Feeding behaviour of pregnant sows monitored by means of RFID active tags

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Abstract
The main aim of the research was to present the technical features of the electronic identification systems to study animals and to analyze the behaviour of pregnant sows kept outdoor using new remote monitoring system. In a pig farm located in a mountainous area of Tuscan-Emilian Apennine an outdoor enclosure was examined by means of an innovative monitoring system based on the use of RFID technology (Radio Frequency Identification). The behavioural studies are presented in this paper. Active tags automatically send impulses so the animals can be identified by even distant readers. This ability is guaranteed by using a power battery. The experimental trials were carried out in January 2008. Inside the pen 15 pregnant sows were kept. They could freely move in the enclosure, using a closed hut for resting, feeders and drinkers. Two sows were provided with an active tag inserted in a collar. The RFID equipment was arranged to monitor the presence of the sows in feeding area. In this way it was possible to analyze the feeding behaviour of the sows.
As first result of experimental trials it was possible to state that RFID technology based on the use of active tags can be suitable for monitoring animals in mid-size outdoor pens, providing digital data that can be easily computerized.

Keywords: RFID, animal monitoring, animal behaviour, pregnant sows.

Introduction
Animal monitoring in outdoor grazing areas or in small pens was carried out with different methodological and technological approaches. Different survey techniques have been defined during last years in order to solve different drawbacks in instruments and to arrive to a significant improvement in data collection results. Techniques used till today have regarded the use of videotaping equipment or photographic cameras, but in the latest years the possibility to follow the animals from space by means of satellite telemetry, especially with GPS, has become a reality (Barbari *et al.*, 2008). The continuous technological progress has required the use of very complex structures and also the design of more and more reliable devices, adaptable to every animal species.

Recently the spatial identification process of animals (Jansen *et al*., 1999; Wismans, 1999) has realized a further development thanks to RFID (Radio Frequency Identification) technology and to other wireless technologies which allow the direct observation of a single animal in specific survey-areas (middle size grazing areas, drinking or feeding areas, cooling areas, etc.).

Such systems have initially found wide spreading in diversified fields such as logistics, transports, etc. For example, the Georgia Ports Authority (GPA) has set to begin installing RFID technology at the Port of Savannah, to track shipments being brought in and out of the port (Wang *et al*., 2006).

With adjustments in size and weight, these devices based on the use of active tags can be suitable for surveys of remote animal monitoring. The system allows to collect digital data on animal position, easily computerizable, even if it does not give detailed information on the behavioural patterns.

The aim of the study was to examine the technical characteristics and to check the application of electronic identification systems for the study of pigs in small outside pens. The presentation of preliminary results can be useful to appreciate the real technical capacities of RFID active tags.

Materials and methods

Specifications of the RFID Technology

The RFID technology is an automatic wireless identification system composed of three units: a transponder (derived from transmitter/responder) or tag, a reader and an antenna. The reader is used to read the information on the tag, which is composed of a memory chip and an antenna. RFID transponders may be active or passive.

Passive tags do not have batteries and work only if they are sufficiently close to electromagnetic impulses. They are inserted on collars, in earrings or in other subcutaneous places using different methods from one species to the other. The tags allow the animals to be identified when they approach the area under survey. In order to collect information on the animals' behavior in the limited study-areas, for example as regarding the use of equipment, the passive tags can adequately fulfill this task.

The system was recently and successfully applied to individual showering cages for pigs (Barbari, 2005) and to groups of cattle close to feeding areas and other functional areas (Eigenberg *et al*., 2005).

Active tags are very interesting, especially for animal behavior studies. They automatically send impulses so the animals can be identified by even distant readers. This ability is guaranteed by using a power battery. These devices can be used to monitor animals in mid-size outdoor pens, providing digital data that can be easily computerized.

The systems can be based on two different operative concepts: RTLS systems (Real Time Location System) and Marker systems (or "markers" as they are called by company, Identec Solutions ILR®). They were described in detail in previous studies (Barbari *et al*., 2008 a; Barbari *et al*., 2008 b).

In this paper only information on RFID tags and position marker running is given. When the tag passes the induction loop connected to the position marker, it is "woken up" and records the information of its position. The UHF Reader transmits and receives data by antennas at distances up to 100m. Each reader guarantees identification of a large number of tags located simultaneously within the study's read zone. The high rate of transmission allows communication even with fast moving tags.

Study area

A testing trial was carried out in the month of January 2008 by the Department of Agricultural and Forest Engineering to investigate a possible application of RFID system in a pig farm located in a mountainous area of Tuscan-Emilian Apennines (Figure 1).

The study area is an outdoor completely fenced pen. The surface is about 6.000 m^2.

The pen is provided with metallic feeders, drinkers and a resting-shading area. Around the feeding area and the resting area markers are placed to collect the presence of animals.

