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Stakeholder Role Differences in the Use of Precision Livestock Farming Tracking Technologies in Europe

| A survey-based story of current practices, confidence gaps, and what needs to think next

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Introduction

Precision livestock farming (PLF)[1,2]

Continuous **Real-time Monitoring**

Environmental Impact

Health **Production/Reproduction**

Welfare **Animal**

TRACKING

[1]: Akinyemi, B. E., Jessiman, L., Turner, S. P., & Siegford, J. M. (2025). Beyond the farm: stakeholder perspectives on precision livestock farming in the swine industry. Frontiers in Animal Science, 6, 1710969.
[2]:Krampe, C., Ingenbleek, P. T., Niemi, J. K., & Serratosa, J. (2024). Designing precision livestock farming system innovations: A farmer perspective. Journal of Rural Studies, 111, 103397.

Introduction

What is animal tracking?

"*Animal tracking* refers to the use of digital sensing, positioning, or vision-based technologies to monitor and record animals' spatial location, movement patterns, activity, and related behavioural indicators over time, to support the assessment of animal health, welfare, production, and management [3]. "

[3]:Berckmans, D. (2017). General introduction to precision livestock farming. Animal Frontiers, 7(1), 6-11.

Introduction

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“Supporting the capacities of digital, data-driven solutions for livestock tracking.”

Livestock production is not a single-actor system but a multi-stakeholder network [4,5].

[4]: Akinyemi, B. E., Jessiman, L., Turner, S. P., & Siegford, J. M. (2025). Beyond the farm: stakeholder perspectives on precision livestock farming in the swine industry. Frontiers in Animal Science, 6, 1710969.
[5]:Krampe, C., Ingenbleek, P. T., Niemi, J. K., & Serratosa, J. (2024). Designing precision livestock farming system innovations: A farmer perspective. Journal of Rural Studies, 111, 103397.

| Survey Lens

Current Practices in Animal Tracking: A Survey

18 languages; **6** sections; **22** questions; **92** responses, **2,5** months, **On**-line, **Mult**-actors

1. *General info.*
2. *Technology Profile*
3. ***Technology Performance & Validation***
4. *Deployment and Practical Challenges*
5. *Data governance*
6. *Technology Value & Impact*

Survey Lens

We aim to understand how farmers and non-farmers, *across different levels of working experience*, perceive and evaluate the PLF technologies they work with.

Roles

- Farmers
- Non-farmers

Technology types

- On-animal sensor *(e.g., Neck collar / smart collar, Ear tag, Leg pedometer / ankle sensor, Rumen bolus, GPS tracker…)*
- Off-animal system *(e.g., Camera, Microphone, Walk-over weighing scale, Automatic milking system, Barn environmental sensors, Feed bin / water trough sensor …)*
- Integrated / multi-source system

Working experiences

- Non-experience
- < 3 years
- 3-5 years
- > 5 years

Section 1 | General Info About You and Your Organization.

1. Which of the following best describes your primary role?
2. What species is your technology primarily designed for?
3. For how many years have you been using or developing livestock tracking technologies?

Section 1 | General Info About You and Your Organization.

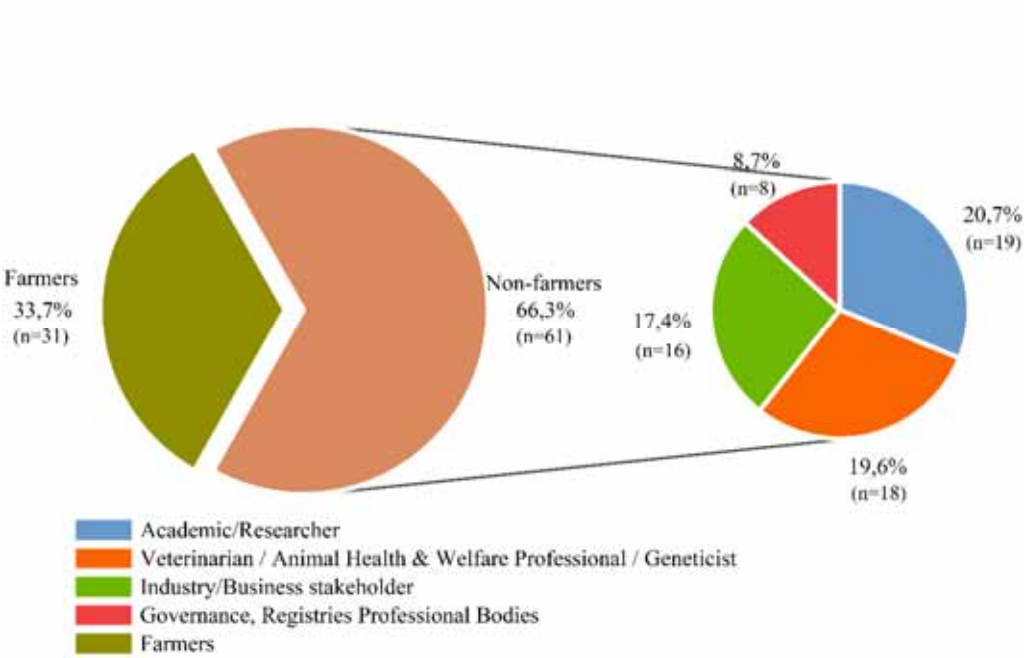
Which of the following best describes your primary role?

