THE GLOBAL STANDARD FOR LIVESTOCK DATA

Sensor Devices Task Force

Survey of Members and Experts

12th June. 2018

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1 Summary

ICAR conducted a survey of its members and experts to obtain their views relevant to the use of sensor data[1] in animal recording. The survey was undertaken from April to May in 2017.

The results of the survey show that a considerable amount of sensor data, related mainly to milking, was being used in 2016 and that substantial growth in both volume and types of data is expected by 2022. However, there are many organisations not currently using or planning to use sensor data.

Growth in the use of sensor data is being constrained by a range of technical, quality and economic factors. These are partially quantified by the survey results.

The survey results identify that ICAR has an important role to play in both establishing guidelines for the use of sensor data and in testing and certifying sensor devices.

ICAR's Sensor Devices Task Force commissioned the survey and has used to results to establish priorities for its work.

2 Background

ICAR established the Sensor Devices Task Force (SD-TF) in 2016. The SD-TF decided it needed better information on the opinions of a range of stakeholders and commissioned a survey to be conducted to gather this data.

The purpose of the survey was to provide the SD-TF with information on the:

- current use of sensor data,
- rate at which usage of sensor data is expected to increase in the future,
- relevance of the data collected by sensor devices,
- obstacles to the use of sensor data,
- role of ICAR in the field of sensor devices and sensor data for animal recording.

The range of stakeholders included ICAR members, manufacturers of sensor devices and experts involved in all aspects of animal recording. The design of the survey is described in more detail in the following section.

The SD-TF used the results of the Survey to determine priorities for its work (refer to section 5 Conclusions).

[1] Defined as *data gathered automatically by devices attached to the animal or in-line during milking/handling/measuring*.

3 Survey Design

The survey was conducted using SurveyMethods[2] in two parts: survey of ICAR members and manufacturers (Members), and a survey of member of ICAR Groups (Experts). The purpose of this breakdown was to gather the opinions of those organizations actively involved in making and using sensor devices (ICAR members and manufacturers) separately from information on the opinions of experts (members of ICAR Groups) in the use of sensor data for genetic evaluation and other purposes.

3.1 Survey of ICAR Members

The full list of questions asked of ICAR members and Manufacturers is given in Appendix 1. The questions covered the following:

- The amount of sensor data gathered and processed by your organisation in 2016 on a range of animal related traits (Q 1 and Q2).
- The amount of sensor data you expect to be gathered and processed by your organisation in 2022 on the same range of animal related traits (Q3 and Q4).
- The extent to which you agree or disagree with a range of statements related to your organisations current involvement with sensor devices, accuracy of sensor devices and factors limiting the uptake of sensor devices (Q5).
- The extent to which you agree or disagree with a range of statements related to the challenges of using sensor devices (Q6 and Q7).
- The extent to which you agree or disagree with a range of statements related to the role of ICAR in relation to sensor data (Q8).
- Activities which your organisation is involved in (Q9).
- Details of the respondent (Q10).

A link to this survey was emailed to all ICAR members (full and associate) and manufacturers on the ICAR contacts database in April 2017.

68 responses were received by late May of 2017, representing a response rate of some 50%.

Responses were analyzed using the statistical tools provided by SurveyMethods[1] and presented to the SD-TF at its meeting in Edinburgh in June 2017.

3.2 Survey of Experts

The full list of questions asked of ICAR Group members (experts) is given in Appendix 2. The questions covered the following:

- The relevance of sensor data on a range of animal traits to the ICAR Group(s) you are a member of (Q1 and Q2).

[2] Surveymethods.com - https://surveymethods.com.

- How widespread you think data gathered by automatic sensors will be in 2022 (Q3 and Q4).
- The extent to which you agree or disagree with a range of statements related to your organisations current involvement with sensor devices, accuracy of sensor devices and factors limiting the uptake of sensor devices (Q5).
- The extent to which you agree or disagree with a range of statements related to the challenges of using sensor data (Q6 and Q7).
- The extent to which you agree or disagree with a range of statements related to the role of ICAR in relation to sensor data (Q8).
- The ICAR Group(s) you are involved in (Q9).
- Details of the respondent (Q10).

A link to this survey was emailed to all members of ICAR Groups (some 170 people) and on the ICAR contacts database in April 2017.

120 responses were received by late May of 2017, representing a response rate of some 70%.

Responses were analyzed using the statistical tools provided by SurveyMethods[1] and presented to the SD-TF at its meeting in Edinburgh in June 2017.

4 Results and Discussion

4.1 Current (2016) Sensor Data Collection and Processing (Q1 Members)

The amount of sensor data currently being collected and processed by ICAR members is summarized in Table 1, which is ordered from the traits with the greatest number of total observations[3] to those with the least number of observations.

The key points from Table 1 are:

- Many respondents are not currently collecting sensor data – from 63% for *milk flow rate* to 96% for *heart rate.*
- Most current sensor data relates to milking – *flow rate, milking time and milk volume at every milking* – followed by heat detection related measures – *heat detection, movement and standing time*.
- There is a substantial amount of sensor device data currently being collected for the full range of traits under consideration albeit, in some cases, by a small number of organisations.

[3] Computed as the sum over all ranges in observation numbers, of the lowest number in each range times the number of organisations in the range.

