



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Summary of Sensor Devices Task Force Work and Charting a Course Moving Forward

Steven Sievert

Chair, ICAR Sensor Devices Task Force

19 June 2019



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Challenges in Modern Herd Recording

Are We
Listening?



Livestock are ideal
candidates for
repeated measures –
What can I tell you?



Producers are
saying I made
the investment -
**How are you
going to use my
farm/herd data?**



Recording organizations
are looking for guidance
– **What do we do?**



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Data Capture & Flow Challenges

Quality of LAN or Internet Connection at Dairy

Many Different Versions of Software – Updates Not Installed

Frequent Updates of Software Creating Data Field Errors

Random or Arbitrary Data Fields Created by Dairyman

Lack of Real-Time Connection – May Only Be Daily or Weekly

System is Too Complex/Labour Intensive for Dairy

Inconsistent Data Definitions

Data Quality – Missing or Incomplete

ID Truncation/Translation/Cross-Referencing

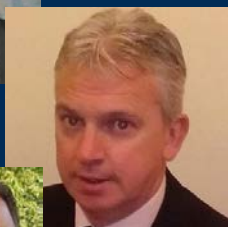


THE GLOBAL STANDARD FOR LIVESTOCK DATA

Network. Guidelines. Certification.



Steven Sievert, Chair, US



Martin Burke, ICAR



Kees de Koning, Netherlands



Uffe Lauritsen, Denmark



Franz Josef Auer, Austria



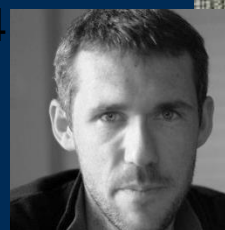
Christa Egger-Danner, ZuchData



Harrie van den Bijgaart, Netherlands



Reinhard Reents, Germany



Clement Allain, France



Brian Wickham, Ireland/NZ



Jeroen van den Ban, Lely



Cecilia Bågenvik, DeLaval

4



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

**Classification,
Qualification &
Potential ICAR
Approval of
Sensor Devices**

**Dissemination
of Recording
Guidelines using
Data from
Sensors**

**Development &
Distribution of
Best Practices
for Data
Collection from
Sensors**



THE GLOBAL STANDARD FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Current State of Sensor Technology

Technology is Improving and Changing Rapidly and Easily Adopted by Producers

Many Isolated Packages without Integration or Linkage

Sensor Users Behave as a 'Community of Practices' – no True Standards or SOPs

Validation, Maintenance, and Calibration Protocols are Missing

There is both System Bias and Individual Sensor Bias



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

SD-TF Survey – Priorities Identified by Members

Milk Yield & Composition

Milk Flow Rate & Duration

Live Body Measurements

Live Activity Measurements

Feed Efficiency Measurements



THE GLOBAL STAND
FOR LIVESTOCK DA

New Sensor Device Page on ICAR website

Links to:

Survey Results

Sensor Summary Table

Trait Characterization/Validation

External Research/Publications

Draft Guidelines (upcoming)

Sensor Devices Task Force

Priorities of the Sensor Devices Task Force

[<read more ...>](#)



NEWS

- Opportunities for the Sensor Devices Task Force
[<read more ...>](#)
- Sensor presentations – ICAR 2018 Conference (Auckland, NZ)
[<read more ...>](#)
- Proceedings of the Precision Dairy Farming Conference
 - 2017 [<get the file ...>](#)
 - 2016 [<get the file ...>](#)
 - 2015 [<get the file ...>](#)

Facts about the Sensor Devices Task Force

- Members of the Sensor Devices Task Force
[<read more ...>](#)
- Terms of Reference of the Sensor Devices Task Force
[<read more ...>](#)
- Test Centres
[<read more ...>](#)
- Meeting of the SD TF in Zutphen
[<read more ...>](#)

ICAR Sensors Overview

- File (as .xlsx) available
[<read more ...>](#)

Sensor use survey report

[<read more ...>](#)



Sensor Trait Characterisation

- File (as .xlsx) [<read more ...>](#)

