TECH CARE

Integrating innovative TECHnologies along the value Chain
to improve small ruminant welfARE management

Technology testing on pilot & large-scale farms

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with the contribution of all the partners of the pilot and large-scale farms

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Testing promising innovating technologies on pilot and large-scale farms

Main objectives:

Pilot trials

- **Test** innovative technologies under **operational environments**,
- **Capture variations** of welfare in **different production systems**,
- **Test** the **robustness** of the technology in different climatic conditions and production systems environments.

Large-scale studies

- **Validate the ease of use** of pre-selected technologies and AWE indicators,
- **Collect large datasets** to refine the creation of targeted algorithms,
- Collect users' feedback of use of the innovative technologies and write **guidelines** for future users.

Pilot farms' activities

- 1. On farm trials
- 2. Transportation trials

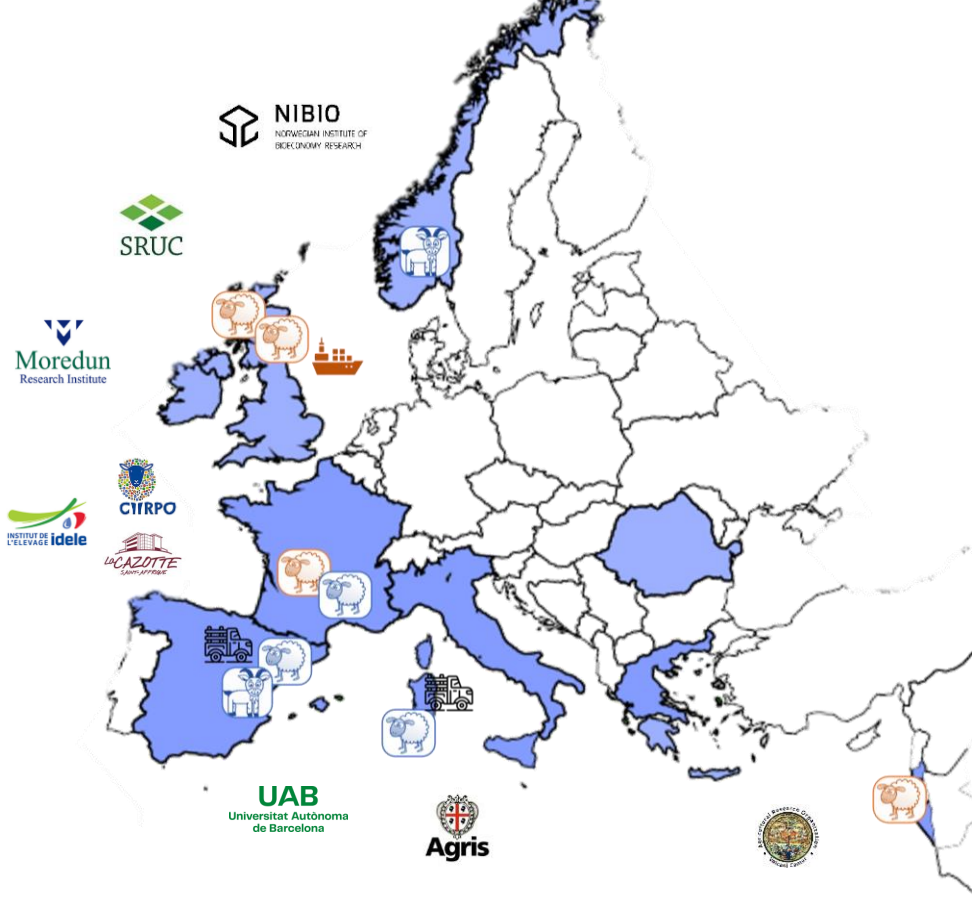
Overview of pilot trials

Key figures (2021 – 2024):

On 8 **experimental farms** in 6 countries.

During **transportation,** in **trailer** and **boat**, in 3 countries.

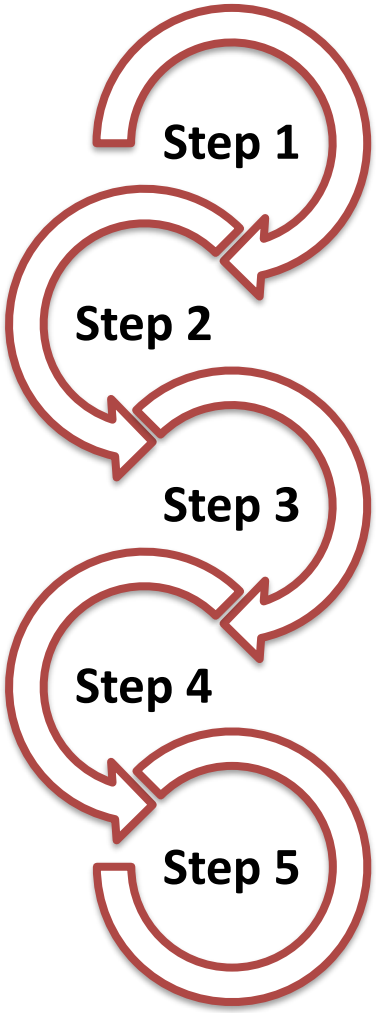
Covering 3 sectors



TRIALS	On farm	Transportation
Meat sheep	10	2
Dairy sheep	7	2
Dairy goat	3	1
Total	**25 trials**	

Overview of pilot trials

Key steps (2021 – 2024):



- Review of pilot **farm facilities** & production systems
- Identification of potential trials

- Selection of **technologies** and animal welfare indicators
- Writing **protocols** and scheduling trials over the years