Table 1. Current sensor data collection and processing. Columns headed "none" to the column headed "Total Resp." contain the number of responses for each option.

Data	% respondents with none	Est. Total Observations	None	1 to 1,000	1,000 to 10,000	10,000 to 100,000	100,000 to 1,000,000	> 1,000,000	Total Resp.
Milk flow rate	63%	10,562,002	42	2	2	6	5	10	67
Milking time	66%	9,552,002	44	2	2	5	5	9	67
Milk volume for every milking	67%	9,543,001	44	1	3	4	5	9	66
Heat detection	66%	7,047,005	44	5	7	4	0	7	67
Movement (steps)	71%	6,344,002	47	2	4	4	3	6	66
Standing or resting time	76%	5,232,004	50	4	2	3	2	5	66
Live-weight	78%	5,224,002	52	2	4	2	2	5	67
Feed intake	74%	4,353,002	49	2	3	5	3	4	66
Eating or chewing	82%	3,230,004	54	4	0	3	2	3	66
Rumination	83%	3,031,004	55	4	1	3	0	3	66
In line milk composition	81%	2,413,003	54	3	3	1	4	2	67
Body condition	91%	2,112,000	61	0	2	1	1	2	67
Teat placement	89%	2,011,003	59	3	1	1	0	2	66
Body temperature	83%	1,013,006	55	6	3	1	0	1	66
Location by GPS	83%	134,003	55	3	4	3	1	0	66
Methane emissions	95%	10,002	63	2	0	1	0	0	66
Heart rate	96%	10,002	64	2	0	1	0	0	67

4.2 Future (2022) Sensor Data Collection and Processing (Q3 Members)

The amount of sensor data expected to be collected and processed in 2022 (five years time) is summarized in Table 2 which is ordered from the traits with the greatest number of estimated total observations[4] to those with the least number of estimated total observations.

Table 2. Projected future (2022) sensor data collection and processing. Columns headed "none" to the column headed "Total Resp." contain the number of responses for each option.

Data	% respondents with none	Est. Total Observations	None	1 to 1,000	1,000 to 10,000	10,000 to 100,000	100,000 to 1,000,000	> 1,000,000	Total Resp.
Milk volume for every milking	46%	14,775,002	30	2	5	7	7	14	65
Milking time	45%	14,758,002	29	2	8	5	7	14	65
Milk flow rate	48%	14,747,002	31	2	7	4	7	14	65
Heat detection	46%	13,595,003	30	3	5	9	5	13	65
Movement (steps)	51%	10,676,003	33	3	6	7	6	10	65
Standing or resting time	58%	10,555,002	38	2	5	5	5	10	65
Body temperature	65%	8,247,002	42	2	7	4	2	8	65
Feed intake	54%	7,776,003	35	3	6	7	7	7	65
Rumination	65%	7,355,003	42	3	5	5	3	7	65
Live-weight	55%	7,350,006	36	6	10	4	3	7	66
Eating or chewing	68%	7,146,003	44	3	6	4	1	7	65
In line milk composition	58%	6,459,003	38	3	9	5	4	6	65
Body condition	62%	6,368,002	40	2	8	6	3	6	65
Location by GPS	67%	5,266,003	44	3	6	6	2	5	66
Heart rate	77%	3,152,004	50	4	2	5	1	3	65
Teat placement	69%	3,138,005	45	5	8	3	1	3	65
Methane emissions	77%	2,224,005	50	5	4	2	2	2	65

[4] Computed as the sum over all ranges in observations numbers, of the lowest number in each range times the number of organisations in the range.

The key points from Table 2 are:

- Fewer, but still a substantial percent – varying from 45% for *milking time* to 77% for *methane emissions* and *heart rate* – of the responding organisations do not expect to be collecting and processing sensor data in 2022.
- The amount of sensor data collected and processed is expected to grow substantially in the next six years (2016 to 2022) across the full range of traits including some of the hard to measure traits such as *feed-intake* and *methane emissions* albeit still involving a relatively small number of organisations.

4.3 Other types of Sensor Data Currently Collected and Processed (Q2 and Q4 Members)

Both of these questions (Q2 and Q4 Members) had free form answers and were analyzed by reading the responses and recording the number of times each type of data was mentioned.

The other types of sensor data currently collected (Q2 Members), or under consideration for the future (Q4 Members) and number of mentions for each is given in Table 3.

Table 3. Other types of sensor data currently being collected (Q2 Mentions for 2016) or planned for the future (Q4 Mentions for 2022).

