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How to monitor welfare issues on sheep and goats farms with innovative technologies?

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1) Introduction and objective

*TechCare project, a step-by-step methodology*

Prioritisation of the most important **welfare issues** for sheep and goats in the EU

Identification of main **methods** that could be used to assess each of these welfare issues by conventional **data collection methods of animal-based assessment**

**How to monitor welfare issues on sheep & goats farms with innovative technologies?**

Prioritisation of appropriate and available PLF tools and digital technologies that can potentially be used to assess these welfare issues

Tools available on the market
Tools under development, prototypes

On farm tests

**Presentation objectives**
1. Reminder of the Welfare issues on which the pilot and experimental farms of the project are working
2. Presentation of tool categories and their contribution to the study of WI
3. Presentation of 3 examples of technologies used in the project to study the welfare of sheep and goats
2) Animal welfare issues studied in TechCare

Welfare Issues

- Under nutrition; Malnutrition
- Mastitis
- Ectoparasites
- Gastrointestinal parasites
- Food competition; Agonistic behaviour
- Lameness; Claw health
- Maternal relationship and lamb mortality
- Inappropriate housing
- Water availability and quality
- Climate stress

From various welfare issues to 4 main welfare indicators categories

- Behavioral change – activity, food, and water intake, contact patterns between animals, especially mothers and offspring (animal-based)
- Weight loss or change in body state (e.g., condition/fatness) (animal-based)
- Milk yield and quality (animal-based)
- Environmental indicators (resource-based)
3) PLF for AWE: five PLF families

1. Identification, location, proximity & activity
2. Liveweight
3. Water consumption
4. Milk yield & quality
5. Environment (indoor & outdoor)

FIVE PLF FAMILIES

TECHNOLOGIES, TOOLS, SENSORS...
### 3.1) Five PLF families: Identification, location & proximity, activity

<table>
<thead>
<tr>
<th>Individual identification</th>
<th>Location &amp; proximity</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ RFID (radio frequency identif.)</td>
<td>✓ Bluetooth Low Energy (BLE)</td>
<td>✓ GPS</td>
</tr>
<tr>
<td>✓ Low frequency (LF) EID readers</td>
<td>✓ GPS tracking</td>
<td>✓ Accelerometers</td>
</tr>
<tr>
<td>✓ Ultra-high-freq. (UHF) readers</td>
<td>✓ Global Navigation Satellite System (GNSS)</td>
<td>✓ Virtual fences</td>
</tr>
<tr>
<td>✓</td>
<td>✓ WISP, LoRA...</td>
<td>✓ Thermal cameras</td>
</tr>
<tr>
<td>✓</td>
<td></td>
<td>✓ Automatic feeders</td>
</tr>
</tbody>
</table>

- **The basis for using other tools**
  - Individual or social *behaviour*
  - Travelled distance
  - *Access to resources* (feed blocs, water troughs)
  - Ewe/lamb *bonds* -> mismothering issues
  - Grassland/ rangeland/ *surfaces* management

- **O** Feeding, drinking, grazing *behaviour*
- **O** Tracking spatial, movement patterns
- **O** Resource *exploration*
- **O** Behavioural organization
- **O** Social *integration*
- **O** Body *temperature*
- **O** Health issues (lameness, mastitis, parasites)
- **O** Predation/stress *sources...*
### 3.2) Five PLF families: Liveweight

<table>
<thead>
<tr>
<th>Static weight platforms (with RFID readers)</th>
<th>Walk-over-Weighing (WoW) platforms</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Static weight platform" /></td>
<td><img src="image" alt="WoW platform" /></td>
</tr>
</tbody>
</table>

- Individual and flock liveweight (**LW**) monitoring
  - **Growth** rate and body **condition**
3.3) Five PLF families: Water consumption

<table>
<thead>
<tr>
<th>Water meters</th>
<th>Water flowmeters</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Water meter" /></td>
<td><img src="image2" alt="Water flowmeter" /></td>
</tr>
</tbody>
</table>

- **Water intake** (frequency and quantity, individual patterns and/or collective motions)
- Heat and hydric **stress**
### 3.4) Five PLF families: Milk yield & quality

<table>
<thead>
<tr>
<th>Milk meters</th>
<th>Milk composition (NiRS &amp; MiRS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Milk meters" /></td>
<td><img src="image2" alt="Milk composition" /></td>
</tr>
</tbody>
</table>

- Milk yield & composition
- **Udder health** status (e.g. indirect assessment mastitis)
### 3.5) Five PLF families: Environment (indoor & outdoor)

<table>
<thead>
<tr>
<th>Indoor</th>
<th>Outdoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ T°C and <strong>humidity</strong> sensors</td>
<td>✓ <strong>Weather</strong> stations</td>
</tr>
<tr>
<td>✓ [Particles]</td>
<td></td>
</tr>
<tr>
<td>✓ <strong>Gazes</strong> detectors [ammonia, CH₄, CO₂]</td>
<td></td>
</tr>
<tr>
<td>✓ Thermal and video surveillance <strong>cameras</strong></td>
<td></td>
</tr>
</tbody>
</table>

- Housing **comfort** and quality
- Quality and **cleanliness** of flooring/bedding
  - **Air** quality
  - **Climatic** conditions and management (performance, decision makings...)