- Trials **setup**, technologies **installations**, **calibration**
- **Data collection** by sensors and observations

- **Databases cleaning**
- **Analysis**, search for relevant **indicators**

- **Trials repetitions** to increase numbers and **variability**
- **Pre-conclusion** before the large-scale deployment phase




1. On farm trials

Meat sheep

Overview of 10 trials carried out on pilot farms (meat sheep)

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PARTNER	PILOT FARM	TRIAL N° - PERIOD	• MAIN INDICATORS • WELFARE ISSUES (WI) ADDRESSED	TECHNOLOGIES TESTED
SRUC	Kirkton	**Trial n°1** – Jan 22 to Mar 22 **Trial n°2** – Jan 23 to Feb 23	• Tracking **food resource areas attendance outdoor** • **Lameness** and other **WI**	• Bluetooth beacons • RFID UHF tags & antennas • Weather station • EID Weight crate
Moredun Research Institute	Firth Mains	**Trial n°1** – May 21 to Oct 21 **Trial n°2** – Apr 22 to Oct 22	• Identifying distinct **behaviours outdoor during grazing** • **Parasitism, lameness, mastitis** and other **WI**	• Bluetooth beacons • RFID UHF tags & antennas • Weather station
Agricultural Research Organization Volcani Center	Volcani	**Trial n°1** – Nov 21 to Feb 22	• Monitoring **weight and growth indoor** • **Nutritional issues** and other **WI**	• Trough AI: RFID UHF tags & antennas, connected water meter, weight crate • Indoor sensors (T°, Hum.)
		Trial n°2 – Dec 22 to Mar 23	• Monitoring body **weight and water trough attendance indoor** • **Pregnancy toxaemia, abortions**	
	Ivri farm	**Trial n°3** – May 23 to Aug 23	• Monitoring **weight and growth indoor** • **Health issues** and in-efficient lambs	
INSTITUT DE L'ELEVAGE idele CIIRPO	Le Mourier	**Trial n°1** – Jan 22 to Mar 22	• Monitoring **weight and growth indoor** • **Parasitism** and other **WI**	• EID Weight crate, WoW • RFID LF tags & antennas
		Trial n°2 – Jun 22 to Jul 22 **Trial n°3** – May 23 to Jun 23	• Tracking **water trough attendance indoor** • **Lameness** and other **WI** • **Monitoring of Temperature, Humidity, CO2** • **Heat / cold stress**	• RFID UHF tags & antennas • Connected water meter • Indoor sensors (T°, Hum.)

Using RFID UHF tags and antennas to track individual attendance to point of interest

Trial: RFID UHF device (Page Up Co.) at feeding blocks in rangelands

PAGE UP Co. UHF prototype

- 1 month trial (**winter** 2023)
- 50 **ewes** on ~20 ha rough grazing
- Outdoor/extensive settings (Scotland)
- Focus on **nutritionnal issues and lameness**

- **Data collected:**
  - **Weight** & **BCS**
  - **Welfare assessment** (AWIN) **scores**: lameness, parasites, fleece cleanliness, dental loss, respiratory issues...
  - **UHF data (detections)** from reader system:
    - Only 8 hours/day (battery capacity)
    - Not at week-end (staff)

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Using RFID UHF tags and antennas to track individual attendance to point of interest

SRUC

Trial: RFID UHF device (Page Up Co.) at feeding blocks in rangelands

- **Indicator:** count the number of days when the ID tag of each ewe was detected near the feeding block.

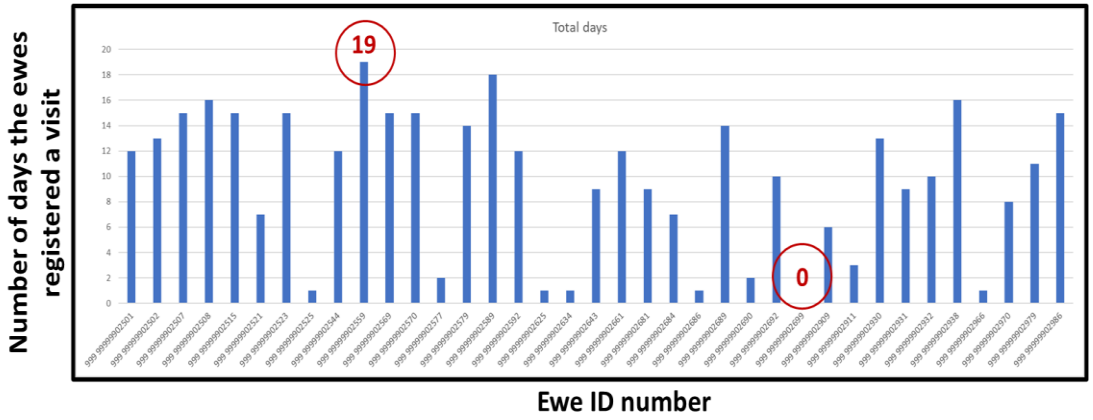
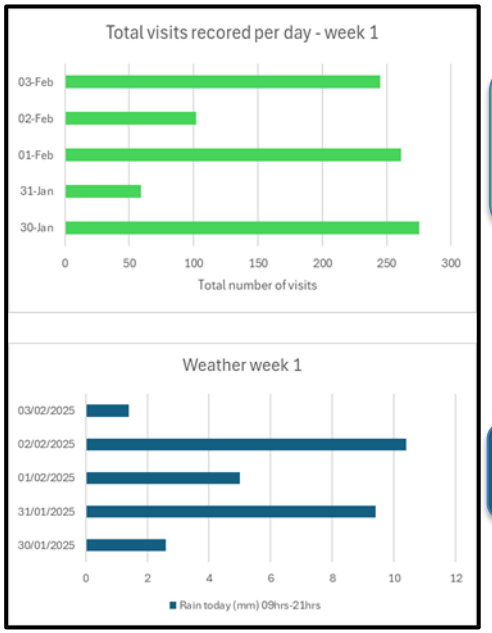