Data	Mentions for 2016	Mentions for 2022
Animal ID at 3-4 meters		1
Bite rate		1
Carcass grade		1
Conductivity of milk	5	
Confidential		1
Grazing	1	
Hyperspectral data from abattoirs		1
Idle time	2	
IgG level in colostrum	1	
In line milk composition		3
Lameness	1	1
Liveweights		1
Lying time	2	
Meat sensory data		1
Milk flow rate	1	
Milk temperature	3	
Milking vacuum	1	
Mobility		1
Real time location	1	
Respiration rate	1	
Rumination	1	
Saturated and unsaturated fatty acid	1	
Walking time	2	
Weather		1

The key points from Table 3 are:

- Organisations are thinking about animal sensor data that can be collected automatically at other locations – *abattoir and milk test laboratory*.
- *Conductivity of milk* and *milk temperature* are traits that should be added to the list of traits of interest to the SD-TF.
- Organisations are thinking about sensor devices collecting environmental data – *weather*.
- One organisation prefers to keep *confidential* the traits they are interested in.
- The list of traits relating to animal activity is not well defined and covers potentially a range of activities – *bite rate, grazing, idle time, lying time, rumination, and walking time.*

4.4 Relevance of Traits – Experts Opinions (Q1 Experts)

The experts (in Q1 Experts) were asked to indicate the relevance of the sensor data traits to the work of the ICAR Group(s) they belong to. The results are given in Table 4.

The key points from Table 4 are:

- The experts give high relevance to the milk production traits (*milk volume for every milking, in line milk composition, milk flow rate, milking time*), the metabolic traits (*feed intake, live weight, body condition*) and reproduction (*heat detection*).
- They see low relevance for *heart rate*, and *location by GPS.*

Table 4. Percent of very relevant plus relevant as scored by Experts (Q1).

Data	Very relevant plus relevant
Milk volume for every milking	80%
Feed intake	78%
Heat detection	75%
In line milk composition	70%
Live-weight	70%
Body condition	69%
Movement (steps)	65%
Milk flow rate	64%
Milking time	57%
Body temperature	56%
Methane emissions	53%
Rumination	52%
Standing or resting time	50%
Eating or chewing	47%
Teat placement	47%
Location by GPS	38%
Heart rate	31%

4.5 Growth in Sensor Data – Experts Opinions (Q3 Experts)

The experts were asked to indicate how widespread they thought sensor data would be in five years time (2022) and were provided with a number of options to select from for each trait. The results are given in Table 5.

The key points arising from Table 5 are:

- The experts, like the members foresee substantial growth in all types of sensor data over the next five years. 85% see *heat detection* from sensor devices increasing by 20% to orders of magnitude. For *heart rate,* the trait with the least gain 53% of the expert foresee growth of 20% to orders of magnitude.
- The milk traits (*milk volume at every milking, in line milk composition*) are assessed as having substantial growth in the next five years.
- Substantial growth is also predicted for the metabolic traits (*live weight, body condition, feed intake, and methane emissions*).
- Very few experts see the amount of sensor data staying the same or declining in the next five years (to 2022).
- Some (7 to 20 out of 118) experts see orders of magnitude (*Plus 1000%*) increases for each of the sensor data traits in the next five years (to 2022).

Table 5. Growth in sensor data as assessed by experts sorted on Grow 20% to orders of magnitude. The table cells for the columns headed Less than now (minus) *to* Total are the number of experts that selected the relevant option.

Data	Grow 20% to orders of magnitude	Less than now (minus)	No change from now	Plus 20%	Plus 100%	Plus 1000%	No opinion	Total
Heat detection	84%	2	10	38	44	17	7	118
Milk volume for every milking	78%	2	12	46	37	9	12	118
Live-weight	77%	2	19	57	27	7	6	118
In line milk composition	76%	0	15	45	38	7	13	118
Movement (steps)	76%	2	15	44	39	7	11	118
Body condition	74%	2	21	46	35	6	8	118
Feed intake	72%	2	23	58	19	8	8	118
Methane emissions	70%	1	22	50	28	5	12	118
Standing or resting time	69%	0	25	48	32	2	11	118
Location by GPS	69%	0	23	44	26	11	14	118
Milk flow rate	69%	2	18	41	32	8	17	118
Milking time	69%	0	21	41	32	8	16	118
Eating or chewing	68%	0	26	53	24	3	12	118
Rumination	68%	0	25	45	29	6	13	118
Body temperature	65%	0	30	45	27	5	11	118
Teat placement	56%	3	31	37	26	3	18	118
Heart rate	53%	1	34	44	15	4	20	118

4.6 Other Data – Experts (Q2 and Q4 Experts)

The experts were asked to identify other traits that should be added to the list of relevant current traits (Q2 Experts) and similarly for projected future traits (Q4 Experts). Both of these questions had free form answers and were analyzed by reading the responses and recording the number of times each type of data was mentioned. The results are summarized in Table 6.

The key points arising from Table 6 are:

- There are many other traits that need to be considered.
- Other sources of sensor data should also be considered including: *milk testing laboratories* and *slaughter factories*.
- There are a number of metabolites and hormones which have been identified as potentials for sensor detection – *acute phase proteins, hormone levels, ketone bodies, LDH in milk, progesterone, rumen pH, and urea.*
- The use of camera gathered and GPS[5] is envisaged – *body volume, camera detected behaviour, counting of animals, proximity of animals for mating and calving, type scores.*

Table 6. Other traits identified by experts with count of mentions for now (2016) and future (2022).

