Improving productive health of dairy cows by genomic selection and management

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A collective achievement

**Industry partners**

*From upstream*
- Breeding companies
- Milk recording / herd support organisations

*To downstream*
- Milk processing industry

**Scientific partners**

- INRA
- IDELE
- ALLICE

Gathered in UMT 3G

A first project bringing together in France stakeholders the whole dairy cattle sector!
Population and phenotypes available

2 (groups of) Breeds:

- Holstein
- Normande

3 (groups of) traits:
All phenotypes having the most significant impact on herd health, animal welfare, and economic viability of herd, and not already evaluated (eg. Mastitis):

- **Ketosis**: ketone bodies estimated from MIR analysis at monthly test-day. **Evaluations available since Aug. 2016**
- **Claw health traits** recorded by trained trimmers
- **Other health traits** recorded by breeders for metritis, retained placenta, milk fever, displaced abomasum…
A genetic evaluation on Ketosis
What is ketosis? How to control it?

The main metabolic disease of dairy cows in early lactation

➡️ What impacts?
- Decrease in milk production (-300 to -500 kg/lact)
- Impact on reproduction (cyclicity delayed and success at first service reduce up to 20%)
- Increased risk of retained placenta and displaced abomasum (x4 à 8)
- Increase in clinical mastitis (x3)

➡️ How often?
- Clinical ketosis: 3 to 4 % of cows
- Sub-clinical ketosis: 12 to 20 % of cows

Aim: Prevent and reduce the risk of ketosis in dairy herd
- Management: From Cetodetect® indicator and specific technical services
- Genetic: a genetic evaluation of ketone bodies to improve genetic level of animals by selection.
1st step: a polygenic evaluation

A large population
- 2 traits for genetic evaluations: log-transformed concentrations estimated from MIR equations:
  - acetone
  - \( \sigma\beta \)-hydroxybutyrate (BHB)
- 1 trait for validation and interpretation of the results: Cetodetect\textsuperscript{®} indicator determined by a decision tree from acetone and BHB concentrations (→health status of animals)
- Population: cows of herds from Western France with performances since 2012

Data edits
- Herds enrolled in official milk recording
- Purebred animals
- Lactations 1-5,
- Days In Milk 7 to 120

Data available for genetic parameters estimation

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Nb Herd x Test-day</th>
<th>Nb Herds</th>
<th>Nb females</th>
<th>Nb lactations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein</td>
<td>2 688 583</td>
<td>183 436</td>
<td>12 378</td>
<td>806 039</td>
<td>1 097 930</td>
</tr>
<tr>
<td>Normande</td>
<td>451 808</td>
<td>32 803</td>
<td>2 890</td>
<td>140 015</td>
<td>189 798</td>
</tr>
</tbody>
</table>
Model for polygenic evaluation

Model

- **2 traits, animal model, repeated data** over lactations
- **Fixed effects:**
  - herd x year
  - month x year of test-day
  - DIM x parity
  - age at 1st calving (or days dry x parity for multiparous)
  - milk analysis laboratory x year
- **Random effects:**
  - Genetic value
  - Permanent envt
### Genetic parameters: Results

#### Heritabilities and Genetic correlations

<table>
<thead>
<tr>
<th></th>
<th>log[BHB]</th>
<th>log[acet]</th>
</tr>
</thead>
<tbody>
<tr>
<td>log[BHB]</td>
<td>0.12</td>
<td>0.851</td>
</tr>
<tr>
<td>log[acet]</td>
<td>0.1</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>log[BHB]</th>
<th>log[acet]</th>
</tr>
</thead>
<tbody>
<tr>
<td>log[BHB]</td>
<td>0.15</td>
<td>0.89</td>
</tr>
<tr>
<td>log[acet]</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

#### Repetabilities and correlations betw. PE

<table>
<thead>
<tr>
<th></th>
<th>log[BHB]</th>
<th>log[acet]</th>
</tr>
</thead>
<tbody>
<tr>
<td>log[BHB]</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>log[acet]</td>
<td>0.879</td>
<td>0.18</td>
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</table>

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<thead>
<tr>
<th></th>
<th>log[BHB]</th>
<th>log[acet]</th>
</tr>
</thead>
<tbody>
<tr>
<td>log[BHB]</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>log[acet]</td>
<td>0.91</td>
<td>0.24</td>
</tr>
</tbody>
</table>

- Moderate/low $h^2$, but low rpt (→ each performance brings much info)
- Analysis of EBVs with Single trait or Multiple trait model: very high EBV correlation

→ ST model for routine evaluation
2nd step: a genomic evaluation

Marker-Assisted (MA) BLUP Genomic Evaluation:

- Between 250 and 3000 pre-detected QTL (BayesC_{\pi}) using haplotypes
- + SNP from EuroG10k chip for the residual polygenic part

Reference population = males + females

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td># genotyped cows with performances</td>
<td>26,899</td>
<td>5,832</td>
</tr>
<tr>
<td># genotyped sires with DYD of ungenotyped daughters</td>
<td>4,314</td>
<td>1,038</td>
</tr>
</tbody>
</table>
First routine evaluation in Summer 2016

Data available
- >7 million of data in Holstein and 1.36 million in Normande

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<tr>
<td># females with EBV</td>
<td>1,394,951</td>
<td>257,785</td>
</tr>
<tr>
<td># males with EBV</td>
<td>6,069</td>
<td>1,077</td>
</tr>
<tr>
<td># females with GEBV</td>
<td>137,367</td>
<td>28,980</td>
</tr>
<tr>
<td># males with GEBV</td>
<td>26,200</td>
<td>4,811</td>
</tr>
</tbody>
</table>

2 new indexes under GÉNO SANTÉ label
- Ketosis index = 50% BHB + 50% acetone
- Productive health index = 30% Ketosis index
  30% Udder health index
  30% Fertility index
  10% Longevity

Evolution of the productive health index in the next years to include new traits such as claw health traits
Incidence of ketosis as a function of female genomic index

Genomic index between -2 and -1, 8% of test-day = clinical ketosis
more 25% = subclinical ketosis

Genomic index between 1 and 2,
Less 1% = clinical ketosis
8% = subclinical ketosis
Reliability

- Genomic evaluation:

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<td>Young animals without performance</td>
<td>0.66</td>
<td>0.58</td>
</tr>
</tbody>
</table>

• Reliability of Ketosis index close to that of other functional traits

- Polygenic evaluation:

• Parent average reliability around 0.30
• Cows with performances: from 0.50 to 0.60
• Bulls: >0.90 when >100 daughters with performances
Polygenic indexes available for herds subscribing to CETODETECT® services

Genomic indexes available for all animals genotyped by EVOLUTION and breeding compagnies partners of GÉNO SANTÉ
GÉNO SANTÉ is a collective achievement around a joint project with shared interests of the entire dairy cattle sector:

- For breeders: cows resistant to ketosis:
  - Limit the use of drugs and time spent to individual care.
  - Reduce production costs / increase profitability

- For herd support organizations:
  - Enhance Cetodetect® services

- For breeding companies:
  - A tool for differentiation in a competitive environment

Additional health traits are planned for next year…
Thank you for your attention