Figure: Total day count per ewe UHF tag detected over the 1-month period



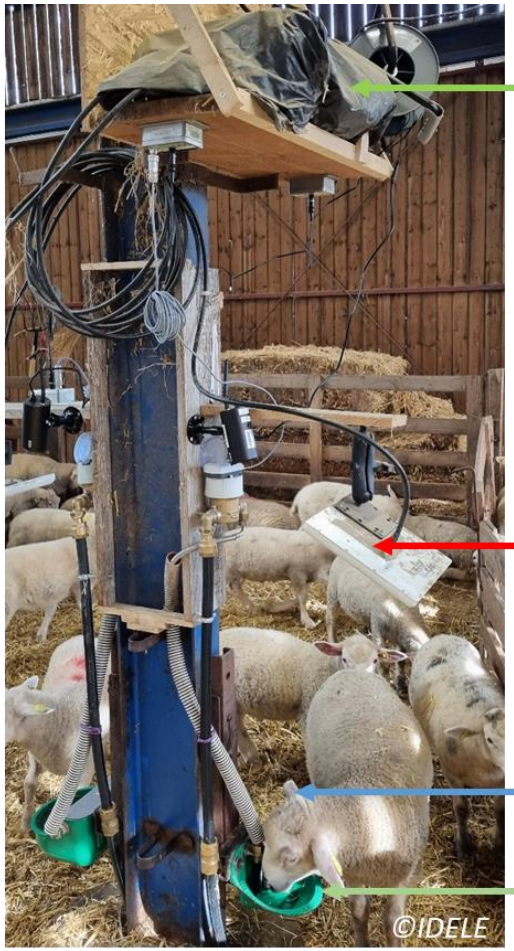
Total ID count per day

Rainfall

High variability detected between ewes (free to come; complementary feeding)
A non-continuous dataset for an indiv. longitudinal study, but "**rainfall**" reduces visit!
Too few welfare issues during the trial, but we capture indiv. variations.

Using RFID UHF tags and antennas to track individual attendance to point of interest

Trial: RFID UHF device (Page Up Co.) at water trough indoor



PAGE UP Co. UHF prototype

- 1 month trial (**summer** 2023)
- 60 fattening **lambs**
- **Indoor** settings in shed (France)
- Focus on **lameness** and other WI

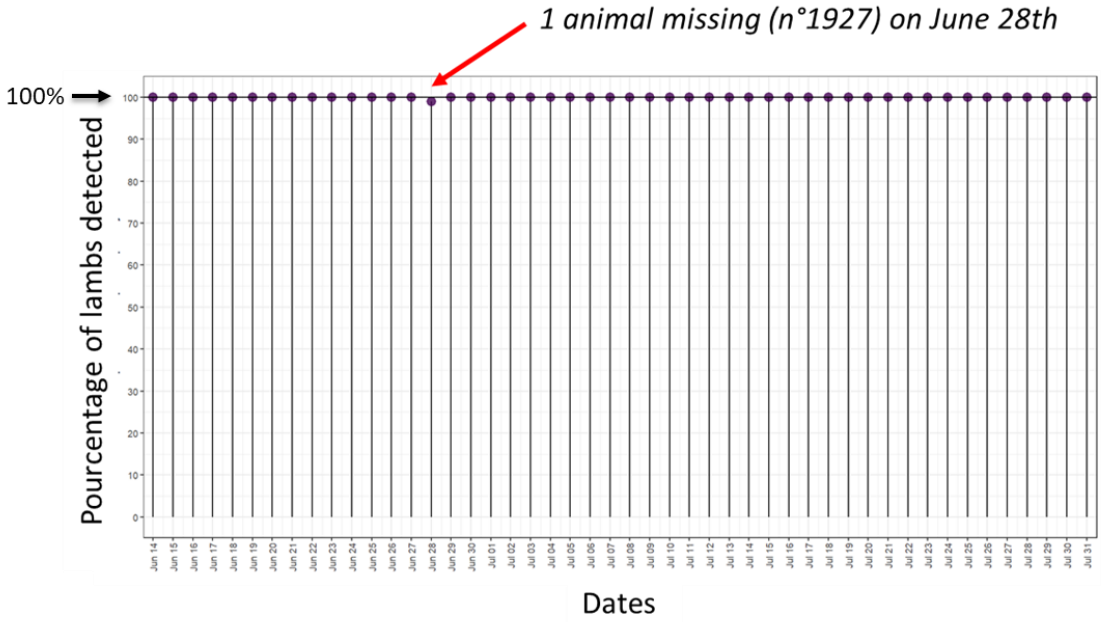
- Data collected:
  - **Weight**
  - Welfare assessment (AWIN**) scores**: lameness, fleece cleanliness, faecal soiling, respiratory issues, injuries ...

  - **UHF data (detections)** from reader system:
    - Every sec. (24h/24h)
    - 4G, Power supply; Web Platform.