ICAR Guidelines

Guidelines for Sensor Devices
are currently under
finalisation



Sensor Research

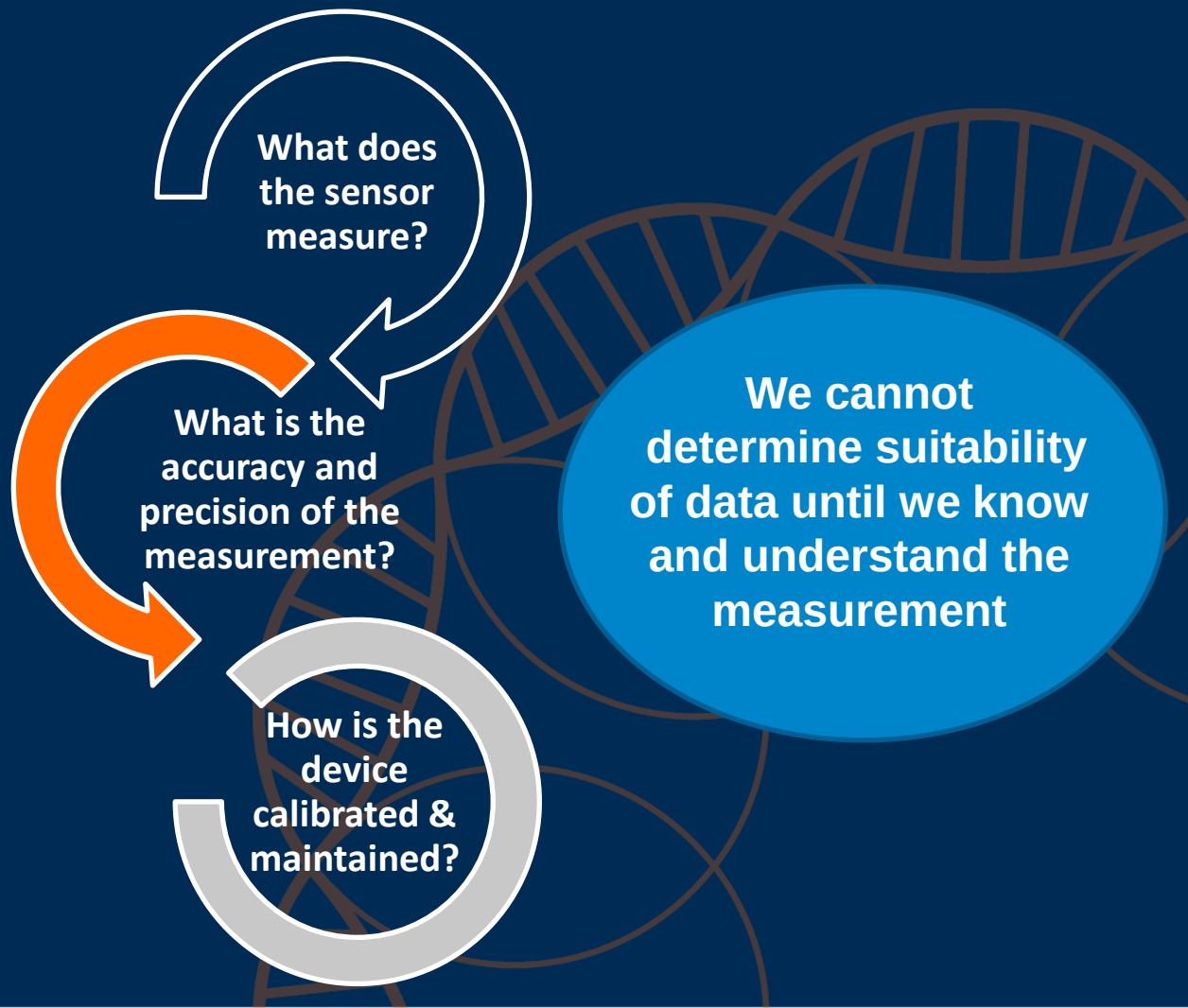
- 4D4F Third Annual Report
[<read more ...>](#)
- 4D4F Technology Warehouse
[<read more ...>](#)
- 4D4F Best Practices Guide on Sensor Devices
[<read more ...>](#)
- 4D4F Dairy Sensor Research Report
[<read more ...>](#)
- 4D4F Report on research priorities on the use of



