INTERNET OF COWS – OPPORTUNITIES AND CHALLENGES FOR IMPROVING HEALTH, WELFARE AND EFFICIENCY IN DAIRYING

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ICAR, Prague 2019
Background

- **Growing world population** (currently 7.5 billion; 2050 9.7 billion (UNO, 2015)) – efficiency
- **Climate change** – resilience, emissions
- **Consumer concerns** – food safety, animal health and welfare
- **Growing farms** – workload, pressure for optimisation and sustainability
- **Enormous technological progress** also in cattle farming
- Digitalisation - **many new opportunities and challenges**
Technological advances

Genomics (VanRaden, 2019)

<table>
<thead>
<tr>
<th>Country</th>
<th>2009</th>
<th>1/2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States and Canada</td>
<td>22,344</td>
<td>3,020,00</td>
</tr>
<tr>
<td>France</td>
<td>8,500</td>
<td>550,000</td>
</tr>
<tr>
<td>Germany</td>
<td>3,000</td>
<td>785,000</td>
</tr>
</tbody>
</table>

Robotics and Artificial Intelligence

- Automatic milking systems
- Automatic feeding systems
- 3D Cameras to detect e.g. BCS
- Others

OMICS technologies

<table>
<thead>
<tr>
<th>Technical Level</th>
<th>Biological Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genomics</td>
<td>Secretome</td>
</tr>
<tr>
<td>Transcriptomics</td>
<td>Resistome</td>
</tr>
<tr>
<td>Proteomics</td>
<td>Microbiome</td>
</tr>
<tr>
<td>Metabolomics</td>
<td>Inflammome</td>
</tr>
</tbody>
</table>

*Oomics technologies combine biology and mathematics*

Wagner, 2018

Information technology

- Large variety of miniaturized low-power smart sensors
- Low-power wireless communication
- Embedded data analytics

Source: https://www.youtube.com/watch?v=xqhdlRmnL98
New technique brings many new phenotypes

Many data
(5 Vs – Volume, Velocity, Variety, Veracity, Value)

Algorithms to derive parameters!

Technological advances allow precise monitoring of animals and environment in realtime!
Rumination and ketosis

Stangaferro et al. (2016):
• significant reduction in activity already 5 days before clinical diagnoses
• Detection rate 91% (49/54)

Attention: alarm based on activity only is not specific!
Sensor to support herd management

Technical level | Interpretation | Integration of information | Decision making

Little communication and integration so far

Rutten et al. 2013
Many isolated solutions

Central cattle databases since decades
AUTOMATION ON FARMS

How frequently are these systems used in Austria?

- automatic milking systems (AMS)
- animal sensor (activity,..)
- feeding robot

Picture: ZAR

Picture: smaXtec

Picture: Wasserbau
Frequency of AMS, animal sensors and feeding robots in Austria (D4Dairy: status 5/2019)

Further big increase is expected concerning online-survey!
WHAT DO FARMERS EXPECT?
Data integration is important for farmers and vets
(ADDA-survey: participation – farmer: LW 19.1%, vets 20.8%)

Importance of integration of data into one platform:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Farmer</th>
<th>Veterinarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteriological milk sample</td>
<td>81</td>
<td>87</td>
</tr>
<tr>
<td>Bulkmilk samples</td>
<td>78</td>
<td>70</td>
</tr>
<tr>
<td>Diagnoses and treatment data</td>
<td>73/72</td>
<td>72</td>
</tr>
<tr>
<td>Disease status</td>
<td>72</td>
<td>83</td>
</tr>
<tr>
<td>Findings from labs</td>
<td>63</td>
<td>88-89</td>
</tr>
<tr>
<td>Services of performance recording</td>
<td></td>
<td>79</td>
</tr>
<tr>
<td>Results of feed analyses</td>
<td></td>
<td>78</td>
</tr>
</tbody>
</table>

80% of the farmers want integrated communication of systems on farm.

Perner et al. 2016; Weissensteiner et al. 2018
Farmers don‘t want.....

- receive results in pdf
- isolated solutions
- indicate one dataset more than once

Expect best service out of device and data!
Linkage between systems

Central cattle database

- slaughter
- dairy company
- weather
- claw trimming
- animal-sensor
- labs
- milking system
- feeding
- welfare
- vet data
- need for linkage

- Performance recording
- Pedigree
- Lab data (e.g. MIR, feed, milk bacteriology)
- Observations
- Vet diagnoses and treatments
- Movements
- Genome data
- Slaughter
- Calving/Insemination
- Claw health
- Housing/Feeding...
- Other (e.g. auctions,..)
- Other (e.g.)
- Central cattle database
OPPORTUNITIES DUE TO DIGITALISATION
Internet of Cows – to improve welfare, health, efficiency

- Somatic cell count
- Diagnoses
- Welfare parameters
- Rumination, activity, pH
- Daily milking information
- Feed intake
- Climate
- Housing climate
- Housing system
- Need for linkage and advanced analyses
- Pathogens
- Use of antibiotics
- Claw health
- Feed quality
- Others (MIR,..)
- Hygiene

Source: LKV-Herdmanager

Picture: Priewasser

Picture: Biomin
Big Data

Challenge - systems are complex:

Complex Systems are co-evolving multiplex networks (Klimek, 2019)

States of individuals/companies... change as a function of the networks. Networks change the states of the individuals.

