New ICAR IDF Guidelines on sensor based behaviour information for functional traits with focus on rumination

by Christa Egger-Danner

Chairperson ICAR Functional Traits Working Group

Background

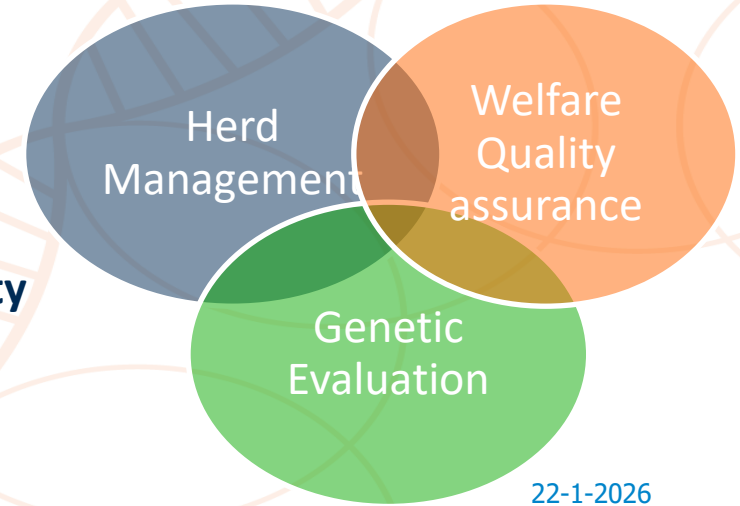
- **Collaboration between ICAR Functional Traits Working Group** (ICAR FTWG) **and IDF Standing Committee of Animal Health and Welfare** (IDF SCAHW) - **work on animal-based indicators to promote welfare in dairy cows!**
  - **ICAR: develop, provide and promote a system and standards for functional traits (services) (WIKI)**
    - harmonize traits
    - recording and validation of data
    - trait definition
    - use of data for herd management, genetics and quality assurance

ICAR Central Health Key
https://www.icar.org/guidelines/icar-central-health-key/

  - **IDF : have dialogue on, and form consensus about new developments in the dairy sector field of animal health and welfare**

IDF and ICAR see the need and potential of improved use of sensor data

- **High potential of Precision Dairy Farming / Farmers are increasingly using** sensors and other technologies
- On-farm sensor systems collect large amounts of data, but just a **small fraction** is currently **used**
  - Veterinary & advisory services
  - Dairy processors
  - Milk recording organizations
  - Breeding organizations
  - …
- **Huge potential for use / enhance sustainability**
  - Across farms and sensor technologies
  - Along the dairy value chain

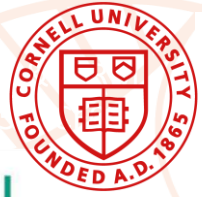


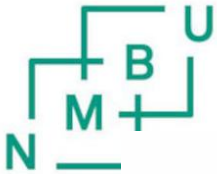
Specific objectives of ICAR FTWG / IDF SCAHW

- Address **sensor-based health and welfare traits** for improvement **of genetics, herd management and welfare quality assurance**
- Bring together **different stakeholders** as technology providers, users of information and scientists: common understanding and knowledge exchange towards our goals
- **Explore opportunities and challenges** for recording, standardization, validation, trait definition and use of this information
- **Develop agreed upon, evidence-based, definitions and standards that support innovation along** the dairy value chain

Promote further and extended use of sensor systems along the value chain to increase sustainability, animal well-being and efficiency in cattle production.

Improving animal health and welfare by using sensor data in herd management and dairy cattle breeding – a joint initiative of ICAR and IDF





Other manufactureres and colleagues from ICAR and other organisations

Way of working: collaboration of different stakeholders (manufacturer, researcher, and representatives from DHI and breeding organisations,..)

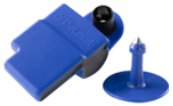
AIM of ICAR IDF Sensor Initiative

- **Many different technologies and devices**
- **Develop guidelines with focus on animal health and welfare**
  - **Standardized definitions**, terminology for health and behaviour conditions of interest – **same "language"**
  - **Standardization to enable exchange across different farms, technologies**,..
  - **Reference standards / protocols**
  - **Best practices for data cleaning**
  - **Best practices / guidelines for use** in genetics, herd management and quality assurance


SenseHub


RumiWatch

Nedap



DeLaval Behavioural Analysis

AfiCollar Behavior monitoring


Afimilk

CowControl

Cowmanager

smaXtec

Start with rumination as a blueprint for other sensor based traits! Continuous development!