Using RFID UHF tags and antennas to track individual attendance to point of interest

Trial: RFID UHF device (Page Up Co.) at water trough indoor

- Are all lambs **ID tags detected** around the water trough area every day?
- Indicator: **percentage of animal ID detected** next to the water trough area

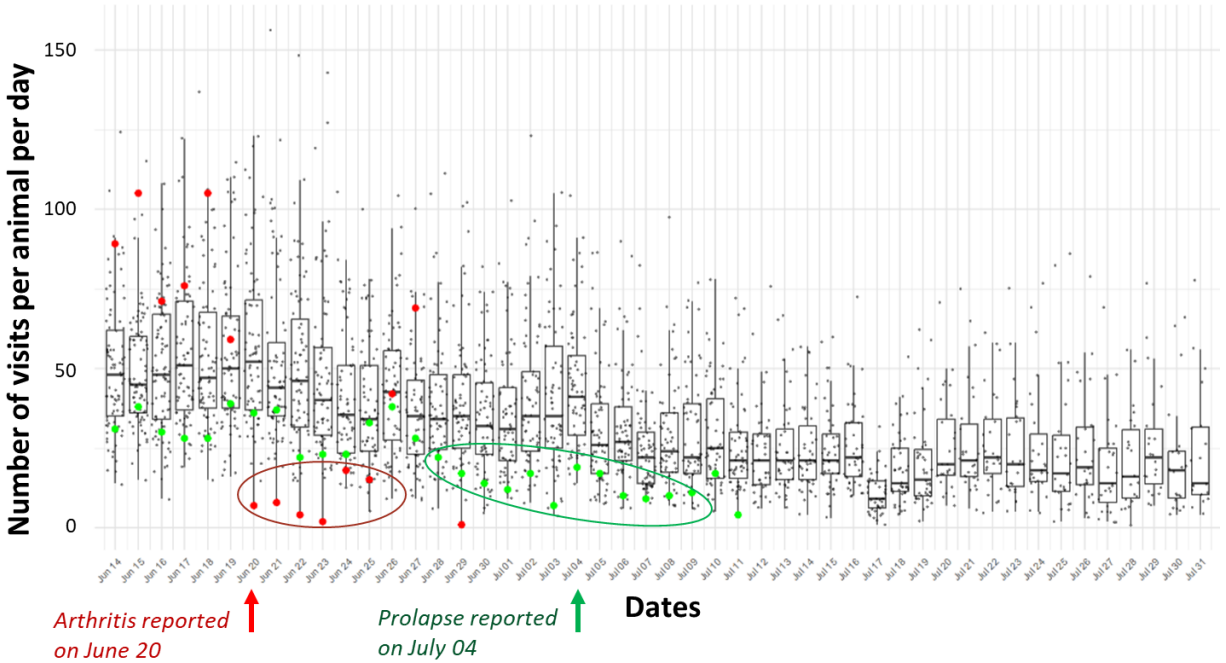


Overview of daily ID detections: identify "missing".
Correct operation of the system and **data collection.**
Simple indicator **without visual evolution of the individual area's attendance**.

Using RFID UHF tags and antennas to track individual attendance to point of interest

Trial: RFID UHF device (Page Up Co.) at water trough indoor

- How does individual attendance at the water trough area evolve?
- New indicator: count the total "visit" (filter: 8 sec. < sequence < 120 sec.) per animal et per day



Interesting **variability between individuals** (behavior, patterns)
Filters sufficient to see a clear-cut drop and a downward trend ←→ Welfare issues
Too few cases of health problems to draw conclusions.

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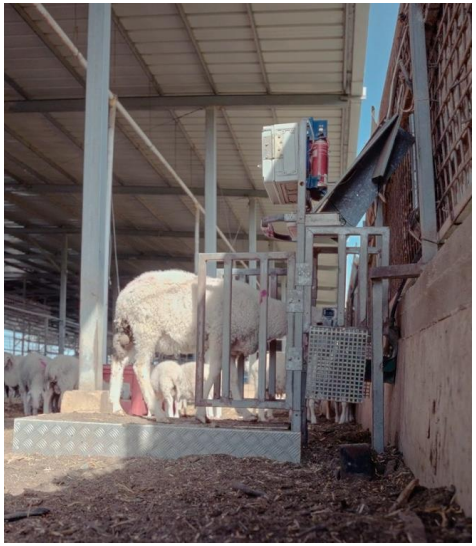
Using RFID UHF tags and antennas to track individual attendance to point of interest

Trial: RFID UHF device (Trough AI) at water trough indoor

Prototype Development combining:

- Real time UHF RFID **detection** at water trough, flowmeter (intake)
- Automated **weighing** monitoring system (2 front legs)



- 4 months trial (**summer** 2023)
- 38 adult **ewes**
- **Indoor** settings in shed (Israel)
- Focus on **lameness, abortions, pregnancy toxaemia and other WI**

- Data collected:
  - **Weight**
  - **Water intake**
  - Welfare assessment scores, health issues
  - **UHF data (detections)** from reader system:
    - Motion sensor (24h/24h)
    - Power supply; Internet, Web Platform.