Data	Mentions for 2016	Mentions for 2022
Acute phase proteins	1	
Automatic milk sampling	1	1
Body measures	1	
Body volume	1	
Calving time	1	1
Camera detected behaviour		1
Carcass conformation	2	1
Carcass fatness	2	1
Carcass weight	2	1
Claw health	1	
Climatic variations	1	
Conductivity	1	
Counting of animals	1	1
Drinking behaviour	1	
Health	1	2
Hormone levels	3	1
Image analysis	1	
Ketone bodies	1	
Lameness	4	5
LDH in milk	2	
Mastitis		1
MIR profiles	1	
Movement-acceleration	1	
Number of foetuses		1
Nutrient composition	1	
Pasture utlisation	1	
Pregnacy		1
Progesterone	3	
Proximity for mating and calving	2	
Quarter bacteria	1	1
Ruminal temperature	1	1
Rumen pH	6	1
Somatic cell counts	3	2
Traceability	2	
Type scores	1	
Urea	1	
Water consumption	2	1

4.7 Members – Agree or Disagree (Q5 Members)

The members were provided with a list of statements and asked to indicate the extent to which they agreed or otherwise (five options – strongly agree, agree, neutral, disagree, or strongly disagree and also able to indicate "no opinion"). The results are summarized in Table 7.

The key points arising from Table 7 are:

- 52% of the responding organisations are actively developing sensor devices for animal recording.
- 49% of the responding organisations believe that the currently available sensor devices for motion/temperature/heart rate measurement provide data very relevant to them.
- 48% of respondents are servicing sensor devices.

[5] Global positioning system.

- 46% of respondents are actively marketing sensor devices for animal recording.
- 42% of respondents believe that at the current rate of progress animal attached sensor devices for motion/temperature/heart rate measurement will become widespread on the farms serviced by them.
- 41% agree that the current in line milk composition sensor devices are not sufficiently accurate for use in milk recording. 16% disagree while 31% have no opinion.
- Opinion on the speed with which in line milk meters will replace traditional milk recording is divided – 25% believe this will happen within five years, 33% disagree and 26% have no opinion.
- 38% of respondents believe current in line milk meters are sufficiently accurate for milk recording while 23% believe they are not and 23% have no opinion.
- The relatively high % with *no opinion* points to a potential knowledge deficit which should be considered by the SD-TF in deciding future priorities.

Table 7. Response to each of eight statements. The second column is a short statement which has been added to aid clarity of the results. The first column contains the full statement. In the interest of space the responses for strongly agree and agree were aggregated as were those for disagree or strongly disagree.

Statement	Short Statement	Strongly agree or agree	Disagree or strongly disagree	No opinion %
My organisation is actively developing sensor devices for animal recording.	Actively developing	52%	25%	11%
The currently available animal attached sensor devices for motion/temperature/heart rate measurement provide data very relevant to my organisation.	Current sensors provide valuable data	49%	10%	18%
My organisation is actively servicing sensor devices for animal recording.	Actively servicing	48%	25%	11%
My organisation is actively marketing sensor devices for animal recording.	Actively marketing	46%	21%	11%
At the current rate of progress animal attached sensor devices for motion/temperature/heart rate measurement will become widespread on the farms serviced by my organisation.	Widespread in future	42%	8%	20%
The current in line milk composition sensor devices are not sufficiently accurate for use in milk recording.	Milk composition sensors not accurate enough	41%	16%	31%
At current rate of progress in line milk meters will replace traditional milk recording within five years.	Replace traditional milk recording in five years	25%	33%	26%
The current in line milk meters are not sufficiently accurate for use in milk recording.	In line milk volume measurement not accurate enough	23%	38%	23%

4.8 Experts – Agree or Disagree (Q5 Experts)

The experts were asked to respond to five and the eight statements put to the members (in Q5 Members). The results are given in Table 8.

The key points arising from Table 8 are:

- The experts have a similar view to members on the current in line milk composition devices. A clear majority (48%) agree they are not accurate enough while a substantial percentage (29%) have no opinion pointing to a potential knowledge gap.
- The experts have a similar view to members and manufacturers on the current in line milk meters with 43% of the view they are sufficiently accurate for use in milk recording and 18% believe they are not. 20% had no opinion.
- Opinion is evenly divided on if *at current rate of progress in line milk meters will replace traditional milk recording*. A not dissimilar result to that from the members and manufacturers.
- The experts are of the view that the currently available sensor devices for motion/temperature/heart rate measurement provide very relevant data (47%) and will become widespread (46%) in the farms serviced by their organisation. This result is similar to that of the members.

Table 8. Experts responses to statements relating to sensor devices. The second column is a short statement which has been added to aid clarity of the results. The first column contains the full statement. In the interest of space the responses for strongly agree and agree were aggregated as were those for disagree or strongly disagree.

Statement	Short Statement	Strongly agree or agree	Disagree or strongly disagree	No opinion %
The current in line milk composition sensor devices are not sufficiently accurate for use in milk recording.	Milk composition sensors not accurate enough	48%	8%	29%
The currently available animal attached sensor devices for motion/temperature/heart rate measurement provide data very relevant to my organisation.	Very relevant physiological devices	47%	8%	17%
At the current rate of progress animal attached sensor devices for motion/temperature/heart rate measurement will become widespread on the farms serviced by my organisation.	Physiological devices will be widespread	46%	10%	17%
At current rate of progress in line milk meters will replace traditional milk recording within five years.	Replace traditional milk recording in five years	29%	29%	18%
The current in line milk meters are not sufficiently accurate for use in milk recording.	In line milk volume measurement not accurate enough	18%	43%	20%

4.9 Challenges to use of data from Sensor Devices (Q6 Members and Q6 Experts)

The members and experts were given the same statements in relation to challenges in the use of sensor data. The results from the two surveys have been combined and are presented in Table 9.