33.7%

- **Farmers** *(Technology end-users)*
- **N=31**

66.3%

- **Non-farmers** *(Technology shaping actors)*
- **N=61**
  - ***Academics/Researchers*** *– 20.7% (n = 19)*
  - ***Veterinarians / Animal health & welfare / Geneticists*** *– 19.6% (n = 18)*
  - ***Industry/Business stakeholders*** *– 17.4% (n = 16)*
  - ***Governance / Registries / Professional bodies*** *– 8.7% (n = 8)*



Section 1 | General Info About You and Your Organization.

What species is your technology primarily designed for?

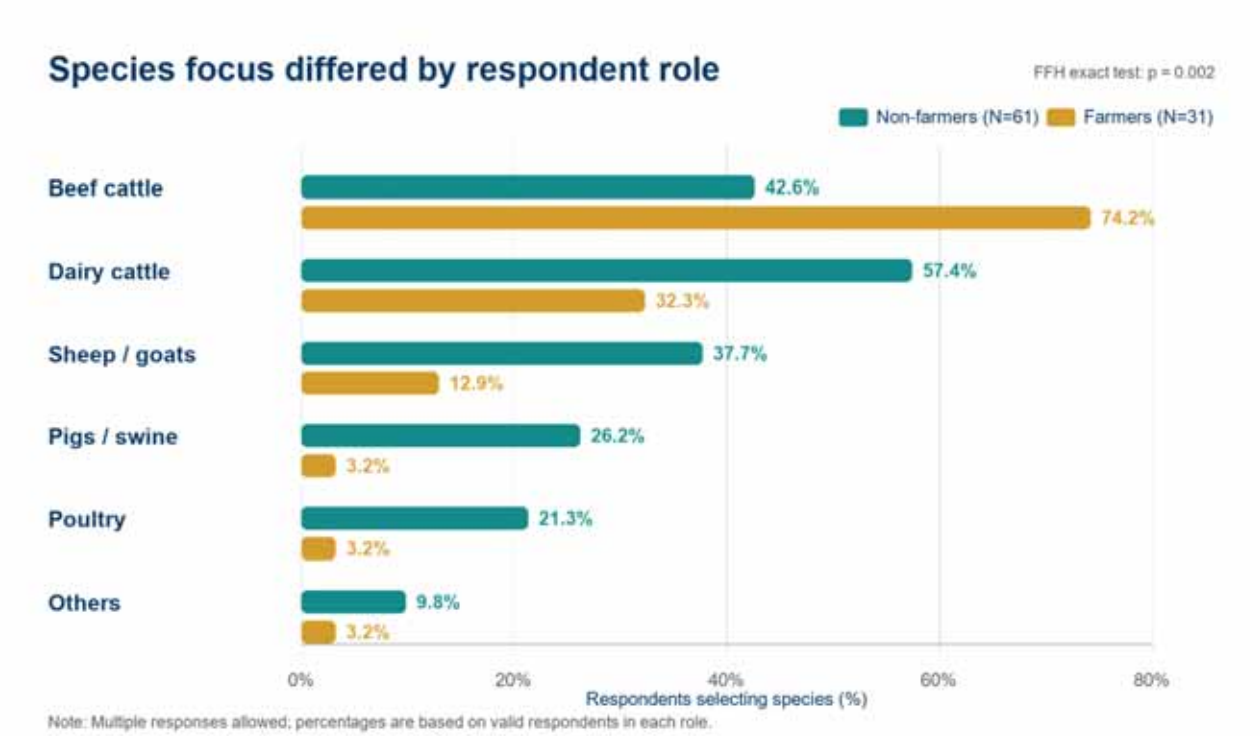
74,2%

- **Farmers** *(N=23)*
- **Beef cattle**

57,4%

- **Non-farmers** *(N=35)*
- **Dairy cattle**

Species focus differed by role *(p = 0.002).*

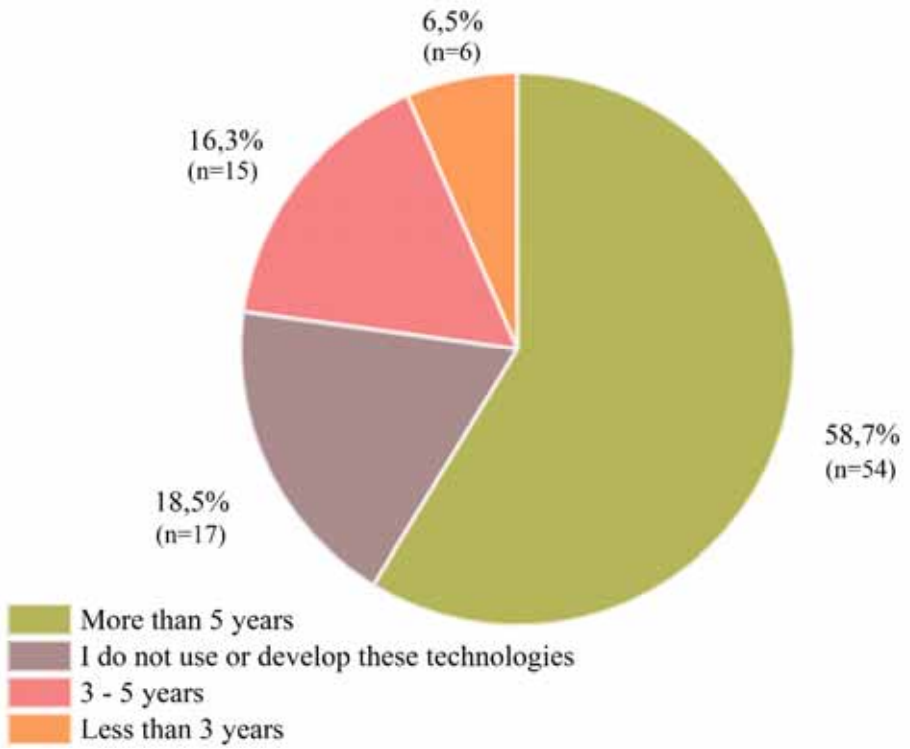


Section 1 | General Info About You and Your Organization.