ICAR IDF Guideline

"Sensor based behaviour information for functional traits with focus on rumination"

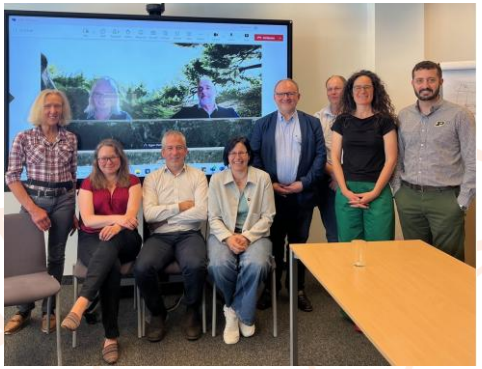
- **Part I – General introduction**
- **Part 2 – Definitions and terminology**
- **Part 3 – Sensor data cleaning**
- **Part 4 – Use of sensor data (focus on time series data) for genetic improvement**

Status: approved by ICAR Board / Feedback members ongoing

Continuous further development and updates

Authors and contributors to this guideline

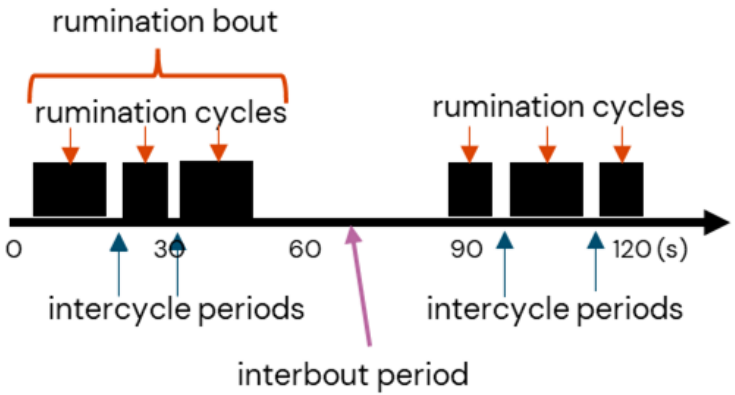
Collaboration of members of the ICAR Working Group on Functional Traits, the IDF Standing Committee of Animal Health and Welfare, international scientists, manufacturer and representatives of other ICAR bodies and stakeholders.



C. Egger-Danner, I. Klaas, L. F. Brito, J. M. Bewley, V. E. Cabrera, S. Dagan, R.H. Fourdraine, N. Gengler, M. Haskell[9], B. Heringstad, J. Heslin, M. Hostens, M. Iwersen, F. Karlsson, G. Katz, M. Moleman, M. Phelan, E. Rossi, K. Schodl, D. Sieben, K. F. Stock, A. Stygar, E. Vasseur, Manufacturer representatives

Thank you for the great collaboration!

Part 2: Terminology & definitions of rumination – agreed



Schirmann et al., 2009, Nørgaard, 2003, Rutter, 2000, Ruckenbusch, 1988, Welch 1970

- **Rumination**: the behavioural activity of ruminants that involves regurgitation, chewing and swallowing of partially digested feed.
- **Rumination cycles or events**: a sequence of rhythmic chewing motions, starting with the regurgitation of a bolus and ending with the re-swallowing of that bolus.
- **Inter-event or inter-cycle period for rumination**: the period that starts when the bolus is swallowed and ends when the next bolus is regurgitated. May be between 3 and 8 seconds.
- **Rumination bout**: a series of rumination events that are separated only by the inter-event intervals required for the swallowing of a bolus and regurgitation of the next bolus.
- **Inter-bout interval**: the period of time between rumination bouts, must be longer than 4-8s.

Rumination time: the total rumination time within a specified time interval, typically calculated for 1 h or 1 day periods. This is the sum of the rumination bouts including the rumination events and inter-event intervals.

Part 2:

Recommended reference standard for rumination - agreed

The reference standard should **preferably be based on human observation but can be camera supported**.