The key points arising from Table 9 are:

- The members and manufacturers have a similar views on the relative importance of the four challenges identified.
- The biggest of the four challenges is *maintaining an automatic electronic connection between the sensor devices and recording databases*.
- The next two are *the risk of linking to the wrong animal* and *the risk of data alteration*.
- Experts see the *risk of linking to the wrong animal* as somewhat less than do the members.
- The issue of battery capacity is the lowest challenge.

Table 9. Challenges to the use of data from sensor devices combined results for member with those of the experts. The second column is a short statement which has been added to aid clarity of the results. The first column contains the full statement. In the interest of space the responses for strongly agree and agree were aggregated as were those for disagree or strongly disagree.

		Members and Manufacturers			Experts		
Statement	Challenge	Strongly agree or agree	Disagree or strongly disagree	No opinion	Strongly agree or agree.	Disagree or strongly disagree.	No opinion.
Creating and maintaining an automatic electronic connection between sensor devices and recording databases remains a major challenge.	Connection to databases	63%	14%	8%	75%	10%	10%
Linking the data from a sensor device with the correct animal in the recording database is a problem that has been well solved.	Risk of linking to wrong animal	44%	20%	12%	34%	28%	10%
There are substantial risks to the data collected by a sensor device being transferred unaltered to the recording database.	Risk of data alteration	42%	25%	14%	40%	14%	18%
Battery capacity in sensor devices is not sufficient to support the required frequency of transmitting sensor data.	Battery capacity	22%	31%	25%	21%	12%	34%

4.10 Other Obstacles to use of Sensor Data (Q7 Members and Q7 Experts)

The question asked was *what other challenges do you see to using sensor data*. The free form answers and were analyzed by reading the responses, categorizing them and recording the number of times each was mentioned by members (Q7 Members) or experts (Q7 Experts). The results are summarized in Table 10.

The key points from Table 10 are:

- The biggest issues are the lack of standards for data transfer from sensor devices to central databases and issues of data ownership.

- Accuracy, including maintenance of accuracy over time and farms, is identified as an obstacle to the uptake of sensor devices for collecting animal recording data.

- There are concerns around the filtering, data editing and data transformation that can or does occur before data transfer to central databases. These changes to the data might be known or not known by the central database.

- Funding, cost to farmers and models for ensuring costs are shared between beneficiaries is seen as an obstacle to the use of sensor data.

Table 10. Other challenges to using sensor data. Number mentions by members and experts sorted by the total number of mentions.

Other Challenges to Using Sensor Data	Mentions - Members	Mentions - Experts	Total
Standards for data transfer from sensors to database	3	7	10
Ownership of data collected via sensors	4	4	8
Cost for the farmer	3	2	5
Accuracy	1	3	4
Converting raw data to useful information	1	3	4
Accuracy of sensor maintained over time	1	2	3
Data transformed by proprietary algorithms pre transfer	1	2	3
Timely feedback		3	3
Big data analysis	1	1	2
Data filtering pre transfer		2	2
Existing production system	1	1	2
Free flow of sensor data	2		2
Funding models		2	2
Information to farmer in an easire to use way	2		2
Manufacturers shielding use of the data	1	1	2
Sensor env. (dirt, air quality, temperature, moisture)	2		2
Animal identification		1	1
Data tampering pre transfer		1	1
Data transparency		1	1
Providers of sensors must be involved with ICAR	1		1
Farmers not using the available data	1		1
Interpretation of sensor data	1		1
Legislation restricting use of the data	1		1
Life time	1		1
Missing data - eg single milkiings in 2x and 3x		1	1
Multiple uses of the same data	1		1
Resolution	1		1
Robotic sensors not ICAR approved	1		1
Sensor calibration between herds		1	1
Suitable sensor for recording feed intake at pasture		1	1

4.11 The Role of ICAR (Q8 Members and Q8 Experts)

The members were given the same statements in relation to the role of ICAR in the use of sensor data as the experts. The results have been combined and are presented in Table 11.

The key points arising from Table 11 are:

- There is very strong support for ICAR to test and certify sensor devices. 78% of members and 90% of experts agree or strongly agree that *ICAR should test and certify sensor devices in concordance with ICAR guidelines (existing and under development) and report the evaluation.*

- There is uniformly strong support for ICAR developing guidelines for the use of sensor data for: quality assurance, animal health and welfare, farm management and genetic evaluations.

- 66% to 68% of members and 78% to 86% of experts agree or strongly agree that *ICAR should be proactive in establishing guidelines for the use of data from sensor devices:*
  - for PRODUCT QUALITY ASSURANCE (including traceability),
  - for decisions on ANIMAL HEALTH & WELFARE,
  - for FARM MANAGEMENT DECISIONS, and
  - for GENETIC EVALUATIONS.

Table 11. The role of ICAR in relation to sensor devices. Combined results for members and manufactures with those of the experts. The second column is a short statement which has been added to aid clarity of the results. The first column contains the full statement. In the interest of space the responses for strongly agree and agree were aggregated as were those for disagree or strongly disagree.