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**INNOVA 1314i**

The Photoacoustic Gas Monitor-INNOVA 1314i selectively

**CX4000**

**gasmet**

**METOS**

**Meteo Pro**

**Météus**
How to monitor AWE with **environmental sensors**?  

**Example**: using T°C and humidity sensors for THI indoor

1) Data on T°C and RH% are **produced**

2) Data are **collected & processed**

3) EWS produced - THI thresholds are **analysed**

4) Farmers’ decision makings around:

- **Temperature** (°C) and
- Relative ambient **humidity** (%) at different points of the shed

- **THI are calculated**

- With regard to:
  - Stocking density
  - Year season
  - Physiological stages
  - Daily routines changes
  - Data from other PLF tools (e.g. heart & respiratory rates, rectal temperature)

- **Comfort**
- Quality of indoor environment and housing conditions
- Stocking density
How to monitor AWE with a Walk-over-Weighing (WoW) platform?

- **Monitoring LW:**
  - Time and labor consuming,
  - Stress source for animals and operators
  - Difficult task in outdoor conditions

- An **automated WoW system** for remote LW monitoring of sheep in a range of systems was developed

Liveweight is collected when the animal **voluntarily crosses** the **WoW platform**, **strategically placed** in a mandatory path, combined with a "attraction" area to stimulate passage.
Feasibility of using the WoW demonstrated in a range of farming conditions

- **Indoor**: adult ewes (*Romane* breed)
- **Outdoor (spring)**: rotational grazing (*Romane* ewelambs)
- **Outdoor (winter)**: extensive grazing (rangeland; adult *Romane* flock)
- **Indoor**: dairy ewes (*Lacaune*) at exit race of milking parlour
- **Outdoor (spring)**: rotational grazing (*Mérinos d’Arlès* ewelambs)
- **Indoor**: fattening lambs (*Mérinos d’Arlès* breed)

More information:

- doi:10.1016/j.compag.2018.08.022
- doi:10.1017/S1751731117002609.
- doi.org/10.1016/j.anopes.2022.100032
- https://arxiv.org/abs/2208.00961
- https://www.youtube.com/watch?v=te0mXY3Yum0&t=19s
How to monitor AWE with a Walk-over-Weighing (WoW) platform?

Body condition; nutritional status; health; behavior

1) Data on individual LWs are produced

- Progress on individual LWs are constantly and automatically collected

2) LW data processed automatically

- Outliers are detected and removed

3) EWS are produced around:

- LW gains or losses (i.e. undernutrition/malnutrition events)
- Growth rates (ADG) in lambs & yearlings
- Health status (e.g. GIP)
- Lambing events
- Behaviour progress (e.g. through kinetics of visits to be related to weather or other events...)

4) Farmers’ decision makings around:

- Feeding and nutrition management
- Grazing & supplementation strategies
- Veterinary assistance
- Labour planning
- Slaughtering schedules

https://oriole.sk8.inrae.fr/
How to monitor AWE with RFID UHF tags and antennas?

Behavioral change, use of key resources; Health

RFID Low frequency vs. High Frequency

Main characteristics and differences

<table>
<thead>
<tr>
<th>EID Tags – RFID</th>
<th>Low-Frequency (LF)</th>
<th>Ultra-High Frequency (UHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water effect</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Read range</td>
<td>Up to 80 cm</td>
<td>Up to several meters (~6m.)</td>
</tr>
<tr>
<td>Adjustable Read range</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Multiple readings</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>
How to monitor AWE with **RFID UHF tags and antennas**?

**Behavioural change, use of key resources; Health**

**Multiple readings in large corridors**

- **Wood fences**
- **Metal fences**

- UHF waves reflect on metallic surfaces: « Tunnel effect » of metal fences

**Instructions:**

- Install UHF tags on each animal, antennas inside/outside of the shed, record data with
- Count animals during batching (entrance/exit of an area/shed)
- Follow the order of individuals
- Identify missing individuals identify animals that are lagging behind
- suspect potential lameness
How to monitor AWE with **RFID UHF tags and antennas**?

**Behavioural change, use of key resources; Health**

Track attendance of individuals at a point of interest (water trough)

- Install UHF tags on each animal, antennas inside/outside of the shed, record data
- Count the number of visits (habits)
- Follow attendance, duration over time
- Identify breaks in habits, drops in attendance, absences
- Suspect health, lameness, or hydration issues

**Example:** Detections of a lambs’ group for 3 consecutive days
01/07/2022 to 03/07/2022

**Example:** Cumulative detections per hour, for 1 lamb, over a period of 2 months
01/06/2022 to 31/07/2022
Conclusions

Making the right choice

✓ A project to **test, adapt and evaluate** a fairly wide range of technologies, for **small ruminant farming systems**
✓ Advance knowledge and the state of the art for these sectors

GPS and proximity sensors, weight platforms, video cameras, EID UHF tags, Accelerometers, GNSS (Global Navigation Satellite Systems) etc.

⇒ **highly frequent in a diversity of situations:** the question to address makes the difference!

✓ **Some essential points to help make the right choice and continue to improve and adapt the solutions**
  - High TRL score (availability in the market... or almost...), for pilots and large-scale farms
  - **Acceptability** and **economic affordability** by the end-user (purchases and subscriptions)
  - **Ease of use**, maintenance
  - **Genericity**: able to cover a range of conditions & situations (e.g., indoor, outdoor, animal category & status)
  - **Combining** techs and applying **EWS ad hoc** (according to the specific local priority): a good “umbrella” approach to detect potential health issues?

Follow the project on our networks to discover the next results