Improvement of the technical-economic management of extensive livestock farms in the Catalan Pyrenees using geolocation and animal monitoring systems

Summary

The project aims to provide the extensive livestock farming sector (cattle, horses and sheep) with new technological tools to obtain and manage as much data as possible from a herd with minimum involvement by the farmer. Geolocation and monitoring of animals uses various algorithms to analyse the information collected in order to identify possible incidents and improve the management of animals and pastures.

This Operational Group, consisting of the Unió de Pagesos (Farmers' Union of Catalonia), the Institute of Agrifood Research and Technology (IRTA), Digitanimal, SL and the cooperatives Pirenaica Societat Cooperativa C. LTDA and Agrària Ramadera del Pallars de Sort, SCCL, focuses on exploring the full potential that these technologies can provide to help overcome the main challenges facing the sector:

1 – Improving the economic viability of farms.

- Adjustment of the devices to herd activity patterns to improve technical-health-financial management.
- Provision of the location and monitoring of the movements and condition of animals and herds.
- The task requiring the most labour is supervising the herd and monitoring the animals' health (behaviour, diseases, births, etc.). Reducing working hours is a key factor in lowering costs and increasing the financial viability of farms.

2 – Efficient and sustainable use of natural resources and the maintenance of biodiversity.

- Analysis of the grouped data related to the animals' location to determine grazing pressure, preserve the pasture's quality and ensure the sustainability of the silvopastoral system.

3 – Proximity of herds to wildlife.

- A third challenge is the fact that herds live in proximity to other wildlife. The technology for detecting wildlife attacks will be assessed, and patterns of behaviour to detect and document them will be established

Objectives

Facilitate control of herds, management of technical-health and pasture data to improve the productivity and viability of extensive livestock farms by using geolocation systems and by monitoring animals using collars.

Characteristics of the technological tools:

- A position sensor that shows the location.
- A triaxial accelerometer, which shows the level of activity.
- A surface temperature sensor.
- A low-consumption long-range communications module.
- A cloud server, and various databases and algorithms for extracting patterns and creating notifications.
- A long-life battery.

Description of the actions carried out in the project

The following specific actions were taken to achieve the objectives:

- Action 1: Implement the use of a geolocation and monitoring system for animals to identify the shortcomings and improvements required in order to carry out the subsequent actions.
- Action 2: Study the behaviour of the herds to determine patterns that can be used to manage pastures on a sustainable basis.
- Action 3: Study the animals' activity and temperature data to ascertain their condition and adjust the patterns of activity to the conditions in the study area, to improve the farms' technical-health-financial management.
- Action 4: Assess the costs and savings involved in using the tested technology, compared to the current management of the farms.
- Action 5**:** Test this technology in the herd in situations simulating wildlife attacks, to record the animal's/herd's reaction and adjust patterns of activity in the event of possible wildlife attacks.

Final results and practical recommendations

Action 1: Implement the use of a geolocation and monitoring system for animals to identify the shortcomings and improvements required in order to carry out the subsequent actions. Although the zone of the Alt Pirineu presents serious challenges to use technologies based on geolocation because of the lack of network, the pilot project shows that there are potential solutions ready to be implemented. The most economical solutions are based on mobile network collars or Sigfox and have produced a satisfactory result, though they have some limits. In the case of mobile network, the limit is in the antenna cost, while in the case of Sigfox is in the fact that a fee has to be paid to use the service and that there is a limit on the number of messages that can be sent per day. The comparison of these two systems has not proved any advantage of one over the other.

Action 2: Study the behaviour of the herds to determine patterns that can be used to manage pastures on a sustainable basis. The data obtained from the collars are useful to know the area where animals pasture, even with emissivities below the 50% and an average of one message per hour. With the use of heat maps or crosschecking with other map layers through SIG systems, we were able to collect useful information about the use of resources, the excess of stocking density in concrete areas or the insufficient use of other areas that might lead to the loss of pasturelands.

Action 3: Study the animals' activity and temperature data to ascertain their condition and adjust the patterns of activity to the conditions in the study area, to improve the farms' technical-health-financial management. Although the results of the second year of the study improved significantly the ones obtained in the first year, the message values per day obtained are below the values that would be optimal according to the distribution company (minimum of 70% of emissivity) in many cases, with regard to its performance in flatter areas. That is why there is still a lot of room for improvement at endowing theses mountain areas with better network. The developing of more durable batteries at a lower cost has to allow to send more messages per day over time, regarding the current 48.

