Opportunities and challenges of new technologies for performance recording with focus on claw health and metabolism

Background – new technologies

Evolution of technologies in dairy production and breeding

On-farm:
- Automatisation (milking systems, feeding systems, etc.)
- Environmental information (climate, remote sensing, etc.)
- Livestock sensors (activity, feeding behaviour, etc.)
Evolution of technologies in dairy production and breeding

On-farm:
- Automatisation (milking systems, feeding systems, etc.)
- Environmental information (climate, remote sensing, etc.)
- Livestock sensors (activity, feeding behaviour, etc.)

In the labs:
- New laboratory diagnostic methods and analyses
- Omics technologies
- High-troughput technologies
Background – new technologies

Advances of digitalisation to be exploited

• Networking and data integration
• Real time analyses
• Big data analyses
• Image / pattern recognition
• …
Background – new technologies

BUT:

• Privacy concerns
  • Farm data ⇒ regarded as farmers’ trade secret
  • Sensor-derived information through proprietary algorithms ⇒ regarded as companies’ intellectual property

• Drawbacks
  • Disconnected data silos
  • Heterogeneous APIs
  • Lack of common standards
Background – services of performance recording organisations

- **Animal data**
  - Keep animal master data up to date

- **Sampling + Recording**
  - Performance recording
  - Collection of milk samples

- **Sample analysis**
  - Lab analyses of milk samples

- **Data collection**

- **Print media**
  - Reports

- **Electronic applications**
  - Herd management tools

- **Face-to-face contact**
  - Patronisation

- **Presentation of data + Provision of information**

- **Advisory service**

- **Basis for**

- **Business development in dairy farms**

- **Breeding value estimation**
Breeding goals include various traits – including “difficult to measure traits”

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Production</th>
<th>Milk yield</th>
<th>Fat yield</th>
<th>Protein yield</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Fat &amp; legs</th>
<th>Survivability</th>
<th>Body size/weight</th>
<th>SCS</th>
<th>Udder health</th>
<th>Calving traits</th>
<th>Milking traits</th>
<th>Feat efficiency/Intake</th>
<th>Other traits</th>
<th>Workability/temperament</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (HWI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia (TWI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia (BPI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada (LP1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark, Finland, and Sweden (NTM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France (GDM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany (RZG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great Britain (EPLJ)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland (EBI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Israel (PD11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy (PFI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan (NTP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand (BW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain (ICO)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland (ISEL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Netherlands (NV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States (TP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States (GMS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States (FMS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States (CMS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States (NMS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cole and VanRaden, 2018
Performance recording of metabolic status

• Traditional approach: milk constituents (fat, protein, urea), reason for culling

• Various sources of data for enhanced information on metabolic status
  • Veterinary diagnoses
  • Additional information from milk sample (mid-infrared spectra from milk, enhanced laboratory diagnostic methods and analyses)
  • Test of ketone bodies in blood or milk
  • Body condition scoring
  • Body weight change
  • Eating and rumination behaviour
  • Feeding information
  • …
### Performance recording of metabolic status

#### Data source | Heritability | Comment
--- | --- | ---
Veterinary diagnoses | *1-2%* | Clinical cases, important for BVE
Test of ketone bodies in blood or milk | *5-10%* | Subclinical cases (higher incidences), important for herd management and BVE
Additional information from milk sample | *ca. 15%* | Auxiliary traits for metabolic status
Body Condition Score | *2-4% for BCS change, BCS > 15%* | Ideal range by breed (Häusler, 2015), change in BCS > 0.5 at beginning of lactation – higher disease risk
Sensor information (rumination data, etc.) | ?????? | Herd management information and potential contribution to (big data) early detection algorithms – auxiliary trait for BVE
Feeding information | ?????? | Herd management information and potential contribution to (big data) early detection algorithms – auxiliary trait for BVE

*Fürst-Waltl et al. 2017*
So far, only few information available about correlation to other predictors for metabolic problems – base for inclusion in herd management and breeding.
Performance recording of claw health status

• Traditional approach: n/a (auxiliary: conformation traits and reasons for culling)

• Various sources of data for enhanced information on claw health status
  • Veterinary diagnoses
  • Claw health status from claw trimmers
  • Lameness scoring
  • Activity information
  • MIR predictors ?
  • …
## Performance recording of claw health status

### Data source | Heritability | Comment
---|---:|---
Veterinary diagnoses | *1-2% | Low incidences (severe cases), important for breeding value estimation (BVE)
Diagnose from claw trimmers | *2-25% | Higher incidences, better quality information. Documentation helpful for herd management and BVE
Lameness scorings | *2-9% | Important herd management information. If standardised use for BVE – auxiliary trait for BVE
Sensor information (activity data, etc.) |  | Herd management information and potential contribution to (big data) early detection algorithms – auxiliary trait for BVE

*Heringstad and Egger-Danner et al. 2018*
Additional aspects to consider for metabolic status and claw health

• Crucial in recording of health status: register application of preventative measures (e.g. propylene glycol)
• Alarms from single information sources are often not specific
• Does combining of information increases predictive ability or correlation to target traits (“Gold Standards”)?
• Some of the data sources require sampling
  • Costs
  • Aligned to farms visit for routine milk recording
• Comprehensive research data sets are needed for algorithm development
• Optimise data availability
Networking is the challenge
Networking is the challenge

Central data base and/or programming interfaces

- Lab data (preg test, bact. milk analysis, etc.)
- Insemination, ET
- Milk recording
- MIR-spectra
- Further data collected from MRO (calving, etc.)
- Dairies
- Auctions
- Slaughterhouse data
- Official animal ID
- Claw trimming
- Veterinary diagnoses
- Drug treatment
- Farmers' observations
- Data from automatisation
- Conformation trait recording
- Genome data

- Breeding value estimation
- Mating plans
- Feeding
- Other
- Science
- Monitoring of agricultural production
- Health performance
- Herd management
- Master data for vets, automatisation systems, claw trimmers, advisory services
D4Dairy – Digitalisation, Data integration, Detection and Decision support in Dairying

Duration: 10/2018 – 09/2022

www.d4dairy.com
Expected benefits for all project partners

- Improved interoperability and data exchange between systems
- **Better tools** for early detection of diseases and optimisation of herd management
- **New and better parameters for breeding** - higher heritability
- Improving animal health and welfare
- Monitoring and improvement of **product quality**
- **Improving the environmental impact** through resource savings
- Efficiency gains and improved sustainability
- Advantage for partners sharing data and knowledge and participating in possibilities of digitalization

Access and creating added value out of data will be key for success in the future!
What does that mean for performance recording in 2030?

What / how to record?

What to deliver?
Performance recording in 2030 – what / how to record

• Record a wide variety of (auxiliary) traits using new recording technologies

• Integrate existing data and technology into performance recording

• Offer performance recording schemes that are aligned with the needs and the abilities of farms and farmers

• High-quality data provision as business model for farms ⇒ Integration with breeding programs
Performance recording in 2030 – what to deliver

- Offer decision (support) systems for farm management based on different sources of data (from performance recording and other sources)

- Make performance recording results available for further automatization of farm processes

- Adapt performance recording schemes to daily/hourly/every second data flow

- Make data streams in dairy production visible