Updated Mechanical engineering – Assaf Godo, on-farm validation – Joseph Lepar, initial idea – Tzach Glasser, On-farm impact evaluation – MSc thesis – Alon Bar Shamai; RF electronics – Lavie Rosenfeld and Josef Grinshpon

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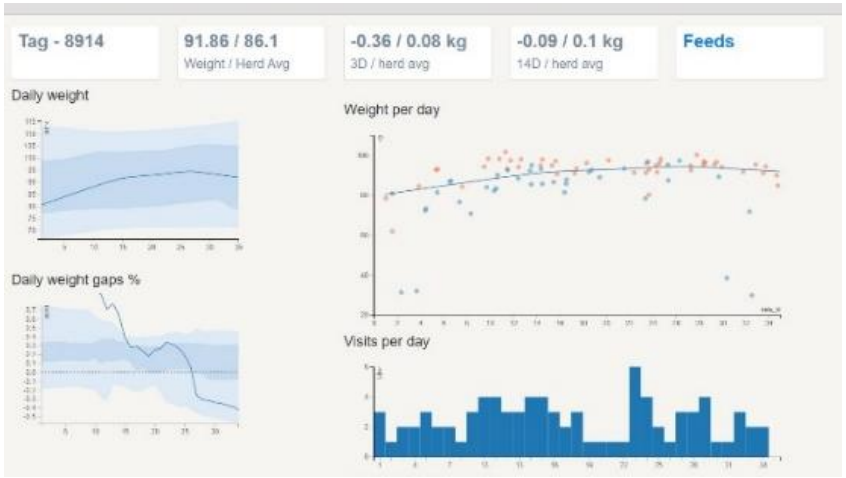
Using RFID UHF tags and antennas to track individual attendance to point of interest

Trial: RFID UHF device (Trough AI) at water trough indoor

- How does individual attendance at the water trough area evolve? And the weight ?
- Indicators: **individual daily weight**, **number of "visits"** per day and per animal
- Algorithm developed and dashboard for monitoring



Examples: Pregnancy toxemia & Lameness issue

Continuous and **real-time monitoring** of vital **animal parameters** (body weight, growth and access to water resources) – **early detection & alerts** to the farmer.
No quantification indicators of pregnancy toxaemia due to a few cases.

Using RFID UHF tags and antennas to track individual attendance to point of interest

Feedbacks from pilot trials using RFID UHF

- **RFID UHF high potential for :**
  - **Tracking several individual attendance** to point of interest → Behaviour, patterns
  - **Detecting** health and welfare **issues** at **an early stage** → Proof of concept

- **Integration with other sensors (weight; flowmeters)**

UHF integration into a **combined device with weighing and drinking monitoring** (Trough AI)

- **Additional indicators useful to the farmer:**
  - Lowering flock mortality by detecting illnesses earlier,
  - Observing flock growth and monitoring animal weight,
  - Monitoring feeding for animals that do not gain weight effectively,
  - Etc.

TROUGH AI

PAGE UP Groupe UBI Solutions

2 promising innovations to be presented tomorrow morning

1. On farm trials

Dairy sheep

Overview of 7 trials carried out on pilot farms (dairy sheep)

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PARTNER	PILOT FARM	TRIAL N° - PERIOD	• MAIN INDICATORS • WELFARE ISSUES (WI) ADDRESSED	TECHNOLOGIES TESTED
Agris	Bonassai	**Trial n°1** – Apr 22 to Jun 22	• **Milk yield at group level** • **Nutritional issues**	• Connected milk tank scales • Indoor sensors (T°, Hum.)
		Trial n°2 – May 22 to Jun 22	• Individual **somatic cell count** • **Mastitis**	• Portable somatic cell count
		Trial n°3 – Mar 22 to Jun 22	• **Individual milk prod., milking order** • **Nutritional issues, mastitis**	• Individual milk meters • RFID LF tags & antennas • EID Weight crate, WoW • Indoor sensors (T°, Hum.) • Weather station
		Trial n°4 – Apr 23 to Jun 23	• **Individual milk prod., weight** • **Nutritional issues** • **Temperature, Humidity** • **Heat stress**	
INSTITUT DE L'ELEVAGE idele LA CAZOTTE SAINT-AFFRIQUE	La Cazotte	**Trial n°1** – May 22 to Jul 22	• **Water trough attendance** • **Lameness and other welfare issues**	• RFID UHF tags and antennas • Connected water meters
		Trial n°2 – Jan 23 to Jul 23	• **Milk yield at group level** • **Nutritional issues** • **Temperature, Humidity** • **Heat / cold stress**	• Connected milk tank scales • Indoor sensors (T°, Hum.,CO2) • Weather station
		Trial n°3 – Jan 23 to Jul 23	• **Water trough attendance** • **Lameness and other welfare issues**	• RFID UHF tags and antennas • Connected water meter
UAB Universitat Autònoma de Barcelona	Facultat de Veterinaria	**Trial n°1** – Sept 22	• **Milk prod & composition, milking order, Somatic cell count, Bacterial culture.** • **Mastitis**	• Individual milk meters • RFID LF bolus & antennas

Exploring the use of data from experimental flock to detect welfare problems in milking dairy sheep

Flock of Bonassai pilot farm (AGRIS)

- 4 months trial (**spring** 2022)
- 500 **lactating ewes**
- **Indoor/outdoor** settings (Sardinia)
- Focus on **mastitis, nutritional issues** and other WI

Objective of the monitoring

➢ *To evaluate the possible detection of ewes welfare problems with a large dataset from several technologies.*

Data collected :

- Welfare assessment scores: BCS, dag score, lameness…
- Animal's diet group (pasture access time, forage, supplementation…)