For how many years have you been using or developing livestock tracking technologies?

58,7%

- **Working Experience >5 years**
- **N = 54**



Section 2 | Technology Profile and Application

1. What type of technology is it?
2. What key indicators does this technology measure? (Please select all that apply)
3. What is the top-1 main purpose for which you use or have designed this technology?

Section 2 | Technology Profile and Application

What type of technology is it?

64,1%

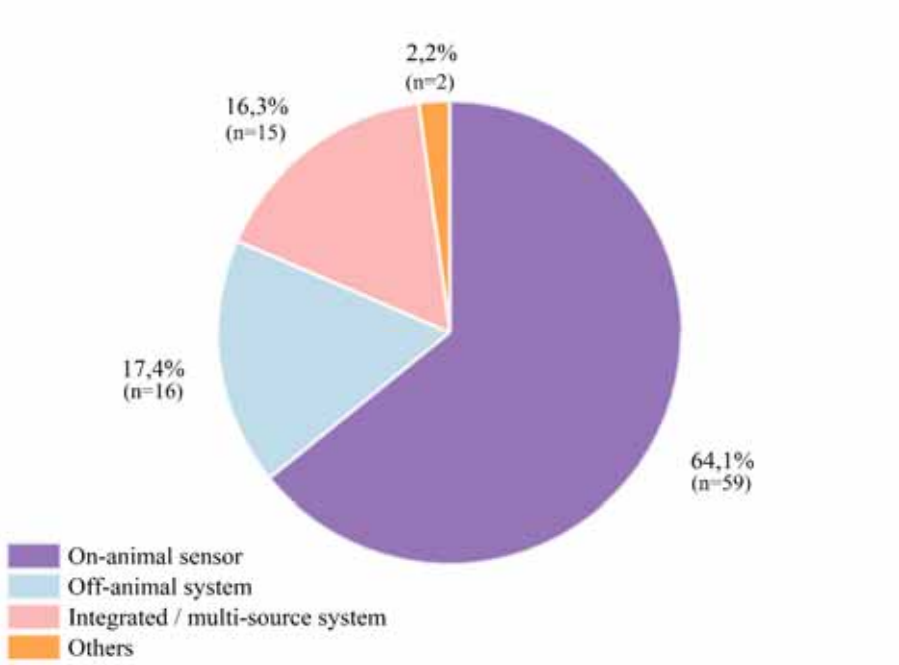
- **On-animal sensors** *(N=59)*
- *The sensor is worn by the animal and produces individual-level data.*

17,4%

- **OFF-animal sensors** *(N=16)*
- *The sensor stays in the environment or equipment and observes the animal from outside.*

16,3%

- **Integrated / multi-source system** *(N=15)*
- *It combines several data streams to provide a more complete picture of the animal, herd, or farm.*



Section 2 | Technology Profile and Application

On-animal sensors are the dominant technology type, but technology choice differs significantly by role *(FFH exact test,$p < .001$):*

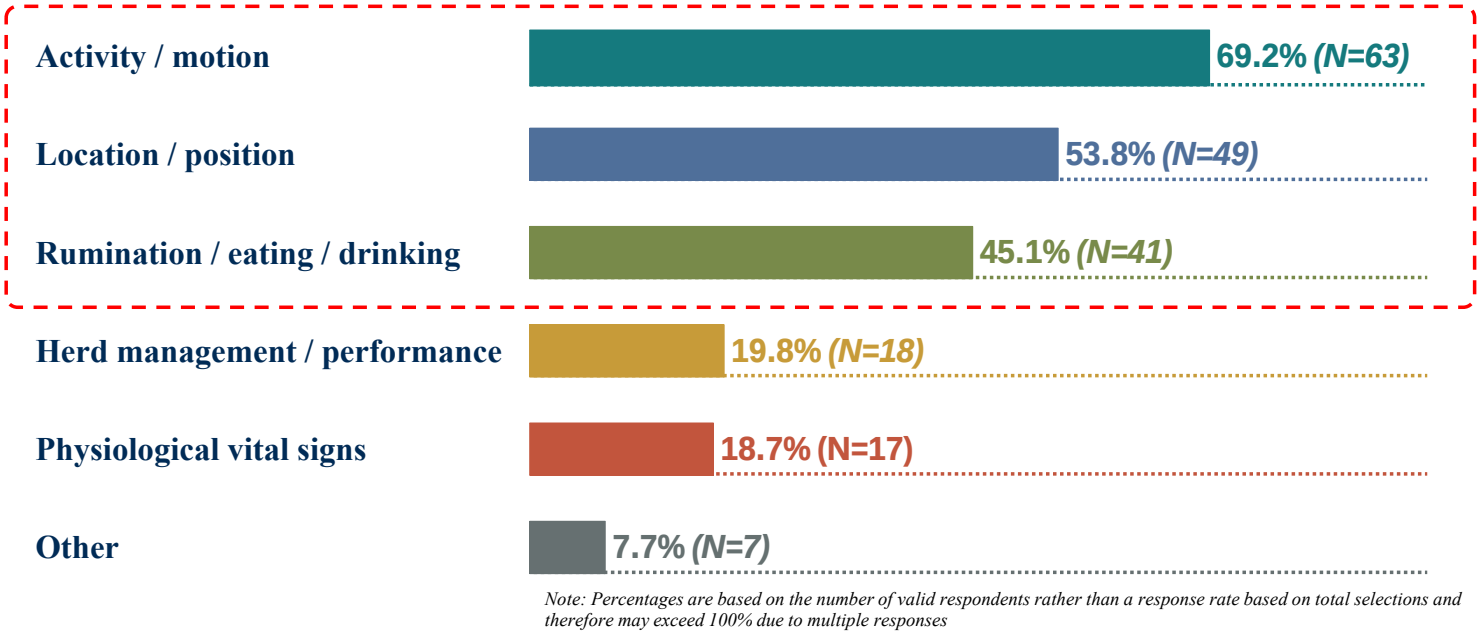
- Farmers almost exclusively use on-animal sensors *(100%, n=30)*,
- Non-farmers are more mixed.