		Members and Manufacturers			Experts		
Statement	Role of ICAR	Strongly agree or agree	Disagree or strongly disagree	No opinion %	Strongly agree or agree.	Disagree or strongly disagree.	No opinion %.
ICAR should test and certify sensor devices in concordance with ICAR guidelines (existing and under development) and report the evaluation.	Test and certify	78%	2%	8%	90%	1%	4%
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for PRODUCT QUALITY ASSURANCE (including traceability).	Guidelines for use of data in quality assurance	68%	3%	8%	78%	5%	4%
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for decisions on ANIMAL HEALTH & WELFARE.	Guidelines for use of data in animal health and welfare	68%	8%	7%	82%	2%	3%
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for FARM MANAGEMENT DECISIONS.	Guidelines for data use in farm management	68%	7%	7%	86%	4%	3%
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for GENETIC EVALUATIONS.	Guidelines for use of data in genetic evaluations	66%	7%	7%	85%	3%	3%

4.12 Activities of members (Q9 Members)

Members were asked to indicate the activities they are involved in. The % involved in each activity is given in Table 12 and other specified activities are given in Table 13.

Key points arising from Table 12 and Table 13 are:

- The full range of activities undertaken by ICAR's members, full and associate, is well represented amongst respondents.

Table 12. Activities which members and manufacturers are involved in.

Activity	%
Artificial insemination data	29
Database operations	19
Equipment manufacturing	36
Genetic evaluation	24
Herdbook data	19
If other, please specify	20
Milk analysis	27
Milk recording	19
No answer	10
Quality assurance	19

- Manufacturers are well represented.
- Other activities represented included advisory services and animal identification.

Table 13. Other specified activities.

Other specified
Advisory services
Animal identification
Automation in laboratories
EID animal temperature sensing
Identification and registration
Knowledge transfer
RFID (radio frequency identification)
Tracking and tracing
Umbrella organisation for genetic improvement

4.13 ICAR Groups involved with (Q9 Experts)

The expert respondents were asked to indicate the ICAR Groups they members of. The number involved in each identified Group is given in Table 14 and other specified Groups are given in Table 15.

The key points arising from Table 14 and Table 15 are:

- All of the current ICAR Groups are well represented amongst the expert respondents.
- A number of closed groups – Accuracy Task Force, Developing Countries, and Animal Fibre are represented.
- The ICAR Board should have been included in the list of ICAR Groups for the sake of completeness.

Table 14. Expert respondent membership of ICAR Groups.

Group	Number
Animal Data Exchange Working Group:	6
Animal Identification Sub Committee:	6
Artificial Insemination and R.T. Working Group:	4
Breed Association Working Group:	5
Conformation Recording Working Group:	5
Dairy Cattle Milk Recording Working Group:	9
DNA Working Group:	7
Feed & Gas Working Group:	13
Functional Traits Working Group:	9
Global Reach Working Group:	5
If other, please specify:	16
Interbeef Working Group:	16
Interbull & ICAR Operations Task Force:	2
INTERBULL Sub Committee:	11
Milk Analysis Sub Committee:	7
No Response	12
PSE-ITF Task Force:	2
Recording & Sampling Devices Sub Committee:	14
Sensor Devices Task Force:	8
Sheep Goat and Small Camelid Working Group:	7
Total	164

Table 15. Other specified ICAR Groups.

Other Specified ICAR Groups
Accuracy Task Force
Animal Care
Certificate of Quality Expert Advisory Grouo
Developing Countries
Animal Welfare
Gas and Feed
Animal Fibre
ICAR Board

4.14 Overlap in Respondents between Members and Experts

An analysis of the email addresses provided by the respondents to each survey found two email addresses in common out of the 50 member and 108 expert respondents, who provided email addresses. On this basis is can be concluded that the respondents for the two surveys were independent of each other.

5 Conclusions

- The survey sample is sufficiently representative of the views of the ICAR community and stakeholders for the results to be used in making decisions on priorities and work plans by the SD-TF.
- A wide range of relevant animal recording data is currently (2016) being gathered by sensor devices.
- The amount of relevant animal recording data gathered by sensor devices is expected to increase substantially in the next five years (by 2022).
- There are a wide number of obstacles to the use of data from sensor devices which need to be addressed if the full potential value of the data is to be realised.
- The future role of ICAR includes device testing, device certification, and preparation of guidelines for the use of animal recording data collected by sensor devices for use in quality assurance, farm management, health & welfare and genetic evaluations.
- The amount of effort required of ICAR to deliver on the roles identified is far too much for the current resources allocated to allow for a speedy delivery. The SD-TF needs to clearly identify and communicate the priority topics and it should focus on ensuring delivery on these in the immediate future.
- ICAR needs some initial successes to demonstrate that it has the ability to help its members deal with the challenges presented by the potential rapid change resulting from developments in sensor devices.
- The SD-TF has considered the results of the survey and concluded that the trait priority should be:
  - Milk yield and composition
  - Milk flow rate and duration
  - Live Body Measurements (Condition Score, Weight)
  - Live Activity Measurements (Rumination, Eating, Walking)
  - Feed Efficiency Measurements (Intake, Methane, Temperature)

12th June, 2018

Reference: SD-TF Survey 2017 v2.docx

ICAR Sensor Devices Survey

* 1. Please indicate the amount of sensor data (data gathered automatically by devices attached to the animal or in-line during milking/handling/measuring) processed by your organisation in 2016.