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Reviewing Sensor Devices





THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Multiple Ways to Classify Sensor Data

Different Needs for Accuracy & Precision

Management Data

- Yield
- SCC
- Milking Speed
- Feed Efficiency

Animal Health Data

- Locomotion
- Reproduction
- Disease
- BCS/Weight

Animal Welfare Data

- Activity
- Mobility
- Eating, Resting
- Heat Stress

Data for Genetic Evaluations

Data Linked to Direct Farm Payments

- Yield
- Fat, Protein
- SCC

Alarm Data

- Heat Detection
- SCC
- Locomotion
- Location

Yes/No Data

- Pregnancy
- Disease

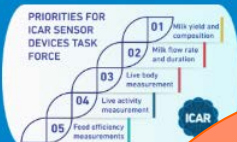
Trend Data

- BCS/Weight
- Milk Flow/Speed
- Feed Efficiency
- Eating, Resting



Sensor Devices Task Force

Priorities of the Sensor Devices Task Force

[<read more ...>](#)

Facts about the Sensor Task Force

- Members of the Sensor Device
<read more ...>
- Terms of Reference of the Sensor Force
<read more ...>
- Test Centres
<read more ...>
- Meeting of the SD TF in Zutphen
<read more ...>

ICAR Guidelines

Guidelines for Sensor Devices
are currently under
finalisation

Section 1 – General Notice for ICAI

NEWS

- Opportunities for the Sensor
<read more ...>
- Sensor presentations – ICAI
(Auckland, NZ)
<read more ...>
- Proceedings of the Precision
Conference
 - 2017 <get the file ...>
 - 2018 <get the file ...>

ICAR Sensors Overview

- File (as .xlsx) available
[<read more...>](#)