Technology types differ significantly in their livestock focus *(FFH exact test, $p = 0.02$)*

- **Ruminants –** on-animal sensors:
  - Beef cattle → *71% , n=35*
  - Dairy cattle → *66%, n=29*
  - Sheep/goats → *58%, n=15*
- **Pigs –** off-animal systems → *53%, n=9*
- **Poultry:** No dominant solution

Section 2 | Technology Profile and Application

What key indicators does this technology measure?

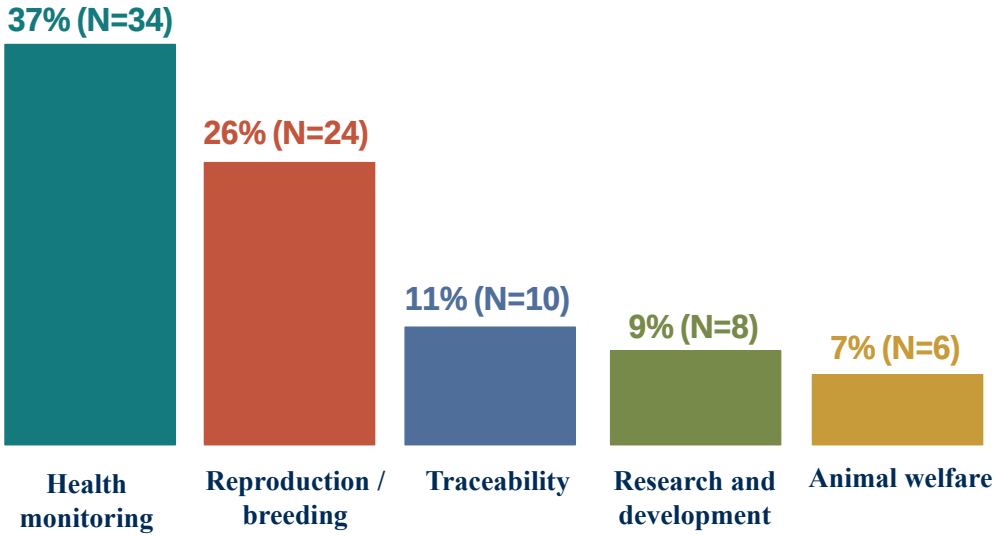


Note: Percentages are based on the number of valid respondents rather than a response rate based on total selections and therefore may exceed 100% due to multiple responses

Although the distribution of indicator types did not differ significantly between farmers and non-farmers *(p=0.149),* both groups showed the same emphasis on these three core measurement : **Activity/motion, Location/position and Rumination / eating / drinking.**

Section 2 | Technology Profile and Application

What is the top-1 main purpose for which you use or have designed this technology?



48.4%

Farmers rank reproduction / breeding first.
(15 / 31)

39.3%

No-farmers rank health monitoring first.
(24 / 61)

The primary purpose of using tracking technologies differed significantly by respondent role *($p = 0.011$).*

