Development, implementation, and future perspectives of health evaluations in the U.S.

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DEVELOPMENT
Rate of new traits

- 1970: Milk + Fat + Protein
- 1976: PDS
- 1980: Milk + Fat + Protein
- 1984: CY$%
- 1990: NMS / FMS / CMS / Prod. Life + SCS
- 2000: CA$ [SCE, DCE, SSB, DSB]
- 2003: DPR
- 2010: HCR + CCR
- 2014: HTR$ [MFVE, DA, KETO, MAST, METR, RETP]
- 2018: Feed Efficiency
- 2020: …???
Changes in emphasis over time

* Striped segments indicate negative weights in the index
Since the 1980s

• Evidence that selection for health events could be successful
  • E.g., Scandinavian countries – direct recording of health events
• Within U.S. – calls for a unified system of reporting health events
  • Possibility for improvement through selection
  • Since 1994 – Indirect selection through traits SCS and PL, and later LIV

• **Introduction of genomics in 2009** – feasible to select for lowly heritable
  traits that are expensive and/or difficult to measure
U.S. hurdles

- No mandated reporting system
- Need a single repository to collect and store data
- No unified way to record health events
  - Standardization critical

(https://www.thesun.co.uk/news/3420620/showjumping-cow-jumps-hurdles-pictures/)
Data flow

• Cooperation from the Dairy Records Processing Centers
  • Flow through DHI system
• Necessary standardization performed by DRPCs
Format 6

Includes 20 health event codes + 4 management codes

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>138-141</td>
<td>4</td>
<td>AAAA</td>
<td>CH</td>
<td>170</td>
</tr>
<tr>
<td>142-149</td>
<td>8</td>
<td>XX..XX</td>
<td>CH</td>
<td>Health event code</td>
</tr>
<tr>
<td>150</td>
<td>1</td>
<td>A</td>
<td>CH</td>
<td>Health event date (YYYYMMDD)</td>
</tr>
<tr>
<td>151-156</td>
<td>6</td>
<td>AA..AA</td>
<td>CH</td>
<td>Health event date type (A = actual; E = estimated)</td>
</tr>
<tr>
<td>157-175</td>
<td>19</td>
<td>AA..AA</td>
<td>CH</td>
<td>Health event segment block # 2</td>
</tr>
<tr>
<td>176-194</td>
<td>19</td>
<td>AA..AA</td>
<td>CH</td>
<td>Health event segment block # 3</td>
</tr>
<tr>
<td>195-213</td>
<td>19</td>
<td>AA..AA</td>
<td>CH</td>
<td>Health event segment block # 4</td>
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</tbody>
</table>
IMPLEMENTATION
Health trait implementation

- April 2018: Official genomic evaluations for 6 direct health traits from CDCB for Holstein
  - Milk fever (MFEV)
  - Displaced abomasum (DA)
  - Ketosis (KETO)
  - Mastitis (MAST)
  - Metritis (METR)
  - Retained placenta (RETP)

- August 2018: Inclusion of health trait sub-index (HTH$) in net merit indices (NM$, FM$, CM$, GM$)
  - 2.3% total emphasis within NM$
Data processing

• Two levels of editing at CDCB
  • General edits – date checks, parent checks, herd checks, etc.
  • Constraints to be included for genetic evaluation – parities 1 to 5, Holstein (currently), minimum/maximum incidence restrictions, etc.
Phenotypes used for evaluation

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Number of Records</th>
<th>Number of Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk fever</td>
<td>1.2 M</td>
<td>0.7 M</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>1.9 M</td>
<td>1.1 M</td>
</tr>
<tr>
<td>Ketosis</td>
<td>1.4 M</td>
<td>0.8 M</td>
</tr>
<tr>
<td>Mastitis</td>
<td>2.4 M</td>
<td>1.4 M</td>
</tr>
<tr>
<td>Metritis</td>
<td>2.0 M</td>
<td>1.1 M</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>2.2 M</td>
<td>1.3 M</td>
</tr>
</tbody>
</table>

*As of April 2019 evaluation
Evaluation models

- Single-trait linear animal repeatability models
- Additional details available

<table>
<thead>
<tr>
<th>Condition</th>
<th>Heritability (observed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk fever</td>
<td>0.6%</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>1.1%</td>
</tr>
<tr>
<td>Ketosis</td>
<td>1.2%</td>
</tr>
<tr>
<td>Mastitis</td>
<td>3.1%</td>
</tr>
<tr>
<td>Metritis</td>
<td>1.4%</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

https://www.uscdcb.com/
Cost considerations

- Direct costs of each event used in development of HTH$
  - Considers veterinary and treatment costs
  - Excludes costs that are accounted for by other traits in NM$ (e.g., declines in fertility, decreased production)
- Yield traits designated as abnormal or “sick” test days are adjusted
  - These test days are accounted for with an additional adjustment (in parentheses above)

<table>
<thead>
<tr>
<th>Event</th>
<th>Direct cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFEV</td>
<td>$34 (38 – 4)</td>
</tr>
<tr>
<td>DA</td>
<td>$197 (178 + 19)</td>
</tr>
<tr>
<td>KETO</td>
<td>$28 (28 + 0)</td>
</tr>
<tr>
<td>MAST</td>
<td>$75 (72 + 3)</td>
</tr>
<tr>
<td>METR</td>
<td>$112 (105 + 7)</td>
</tr>
<tr>
<td>RETP</td>
<td>$68 (64 + 4)</td>
</tr>
</tbody>
</table>
Variance adjustments