Sensor Trait Characterisation

- File (as `xlsx`) < **read**

ICAR OVERVIEW OF RECORDING AND SENSOR DEVICES AND SAMPLING SYSTEMS ON DAIRY FARMS										TRAIT ANALYSIS										Field of Application										
Manufacturer	Name Device	Purpose	Measuring principle	Accuracy & Precision tested by	ICAR certified	Conventional milking	Robotic milking	Milk weight	Sample fat (est. anal.)	Prot	Lact	Udder	Cond	SDC	Temp	Milk color	Prog	BHB	Ldlc	Body cond	Body length	Activity	Lameness	Cow position	Feed intake	Udder ratio	Udder pit	Heat	Milking, a.s. milk yield, composite	Feeding, a.s. feed uptake, roughage uptake, rumination
Alfmilk	Alf-lite	Milk recording device & sampler	volumetric/arithmetic	ICAR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Alfmilk	Alf-lite Pro	Milk recording device & sampler	volumetric/arithmetic	ICAR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Alfmilk	Affluo 2000	Milk recording device & sampler	volumetric/arithmetic	ICAR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Alfmilk	Affluo MPC	Milk recording device & sampler	volumetric/arithmetic	ICAR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Alfmilk	Affluo 9000	Milk recording device & sampler	volumetric/arithmetic	ICAR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Alfmilk	Affluo IL	Activity meter to measure the amount of activity (cow in heat)	activity sensor	Factory		x	x														x									
Alfmilk	AffluoWegh	milk volume measurement using weighing cells	load cells	Factory		x	x														x									
Alfmilk	AffluoLab	Milk compositional analysis and udder health monitoring	Fat, protein, lactose content and blood in milk (robot)	Factory		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	
Alfmilk	Smart Herdman	Activity meter to measure the amount of activity (cow in heat) with eating & rumination monitoring	activity sensor	Factory		x	x														x								x	
Agri	CowManager	Rumination monitoring, heat monitoring, position	activity sensor	Factory		x	x																		x	x	x			
Agri	AgriCam CDD-Master	Udder health monitoring	Thermal imaging	Factory																										
Agri	AgriCam CDD-Master	Milk recognition device & udder health monitoring	Thermal imaging	Factory																										
Validation criteria for trait characterization										Quantitative methods										Qualitative methods										
2	Trait	Purpose	Definition characteristics	Reference method or standard	Measurement	Method	Measurement	Quantitative/Qualitative	Units	Lower limit	Upper limit	Repeatability (CV)	Reproducibility (CV)	Accuracy (CV)	Lower limit	Upper limit														
15	Milk fat	Economic value of milk (milk payment)	Milk fat content	Gravimetry (Rose-Gottlieb, ISO 12111 (OF 1)	Milk (cow, goat, sheep, buffalo)	Mid infrared	Calculated fat content from absorbed light at specific wavelengths for milk fat in the mid-IR region	Quantitative	%m/m	1.0%	9.0%	0.014% at 4.0%	0.028% at 4.0%	0.07% at 4.0%																
16	Milk fat	Traditional milk recording	Milk fat content	Gravimetry (Rose-Gottlieb, ISO 12111 (OF 1)	Milk (cow, goat, sheep, buffalo)	Various, e.g. NIR, MIR, ultrasound	Physico-chemical characteristic related to milk fat content	Quantitative	%m/m	1.0%	9.0%	0.014% at 4.0%	0.028% at 4.0%	0.1% at 4.0%	fat	fat														
17	Milk fat	On-farm monitoring of animal production	Milk fat content	Gravimetry (Rose-Gottlieb, ISO 12111 (OF 1)	Milk (cow, goat, sheep, buffalo)	Various, e.g. NIR, MIR, ultrasound	Physico-chemical characteristic related to milk fat content	Quantitative	%m/m	1.0%	9.0%	0.014% at 4.0%	0.028% at 4.0%	0.1% at 4.0%	fat	fat														
18	Milk protein	Economic value of milk (milk payment)	Milk protein content	Titrimetry (Kjeldahl, ISO 8968 (OF 20)	Milk (cow, goat, sheep, buffalo)	Mid infrared	Calculated protein content from absorbed light at specific wavelengths for milk protein in the mid-IR region	Quantitative	%m/m	2.0%	7.0%	0.014% at 3.0%	0.028% at 3.0%	0.07% at 3.0%	protein	protein														
19	Milk protein	Traditional milk recording	Milk protein content	Titrimetry (Kjeldahl, ISO 8968 (OF 20)	Milk (cow, goat, sheep, buffalo)	Various, e.g. NIR, MIR, ultrasound	Physico-chemical characteristic related to milk protein content	Quantitative	%m/m	2.0%	7.0%	0.014% at 3.0%	0.028% at 3.0%	0.1% at 3.0%	protein	protein														
20	Milk protein	On-farm monitoring of animal production	Milk protein content	Titrimetry (Kjeldahl, ISO 8968 (OF 20)	Milk (cow, goat, sheep, buffalo)	Various, e.g. NIR, MIR, ultrasound	Physico-chemical characteristic related to milk protein content	Quantitative	%m/m	2.0%	7.0%	0.014% at 3.0%	0.028% at 3.0%	0.1% at 3.0%	protein	protein														
21	Milk lactose	Economic value of milk (milk payment)	Milk lactose content	HPLC (ISO 22642 (OF 198) or enzymatic	Milk (cow, goat, sheep, buffalo)	Mid infrared	Calculated lactose content from absorbed light at specific wavelengths for milk lactose in the mid-IR region	Quantitative	%m/m	3.0%	6.0%	0.014% at 4.5%	0.028% at 4.5%	0.07% at 4.5%	lactose	lactose														
22	Milk lactose	Traditional milk recording	Milk lactose content	HPLC (ISO 22642 (OF 198) or enzymatic (ISO 5765 (OF 79)	Milk (cow, goat, sheep, buffalo)	Various, e.g. NIR, MIR, ultrasound	Physico-chemical characteristic related to milk lactose content	Quantitative	%m/m	3.0%	6.0%	0.014% at 4.5%	0.028% at 4.5%	0.15% at 4.5%	lactose	lactose														
23	Milk lactose	On-farm monitoring of animal production	Milk lactose content	HPLC (ISO 22642 (OF 198) or enzymatic	Milk (cow, goat, sheep, buffalo)	Various, e.g. NIR, MIR, ultrasound	Physico-chemical characteristic related to milk lactose content	Quantitative	%m/m	3.0%	6.0%	0.014% at 4.5%	0.028% at 4.5%	0.15% at 4.5%	lactose	lactose														
24	Milk urea	Monitoring energy/protein balance in feeding	Milk urea content	Differential pH-method (ISO 14637 (OF 195)	Milk (cow, goat)	Various, e.g. MIR, enzymatic	Physico-chemical characteristic related to milk urea content	Quantitative	mg/100 ml	5	60	1.4 at 25 mg/100 ml	2.8 at 25 mg/100 ml	6.0 at 25 mg/100 ml																
25	Milk urea	Monitoring energy/protein balance in feeding	Milk urea content	Differential pH-method (ISO 14637 (OF 195)	Milk (cow, goat)	Various, e.g. test strips	Physico-chemical characteristic related to milk urea content	Qualitative								5														
26	BHB/ketone bodies	Signalling (risk of sub-clinical ketosis and/or acetone in milk)	Beta-hydroxybutyric acid and/or acetone in milk	Flow injection analysis or blood BHB-A?	Milk (cow)	MIR	Physico-chemical characteristic related to BHB and/or acetone content	Quantitative	mmol/L	0.0	2.0																			
27	BHB/ketone bodies	Signalling (risk of sub-clinical ketosis and/or acetone in milk)	Beta-hydroxybutyric acid and/or acetone in milk	Flow injection analysis or blood BHB-A?	Milk (cow)	Various, e.g. test strips	Physico-chemical characteristic related to BHB and/or acetone content	Qualitative								0.0														
Checklist with key questions										Validation criteria										References										