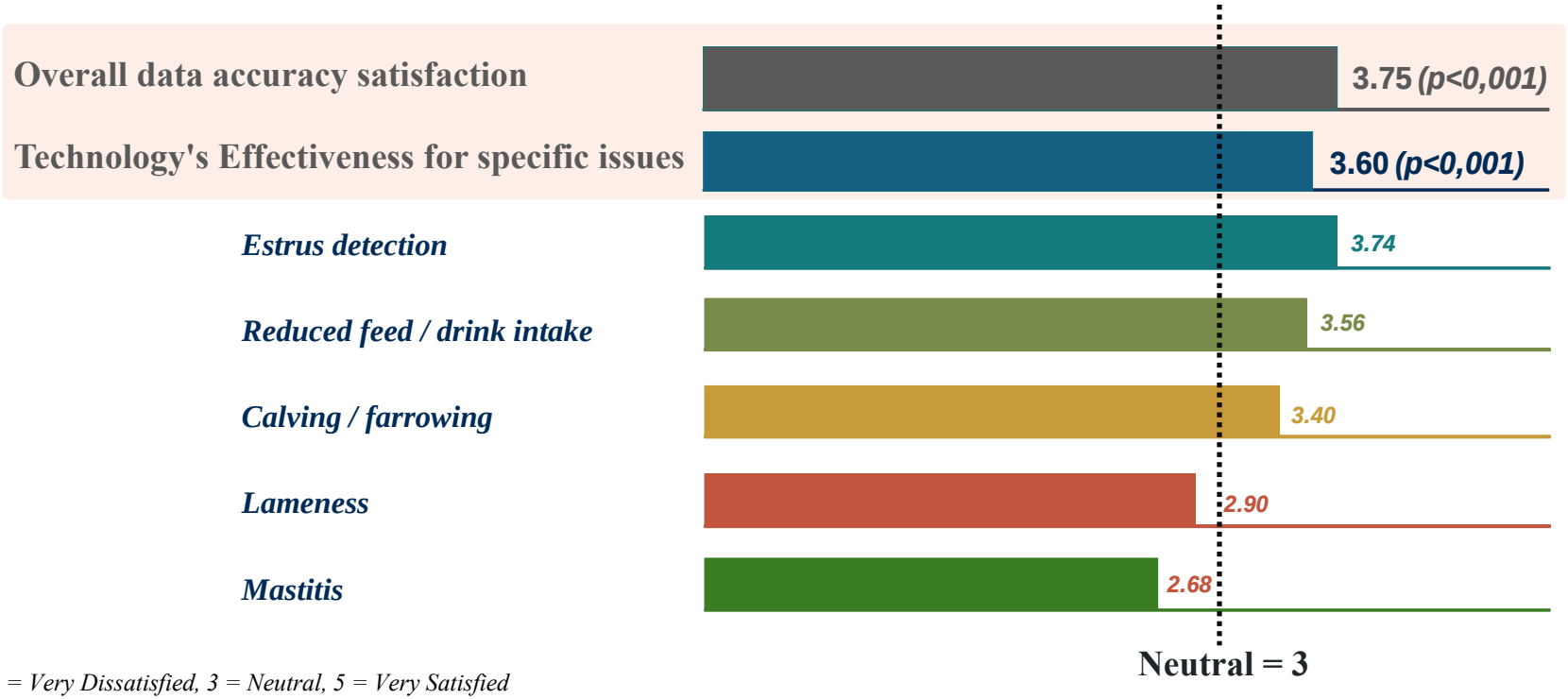
Take home message

“ Animal tracking is dominated by on-animal sensors measuring activity, location, and feeding behaviour, while farmers mainly use these technologies for reproduction and non-farmers for health monitoring. ”

Section 3 | Data Quality and Validation of commercial digital technology

1. On a scale of 1 to 5, how satisfied are you with the overall accuracy of the data provided by the technology for its main purpose?
2. Please rate the technology's effectiveness in identifying the following specific challenges (if applicable).
3. How was the technology's performance validated?

Section 3 | Data Quality and Validation of commercial digital technology



Note: 1 = Very Dissatisfied, 3 = Neutral, 5 = Very Satisfied

Data accuracy satisfaction *(p=0.667)*

3,81 / 5 **Farmers** 3,72 / 5 **Non-Farmers**

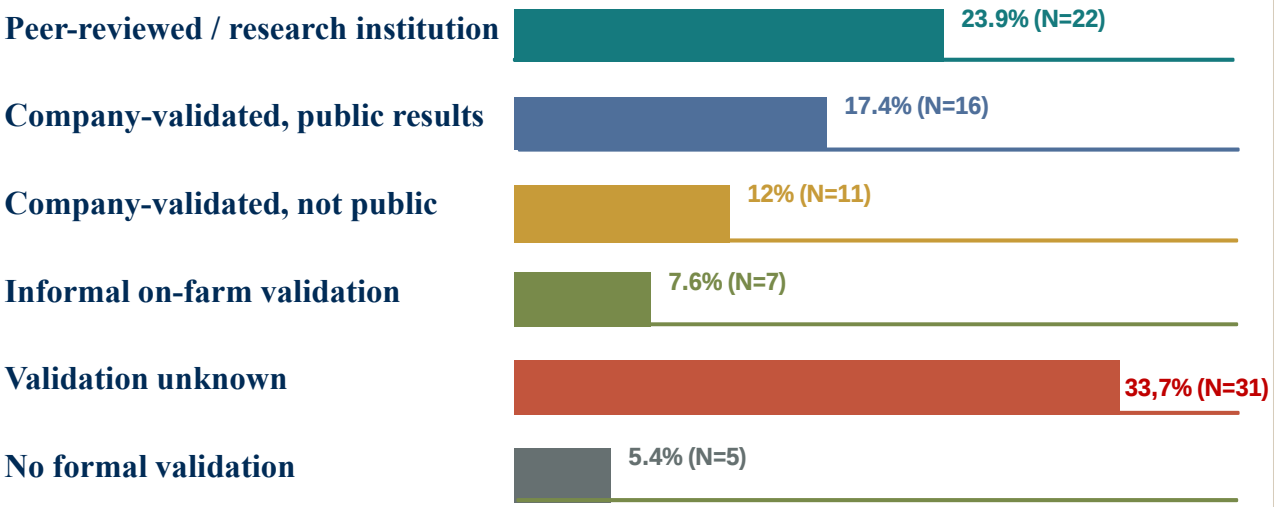
Technology's Effectiveness *(all p > .05).*

3,59 / 5 **Farmers** 3,61 / 5 **Non-Farmers**

Despite different reasons for using tracking technologies, farmers and non-farmers evaluated their performance in broadly similar ways.

Section 3 | Data Quality and Validation of commercial digital technology

How was the technology's performance validated?



