and country, e.g.
- Weight, Calving age, Yield
- Stillbirth rate, Calving difficulty
- Fertility, Frequency of diseases
Milk production traits

Results depend on:

- Sales value of milk – marginal feed costs
  - Distribution of 1\textsuperscript{st}, 2\textsuperscript{nd} and later lactations
  - Lactation yield of culled cows and staying cows
  - Calving age, calving interval, days dry
  - Milk used for calf feed
  - Milk discarded due to diseases
## Input examples

Assumed average phenotypic milk production, 305 day yield (kg)

<table>
<thead>
<tr>
<th></th>
<th>RDM DNK</th>
<th>SRB SWE</th>
<th>AYS FIN</th>
<th>HOL DNK</th>
<th>HOL SWE</th>
<th>HOL FIN</th>
<th>JER DNK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Milk, 1\textsuperscript{st} lact.</strong></td>
<td>7217</td>
<td>7755</td>
<td>7477</td>
<td>7808</td>
<td>8558</td>
<td>7995</td>
<td>5345</td>
</tr>
<tr>
<td><strong>Milk, 2\textsuperscript{nd} lact.</strong></td>
<td>7891</td>
<td>8470</td>
<td>8528</td>
<td>8863</td>
<td>9843</td>
<td>9162</td>
<td>6006</td>
</tr>
<tr>
<td><strong>Milk, 3\textsuperscript{rd} lact.</strong></td>
<td>8212</td>
<td>8790</td>
<td>8902</td>
<td>9239</td>
<td>10074</td>
<td>9648</td>
<td>6246</td>
</tr>
<tr>
<td><strong>Protein, 1\textsuperscript{st} lact.</strong></td>
<td>254</td>
<td>271</td>
<td>258</td>
<td>260</td>
<td>284</td>
<td>268</td>
<td>214</td>
</tr>
<tr>
<td><strong>Protein, 2\textsuperscript{nd} lact.</strong></td>
<td>280</td>
<td>296</td>
<td>293</td>
<td>299</td>
<td>326</td>
<td>309</td>
<td>247</td>
</tr>
<tr>
<td><strong>Protein, 3\textsuperscript{rd} lact.</strong></td>
<td>289</td>
<td>303</td>
<td>300</td>
<td>308</td>
<td>331</td>
<td>320</td>
<td>255</td>
</tr>
<tr>
<td><strong>Fat, 1\textsuperscript{st} lact.</strong></td>
<td>303</td>
<td>335</td>
<td>320</td>
<td>317</td>
<td>337</td>
<td>311</td>
<td>313</td>
</tr>
<tr>
<td><strong>Fat, 2\textsuperscript{nd} lact.</strong></td>
<td>333</td>
<td>363</td>
<td>361</td>
<td>361</td>
<td>389</td>
<td>356</td>
<td>355</td>
</tr>
<tr>
<td><strong>Fat, 3\textsuperscript{rd} lact.</strong></td>
<td>346</td>
<td>377</td>
<td>377</td>
<td>379</td>
<td>403</td>
<td>378</td>
<td>371</td>
</tr>
</tbody>
</table>
### Input examples

Assumed average phenotypic culling rates within lactations

<table>
<thead>
<tr>
<th></th>
<th>RDM DNK</th>
<th>SRB SWE</th>
<th>AYS FIN</th>
<th>HOL DNK</th>
<th>HOL SWE</th>
<th>HOL FIN</th>
<th>JER DNK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} lact.</td>
<td>33 %</td>
<td>34 %</td>
<td>25 %</td>
<td>30 %</td>
<td>31 %</td>
<td>25 %</td>
<td>29 %</td>
</tr>
<tr>
<td>2\textsuperscript{nd} lact.</td>
<td>38 %</td>
<td>39 %</td>
<td>35 %</td>
<td>40 %</td>
<td>40 %</td>
<td>35 %</td>
<td>34 %</td>
</tr>
<tr>
<td>3\textsuperscript{rd}+ lact.</td>
<td>43 %</td>
<td>44 %</td>
<td>50 %</td>
<td>50 %</td>
<td>50 %</td>
<td>50 %</td>
<td>39 %</td>
</tr>
</tbody>
</table>
## Results:

