Working of Active RFID Tag in Tests on Pigs and Horses

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ABSTRACT

Active RFID beacon tags, combined with technologies based on the use of area markers, are a solution to automate the recording of data about the identification of the animals in the space. The tags available on the market are still of big size when applied on animals because they are designed for automotive or logistic purposes. The applicability of tags as well as their correct functioning are related to the size and the body structure of the animal species taken into consideration.

Previous studies were carried out on pigs. Although the hard experimental conditions, the trials with pigs provided enough information to test RFID active tags on other animal species.

An experimental trial has been recently conducted with horses. Inside a paddock three different areas were bordered with the markers: drinking place, manger and resting room. Two horses were equipped with tags. Horses have a completely different body structure from pigs. The tag application is simpler. Furthermore horses behave in a different way from pigs inside a bounded area. Therefore also the tags work differently displaying records more clearly and computably.

Outcomes of RFID tags were compared with video recordings obtained in the same situation in order to count missteps or loss of data. The results show critical states related to the animals, size of the area monitored, presence of interference situations and other parameters.

The evaluation tests carried out on pigs and horses provide information about how the system works. The different conditions recorded on pigs and horses are useful to understand how to apply this technology in different cases of study.

Keywords: Active RFID, area marker, automatic data recording, space monitoring, Italy.

1. INTRODUCTION

Farm building science, as well as all the other sciences concerning breeding management, needs a lot of information about animal behaviour. Data are necessary to test management improvement and technological solutions in order to increase animal welfare and to obtain more streamlined breeding process.

Much information is related to the position of the animals in the space available for them. The position depends on individual and group choices and preferences. To obtain this kind of information by using video recording for statistical results or real time subsequent management, actions could be more and more expensive, because of the labour costs for monitoring, when the number of animals increases. In some cases a solution could be the use of automatic video

M. Barbari, S. Simonini. "Working of Active RFID Tag in Tests on Pigs and Horses". International Commission of Agricultural and Biological Engineers, Section V. Conference "Technology and Management to Increase the Efficiency in Sustainable Agricultural Systems", Rosario, Argentina, 1-4 September 2009. The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the International Commission of Agricultural and Biosystems Engineering (CIGR), and its printing and distribution does not constitute an endorsement of views which may be expressed. Technical presentations are not subject to the formal peer review process by CIGR editorial committees; therefore, they are not to be presented as refereed publications.

recognition, but till now computer processing has not been able to recognize animal individual so the system should provide less information.
Different Real Time Location Systems are available to report automatically the position of things in the space. They are based on radio frequency identification, but few of them are suitable for animal monitoring purposes. Beacon active RFID tag with an area marker is one of them.

2. MATERIALS AND METHODS

After two tests carried out on pigs, a new test with horses was planned. We have learnt from the mistakes of the two previous experiences (Barbari *et al.*, 2008; Barbari *et al.*, 2008), carried out in really bad conditions, how to get the best outcome from the system . A comparison with the previous studies therefore completes this research.
The trial lasted 10 days, from March 13th to March 23rd 2009. Five days (March 17 – 21) were analyzed for this study. On March 20th the horse was without tag for a long period.
At the beginning of the experiment two horses were involved, but few hours later one of them destroyed part of the RFID monitoring system of the other one trying to eat it. This reduced the data collection to one head.

2.1 **Description of the Area and Experiment Design**

The test was carried out inside a horse paddock, enclosed with stake and electric fence, 28 x 15 m wide. The paddock was provided with a wood shelter for the rest of the animal, a manger with manual supply and an automatic drinker. Shelter and manger were in one short side of the paddock whereas the trough with drinker in the other to stimulate the animal to move from one part to the opposite one.
An active beacon tag was applied at the horse using an iPod touch armband modified to contain it. Figure 1 shows the armband applied to the horses. The tag was set with a ping rate of 2 seconds so it sent signal at this slot. Two antennas received the signal emitted by the beacon tag. A reader converted the signal of the antennas and sent it to the computer to record it. Three marker devices were used to bound the area of interest: one to mark the manger, one for the drinker and one for the resting shelter.