67,7%

Farmers often unknown how to validate data. *(21 / 31)*

68.8%

Non-farmers more often reported clear formal pathways:

- **research-based** *(34.4%, 21 / 61)*
- **company-led validation** *(34.4%, 21 / 61)*

How technologies were validated varied strongly by role *($p < .001$).*

Section 3 | Data Quality and Validation of commercial digital technology

Take home message

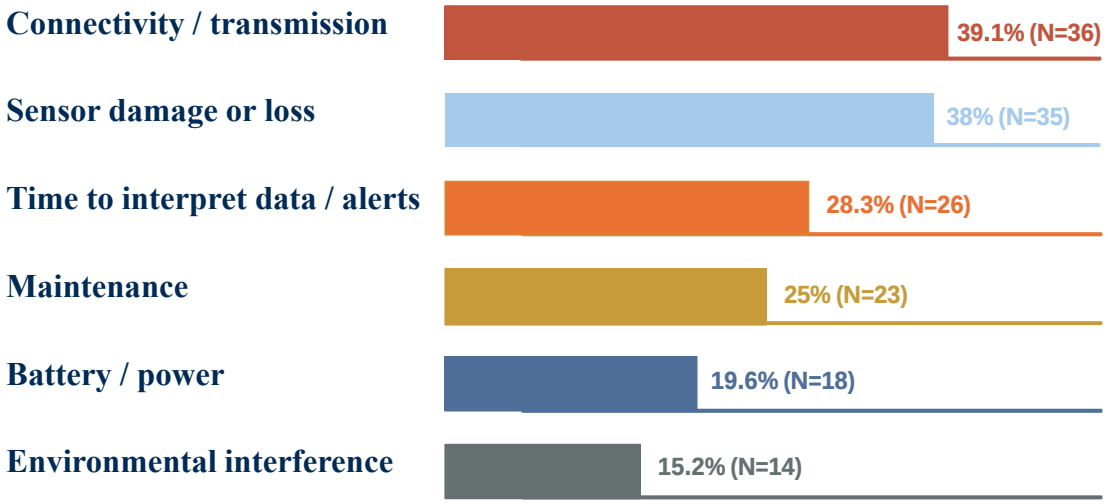
“ Respondents generally trusted the technology’s performance, but validation was unevenly understood farmers often did not know how validation was done, while non-farmers more often reported research-based or company-led validation routes. ”

Section 4 |Deployment and Practical Challenges

1. How would you rate the difficulty of the initial installation and setup of the system?
2. What are the biggest practical challenges you have faced?

Section 4 | Deployment and Practical Challenges

What are the biggest practical challenges you have faced?



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How would you rate the difficulty of the initial installation and setup of the system?

3,56 / 5

Ease of installation, 1 very difficult to 5 very easy.

Installation and setup were rated significantly above the neutral midpoint *(p<0,001),* with farmers finding it significantly easier than non-farmers *(3.86 vs 3.41, p = .018).*

The most common operational issues were:

- *Data connectivity/transmission,*
- *Sensor damage or loss,*
- *Time to interpret outputs or alerts,*

with similar patterns across respondent roles *(p=0,25).*

Take home message

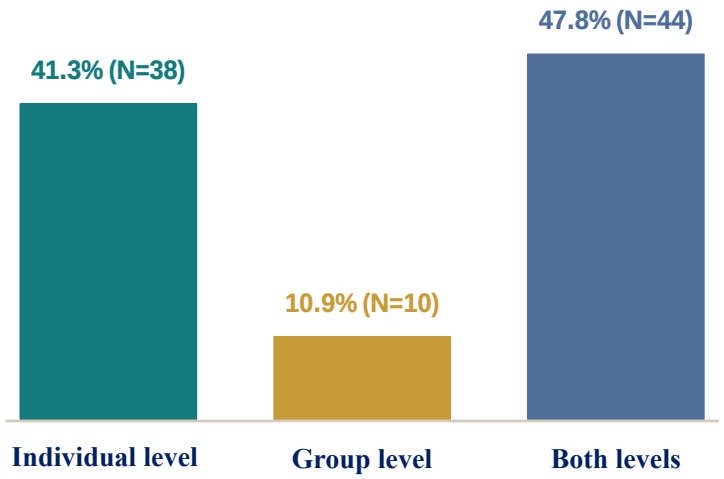
" Installation is not the main obstacle; the real challenge is keeping systems reliable in daily use, especially connectivity, sensor durability, and interpreting outputs. "

Section 5 | Data Management, Sharing, and Security

1. Is the collected data provided at the individual animal level or at the group/herd level?
2. How easy is it to integrate the data from this technology with other farm management software?
3. Who has access to the raw data generated by the system?
4. Are there any conditions that prevent you (or your clients) from sharing data with trusted partners
5. Under what conditions would you be willing to share livestock data generated by your farm/technology?

Section 5 | Data Management, Sharing, and Security

Is the collected data provided at the individual animal level or at the group/herd level?



Data provision level did not differ significantly by respondent role *(p=0.3)*.

How easy is it to integrate the data from this technology with other farm management software?

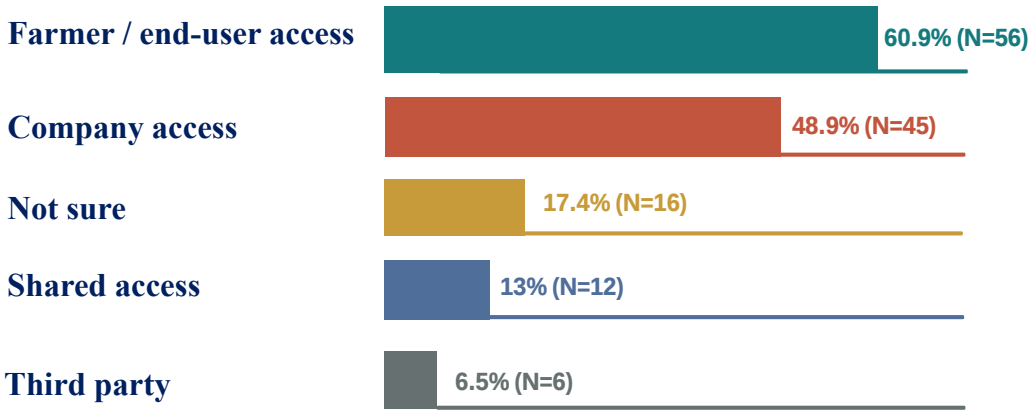
3,00 / 5

Ease of integrating data with farm management software, 1 very difficult to 5very easy.