The collar temperature sensor may be more useful not in terms of the temperature value, which might differ between animals because of the position of the collar, but in terms of the variation patterns it may record. That is because it may help detecting changes in the animal activity, since when they move the head, the sensor comes closer and gets away from the neck and so does the recorded temperature. Nevertheless, notable changes in the average temperature patterns of an entire herd may indicate

important things. Finally, it is recommended to refuse every sensor that records data continually over time below the 15ºC, since it means that they are not working properly.

A way of working on the data recorded by the collars is analysing in detail the sudden changes that may be observed in a herd. The accuracy of the analysis depends on the quality of the networks and on the amount of the collars in the herd. Data should be crossed with other layers, such as orography, daily meteorology, pasture state, cowboy and shepherd movement, tourism interaction, potential predator movement, etc. A second choice is reverse evaluation, this is, carrying out a retrospective analysis of the algorithm behaviour of a particular case. A third choice is that algorithms emit a warning signal when detect a significant change in the way an animal behaves. With regard to this, we have to mention a successful case in which the system warned about a problem in an animal and when we went to look for him, we found that it got mastitis and had to be treated. The aim is that all the work done relying on the conclusions 4 and 5 might end in a signal system.

Although we had available 163 collars for the first season and 228 for the second one, so we got 391 opportunities to follow an expectant female, in the present study we only had 3 animals in this condition, so it was not enough to extract meaningful data. However, everything points to the fact that if the system knows that an animal is pregnant, it might emit a warning signal for the shepherd of a message per hour (even in low emissivity mountain areas), taking into account the changes in the animal activity and temperature with regard to its history and to the rest of females, and the propensity to go to the peripheral areas of the group.

While the warning system was able to detect a case of mastitis, and the combination of activities and temperatures may be useful to identify expectant animals that are about to give birth, lame animals did not show any clear pattern able to be identified by the system, according to the current data, so we will have to wait to collect more accurate information on this type of animals to be able to deal with them.

To know the moves and the use of space of sheep herds, we may use information collected along the day, but to know the state of the animals it is better focusing on night hours, which are the ones where there is no human intervention.

Action 4: Assess the costs and savings involved in using the tested technology, compared to the current management of the farms. The use of this tool does not generate any important economical saving within the productive system, though it supposes an improvement of the animal and pasture management, as well as the optimisation of the time of shepherd. If we compare productive systems that use collars and the ones that do not use them, we observe improvement on different aspects. First of all, there is a reduction of the number of hours of dedication in the cases with collared herds. Furthermore, it improves and speeds up herd management in the pastures, as well as of reducing the time spent in locating the animals in the pasture areas, which is key in high mountain areas with difficult access. Moreover, the use of collars also contributes to identify whether there is any animal with health problems and to detect predator attacks, which are very important aspects for high mountain herds.

Action 5: Test this technology in the herd in situations simulating wildlife attacks, to record the animal's/herd's reaction and adjust patterns of activity in the event of possible wildlife attacks. Despite the low coverage of potential bear attacks by the study and the connection problems of the collars in many places of the study area, the data shows great potential to warn the shepherds of behavioural changes compatible with the presence of that predator, since it has been possible to detect changes in the activity and/or superficial temperature of animals in cases where an attack has

taken place or where the presence of bears was confirmed. In the future, more available data should be able to generate an alarm relying on the information collected by the system and proper algorithms.

Although a simulated attack was planned to be realised within the study once the behaviour patterns before possible bear attacks were established, the low incidence of recorded attacks suggested putting the simulation aside for future studies, because the stressful situation that would provoke on the animals makes the simulation inadvisable and only feasible when it may be useful for a real validation of a database with enough real data collected by geolocation systems. These conditions are not met for now.

Conclusions

In conclusion, it has been proved that this technology is an opportunity for extensive livestock farming, even though the following is necessary:

- Ensuring proper network to achieve the greatest emissivity of collars.
- Shepherds should know what type of network they got when purchasing collars (mobile network, Sigfox network, Lora network…).
- Antenna installers are recommended. They should be technicians (which may belong to the own public administration, if it already exists, or to the private sector) and would be in charge of the antenna maintenance and testing before animals reach the mountain and during the season.

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Subject area(s) of application

- ☒ Agricultural production system
- ☒ Agricultural practice
- ☒ Livestock farming and animal welfare
- ☒ Biodiversity and environmental management
- ☒ Competitiveness and agricultural and forestry diversification

Geographical area(s) of application

PROVINCE(S): Lleida
REGION(S): Pallars Sobirà

Project website and dissemination

www.uniopagesos.cat

https://www.youtube.com/watch?v=lqf-Sdv5Ods

More information on the project

PROJECT DATES	TOTAL BUDGET
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