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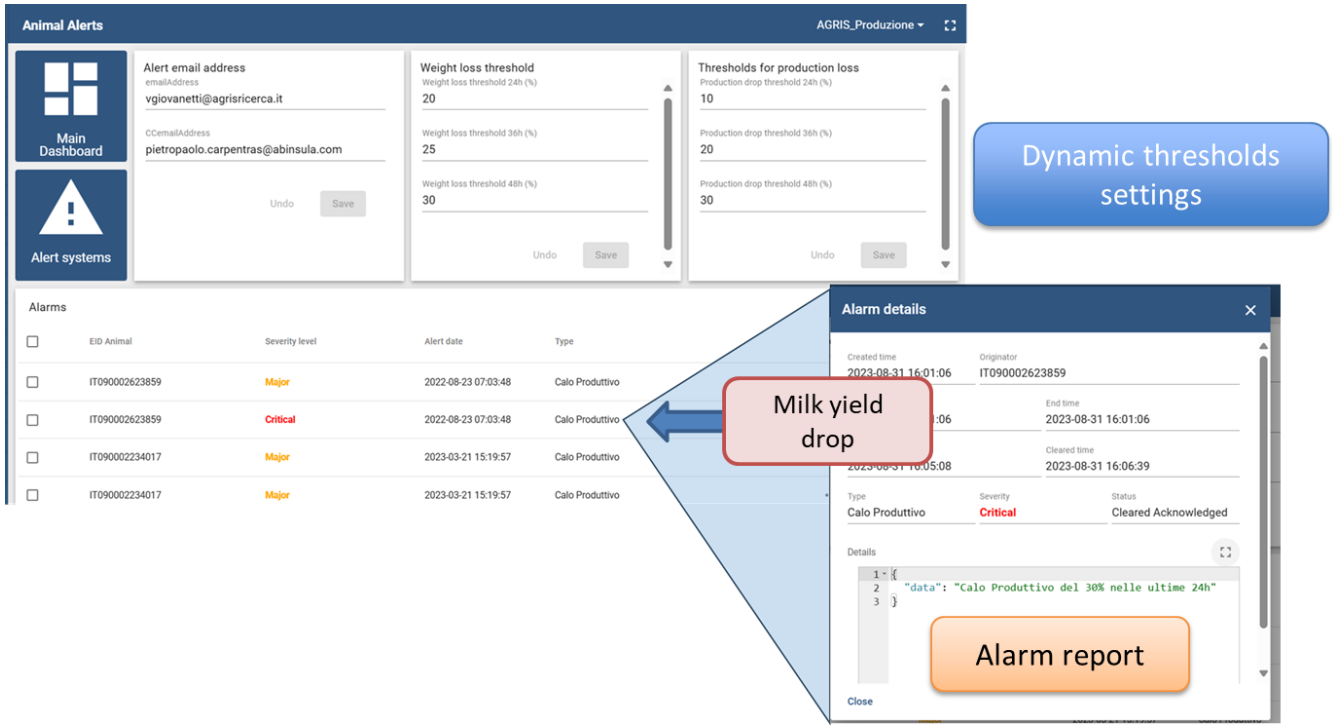
Exploring the use of data from experimental flock to detect welfare problems in milking dairy sheep

Agris

TECHNOLOGIES USED / TESTED	DATA COLLECTED
DeLaval **Milk meters** MM25 + DelPro **software + RFID LF bolus + antennas**	Individual daily milk yield (twice/day) Milking order (twice/day)
Weight static scale (Tru-Test – Datamars) **+ RFID LF bolus + antennas**	Live weight (once a month)
Milkoscan and Fossomatic + Portable somatic cell count	Milk analysis (once a month) SCC levels
Milk tank weight scales	Group milk production weight (every day)
Weather station + indoor sensors	T°, Hum., rainfall, wind, THI (every day)

Exploring the use of data from experimental flock to detect welfare problems in milking dairy sheep

- Creation of a **web dashboard** (Abinsula Company) to record, download and combine the data from different technologies.



- **Development of alert system** (thresholds ongoing implementation) to give **useful warnings indicators** to the farmer / researcher of **potential animal welfare problems** (indiv / group level).

Exploring the use of data from experimental flock to detect welfare problems in milking dairy sheep

Dataset from AGRIS (Sardinia) sent to ARO (Israel) for **statistical analysis** and **algorithm development.**

- Focus on relationship between **milking order change and SCC level**

Findings:

"Predicting somatic cell count in dairy ewes based on milking order"
(G. Shalit Mishal *et al*., Submitted to Animal)

A Laboratory for Precision Livestock Farming (PLF), Volcani Institute, Rishon LeZion 7505101, Israel.

B Department of Industrial Engineering and Management, Ben-Gurion University of the Negev, Beer-Sheva 8410501, Israel.

First highlights:

- Changes in the voluntarily entering order to the milking parlour **may serve as an early warning indication of elevated SCC** (subclinical mastistis) levels in Sarda dairy ewes.

Predictive models help optimize resources and improve animal health and welfare management, **while direct measurement is still useful but often more limited in scope and frequency.**

Exploring the link between milking order and udder health in milking dairy sheep

Findings

Highlights from other trial (Spanish dataset): "Milking order of healthy and subclinically mammary infected dairy ewes in mid lactation"

UAB Universitat Autònoma de Barcelona

A. Recio 1, A. Elhadi 1, A. Salama 1, R. Costa 2, X. Such 1, J. Piedrafita 1 and G. Caja 1.

1 Group of Research in Ruminants, Department of Animal and Food Sciences

2 Servei de Granges i Camps Experimentals

Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

Hypothesis related to milking order:

Healthy ewes come earlier VS sick (mastitis) ewes come **on delay.**

Problem: Mastitis in small ruminants has:

Low prevalence for clinical (<5%)
High prevalence fo subclinical (>30%)
Controversial link with SCC (>500·103 cells/mL?)
→ Intramammary infection needs to be assessed by **bacterial culture**
→ **trial at UAB**

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Exploring the link between milking order and udder health in milking dairy sheep

Findings

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"Milking order of healthy and subclinically mammary infected dairy ewes in mid lactation" (Recio A. et al., 2024).