The integration score is exactly neutral, no role difference emerged *(p=1.00).*

Section 5 | Data Management, Sharing, and Security

Who has access to the raw data generated by the system?



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77,4%

Farmers more often reported that farmers/end-users had access to raw data .
(24 / 31)

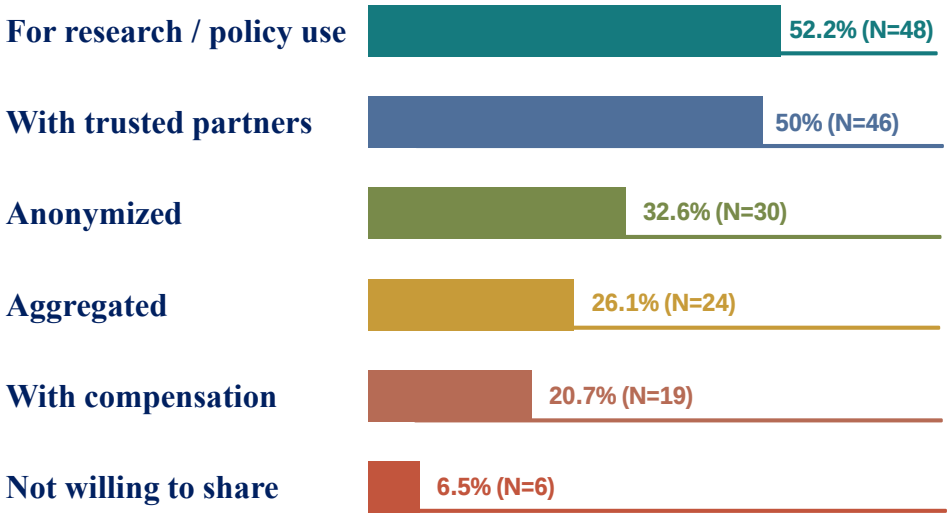
52,5%, 50,8%

Non-farmers more often reported:

- **Farmers/end-users** *(52,5%, 32 / 61)*
- ***Companies****(50,8%, 31 / 61)*

Raw data access differed significantly by role *(p =0,033).*

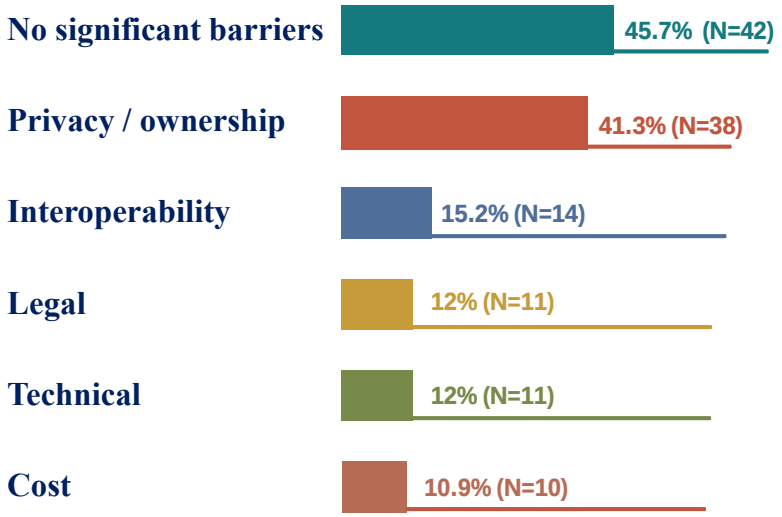
Section 5 | Data Management, Sharing, and Security



Under what conditions would you be willing to share livestock data generated by your farm/technology?

Preferred sharing conditions differed by role *(p=0.026):*

- **Research use was most common among non-farmers** *(63.9%, N=39/61),*
- **Trusted partners was the top condition among farmers** *(48.4%, N=15/31).*



Are there any conditions that prevent you (or your clients) from sharing data with trusted partners

Perceived barriers also differed by role *(p = 0.031):*

- **Privacy was the main concern, especially among non-farmers** *(50.8%, N=31/61),*
- **Farmers more often reported no major barriers to sharing** *(58.1%,N=18/31).*

Section 5 | Data Management, Sharing, and Security

Take home message

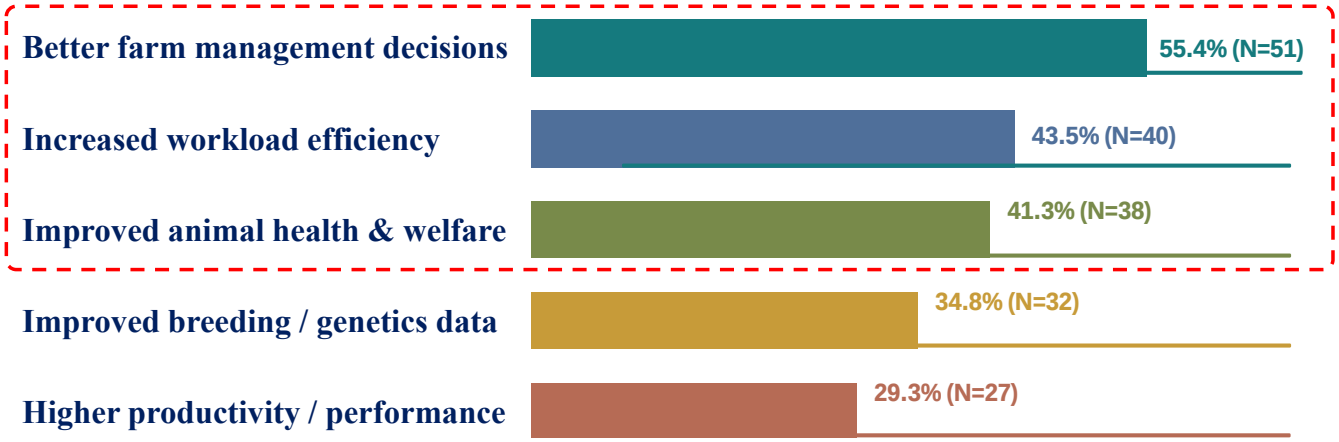
" Data is often available at useful levels, but integration remains neutral and sharing attitudes differ by role: farmers more often report no major barriers, while non-farmers favour research use but raise stronger privacy concerns. "

