Use of sensor data for breeding and genetics

Heringstad, Bjørg[1,2]* & Karoline A. Bakke[2]

[1]Department of Animal and Aquacultural Sciences, Faculty of Biosciences, Norwegian University of Life Sciences
[2]Geno Breeding and A.I. Association, Norway

ICAR / IDF WORKSHOP, Toledo, Spain, 25 May 2023
Using sensor data for animal health and welfare improvement along the dairy value chain: Merits and requirements

Sensor data possible useful for dairy cattle breeding and genetics

Automatic Milking Systems (AMS)

- Udder health indicators
- Fertility indicators
- BodyConditionScore (camera)
- Body weight
- Udder conformation
- Behaviour
-
-

+ Associated sensors

- Activity meters
- 3D-camera BCS
- Rumination
- Body temperature
-
-

Sensor data possible useful for dairy cattle breeding and genetics

Advantages

- Automatic, continious recording
- Objective, frequent measures
- Less affected by herd management decissions

Challenges

- Different systems, providers, versions
- Access to data, data ownership
- Routine collection of data to central database

- More presice phenotypes?
- New traits that can supplement or replace current traits

Examples of use of sensor data for breeding and genetics

- **Cow activity** measure can be used to define new fertility traits
- Behaviour and milking efficiency traits can be derived from data from **automatic milking systems** (AMS)
- **AMS** provide udder health indicators

Breeding for improved cow fertility

Current fertility traits:

- Phenotypes: Insemination (AI) records and calving dates
- Success rate traits:
  - 56 d non-return
  - Conception rate
  - No of AI to conception
- Interval traits:
  - Interval from calving to first AI
  - Interval from 1st to last AI
  - Calving interval

Challenging traits:

- Low heritability

➥Need better and more precise phenotypes

– New technology - new oportunities

- automatic heat detection system

Cow activity measures widely used in herd management tools for heat detection

JDS Communications®
2023; 4:99–100
https://doi.org/10.3168/jdsc.2022-0251
Short Communication
Genetics

Aim

Examine whether new traits based on activity measures can be useful for genetic evaluation of cow fertility in Norwegian Red

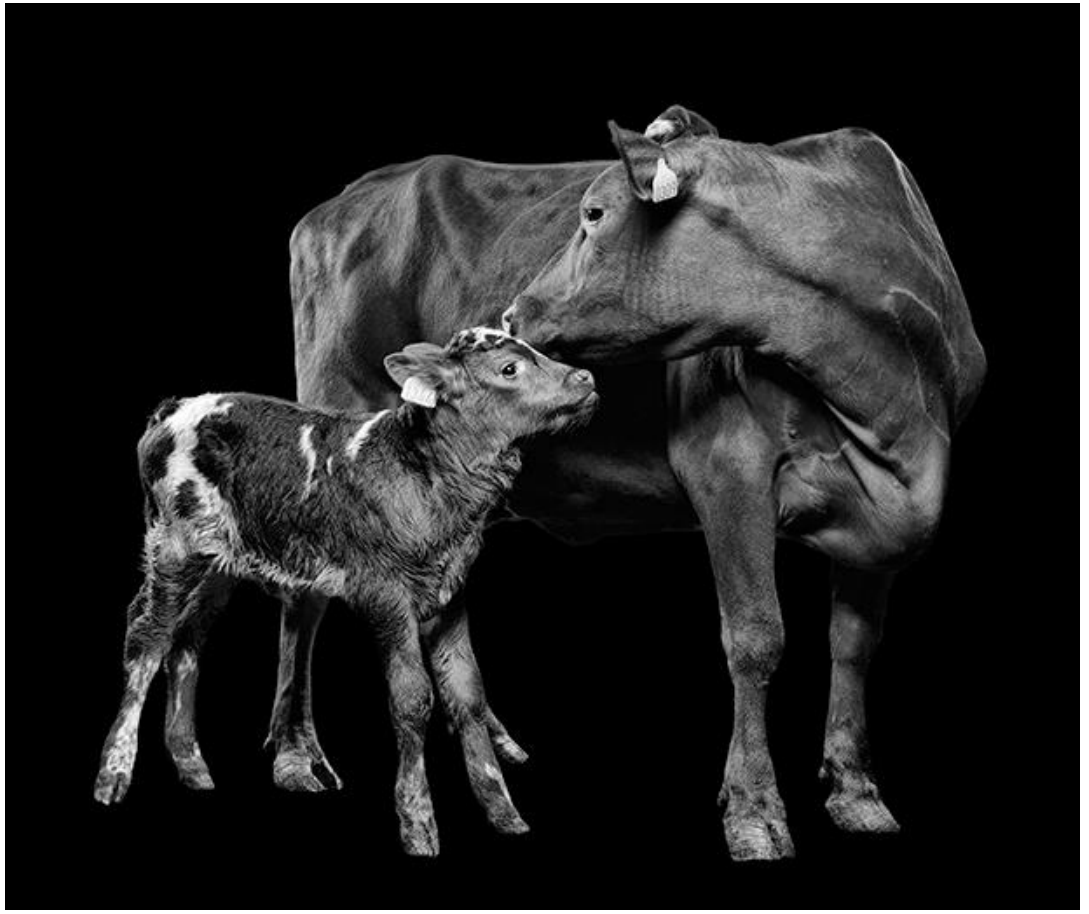
Cow activity measurements can be used to define new fertility traits for use in genetic evaluation