	None	1 to 1,000 observations	1,000 to 10,000 observations	10,000 to 100,000 observations	100,000 to 1,000,000	Greater than 1,000,000 observations
Live-weight	m	m	m	m	m	m
Body condition	m	m	m	m	m	m
In line milk composition	m	m	m	m	m	m
Milk volume for every milking	m	m	m	m	m	m
Milk flow rate	m	m	m	m	m	m
Milking duration (milking time)	m	m	m	m	m	m
Body temperature	m	m	m	m	m	m
Feed intake	m	m	m	m	m	m
Methane emissions	m	m	m	m	m	m
Rumination	m	m	m	m	m	m
Eating or chewing	m	m	m	m	m	m
Heart rate	m	m	m	m	m	m
Standing or resting (time)	m	m	m	m	m	m
Movement (steps)	m	m	m	m	m	m
Location (by GPS)	m	m	m	m	m	m
Heat detection (intensity of activity at oestrus)	m	m	m	m	m	m
Teat placement	m	m	m	m	m	m

2. What other types of sensor data does your organisation process now?

_____

_____

_____

_____

* 3. Please indicate the amount of data gathered by automatic sensors you expect to be processed by your organisations in five years time (2022).

	None	1 to 1,000 observations	1,000 to 10,000 observations	10,000 to 100,000 observations	100,000 to 1,000,000	Greater than 1,000,000 observations
Live-weight	m	m	m	m	m	m
Body condition	m	m	m	m	m	m
In line milk composition	m	m	m	m	m	m
Milk volume for every milking	m	m	m	m	m	m
Milk flow rate	m	m	m	m	m	m
Milking duration (milking time)	m	m	m	m	m	m
Body temperature	m	m	m	m	m	m
Feed intake	m	m	m	m	m	m
Methane emissions	m	m	m	m	m	m
Rumination	m	m	m	m	m	m
Eating or chewing	m	m	m	m	m	m

Heart rate	m	m	m	m	m	m
Standing or resting (time)	m	m	m	m	m	m
Movement (steps)	m	m	m	m	m	m
Location (by GPS)	m	m	m	m	m	m
Heat detection (intensity of activity at oestrus)	m	m	m	m	m	m
Teat placement	m	m	m	m	m	m

4. What other types of sensor data do you expect your organisation will process in the next five years?

_____

_____

_____

_____

* 5. Please indicate the extent to which you agree or disagree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion
My organisation is actively developing sensor devices for animal recording.	m	m	m	m	m	m
My organisation is actively marketing sensor devices for animal recording.	m	m	m	m	m	m
My organisation is actively servicing sensor devices for animal recording.	m	m	m	m	m	m
The current in line milk meters are not sufficiently accurate for use in milk recording.	m	m	m	m	m	m
The current in line milk composition sensor devices are not sufficiently accurate for use in milk recording.	m	m	m	m	m	m
At current rate of progress in line milk meters will replace traditional milk recording within five years.	m	m	m	m	m	m
The currently available animal attached sensor devices for motion/temperature/heart rate measurement provide data very relevant to my organisation.	m	m	m	m	m	m
At the current rate of progress animal attached sensor devices for motion/temperature/heart rate measurement will become widespread on the farms serviced by my organisation.	m	m	m	m	m	m

* 6. Please indicate the extent to which you agree or disagree with the following statements relating to the challenges in using sensor data.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion
Creating and maintaining an automatic electronic connection between sensor devices and recording databases remains a major challenge.	m	m	m	m	m	m
Linking the data from a sensor device with the correct animal in the recording database is a problem that has been well solved.	m	m	m	m	m	m
There are substantial risks to the data collected by a sensor device being transferred unaltered to the recording database.	m	m	m	m	m	m
Battery capacity in sensor devices is not sufficient to support the required frequency of transmitting sensor data.	m	m	m	m	m	m

7. What other challenges do you see to using sensor data?

_____

_____

_____

_____

* 8. What role should ICAR play? Please indicate the extent to which you agree or disagree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for FARM MANAGEMENT DECISIONS.	m	m	m	m	m	m
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for GENETIC EVALUATIONS.	m	m	m	m	m	m
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for decisions on ANIMAL HEALTH & WELFARE.	m	m	m	m	m	m
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for PRODUCT QUALITY ASSURANCE (including traceability).	m	m	m	m	m	m
ICAR should test and certify sensor devices in concordance with						

ICAR guidelines (existing and under development) and report the evaluation.	m	m	m	m	m	m

* 9. Please indicate the activities which your organisation is involved in

q Milk recording q Genetic evaluation q Database operations q Equipment manufacturing q Herdbook data q Artificial insemination data q Milk analysis q Quality assurance
q If other, please specify

_____

* 10. Please provide a few details about yourself

First Name _____

Last Name _____

Country _____

Email Address _____

Sensor Devices Survey for ICAR Group Members

* 1. Please indicate the relevance of sensor data (data gathered automatically by devices attached to the animal or in-line during milking / handling / measuring) to the activities of the ICAR Group you are a member of.