Figure 1. Tag Applied to the Horse (on the Leg and on the Cloak)

Two cameras and one digital video recorder were used to compare the images with the RFID system. One camera was used to check the manger and the shelter and the other one to control the drinker. Both of them had the night viewer. In this paper drinking area is not taken into consideration.
A computer set with a Solid State Drives was used to minimize the risk to lose data because of animal pushes or during the hard transport conditions. In the area there was a simple access to electricity at 220 V.

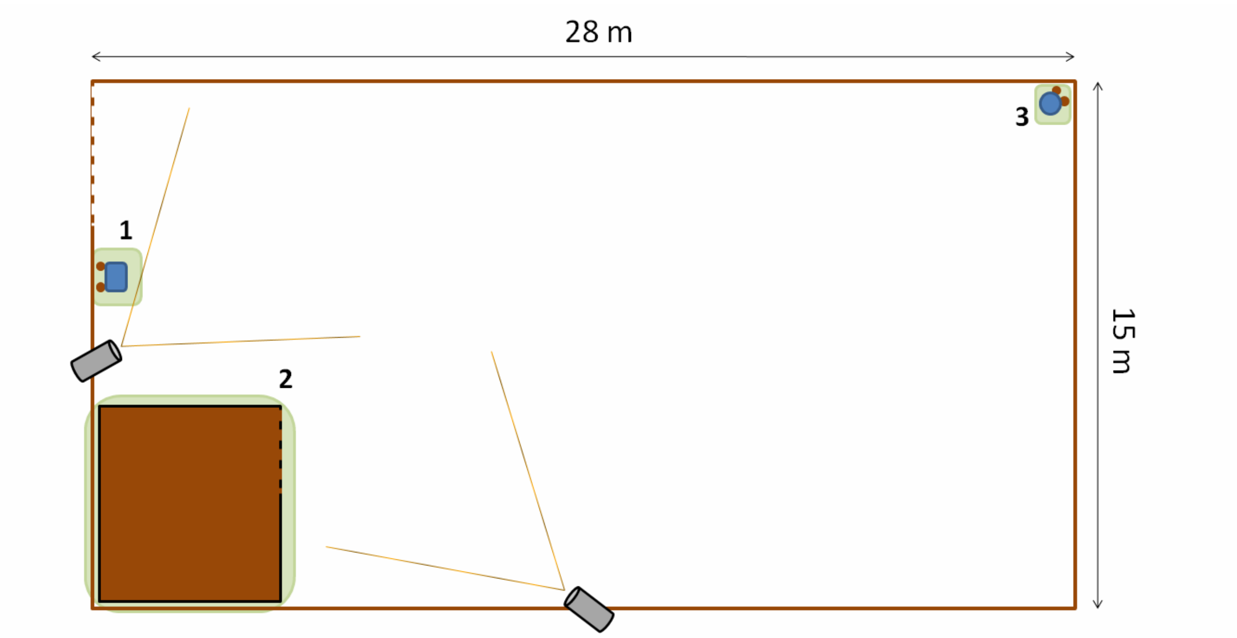

Figure 2. Layout of the Experimental Paddock

All the listed devices were connected to the power supply. The loop of the marker in the resting area was positioned inside the shelter fastened to wood. The loops of the manger and the drinker were mounted around them in order not to harm the animal.

2.2 **RFID System Functionality**

The core of the system was a beacon active tag designed by IDENTEC Solution. Its dimension was 131 x 28 x 21 mm per 50 g of weight. It was quite big for animal use. The beacon tag sent a signal with a 2 second ping rate. The antennas work in a range from few centimetres to 100 meters. The reader was connected to the computer and received signals from antennas by cables. It could manage 100 tags in the same time. Markers were provided with an integrated antenna called loop made with an electric cable.
The loop could cover an area from few square centimetres to 100 square meters. When the tag enters the loop, the marker drives it to change the signal to send to the reader with the number of identification of marker. The range of work around the loop could be regulated according to the marker setting and environmental conditions. By using a specific tag with led that lights when stimulated, it was possible to adjust the system.