€ / kg standard milk

<table>
<thead>
<tr>
<th></th>
<th>DNK</th>
<th>SWE</th>
<th>FIN</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDC</td>
<td>0.17</td>
<td>0.17</td>
<td>0.23</td>
<td>0.19</td>
</tr>
<tr>
<td>HOL</td>
<td>0.17</td>
<td>0.17</td>
<td>0.21</td>
<td>0.18</td>
</tr>
<tr>
<td>JER</td>
<td>0.16</td>
<td></td>
<td></td>
<td>0.16</td>
</tr>
</tbody>
</table>
Comments to yield results

- DNK and SWE value of yield is very similar
- FIN south value of yield is slightly larger than DNK and SWE
  - FIN south is the larger part of Finland
  - Northern Finland has an even larger value
Fertility

Fertility traits evaluated:
- First to last AI for heifers and cows
- Number of AI’s for heifers and cows
- Calving to first AI for cows

Factors of importance
- AI Costs
- Work (AI and heat surveillance)
- Beef production profit (extra calves)
- Milk production profit (extra milk production)

Not included: Cost of off-season calving
Economic value
Mastitis and other diseases

Breeding value of “Frequency of 1st cases”
  • 1st, 2nd and 3rd lactation

Value depend on:
  • Total number of cases (number of repeated treatments)
  • Cost of veterinary treatment
  • Extra work
  • Discarded milk
Longevity

Effects

- Distribution of lactations and milk production
- Number of calving per year (beef production)

70% of variation in longevity is explained by fertility, udder health, other diseases, conformation of udder and of feet & legs

A perfect model would distribute value to these traits
Sensitivity analyses

- Sales value of milk increased by 10%
- Feed cost was increased by 10%
- Sales value of beef was increased by 10%
- Price differences between EUROP form classes was increased by 10%
- Value of pregnant heifer was reduced to the slaughter value
- Labour costs was increased by 10%
- Veterinarian cost was increased by 10%
- 20€ was added to cost per insemination
Sensitivity analyses

- Sales value of milk increased by 10%
  - EV Yield:  + 16 - 18%
  - EV Fertility: slightly up
  - EV Udder health:  + 2-3%

- Feed cost was increased by 10%
  - EV Yield:  - 7-8%

- Sales value of beef was increased by 10%
  - EV Daily gain: Approx. + 30%
  - EV stillborn: Approx. + 10%
  - EV longevity: Approx - 6%
Sensitivity analyses

- EUROP form value increased by 10%
  - EV EUROP form score: + 10%

- Value of pregnant heifer reduced
  - EV stillborn: - 30 to 40% (Jersey more)
  - EV fertility: - 50 to 70%
  - EV longevity: Approx - 50%

- Labour cost increased by 10%
  - EV of functional traits: + 2 to 4%
  - EV conformation: + 10%
Sensitivity analyses

- Veterinarian cost increased by 10%
  - EV calving ease: + 5 to 7%
  - EV disease traits: + 5 to 7%

- Cost per AI increased by 20 EURO
  - EV first to last ins: + 30 to 40%
## Index weights from model

<table>
<thead>
<tr>
<th>Trait</th>
<th>HOL</th>
<th>RDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Growth</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>Fertility</td>
<td>0.41 (0.32)</td>
<td>0.28 (0.23)</td>
</tr>
<tr>
<td>Calving - direct</td>
<td>0.20</td>
<td>0.15</td>
</tr>
<tr>
<td>Calving - maternal</td>
<td>0.22</td>
<td>0.13</td>
</tr>
<tr>
<td>Udder health</td>
<td>0.46 (0.35)</td>
<td>0.34 (0.29)</td>
</tr>
<tr>
<td>Other health</td>
<td>0.16 (0.11)</td>
<td>0.13 (0.10)</td>
</tr>
<tr>
<td>Body</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Feet &amp; legs</td>
<td>0.10 (0.04)</td>
<td>0.07 (0.06)</td>
</tr>
<tr>
<td>Udder</td>
<td>0.12 (0.09)</td>
<td>0.14 (0.09)</td>
</tr>
<tr>
<td>Milking speed</td>
<td>0.11</td>
<td>0.07</td>
</tr>
<tr>
<td>Temperament</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Longevity</td>
<td>0.15 (0.49)</td>
<td>0.09 (0.28)</td>
</tr>
</tbody>
</table>

