Implementation of genomic evaluation for digital dermatitis in Canada

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Hoof Lesions

• In Canada, around 25-30% of cows have at least one hoof lesion

• Hoof lesions compromise animal welfare

• Economic loss, costs associated with:
  – Treatment of lesions
  – Decreased cow performance
• Improving management practices at herd level

• Through genetic selection
Improving Hoof Health in Canadian Dairy Herds

• Project funded by the Dairy Research Cluster 2
  – Dairy Farmers of Canada, Agriculture and Agri-Food Canada, CDN, Canadian Dairy Commission
• Principal investigator: Dr. Filippo Miglior (Canadian Dairy Network & University of Guelph)
• 2014-2017
Objectives

Improve hoof health in Canada

1. Centralize data collected by hoof trimmers into a coherent and sustainable national data base
   – Standardize the hoof lesion data
   – Develop a data pipeline: Hoof trimmers - CDHI - CDN

2. Develop a DHI management report for producers

3. Develop genomic evaluations for hoof health
Objectives

• Standardize the hoof lesion data collection

• Develop a data pipeline

  Hoof trimmers - Canadian DHI - Canadian Dairy Network

• Develop a DHI management report for producers

• Develop genomic evaluations for hoof health
Standardize the hoof lesion data collection

Hoof Supervisor System

- Codes of lesion
- Severity
- Claws
- Zones
Standardize the hoof lesion data collection

**Hoof Supervisor System - Codification**

<table>
<thead>
<tr>
<th>Code</th>
<th>Lesion Name</th>
<th>Page</th>
<th>Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>Sole Ulcer</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>T</td>
<td>Toe Ulcer</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>W</td>
<td>White Line Lesion</td>
<td>12</td>
<td>1,2,3</td>
</tr>
<tr>
<td>H</td>
<td>Sole Hemorrhage</td>
<td>16</td>
<td>4,5,6</td>
</tr>
<tr>
<td>F</td>
<td>Foot Rot</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>D</td>
<td>Digital Dermatitis</td>
<td>22</td>
<td>9,10</td>
</tr>
<tr>
<td>E</td>
<td>Heel Erosion</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>I</td>
<td>Interdigital Dermatitis</td>
<td>26</td>
<td>0,10</td>
</tr>
<tr>
<td>C</td>
<td>Corkscrew Claw</td>
<td>27</td>
<td>7</td>
</tr>
<tr>
<td>V</td>
<td>Vertical Fissure</td>
<td>28</td>
<td>7,8</td>
</tr>
<tr>
<td>X</td>
<td>Axial Fissure</td>
<td>29</td>
<td>11,12</td>
</tr>
<tr>
<td>G</td>
<td>Horizontal Fissure</td>
<td>32</td>
<td>7,8</td>
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<tr>
<td>Z</td>
<td>Thin Sole</td>
<td>35</td>
<td>4,5</td>
</tr>
<tr>
<td>K</td>
<td>Interdigital Hyperplasia</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>L</td>
<td>Periople Ulcer</td>
<td>39</td>
<td>11</td>
</tr>
</tbody>
</table>
54 trimmers across Canada now routinely provide hoof health data to Canadian DHI

Additional trimmers invited to participate to the data collection
Objectives

• Standardize the hoof lesion data collection

• Develop a data pipeline

  Hoof trimmers - Canadian DHI - Canadian Dairy Network

• Develop a DHI management report for producers

• Develop genomic evaluations for hoof health
Data Pipeline

- Herd inventory Interface
- Canadian DHI
- Hoof Trimmers
- Mgmt report
- Canadian Dairy Network
- Dairy Producers
- Weekly GEBV for hoof health
- Trimming & HS Reports
- Hoof Lesions
Objectives

• Standardize the hoof lesion data collection
• Develop a data pipeline

  Hoof trimmers - Canadian DHI - Canadian Dairy Network

• **Develop a DHI management report for producers**
• Develop genomic evaluations for hoof health
DHI Management Report