THE GLOBAL STANDARD FOR LIVESTOCK DATA

Add New Section to Guidelines

Overview of Data Use from SD Systems
Automated Animal ID & Data Capture
Data Connectivity
Data Credibility

- * Missing Data Points
- * Outlier Handling
- * Data Smoothing

Data Transfer and Usability Standards

Linked to Specific Performance Standards in
Other Sections of ICAR Guidelines.

Linked to Sensor Device/System Testing
Guidelines (Section 11)

ICAR GUIDELINES

ICAR has updated how we structure and present our Guidelines. The new format makes them easier to browse and to access your specific interests. All feedback is welcome. Please note that the content has not changed.

▼ [Section 01 - General Rules](#)

▼ [Section 02 - Cattle Milk Recording](#)

▼ [Section 03 - Beef Cattle Recording](#)

▼ [Section 04 - DNA Technology](#)

▼ [Section 05 - Conformation Recording](#)

▼ [Section 06 - AI and ET Data and Fertility Analysis](#)

▼ [Section 07 - Bovine Functional Traits](#)

▼ [Section 08 - Certificate of Quality](#)

▼ [Section 09 - Dairy Cattle Genetic Evaluation](#)

▼ [Section 10 - Identification Device Certification](#)

▼ [Section 11 - Milk Recording Devices](#)

▼ [Section 12 - Milk Analysis](#)

▼ [Section 13 - On-line Milk Analysis](#)

▼ [Section 14 - Alpaca and Goat Identification and Fibre](#)

▼ [Section 15 - Data Exchange](#)

▼ [Section 16 - Dairy Sheep and Goats](#)

▼ [Section 17 - Buffalo Milk Recording](#)

▼ [Section 18 - Breed Associations](#)



THE GLOBAL STANDARD
FOR LIVESTOCK DATA



Network. Guidelines. Certification.