As this technology is based on radio frequency, it is absolutely necessary that the tag is always free in the air. During trials with sows, the main problem was that the animals slept covering the tag, causing the loss of important amount of data. To avoid it the first place we thought suitable to apply the tag was the leg of the horse.

2.3 **Elaboration**

At the end of the trial, the video was transferred onto a spreadsheet in order to compare the data obtained by video images with the data of the active RFID system recording. Human observation of the video was used as a reference. The RFID database was exported in a spreadsheet and some formulas were used to obtain data usable in a friendly way. The comparison allowed us to evaluate the reliability of the RFID devices to match the events and to count the time (seconds) when the animal was in the marked area. Events were considered “in and out” of the shelter and of the manger. There were 108 seconds of difference between the two systems because of misalignment of the internal clock. This difference was reckoned during the data analysis step. The drawing up of a model was necessary in order to compare trials, with animals of different species and in different environmental conditions. Reference records were established as estimators of the precision of the RFID system in different situations. If the RFID system works perfectly, the relation between the data has to be a linear function with a slope equal 1 and to y-intercept equal to 0. Otherwise, for lower records the linear regression output will be a function with a slope lower than1. Slope range could move from 0 to 1 according to the precision of the system in different situations. The more precise the records are the more the slope tends to 1. Different slopes could explain differences between areas, animals and happened problems. The line with slope equal to 1 has been drowned in all the figures to have a reference mark to compare with other lines.
Statistical analysis of the error of the RFID device was not taken into consideration because the system was too much affected by external factors which are the subject of this study.

3. RESULTS AND DISCUSSION

Since the horse lost the armband from its leg after few minutes, the tag was linked at the cover of the animal just under the neck. This position was perfect for radio interconnection with the marker of the manger but not for the marker of the shelter. During the long time resting the animal inside the shelter lied down covering the tag causing the loss of data. Furthermore, for an unknown reason, it tried to take the tag out of the cover and after several attempts the horse tore it off. For this reason the data of the day 4 were not usable. The horse ruined the armband, so adhesive tape was used to link it again (Fig. 3). The final position was higher than the first one causing mismatching with the loop antenna of the shelter marker. Inside it, the loop was closed to the base of the frame so it was probably too far for the tag. RFID data of day 5 showed this problem.

Figure 3. Tag and Armband Before and After the Trial

3.1 **Manger Monitoring Comparison**

During the fourth day of recording, the RFID system reported 98% of the events at the manger (107 of 109). There was a loss of 2 events on day 2 because of a lack of power at the manger marker. The regression line of the recording of seconds by RFID devices during the first three days showed a slope of 0.957 with no data particularly far from the line (Fig. 4). This results mean no particular problems happened. The RFID recorded constantly with precision, closed to the reference.
Also during day 5, when the position of tag changed, the data displayed the same values. The slight difference in the slope could be caused by a different ranging work between tag and manger marker.