- 52 days trial (**lact.** 2022)
- 112 **lactating ewes**
- **Indoor** settings (Spain)
- Focus on **mastitis**

TECHNOLOGIES USED	DATA COLLECTED
DeLaval **Milk meters** MM25 SG + **RFID LF bolus + antennas**	Individual daily milk yield (twice/day) Milking order (twice/day)
ALLIC Laboratory, Spain	Milk composition analysis + SCC (once a month)
Bacterial culture (blood-agar/oven)	Bacterial identification (week+1 when SCC >500·10^3 cells)

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Exploring the link between milking order and udder health in milking dairy sheep

Findings

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"Milking order of healthy and subclinically mammary infected dairy ewes in mid lactation" (Recio A. et al., 2024).

→ ***Detailed materials, methods and results available online on TechCare website:***
https://techcare-project.eu/wp-content/uploads/2024/09/Recio_etal_2024_eaap75_milking-order-sheep_oral_s65.pdf

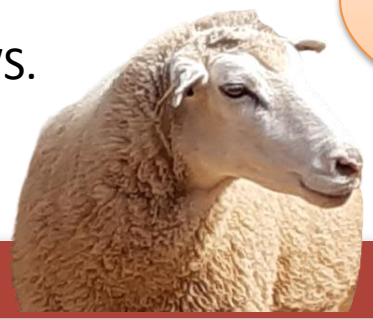
Some conclusions of this trial:

Is milking order feasible as EWS for mastitis in dairy ewes?

1) With this dataset, SCC has not enough sensitivity for subclinically infected sheep udders

2) Milking order:
- Does not discriminate subclinically intramammary infection ewes.
- Depends on BW, breed milkability and parity.
- Last entering ewes have worst udder health.

3) **Other indicators** should be explored as mastitis EWS.






1. On farm trials

Dairy goat

Overview of 3 trials carried out on pilot farms (dairy goat)

PARTNER	PILOT FARM	TRIAL N° - PERIOD	• MAIN INDICATORS • WELFARE ISSUES (WI) ADDRESSED	TECHNOLOGIES TESTED
NIBIO	Meløya	Trial n°1 – Jun 22 to Sep 22	• **Milking order** • **Mastitis, lameness and other welfare issues** • **Daily milk yield, weather conditions** • **Mastitis, lameness and other welfare issues** • **Distance walked** • **Lameness**	• RFID LF tags and antennas • RFID UHF tags and antennas • Individual milk meters • Weather station • GPS, Bluetooth eartags
	Meløya	Trial n°2 – Jul 23 to Sep 23		
	Storsteigen	Trial n°3 – Feb 23 to Apr 23	• **Milking order** • **Mastitis, lameness and other welfare issues**	• RFID LF tags and antennas • RFID UHF tags and antennas • Individual milk meters • Indoor sensors (T°, Hum.)

Exploring the use of different technologies to capture variations in outdoor dairy goat system

- 4 months trial (**summer** 2023)
- 28 Norwegian **dairy goat**
- **Outdoor/mountain** settings (Norway)

- Focus on **mastitis, lameness** and other WI

Objective

➢ *To test monitoring of:*
- *milking order*
- *order on way/return to pasture*

Data collected :

- Welfare assessment scores: Udder score, lameness, mastitis, injuries, …

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Exploring the use of different technologies to capture variations in outdoor dairy goat system

NIBIO

Weather station: SEBA Hydrometri

Milkmeter (individual): GEA

Tech tested in mountain / outdoor facilities

GPS collars and 'bluetooth eartag': RealtimeID

RFID LF: Biocontrol

RFID UHF: Page Up

Exploring the use of different technologies to capture variations in outdoor dairy goat system

Indoor challenges:

- **Welfare assessment variability:**

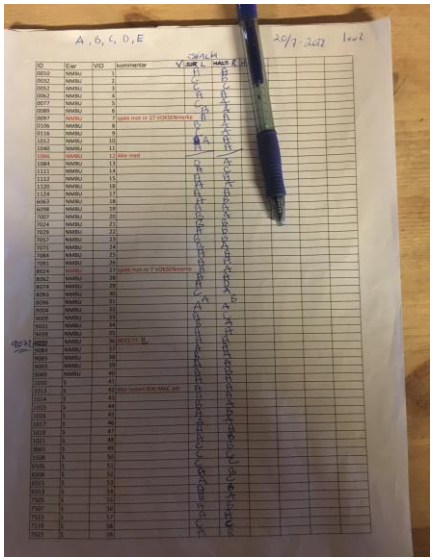
  Few cases (lameness, mastitis…)

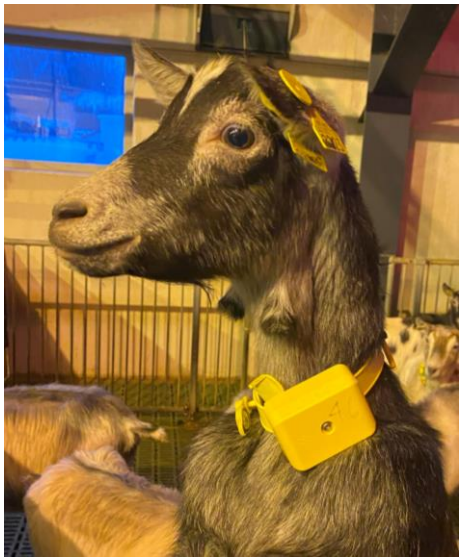
  → no data analysis possible

- **Goats eat almost everthing !!**

  Ear tags and beacons **chewed**, unusable

  →need for protected and adapted technology for small ruminants





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Exploring the use of different technologies to capture variations in outdoor dairy goat system

NIBIO

Outoor challenges:

- **Trials with GPS collars associated with accelerometers & BLE eartag (RealTime ID):**






Technology prematurity: promising technology but poor data collection and quality.