Animal ID is More Important Than Ever



- The 'official ID' of an animal most likely will not be the same as ID associated with sensor measures
- Animals may have multiple IDs over their lifetime
- Animals may have multiple IDs on their body at once
- Databases will need to have protocols for ID cross-referencing and validation
- Need protocols for on-farm validation of the ID system and for data transfer/custody



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

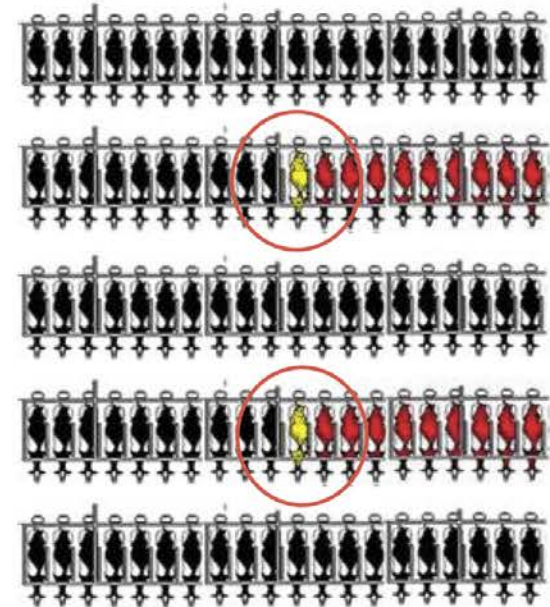
Network. Guidelines. Certification.

Reliable Data - Auto ID Systems

Example: 2x20 Parlor, ID at the entrance

ID rate 98%

- 100 cows = 5 loads
- 98% ID = 2 cows missed in 5 loads
- On average the missed cow is in mid load
Data of 10 cows is assigned to wrong cows



RESULT: DATA RELIABILITY = 80%
20 cows out of 100 assigned with wrong data



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Raw Data vs. Displayed Data vs. Usable Data

Handling of missing data points

- How are missing points estimated?
- Mean of actual data only?

Outlier handling and exclusion

Data smoothing

Range of accurate measurement for sensor

Data Precision

Evaluation of algorithm

- Test data set to send through system algorithm to validate output?
- Protecting IP must be a consideration