• Working group with hoof trimmers, dairy advisors, veterinarians and researchers
  – To develop a new DHI management report on hoof health

• This report may include
  – Prevalence of lesions on farm
  – Trends over time
  – Benchmarks with province and national averages

• Added value for trimmers and dairy producers
Objectives

• Standardize the hoof lesion data
• Develop a data pipeline
  Hoof trimmers - Canadian DHI - Canadian Dairy Network
• Develop a DHI management report for producers
• Develop genomic evaluations for hoof health
Data

• Historical data from provincial projects up to 2012
• New pipeline data
  – From summer 2015 for Quebec
  – From early 2016 Ontario
  – From mid 2016 for newly recruited trimmers
• Historical data from hoof trimmers
• Heritability and Repeatability of hoof lesions
• Effect of pre-selection of cows for trimming
• Correlations with conformation traits
• Severity vs. Binary
• Threshold vs. Linear Model
• Single-step GBLUP
Genetic Evaluation at CDN
Prevalence of Hoof Lesions

- Digital dermatitis: 17.4%
- Interdigital dermatitis: 2.6%
- Interdigital hyperplasia: 2.2%
- Heel Horn Erosion: 2.4%
- Sole hemorrhage: 7.2%
- Sole ulcer: 8.5%
- Toe ulcer: 1.4%
- White line lesion: 4.8%
Digital Dermatitis Holsteins

• 307,172 records
• 127,729 cows
• 8,293 sires
• 332,561 - animals in pedigree (4 generations)

Aim is 10-20% of milk recorded cows
Single-step GBLUP

- **Single-trait** (no indicators)
- **Animal linear model with repeated observations** (0/1)
- **Single-step GBLUP using Mix99**
- **Environmental factors:**
  - Herd-Trimming Session
  - Trimmer
  - Days after calving
  - Parity
  - Cow effect (PE)
• Genetic parameters:
  – Heritability: **0.08**
  – Repeatability: **0.20**

• Reference population (animals):
  – All genotyped sires and cows that are in the pedigree

• Single-step: **19,459** animals
  – 5,268 sires
  – 7,178 cows
  – 7,013 cows with data
For bulls only:

- Genomic Estimated Breeding Values and Reliabilities
- Like all CDN functional traits, evaluations expressed as Relative Breeding Values (RBV):
  - mean = 100  \( \text{SD} = 5 \) for base sires
  - reversed in sign: higher RBV indicate better resistance to Digital Dermatitis
• Digital Dermatitis proof of a sire official when:
  – Minimum 5 herds
  – Minimum reliability of 70%
RBV distribution by % Healthy Records

Healthy Records (%) vs. RBV

80 85 90 95 100 105 110 115

0 40 50 60 70 80 90 100

Healthy Records (%)
### RBV distribution

<table>
<thead>
<tr>
<th>Bulls</th>
<th>Proof</th>
<th>% Healthy Records</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Bottom 10</td>
<td>82</td>
<td>2.0</td>
</tr>
<tr>
<td>Top 10</td>
<td>114</td>
<td>1.7</td>
</tr>
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</table>
• Hoof trimmers willing to share data and to develop a standard recording protocol identified across Canada
• Routine flow of hoof lesion data from hoof trimmers to Canadian DHI and to Canadian Dairy Network
• Genomic evaluations for Digital Dermatitis from December 2017
• Soon DHI herd management report for Hoof Health
Acknowledgements

Supported by a contribution from the Dairy Research Cluster Initiative (Dairy Farmers of Canada, Agriculture and Agri-Food Canada, the Canadian Dairy Network and the Canadian Dairy Commission) and by Ontario Genomics
<table>
<thead>
<tr>
<th>Traits</th>
<th>Rear side rear view</th>
<th>Feet &amp; Legs</th>
<th>Locomotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Dermatitis</td>
<td>-0.28</td>
<td>-0.24</td>
<td>-0.45</td>
</tr>
</tbody>
</table>

![Diagram of a cow showing conformation traits.](image-url)