B. Heringstad[1,2]* and K. B. Wethal[2]

Cow fertility included in the breeding program for **Norwegian Red** since the 1970's

Data and edits

- Daily activity measure data
- 284 herds with Lely milking robot and activity tags
- 13,224 lactations
- 8,139 Norwegian Red cows
- Daily activity measures from 10 to 150 days in milk for cows with at least 50 records



Trait

Interval (days) from **c**alving to **f**irst **h**igh **a**ctivity (CFHA)

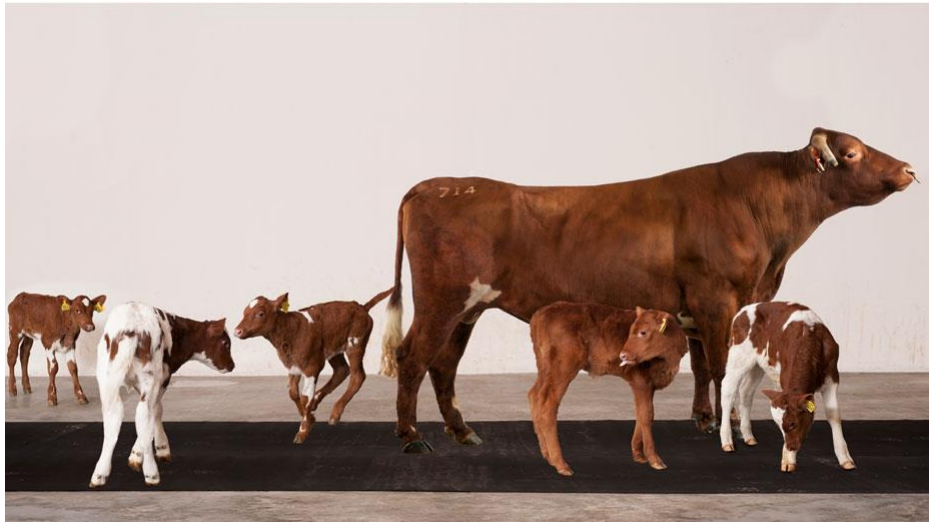
87% of the cows had at least one episode of high activity recorded.