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

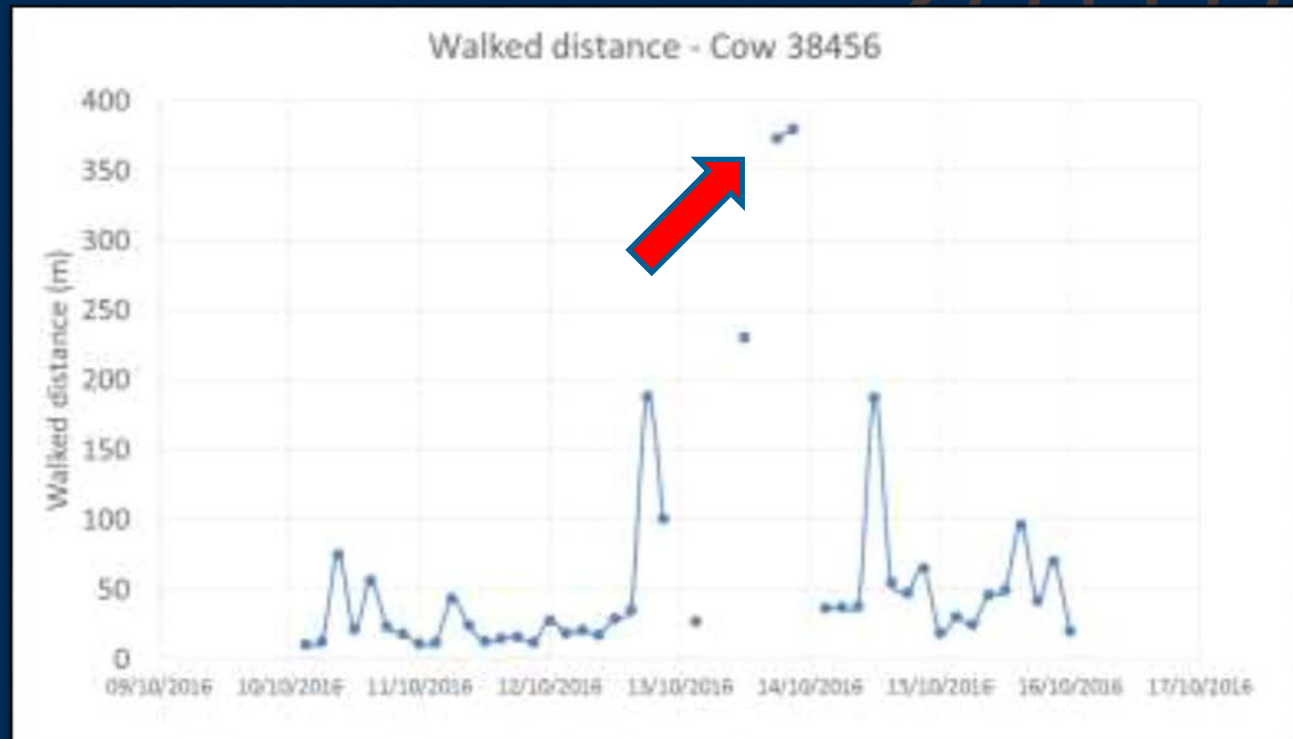
Connectivity is a Concern

How is the value
computed?

Estimations?

Mean values without
missing data?

Affects the quality of
data entering the
system





THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

How Will We Value Sensor Data?

Equivalency to Traditional Test Day Data

- Define parameters that approximate the accuracy and precision of traditional milk recording parameters like milk yield or composition

Separate Classes of Data

- Currently Supervised or Owner Sampler Test Types – will we have a test type or class for specific sensor data?

Weighting of Data

- Data collection rating system that puts relative weight on data type, collection interval, and parameters measured

Use Validated Data Directly

- New parameters may deliver data with acceptable accuracy and precision and the data is used with minimal editing

Exclusion of Certain Data

- Results from specific parameters may be deemed to be unsuitable for herd recording programs at the present time



Data Usability Standard

Includes Data Use, Species, System and Scheme along with A, R, & R

SC/WG with expertise will adopt format and provide performance standards for each trait or measurement

Brings clarity to manufacturers & MROs

Full Name	Body Condition Score
Common Abbreviation	BCS
Record Identifier Code	BCS

Type	Animal Management	Benchmarking	Genetic Evaluation
Quantitative	Yes	Yes	Yes
Qualitative	NA	NA	NA

Species	Notes/Comments
Cattle – Dairy	All life cycle stages
Cattle – Beef	All life cycle stages

System	System Code	Format
Visual Score	V or 1	a1 or i1
Camera	S or 2	a1 or i1

Schema	Schema Code	Schema Format	Data Range	Data Minimum Resolution	Data Format	Notes
Dairy Cattle (NA, UK, EU)	DC	a2	1-5	0.25	f3.2 or i3	i3 format when multiplying BCS x 100
Beef Cattle	BC	a2	1-9	1	i1	
New Zealand	NZ	a2	1-10	1	i1	

[illegible]



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Sensor Approval and Validation

- Development of ICAR guidelines for sensors
- New testing & validation protocols
- Co-innovation & cooperation with manufacturers

Routine Procedures & Best Practices

- Installation protocols
- Routine calibration and monitoring procedures
- Development of best practices for recording organizations

Guidelines for Sensor Device Testing, Approval, Calibration or Routine Checking Procedures will be added to Section 11