	Very relevant	Relevant	Neutral	Not relevant	No opinion
Live-weight	m	m	m	m	m
Body condition	m	m	m	m	m
In line milk composition	m	m	m	m	m
Milk volume for every milking	m	m	m	m	m
Milk flow rate	m	m	m	m	m
Milking duration (milking time)	m	m	m	m	m
Body temperature	m	m	m	m	m
Feed intake	m	m	m	m	m
Methane emissions	m	m	m	m	m
Rumination	m	m	m	m	m
Eating or chewing	m	m	m	m	m
Heart rate	m	m	m	m	m
Standing or resting (time)	m	m	m	m	m
Movement (steps)	m	m	m	m	m
Location (by GPS)	m	m	m	m	m
Heat detection (intensity of activity at oestrus)	m	m	m	m	m
Teat placement	m	m	m	m	m

2. What other types of sensor data should be added to the list above?

_____

_____

_____

_____

* 3. Please indicate how widespread you think data gathered by automatic sensors will be in five years time (2022).

	Less than now (minus)	No change from now (equal)	More than now (plus 20%)	Much more than now (plus 100%)	Orders of magnitude more important than now (plus 1000%)	No opinion
Live-weight	m	m	m	m	m	m
Body condition	m	m	m	m	m	m
In line milk composition	m	m	m	m	m	m
Milk volume for every milking	m	m	m	m	m	m
Milk flow rate	m	m	m	m	m	m
Milking duration (milking time)	m	m	m	m	m	m
Body temperature	m	m	m	m	m	m
Feed intake	m	m	m	m	m	m
Methane emissions	m	m	m	m	m	m
Rumination	m	m	m	m	m	m
Eating or chewing	m	m	m	m	m	m
Heart rate	m	m	m	m	m	m

Standing or resting (time)	m	m	m	m	m	m
Movement (steps)	m	m	m	m	m	m
Location (by GPS)	m	m	m	m	m	m
Heat detection (intensity of activity at oestrus)	m	m	m	m	m	m
Teat placement	m	m	m	m	m	m

4. What other types of sensor data should be added to the list above?

_____

_____

_____

_____

* 5. Please indicate the extent to which you agree or disagree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion
The current in line milk meters are not sufficiently accurate for use in milk recording.	m	m	m	m	m	m
The current in line milk composition sensor devices are not sufficiently accurate for use in milk recording.	m	m	m	m	m	m
At current rate of progress in line milk meters will replace traditional milk recording within five years.	m	m	m	m	m	m
The currently available animal attached sensor devices for motion/temperature/heart rate measurement provide data very relevant to my organisation.	m	m	m	m	m	m
At the current rate of progress animal attached sensor devices for motion/temperature/heart rate measurement will become widespread on the farms serviced by my organisation.	m	m	m	m	m	m

* 6. Please indicate the extent to which you agree or disagree with the following statements relating to the challenges in using sensor data.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion
Creating and maintaining an automatic electronic connection between sensor devices and recording databases remains a major challenge.	m	m	m	m	m	m
Linking the data from a sensor device with the correct animal in the recording database is a problem that has been well solved.	m	m	m	m	m	m
There are substantial risks to the data collected by a sensor device being transferred unaltered to the recording database.	m	m	m	m	m	m
Battery capacity in sensor devices is not sufficient to support the required frequency of transmitting sensor data.	m	m	m	m	m	m

7. What other challenges do you see with using sensor data?

_____

_____

_____

_____

* 8. What role should ICAR play? Please indicate the extent to which you agree or disagree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for FARM MANAGEMENT DECISIONS.	m	m	m	m	m	m
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for GENETIC EVALUATIONS.	m	m	m	m	m	m
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for decisions on ANIMAL HEALTH & WELFARE.	m	m	m	m	m	m
ICAR should be proactive in establishing guidelines for the use of data from sensor devices for PRODUCT QUALITY ASSURANCE (including traceability).	m	m	m	m	m	m
ICAR should test and certify sensor devices in concordance with ICAR guidelines (existing and under development) and report the evaluation.	m	m	m	m	m	m

Page 3 - Respondent

* 9. Please indicate the ICAR Group(s) that you are involved in

- Q Animal Identification Sub Committee
- Q INTERBULL Sub Committee
- Q Milk Analysis Sub Committee
- Q Recording & Sampling Devices Sub Committee
- Q Interbull & ICAR Operations Task Force
- Q PSE-ITF Task Force
- Q Sensor Devices Task Force
- Q Animal Data Exchange Working Group
- Q Artificial Insemination and R.T. Working Group
- Q Breed Association Working Group
- Q Conformation Recording Working Group
- Q Dairy Cattle Milk Recording Working Group
- Q DNA Working Group
- Q Feed & Gas Working Group
- Q Functional Traits Working Group
- Q Global Reach Working Group
- Q Interbeef Working Group
- Q Sheep Goat and Small Camelid Working Group
- Q If other, please specify

_____

* 10. Please provide a few details about yourself

First Name _____

Last Name _____

Country _____

Email Address _____