Mean CFHA 42 days (SD=28)

Reflects the cow’s ability to return to estrus cyclicity and show heat after calving

Heritability

σ^2_a	σ^2_{pe}	σ^2_e	h^2
32.14 (8.29)	13.35 (10.79)	596.16 (10.98)	0.05



Other studies of interval to first high activity

- Løvendahl and Chagunda (2009)
  - 515 cows with records
  - h^2 from 0.12 to 0.18 (0.07)
- Ismael et al. (2015)
  - 3,533 cows with phenotypic records
  - h^2 = 0.16 (0.04)

The trait CFHA

- showed significant genetic variation with a heritability of 0.05
- reflects the cow's ability to return to estrus cyclicity and show heat after calving
  - important aspect of cow fertility

Other possible traits?

- Heat strength

  Hight and duration of high activity peak

- Conception rate

Cow activity measurements

- can be used for genetic evaluations
- provide information on new traits that can supplement or replace current traits
- Records already exist for a large proportion of the population
- How can we best make use of these data?

  All cows included?

  Tags on all cows in the herd always?

Behaviour and milking efficiency traits derived from data from AMS

J. Dairy Sci. 102:8221–8233
https://doi.org/10.3168/jds.2019-16625

Genetic analyses of novel temperament and milkability traits in Norwegian Red cattle based on data from automatic milking systems

K. B. Wethal* and B. Heringstad
Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences, PO Box 5003, 1432 Ås, Norway

Data:

77 herds with DeLaval

4883 Norwegian Red cows

1 mill daily records

Heritability (h^2) with standard error (SE) of behaviour and milkability traits

Trait	h^2	SE
Boxtime (min)	0.27	0.03
Milking efficiency (kg/min)	0.22	0.03
Handling time (min)	0.05	0.01
Log-Handling time	0.07	0.02
Flowrate (kg/min)	0.48	0.04
Milking frequency (no)	0.05	0.01
Milking interval (hours)	0.02	0.001

Behaviour and milking efficiency traits derived from data from AMS

Heritability (h^2) with standard error (SE) of behaviour and milkability traits

Trait: Proportion of milkings (summarized over lactation) with	h^2	SE
Kick Offs	**0.13**	0.03
Incomplete milkings	**0.14**	0.03
Teat not found	**0.12**	0.03
Rejected Milkings	**0.05**	0.02

- Several traits that potentially could be used in routine genetic evaluation
- New traits that can supplement or replace current traits

AMS provide udder health indicators

- Electrical conductivity (EC)
  - Standard equipment
  - Quarter level
- Online CellCounter (OCC)
  - Available per cow per milking

J. Dairy Sci. 103:7188–7198
https://doi.org/10.3168/jds.2020-18343

A genetic study of new udder health indicator traits with data from automatic milking systems

K. B. Wethal,[1]* M. Svendsen,[2] and B. Heringstad[1]
[1]Department of Animal and Aquacultural Sciences, Faculty of Biosciences, Norwegian University of Life Sciences, PO Box 5003, 1432 Ås, Norway
[2]Geno Breeding and AI Association, 2326 Hamar, Norway

Data

- EC from 77 herds, 4700 cows, 2.3 mill milkings
- OCC from 24 herds, 1500 cows, 400.000 milkings

Heritability and genetic correlations

Estimated heritability on diagonal and genetic correlations below diagonal. Standard error in parenthesis

Trait	ECmax	ECmean	lnOCC
ECmax	0.23 (0.02)		
ECmean	0.99 (0.002)	0.35 (0.03)	
lnOCC	-0.0004 (0.17)	0.04 (0.16)	0.09 (0.03)

From Wethal et al. (2020)

- EC traits are heritable
- No genetic correlation between EC and OCC
- Value of EC as indicator for genetic evaluation of udder health is questionable

Sensor data can be used for genetic evaluations

Advantages and new opportunities:

- Automatic, continious recording
- Objective, frequent measures
- Records already exist for a large proportion of the population
- New traits that can supplement or replace current traits

Challenges:

- Different systems, providers, versions
- Data quality
  - Calibration, maintainence procedures, follow up
  - Need validation
- Access to data
  - «raw data» - summarized data – processed data
  - Insight / documentation of algorithms/variables
- Data ownership
- Vaste amount of data generated
  - Complex data - Recorded for herd management - How to best utilize it for breeding and genetic evaluation?
- Routine collection of data to central database