Figure 1. Study area monitored during testing trials

Methods

A rigorous protocol was arranged in order to fully test the methodology and to draw objective conclusions about the potential applications of the system. The protocol was organized in different operational phases:

(1) setting up of RFID components, like antennas, reader, position-marker for external loop, hub and laptop (Figures 2 and 3);

Figures 2 and 3. Installing antennas and reader for RFID system

(2) uploading configuration parameters to the RFID active-tags (identification number, the ping-rate of transmission, etc.);
(3) deployment of the RFID active-tags on the sows;
(4) capturing the animals and recovering instrumentation;
(5) processing data on PC.

Five pregnant sows in a group of 15 sows were provided with a RFID tags, inserted inside a plastic box fixed on a neck collar (Figures 4 and 5).

Figures 4 and 5. The active tag is put inside a plastic box and connected to a collar support to be fixed to the neck of the animal

The boxes were painted with different colours to recognize the single head.

During the processing phase we selected two tags (0.380.111.929 and 0.380.001.250) to be the data source for the analysis. Respectively they automatically send impulses to distant readers in regular intervals of 30s and 2s.

The experimental trials went on for 15 days. Three days were chosen for processing, that is from January 20th to January 22nd 2008.

Figure 6. Sows with RFID-collar close to feeding area

Results

The data collected during the experimental trials, immediately available in digital format (xls format), were examined and analyzed (Table 1).

From the analysis of the data significant evaluations in quantitative terms emerged (639 total data). However the qualitative judgment on the position is not positive. From the observation and selection of assessments only the number of presences of animals in the

feeding area was drawn. It was not possible to evaluate the real time presence of the sows inside the area.

Table 1. Data collected by transponder available in spreadsheets

Date	Time	IP address of Reader	ID of Reader	ID of Tag	Tag battery life	Marker data
Jan 20-08	11:00:28 AM	192.168.0.84	0074611309	0.380.001.250	Good	New 1 1576s
Jan 20-08	11:00:48 AM	192.168.0.84	0074611309	0.380.111.929	Good	New 1 8028s
Jan 20-08	11:01:14 AM	192.168.0.84	0074611309	0.380.001.250	Good	New 1 1622s
Jan 20-08	11:01:18 AM	192.168.0.84	0074611309	0.380.111.929	Good	New 1 8058s
Jan 20-08	11:01:30 AM	192.168.0.84	0074611309	0.380.001.250	Good	New 1 1638s
Jan 20-08	11:03:33 AM	192.168.0.84	0074611309	0.380.001.250	Good	New 1 22s

The graph of figure 7 clearly shows how the two monitored sows gave very different results in terms of attendance at the feeding area.

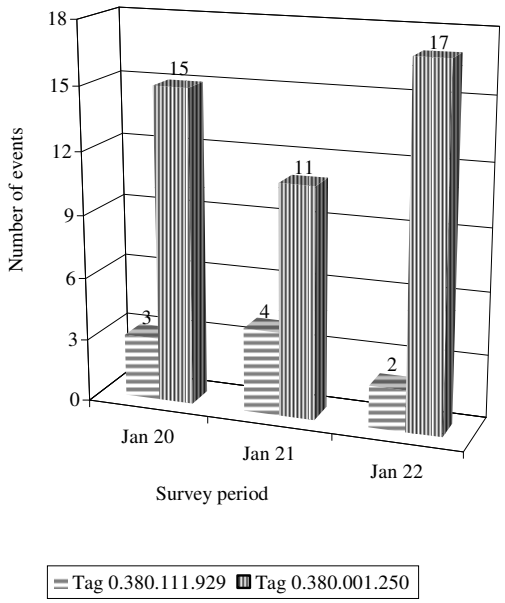

Figure 7. Attending of the feeding area by the two sows

For tag 0.380.001.250 the number of counted events (43) is much higher than for tag 0.380.111.929 (only 9), even if with diversified acquiring times. As a result, we can state that for studies on the behaviour of animals it is much better to use devices with short intervals (e.g. 2s), in order to obtain much detailed information.

During the data processing it was not possible to gather information on the times of attendance of the sows at the feeding area, due to problems on the software for the data management which is at the moment in phase of implementation.

Therefore, especially in this step of hardware and software experimentation it would useful to support the RFID technology with videocameras in order to compare images with data coming from RFID system and to obtain more information in terms of reliability and real precision in measurements.

Conclusions

The active RFID transponder could provide benefit in the scientific research of animal behaviour. The use of active RFID transponders working together with markers could be an excellent substitute of videocamera survey to monitor animal behaviours for scientific researches.

Further improvements could regard the device installed on the animal (neck collar or other system), that needs to be reduced in size and weight and designed in such a way to reduce lesions on the skin and losses on the ground.

First trials seem to show good results of applicability, considering that the systems are not engineered for this specific purpose. As for the development of passive RFID, the fall of tag size and price of the system will open new opportunities to find application in animal breeding field with regard to rational management of resources, animal welfare and consumer satisfaction. The availability of increasingly cheap RFID systems can encourage the spreading in scientific researches about animal behaviour.

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