(Figures before redistribution of values for longevity)
Process – joint Nordic breeding goal

Economic basis 2007

Best possible estimates for the current economic situation in Finland, Sweden and Denmark

We did not find very big country differences

(Work done by project group of geneticists)
Process – joint Nordic breeding goal

Expectations for the future – traits getting bigger/smaller value 5-10 years ahead

• Like looking in the crystal ball
• Signals about economic, animal welfare, future rules for keeping cows, ethical views etc.
Process – joint Nordic breeding goal

Joint Nordic Breeding Goal

- Final decisions made at a workshop involving representatives from all Nordic Breeding organizations
- Result - NTM-index close to the theoretical recommendations
<table>
<thead>
<tr>
<th>Trait</th>
<th>HOL Model</th>
<th>NTM</th>
<th>RDC Model</th>
<th>NTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>0.75</td>
<td>0.75</td>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td>Growth</td>
<td>0.06</td>
<td>0.06</td>
<td>0.10</td>
<td>0.00</td>
</tr>
<tr>
<td>Fertility</td>
<td>0.31</td>
<td>0.31</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>Calving - direct</td>
<td>0.15</td>
<td>0.15</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Calving - maternal</td>
<td>0.17</td>
<td>0.17</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Udder health</td>
<td>0.35</td>
<td>0.35</td>
<td>0.31</td>
<td>0.32</td>
</tr>
<tr>
<td>Other health</td>
<td>0.12</td>
<td>0.12</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Body</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Feet &amp; legs</td>
<td>0.08</td>
<td>0.15</td>
<td>0.06</td>
<td>0.09</td>
</tr>
<tr>
<td>Udder</td>
<td>0.09</td>
<td>0.18</td>
<td>0.13</td>
<td>0.32</td>
</tr>
<tr>
<td>Milking speed</td>
<td>0.08</td>
<td>0.08</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Temperament</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Longevity</td>
<td>0.11</td>
<td>0.11</td>
<td>0.08</td>
<td>0.08</td>
</tr>
</tbody>
</table>
## Gain from NTM for HOL

Correlations between EBV’s for AI bulls born 2001-2003

<table>
<thead>
<tr>
<th>Trait</th>
<th>Correlation with NTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>0.49</td>
</tr>
<tr>
<td>Growth</td>
<td>0.00</td>
</tr>
<tr>
<td>Fertility</td>
<td>0.39</td>
</tr>
<tr>
<td>Calving - direct</td>
<td>0.28</td>
</tr>
<tr>
<td>Calving - maternal</td>
<td>0.37</td>
</tr>
<tr>
<td>Udder health</td>
<td>0.46</td>
</tr>
<tr>
<td>Other health</td>
<td>0.47</td>
</tr>
<tr>
<td>Body</td>
<td>-0.04</td>
</tr>
<tr>
<td>Feet &amp; legs</td>
<td>0.12</td>
</tr>
<tr>
<td>Udder</td>
<td>0.40</td>
</tr>
<tr>
<td>Milking speed</td>
<td>0.09</td>
</tr>
<tr>
<td>Temperament</td>
<td>0.03</td>
</tr>
<tr>
<td>Longevity</td>
<td>0.51</td>
</tr>
</tbody>
</table>
Economic value of one NTM unit per cow year

<table>
<thead>
<tr>
<th>Breed</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOL</td>
<td>10.2 EURO</td>
</tr>
<tr>
<td>RDC</td>
<td>9.1 EURO</td>
</tr>
<tr>
<td>JER</td>
<td>7.8 EURO</td>
</tr>
</tbody>
</table>
Genetic trend for HOL

NTM index

Birth year


App. 250 EUR
Overall aim of NTM

- High yielding cow
- Improved genetic level for functional traits – health & fertility
- Leads to improved longevity and economically enhanced dairy cows

Fullfilled!!

More information: http://www.nordicebv.info/Publications/
Joint Nordic Breeding Goal
– a positive debate lead to the NTM
Acknowledgement

- The work towards the NTM index has been carried out by Jørn Pedersen, Danish Cattle Federation and a Nordic working group including:
  - Minna Toivonen, Finland
  - Jan-Åke Eriksson, Sweden
  - Morten Kargo Sørensen, Denmark
  - Gert Pedersen Aamand, NAV