D4Dairy:
Disentangle causative relationship for diseases (Multi layer approach). What interacts with what, how long, how strong, under which conditions?

Learn about causative relationship above correlations!
Digitalisation should achieve...

- better decision support tools
- process optimisation by
  - collection
  - integration
  - analysis
-...

Improved value and benefit

Decision support for improvement of udder health e.g. targeted treatment, dry-off strategy

- less mastitis
- less use of antibiotics
Opportunities due to digitalisation

- Reduction of work load for farmers
- Better and precise parameters for prevention and early detection of health disorders
- Higher heritabilities and increased genetic gain
- Improved possibilities for monitoring of animal health and animal welfare
- Optimisation of processes – saving of resources
- Sustainable and more efficient production
Where is work needed to be done?
Interoperability of systems

**Interoperability of systems:** communication at farm / with external systems

- many different systems with many different standards
- each information at the right time on the right place according privacy, transparency and data protection issues …

Various examples – NCDX, JoinData, 365Farmnet, ....! Functionality and trust in the system is crucial!
Data Integration / Data communication

Network
• Communicate data

Harmonise
• Data formats ("36 C" vs. "100100 Celsius")
• Data meaning ("36 C" vs. "96.8 F")
• Data quality ("36 C" vs "36.7 C")
• e.g. diagnoses, ..

Access
• Give access to data
• Protect ownership (Römer, 2018)

Importance of ICAR for standardisation – important that these standards are also used!
Communication between systems
Avoid multiple recording of data

Example: treatment of cow by vet – till action in robot (separation of milk or stop of milking of cow)

from veterinarian to automatic milking system

treatment and electronic documentation
waiting period for milk
milk separated or cow stopped for milking

AIM: one data entry only for each dataset – no multiple recording!
Communication between systems
Avoid multiple recording of data

Start with simpler steps – presently not even communication of animal-ID, calvings, inseminations,... is standard!
Comparability of results

- Comparability of results / Standardisation
  - are results from labs comparable across labs?
  - are results from different sensors comparable?
  - ..
Example for data integration
Results of bacteriological milk samples in herd management tool of RDV

Necessary measures:

- Standards of analyses in lab and definition of findings harmonised (guideline developed) ✓
- Data protection issues elaborated and solved ✓
- Development of analyses and benchmarks for herd management tools (see poster Suntinger et al. 2019; Obritzhauser et al. 2019) ✓
Challenges

- Interoperability / Communication
- Comparability of results / Standardisation
  - are results from labs comparable across labs?
  - are results from different sensors comparable?
  - ...
- Integration of different data in system
  - correlation between traits
  - ...
- Data privacy protection
  - data protection
  - privacy / „ownership“ / purpose
  - business interests
  - ...
- Access reliable internet (partly)
D4Dairy – Digitalisation, Data integration, Detection and Decision support in Dairying

Project period: 1.10.2018 – 30.9.2022
Partner: 31 Economic, 13 Scientific partners
Budget: 5.5 Mill Euro (50% from Economic partners)
Focus of data driven research within D4Dairy

Data Integration/
Data exchange
herd management, data protection, Intellectual Property
Rights

Use of sensor data for
decision support
(early detection of
diseases, herd
management...)

Interoperability and optimization of processes (e.g.
feeding)

Reduction of antibiotics, action to reduced antimicrobial
resistance

Digitalisation and dissemination

Mycotoxin
detection and
Control strategies

Genetic and
Genomics

Housing Climate, animal health and
welfare, efficiency

BigData Analyses for Prognostic Disease
Markers

Mid-Infra-Red-Spectra for Disease Detection

D4Dairy - Digitalisation, Data integration, Detection and Decision support in Dairying
D4Dairy – Project partners

13 Research Partners

31 Company Partners (along value chain)

Cooperation partners for specific topics
Summary – Internet of Cows

- Many **new opportunities** due to technological advances
- **Better tools for to improve health, welfare, efficiency**
- Communication and use of advanced technology can increase benefit – **farmer expects communication between systems**
- **Challenges** (harmonisation, communication, business interests, data protection,...)
- **Multidisciplinary approaches** to solve challenges
- **Cooperation** is key for success
- **Benefit for farmers and community are essential**!
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Cooperation is base for success with digitalisation

Thank you for your attention!

www.d4dairy.com or www.d4dairy.eu