Section 6 | Value, Impact, and Best Practices

1. Overall, to what extent do you believe the technology has provided a positive return on investment (ROI)?
2. What has been the most positive impact of using this technology? Please select up to three options.
3. In your opinion, what is the biggest barrier preventing the wider adoption of this type of technology in the livestock industry?

Section 6 | Value, Impact, and Best Practices

What has been the most positive impact of using this technology? Please select up to three options.



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Overall, to what extent do you believe the technology has provided a positive return on investment (ROI)?

3.96 / 5

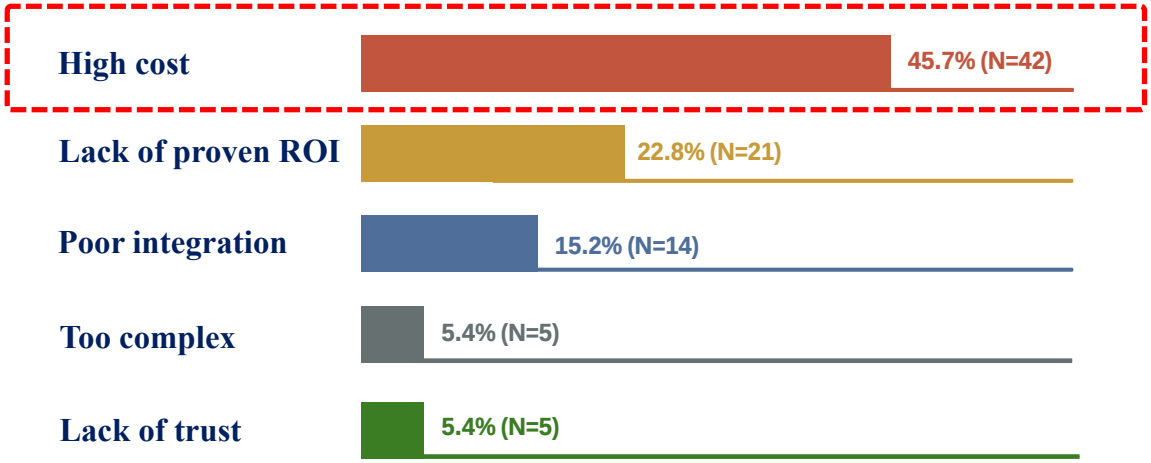
1 = Strong negative return; 3 = Neutral; 5 = Strong positive return

The mean ROI score was significantly above neutral *($p<0.001$),* **with no difference between farmers and non-farmers** *($p = 0.80$).*

Main benefits centred on farm decision-making and efficiency, with similar patterns across roles *($p = 0.80$).*

Section 6 | Value, Impact, and Best Practices

In your opinion, what is the biggest barrier preventing the wider adoption of this type of technology in the livestock industry?



67,7%

- **Farmers (N=21/31)**

34,4%

- **Non-farmers (N=21/61)**

High cost was the main barrier to wider adoption, reported more often by farmers than non-farmers although the role difference was not statistically significant *(p = 0.067).*

Take home message

" Respondents see livestock tracking as delivering positive value, mainly through better farm management decisions, workload efficiency and animal welfare, but high cost remains the main barrier to wider adoption. "

Take home messages

Section 2 |

“ Animal tracking is dominated by **on-animal sensors** measuring activity, location, and feeding behaviour, while farmers mainly use these technologies for reproduction and non-farmers for health monitoring. ”

Section 3 |

“ Respondents generally trusted the technology’s performance, but **validation** was unevenly understood farmers often did not know how validation was done, while non-farmers more often reported research-based or company-led validation routes. ”

Section 4 |

“ Installation is not the main obstacle; the real challenge is keeping systems **reliable in daily** use, especially **connectivity**, sensor durability, and interpreting outputs. ”

Section 5 |

“ Data is often available at useful levels, but integration remains neutral and **sharing** attitudes differ by role: farmers more often report no major barriers, while non-farmers favour research use but raise stronger privacy concerns. ”

Section 6 |

“ Respondents see livestock tracking as delivering positive value, mainly through better farm management decisions, workload efficiency and animal welfare, but **high cost** remains the main barrier to wider adoption. ”

Suggestions:

Livestock tracking technologies are already delivering value, but wider adoption will depend on moving from sensor availability to trusted, validated, integrated, and affordable decision-support systems.

A. Make validation clearer and more visible to end-users.

Farmers often do not know how technologies were validated, so validation evidence should be communicated in a simple, transparent, and farm-relevant way.

B. Improve everyday reliability and usability.

Future systems should focus on connectivity, sensor durability, easier interpretation of outputs, and smoother integration with farm management software.

C. Strengthen trust, data governance, and economic value.

Adoption will require clearer data-access rules, privacy safeguards, trusted sharing models, and stronger evidence of return on investment.

D. …

Thanks!