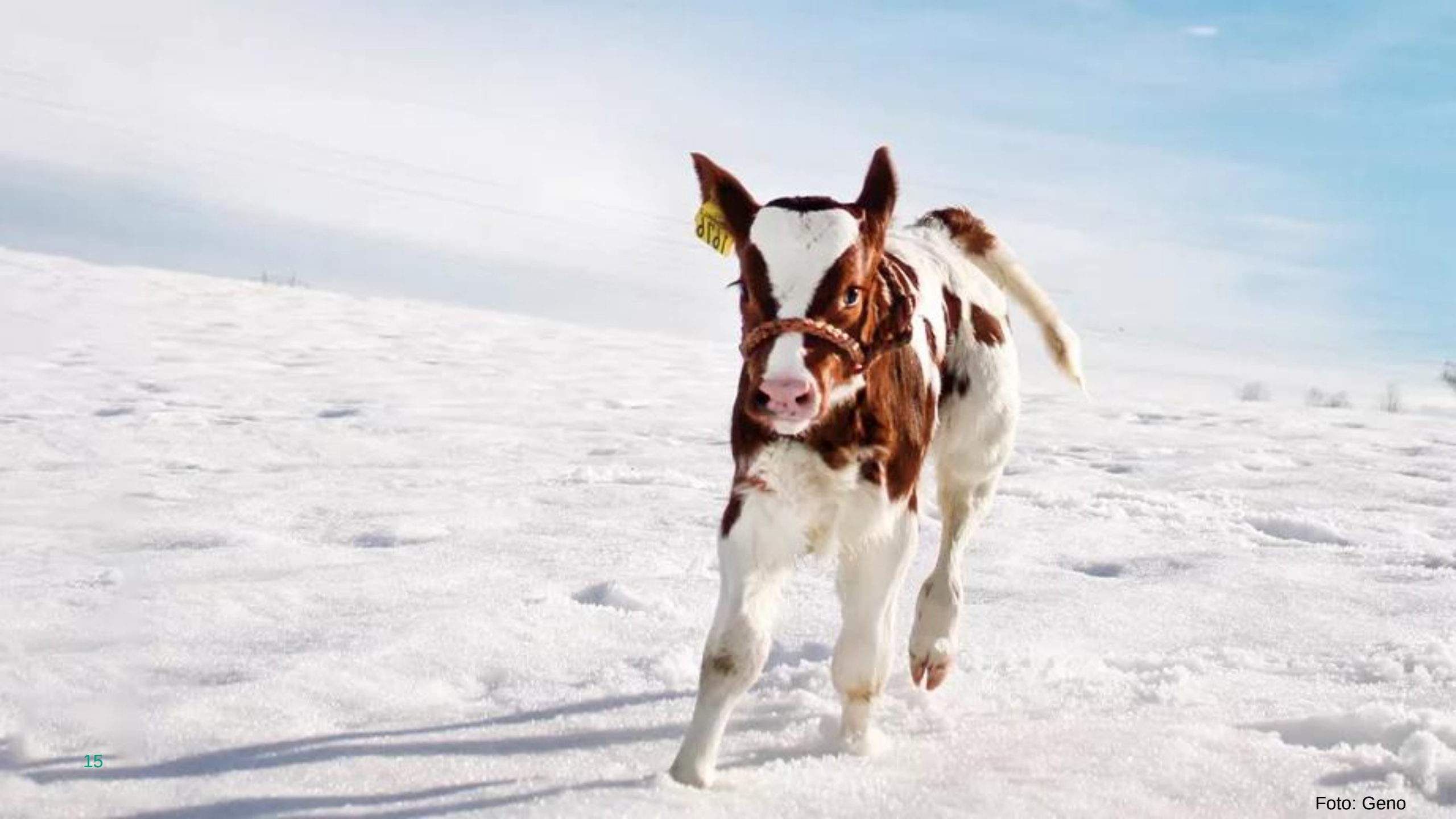


Foto: Geno