• Linear model used with binary trait
• Phenotypic pre-adjustments applied to all health events
  • Phenotypes are adjusted based on calving year, parity, and heritability of the trait prior to genetic evaluation
• Similar to methodology described by Wiggans and VanRaden, 1992 and the adjustment applied to livability
• Implemented April 2019
Variance adjustments

• Most health traits had PTA correlations ranging from 0.92 to 0.98 for bulls with > 70% REL born since 2000
  • Exception – milk fever
• For all traits – first lactation trends agreed with the new trends more closely than with the old trends.
Interbull validation

- MAST now sent along with SCS PTA to Interbull for Udder Health trait group
- Validation of genetic trends
- Only see on average a 1 point increase in reliability
- Minimal foreign bulls from countries supplying MAST directly that also have genotypes available in the US
FUTURE PERSPECTIVES
Future developments

• Health evaluations for Jersey
  • Genomic evaluations for the 6 health traits
  • Reliability approximately 10-15 points lower than Holstein on average
  • See L. Jensen’s talk – ADSA Tuesday 10:30 AM Room 207/208
Future developments

• Multiple trait evaluations
  • Approximate genetic correlations
  • Mastitis & SCS
  • Groups of traits – metabolic, reproductive?

<table>
<thead>
<tr>
<th></th>
<th>Protein</th>
<th>PL</th>
<th>LIV</th>
<th>SCS</th>
<th>DPR</th>
<th>CCR</th>
<th>HCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFEV</td>
<td>-0.21*</td>
<td>-0.10</td>
<td>0.08</td>
<td>-0.02</td>
<td>-0.07</td>
<td>-0.08</td>
<td>-0.01</td>
</tr>
<tr>
<td>DA</td>
<td>0.15</td>
<td>0.40*</td>
<td>0.41*</td>
<td>-0.14</td>
<td>0.30*</td>
<td>0.30*</td>
<td>0.12</td>
</tr>
<tr>
<td>KETO</td>
<td>0.20*</td>
<td>0.39*</td>
<td>0.31*</td>
<td>-0.25*</td>
<td>0.41*</td>
<td>0.39*</td>
<td>0.19*</td>
</tr>
<tr>
<td>MAST</td>
<td>0.06</td>
<td>0.52*</td>
<td>0.39*</td>
<td>-0.68*</td>
<td>0.32*</td>
<td>0.31*</td>
<td>0.10*</td>
</tr>
<tr>
<td>METR</td>
<td>0.27*</td>
<td>0.47*</td>
<td>0.33*</td>
<td>-0.21*</td>
<td>0.44*</td>
<td>0.45*</td>
<td>0.29*</td>
</tr>
<tr>
<td>RETP</td>
<td>0.02</td>
<td>0.21*</td>
<td>0.16*</td>
<td>-0.13</td>
<td>0.19*</td>
<td>0.19*</td>
<td>0.19*</td>
</tr>
</tbody>
</table>
Potential health traits

- Continued investigation on economically important health traits
  - Lameness or locomotion
    - Events represent a variety of reasons for lameness – injury, conformation, metabolic, infection
    - How to differentiate between these?
  - Johne’s

(https://vetextension.wsu.edu/research-projects/lameness/)
Potential health traits

• Calf health & calf termination
  • Dairy calf death losses estimated at $327.3 million in 2015 (Lombard et al., 2019)
  • Possible to include calf/heifer health records with Format 6
  • Lombard et al., 2019 – proposed death loss categorization scheme
    • Pursuing Data Quality group of CDCB working with this scheme and termination reasons already collected by CDCB
  • Goal: expand termination codes to include calves/heifers

(https://hoards.com)
Maintenance of data pipelines

- Expand current pipelines to capture additional information
- Monitor data being submitted, accepted, and rejected
- Two-way communication with data providers
- Updates to standardization “dictionaries” as needed
New functional traits

- Feed efficiency
  - Project funded by Foundation for Food and Agriculture Research (FFAR) and CDCB
  - Institutions include Michigan State University, University of Wisconsin, Iowa State University, University of Florida, and USDA Animal Genomics and Improvement Laboratory
  - Continuing the work of USDA NIFA grant
  - Projected that breeding for more efficient dairy cows could save the U.S. dairy industry $540 million per year
  - Inclusion of feed efficiency in Net Merit $
Creation of data pipelines

• New data types
  • E.g., feed intake data, sensor data
    • Different systems at various institutions
    • Protocol needs to be developed to streamline data processing
  • Need for standardization
Evaluation sources

• Increasing number of similar evaluations from different sources
  • Published methodologies
    • Health $ (CDCB)
    • Clarifide Plus (Zoetis)
  • Proprietary evaluations / indices
    • TransitionRight index (ABS)
    • Better Life Health index (CRV)
    • Ideal Commercial Cow index (Genex)
Differing results

- Traits with limited data + low heritabilities
  - Different populations
  - Different editing
  - Different statistical model
  - Different presentation
  - Different economic assumptions
Handling multiple sources

• Producers have to consider the source of information
• Critical to not focus selection on only a few traits
• What does the future hold?
Continued progress

- More data available than ever before – making selection for new traits possible
- Continual improvement of available traits
- Phenotypes are critical
  - Establishment and maintenance of data pipelines
  - Quality control standards
Acknowledgements

CDCB
AGIL
DRPCs, DRMS
Dairy producers
Thank You!