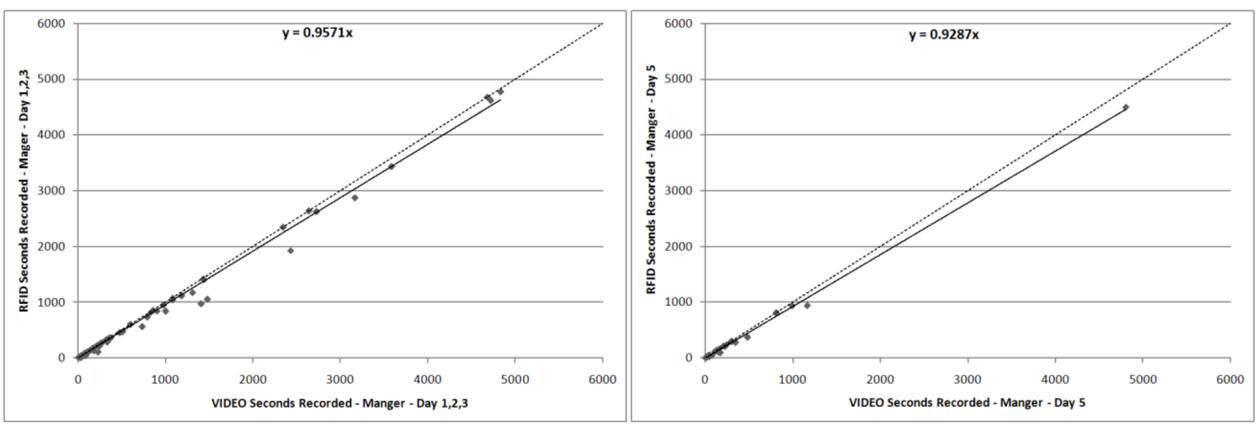

Figure 4. Manger Monitoring Comparison

3.2 **Shelter Monitoring Comparison**

The RFID system recorded the 98% of the events (53 of 54) occurred in the shelter. The only event which was not recorded was on day 5. In day 1, day 2, day 3 the regression line of the RFID records had a slope equal to 0.876 (Fig. 5). During these days there were several short time events (less than 2000 seconds), several medium time events (from 2000 to 6000 seconds) and few long time events (up to 6000 seconds).

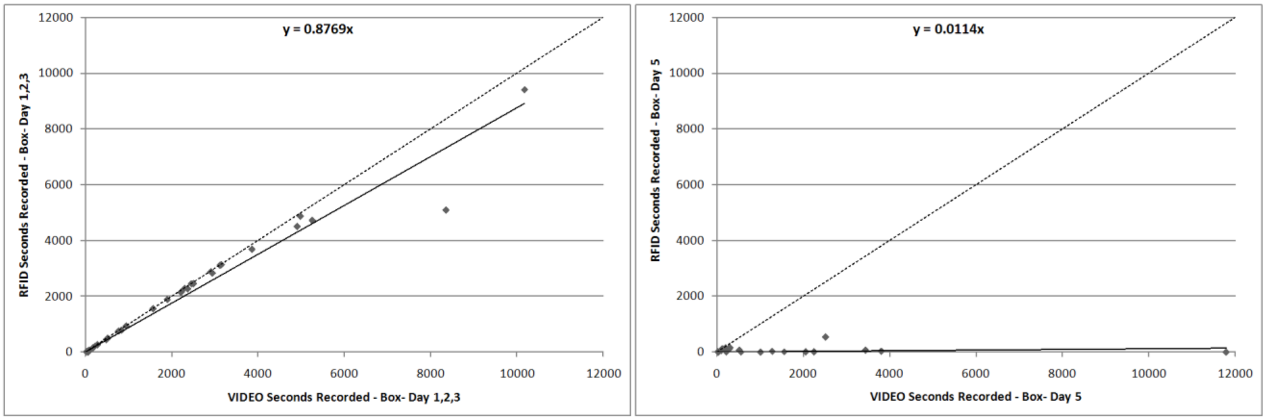

Figure 5. Shelter Monitoring

The lower precision of the data obtained inside the shelter compared to the manger must be related to the position of the tag during the rest. As a matter of fact, a major loss of data occurred during medium and long time events. In these periods the animal may have lied on its back during part of the rest, causing the covering of the tag. One of these events showed big losses in the time recorded.

During day 5, when the position of the tag was higher, the RFID system got some problems. Differently from the manger marker, the tag was too far to receive the signal from the shelter marker. All the events were registered but the data about the length of staying inside the shelter were completely wrong. The slope of the regression line was 0.011 showing that when the horses crossed the door, the system stopped recording all the times.