A) **Continuous visual observation** of a cow by well-trained human being in real-time

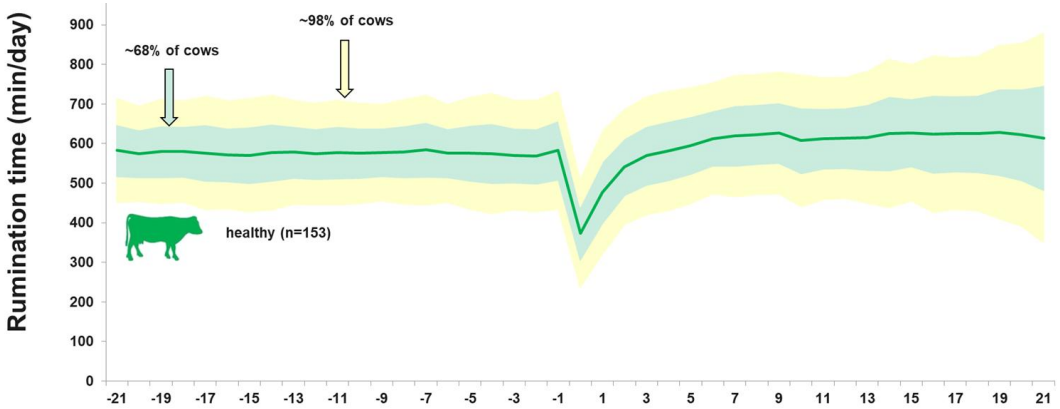
- Rumination is defined as a cow chewing and swallowing a ruminating bolus while moving her head and jaw with a rhythmic motion. Regurgitation of a bolus and swallowing of a bolus can be identified. The cow is not showing eating behavior, such as taking a bite of feed.

A) **Video footage of cow**, with manual assessment of rumination behavior by human observer. The camera placement is crucial, the face of the cow needs to be in focus. Ideally, more than one camera is used to have several views.

Suggested KPIs for sensor-based rumination data

agreed

- Total daily rumination time in minutes per day
- Proportion of time spent ruminating per day
- Rumination time per time unit to enable investigation of circadian patterns and deviance, e.g. daily, hourly or 2-hourly summaries



Same principle applies to other behavioral traits like eating.

Part 3 - Sensor data cleaning

Recommendations for data cleaning

General guidelines for understanding the data, regardless of the quality management measures implemented by the sensor technology provider

Five-step framework:

- **Verification of the data** preprocessing
- **Understanding the data**
- **Checking data completeness**
- **Evaluating data plausibility and outlier detection**
- **Addressing technology-related noise**

Schodl, K., A. Stygar, F. Steininger, and C. Egger-Danner. 2024b. **Sensor data cleaning for applications in dairy herd management and breeding**. Front. Anim. Sci. 5:1444948. https://doi.org/10.3389/fanim.2024.1444948.

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

General

- For genetic purposes: **rumination proxy of feed efficiency** and **functional traits such as metabolic diseases and claw health, reproduction, resilience,..**
- **Limited information in the literature / research ongoing**
- **Rumination variables might be more useful** for breeding and management purposes **when combined with other datasets such as sensor-based activity measures** (e.g., lying, standing, eating, drinking).
- **Sensor derived traits are proxies** and are **not comparable with veterinarian diagnoses!**

Journal of Dairy Science / INVITED REVIEW: **Using data from sensors and other precision farming technologies to enhance the sustainability of dairy cattle breeding programs (Brito et al. 2025)**

https://www.sciencedirect.com/science/article/pii/S0022030225006812

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

- **Introduction**
- **Required information – see later**
- **Data cleaning and integration** – additional recommendations to use in genetics
- **Trait definitions**
- **Factors influencing rumination time**
- **Genetic models**
- **Challenges / tricky points**
- **Additional points to consider**
- **How to combine data from sensor with traditional recording / functional traits?**
- **Open questions to follow up**

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Which data to share for genetic evaluation – recommendations with focus on rumination?

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Required information

Essential input for routine genetic evaluation

1. Animal Information

- **Unique Animal ID:**
  - **Use the ICAR ADE format** (several identifier formats are accepted): Breed + Country + Sex + Identification number / Refer to ICAR guidelines
  - **Recommendation:** Parties exchanging data will agree on the data format for a unique Animal ID.