Draft Guidelines under Review and will be handled by RSD-SC

Target November 2019 followed by ICAR Board review and vote by General Assembly



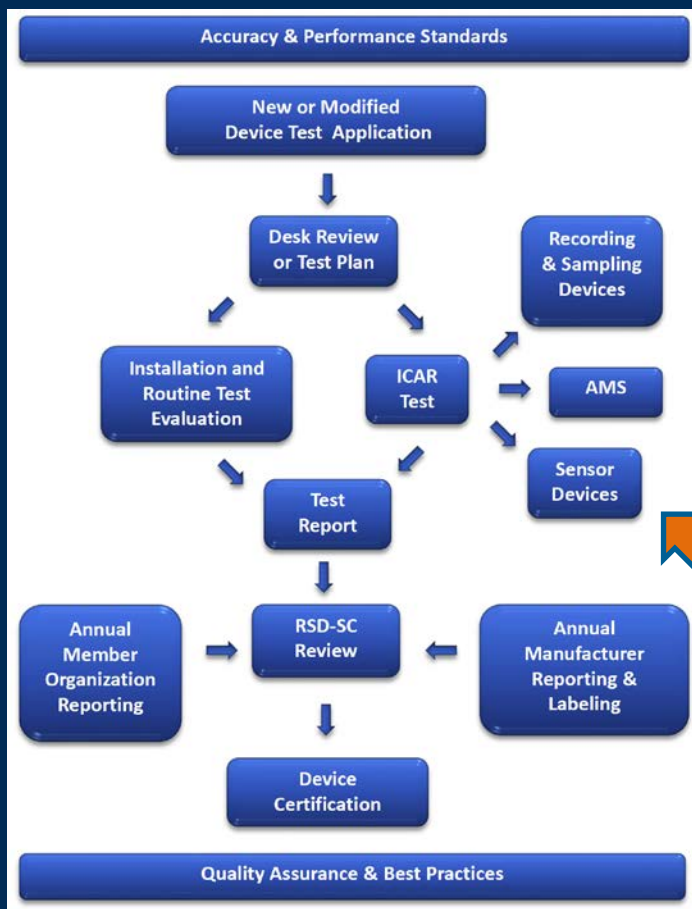
THE GLOBAL STANDARD FOR LIVESTOCK DATA



THE GLOBAL STANDARD FOR LIVESTOCK DATA

Section 11 - Guidelines for Testing, Approval and Checking of Recording and Sampling Devices List of Procedures

Revisions to Section 11



- [Overview] Guidelines for Testing, Approval and Checking of Recording and Sampling Devices
- [Procedure 1] Procedure for Application for Testing of Recording and Sampling Devices or Sensor Devices and/or Systems
- [Procedure 2] Procedure for Testing of Traditional Milk Recording and Sampling Devices
- [Procedure 3] Procedure for Testing of Automatic Milk Recording and Sampling Systems
- [Procedure 4] Procedure for Testing of Sensor Devices and/or Systems
- [Procedure 5] Procedure for Evaluation of Installation and Routine Calibration Procedures for Recording and Sampling Devices
- [Procedure 6] Procedure for Evaluation of Installation and Routine Calibration Procedures for Sensor Devices and/or Systems
- [Procedure 7] Procedure for Computerized Solutions for Periodic Checking of Recording and Sampling Devices
- [Procedure 8] Procedure for Computerized Solutions for Periodic Checking of Sensor Devices and/or Systems
- [Procedure 9] Procedure for Test-Day Practices Using Recording or Sensor Devices and Electronic Identification Simultaneously
- [Procedure 10] Procedure for Test-Day Practices for Obtaining Milk Samples on Individual Animals from Sampling Devices
- [Procedure 11] Procedure for Labeling of ICAR-Certified Devices
- [Procedure 12] Procedure for Annual Reporting of ICAR-Certified Devices in the Marketplace by Manufacturers
- [Procedure 13] Procedure for Annual Reporting of ICAR-Certified Device Usage and Satisfaction by Member Organizations
- [Procedure 14] Procedure for ICAR Certification of Devices



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

ICAR Universal Coding Systems for Devices

Development and delivery by Interbull (tentative) on behalf of ICAR

Will include traditional recording devices and sensor devices/systems

Allow for data source characterization by member organizations, data handlers and data users

In addition to device code, system would include:

- | | | |
|----------------|-------------------|---------------------------|
| -Manufacturer | -Device Name | -Other Marketplace Names |
| -Software Name | -Software Version | -Firmware (if applicable) |
| -Data measured | -ICAR Status | -ICAR Status Date |



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Network. Guidelines. Certification.

Work of SD-TF concludes at ICAR 2019 in Prague

Recording and Sampling Devices SC (RSD-SC) assumes responsibility for guidelines revisions

RSD-SC develops new testing protocols and continues manufacturer outreach

ICAR SC and WG adopt data usability standard, providing performance standards for each sensor measurement or trait

Interbull works with RSD-SC to develop and deliver universal coding system for all devices

ICAR Board to set direction with respect to appropriate level of certification, approval, verification, validation or other term for sensor devices/systems and data generated from them.

**What's
Next?**