3.3 **Pigs - Horses Comparison**

Using a linear line figure model it was possible to compare the horses trial records with the data of the previous studies (Barbari *et al.*, 2008; Barbari *et al.*, 2008). These studies concerned the use of active beacon RFID tag with marker to localize the pigs when they had a rest inside an area with cooling system. The RFID system had many problems to record long time rest (Fig. 6). The main cause of loss of data was related to the position of the tag. A collar specific for pigs was created. As the conformation of the head of the animal did not allow to lock the collar in a precise position, the tag shifted the position around the neck. During the rest the pigs lied down lots of time covering the tag. Another problem was the loss of the collar by the sows.

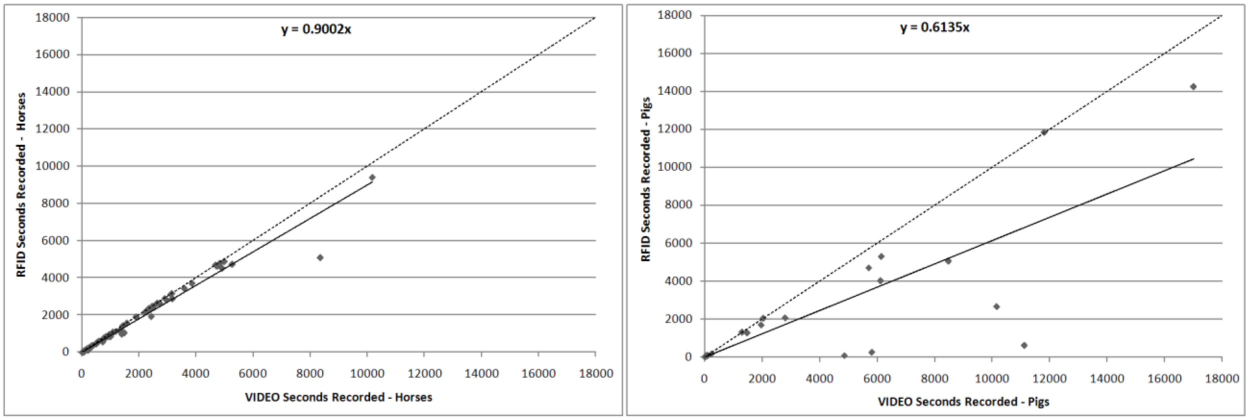

Figure 6. Pigs/Horses Monitoring Comparison

The horses RFID records showed better precision than the pigs' ones. The regression line of total data about the horses position had a slope of 0.900 compared to the 0.613 of the pigs. Since the body shape of the horse permitted a better place to fit the tag, the RFID system was much more precise to locate the position.

4. CONCLUNSION

In despite of the better results in the horse trails than in pig ones, the reasons of the loss of data remained the same, that is the loss of the tag or the covering of it during the rest. Some software adjustment may reduce the losses during rest but the problem remains the size of the tag. It is too big for most of the animals. Till now the tag integrated in the collar has been useful for cows and bandaged in the leg for horses and other big size animals.
As for the study about horses, active RFID system with marker proved the 98% of events and good precision to report the length of the events. The same results can be reasonably supposed with cows. The system is sufficiently precise to substitute or only to support video recording in a lot of studies, where precision of few seconds is not necessary. Smaller tag will be easily put on the animal in a position where it would be always free into the air, such as ears for pigs and small animals, integrated inside a pedometer for cows. For horses, where size is smaller there are many places to link it: at the cover, in a structure similar a pedometer, etc. The same results are suitable for zoo animals or wild species.
If reliability is proved, active RFID system can become useful not only for behavioural studies. It may be integrated in the advanced management systems of breeding and in a lot of other economic activities where animals are involved. For example:

1) lots of symptoms of animal illness are related to the time spent to eat, drink, rest and other behavioural patterns. An alarm connected with the active RFID software will provide further information.

2) A breeding system organized with diurnal outside pasture and nightly inside rest could be supported with a system which provides the manager with the information about the number or individual animals which are inside a shed, for example a shelter for valuable horses, a

sheepfold for sheep, and other houses for other breeding animals, zoo species and wild animals.

5. REFERENCES

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