GPS-tracking data for calculations of '**distance walked**': This would need very frequent data to detect differences between dairy goats as **they graze in a flock** and thus has similar distance walked on a rough scale.

More R&D is needed on tech product "eartag with accelerometer" and "bluetooth communication" to consider it useful for Early Warning System.

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Exploring the use of different technologies to capture variations in outdoor dairy goat system

NIBIO

Outoor challenges for stting up technologies

Difficulties in adjusting the **reading quality** in this installation for RFID UHF outdoor

Date	Reader	Antenna	Animal	Read count	RSSI Min	RSSI Average	RSSI Max	RSSI Instantaneous
22.02.2023 05:39	AE3F22-A220	2	99 999 999 903 808	2	-68	-68	-68	-68
22.02.2023 05:39	AE3F22-A220	2	99 999 999 903 805	2	-68.5	-68.5	-68.5	-68.5
22.02.2023 05:39	AE3F22-A220	1	99 999 999 903 818	12	-66.5	-66.5	-66.5	-66.5
22.02.2023 05:50	AE3F22-A220	2	99 999 999 903 815	26	-66.5	-66.5	-66.5	-66.5
22.02.2023 05:50	AE3F22-A220	2	99 999 999 903 815	24	-67	-67	-67	-67
22.02.2023 05:51	AE3F22-A220	2	99 999 999 903 833	8	-66	-66	-66	-66
22.02.2023 07:37	AE3F22-A220	1	99 999 999 903 841	2	-71	-71	-71	-71
22.02.2023 07:37	AE3F22-A220	1	99 999 999 903 878	8	-68	-68	-68	-68
22.02.2023 07:37	AE3F22-A220	1	99 999 999 903 868	2	-69	-69	-69	-69

→ **missing readings and data**

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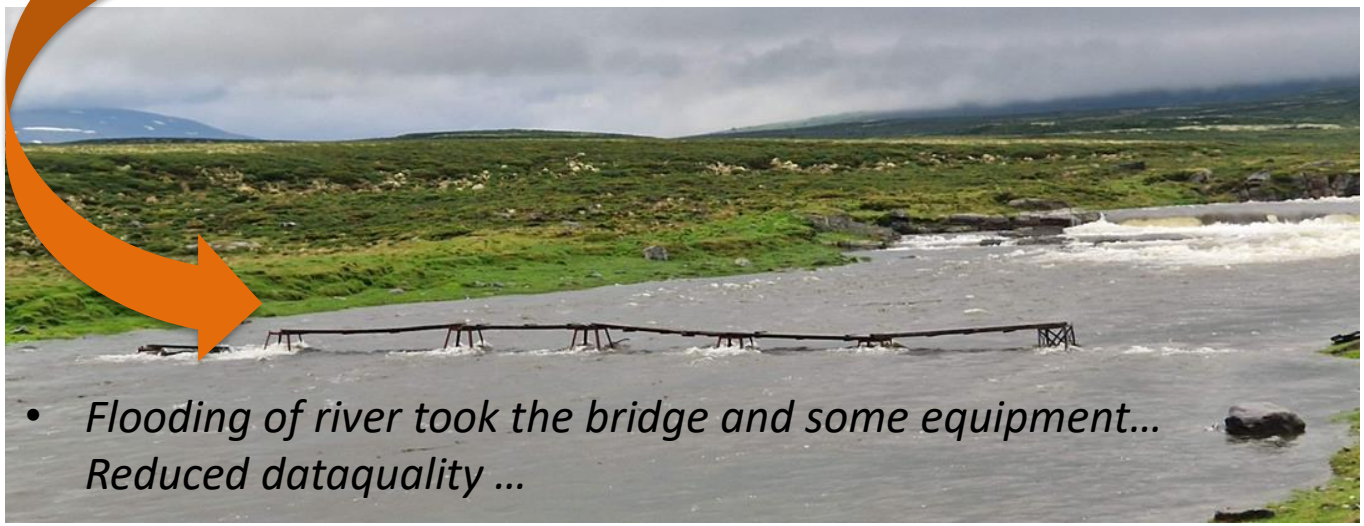
Exploring the use of different technologies to capture variations in outdoor dairy goat system

NIBIO

Outdoor conditions are always challenging for the use of technology!

Extreme weather conditions (climate change?) during trials

- **Changing grazing routine** for goats



- *Flooding of river took the bridge and some equipment… Reduced dataquality …*

- Broken bridge

Take home messages from the on-farm pilot trials

- ✓ **Promising technologies** tested in various sectors and environmental conditions: small ruminants challenges!
- ✓ **Innovative approaches** to capture **variation** between individuals
- ✓ Often **too few welfare cases** to draw final conclusions, but **interesting and promising trends!**
- ✓ Studies to be continued to **further investigate the potential of technologies with data / indicators**
- ✓ Trials which allowed us to select **3 main case studies to collect large dataset during large-scale studies**:
  - ✓ *Weight crate & RFID LF*
  - ✓ *Individual milk meters & RFID LF*
  - ✓ *Indoor sensor & weather station*

Many thanks to all the great colleagues involved in these challenging trials across Europe!

TechCare projet – 07/07/2022 France. IDELE