    For genetic evaluation it is **recommended to work with farms using a herd management system and where there is the link to a national ID**.

    Requirements to participating farms: farmer must make sure that there is **link from the sensor to a unique animal ID**

Although not recommended, sensors (and 15-digit RFID-tags) might be reused on different animals over this cannot be avoided, we recommend farmers to record this information for further verification!

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Required information

Essential input for routine genetic evaluation

- **Breed:**
  - Use ICAR/Interbull breed codes
  - Refer to breed codes
  - **Recommendation:** Parties exchanging data need to agree on the breed codes to be used
- **Lactation Number** (available from other sources, e.g. DHI)
- **Calving Date** (from other sources):
  - Format as YYYY-MM-DD

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Required information

Essential input for routine genetic evaluation

2. Farm Information:

- **Farm ID and Site ID** (use ICAR ADE standards)
- **Location:**
  - Postal code, city, state/province, country, time zone

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Required information

Essential input for routine genetic evaluation

3. Sensor Information:

- **Sensor brand:**
- **Sensor type: (**e.g., based on accelerometers, acoustics)
- **Sensor version (or update):** not possible
  - *Recommendation:* Data quality assurance is important for modelling in genetic evaluations.
- **Sensor Unique ID** (not required as linked to animal ID)
  - *Comment: If the same sensor would be used on different animals, it is important that the information provided enables detection.*
- **Sensor ICAR Device reference ID: 8 digit identifier**
  - *It is part of other efforts within ICAR where manufacturers can obtain an ID for some type of device they are offering to customers.*

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Required information

Essential input for routine genetic evaluation

Rumination Data:

- **Rumination Time:**
  - **Common basic agreement:** aggregated summary of total minutes per animal per day for routine data exchange.
  - **Unit:** min/day
  - **Date/Timestamp:** YYYY-MM-DD (for aggregated daily values, we suggest indicating the time period summarized for example, from 00:00 to 24:00 h)
  - **Total daily number of minutes with measurements for rumination:** When **providing daily summaries** of rumination per individual cow, the receiver of the data will need more information about the data editing and handling of missing values and the completeness of the shared data.
  - **Data of higher granularity (e.g. aggregated values in minutes per hour (min/h), minutes per 2 hours – min/2h)**
    - for estimating the effect of **circadian patterns**.
    - **require specific agreements** between parties for specific projects.

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Data sharing for other activity parameters

Required information for rumination applies to other behavioural traits that are measured in minutes, e.g. **like eating, lying** as well as the other arrangements for rumination like total daily number of measurements.

Other potentially relevant information for genetic evaluations:

Index information and alarms

- **Animal-ID**
- **Alarm date**
- **Description / name of the index / resolution or frequency (event based or daily, hourly,..), scale or coding**

Note: there are nearly no studies using alarms for genetic analyses. Differences between brands,…
No recommendations elaborated so far.

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Data sharing for other activity parameters

Optional Information

- **Data from rumination based or related sensors:**
  - Frequently-collected eating time and activity level (also for data cleaning)
  - Alarms (e.g., heat detection, calving, disease) and indexes (health, activity, …)

- **Other data sources will be needed** (or very valuable) for genetic evaluations: reproduction data (e.g., heat and insemination dates), health events, information on housing, milking system, grazing, feeding group, and milk yield traits (daily or per milking event).

Part 4 - Use of sensor data (focus on time series data) for genetic improvement

Additional information at sensor brand level of interest

The following aspects should be documented and clarified for each sensor brand or system used:

- **Animal identification**
- **Data aggregation**
- **Sensor placement**
- **Handling of missing information**
- **Interpretation of null and zero values**
- **Trait documentation**

ICAR IDF Guideline - Summary

"Sensor based behaviour information for functional traits with focus on rumination"

- **Part I – General introduction**
- **Part 2 – Definitions and terminology**
- **Part 3 – Sensor data cleaning**
- **Part 4 – Use of sensor data (focus on time series data) for genetic improvement**

Status: approved by ICAR Board / Feedback members ongoing

Continuous further development and updates – presently work related to reference standards ongoing / Use case for herd management / quality assurance planned

Publication expected in March 2026