Information technology for meat supply chain traceability

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Abstract

Technical features of RFID technology were tested with the aim of the implementation in traceability system with automatic data capture of identified animals.
Area of detection of two antennas of different size were described and reading performance when multiple tags are present in the reading area were compared. The feasibility of implementing a RFID system for the identification of small animals like piglets at weaning was evaluated by on-farm trials.

Keywords: traceability, RFID, farm management.

Introduction

The fulfillment of mandatory traceability as well as the increasing consumers demand of safety and quality information about products has led to the need, for each food product, to be followed by an increasing amount of data during the whole supply chain.

For meat, due to several sanitary crisis, breeders as well as slaughterhouses, are requested to collect and store different kinds of information. For example for cattle, in Italy, data regard: individuals identification and registration in the national register, mandatory sanitary data collected by sanitary officers and stored in official databases, other sanitary data that must be kept by the farmer, breed registers data and mandatory and voluntary traceability data.

Information is stored in different databases or manually written. Often there is no sharing of data among different databases.

The storage of all this information with this system is very time consuming and increases production costs.

The availability of automatic data collection could increase competitiveness of the meat supply chain as well as the reliability of the traced information.

Automatic identification by RFID coupled to other data capture systems as for example bar code reading are proposed for the automation of the data collection while electronic data interchange (EDI) should be adopted to reduce multiple collection of the same data along the whole meat chain. This implies a good integration of all the chain stakeholders which is fundamental to increase reliability and achieve more rational systems.

Moreover, as supply chains involve often stakeholders in different countries, a good interrelation among the information at international level should be achieved.

Animal identification RFID systems were envisaged in past years through many international research programs and ISO standard were established in the early year 1996 which adopted the frequency of 134 kHz for animal identification. In the European Union this standard has been chosen for mandatory identification of sheep and goats (starting from 1st January 2010) and for voluntary identification of beef cattle.

However, techniques based on ISO standard which were mainly developed for beef cattle, can raise some problems for use on other species.

Our work is aimed to find the best technical features needed for RFID animal identification systems in the breeding farms in Piedmont region and to evaluate some possibilities of automating also data collection of non-mandatory data for voluntary traceability and farm management.

In particular some limits of the passive, low frequency, identification technique were defined for pigs and cattle identification.

Materials and methods

The research was carried out in laboratory as well on living animals.

Reading performances of different types of transponders were determined by two different static readers.

Static readers were: reader E, an Edit-ID, Auckland, New Zealand panel antenna (850 mm x 650 x 45 mm, fig. 1) and reader G, a Gallagher Smart-reader (600 mm x 400 mm x 50 mm, fig. 2).

Figure 1. Reader E panel

Figure 2. Reader G panel

The system were both ISO 11784/11785 compliant, reading both HDX and FDX-B tags.

In laboratory tests the reading area of the two panels were compared in different tag orientations (parallel, null and radial orientation). A section of the reading volume in front of the antenna was estimated at half height of the antenna following a plan perpendicular to the antenna.

Reading area was determined for each tag type.

Dynamic laboratory readings were performed by a trolley simulating piglets movements and reading errors due to tag collision were defined. Readings were performed mounting on the trolley different tags at increasing distance with a defined speed and along a straight trajectory in front of the antenna at defined distances.

The trolley speed was constant ranging from 0.8 to 3 m/s. Number of readings were counted during the passage in front of the antenna for a 2 m path and reading share of the different tags was calculated.

In a close-cycle pig farm 315 piglets were identified by an ear-tag . The lot was divided in four sub-lot of piglets which were tagged with a different type of transponder. HDX and FDX-B button tag of different types (tab. 1) were applied to the right ear of the piglet using the apposite tagger plier. Piglets were tagged at weaning, day 21 and readings were performed on the same day by two different static readers.

As reading performance at passage widths which allow the passage of more than one piglet at a time resulted to give very poor reading performances (Gay et al., 2007), a 20 cm width passage was adopted for both antennas.

Dynamic reading efficiency (DRE %) was calculated according to Caja et al., 1999 (DRE% = devices which have been read/readable transponder present*100).

Table 1. Features of the electronic eartags tested in laboratory, applied to piglets.

	Brand	**Model**		**Diameter (mm)**		**Weight (g)**
				female	male	
A	Allflex	V3 LW	HDX	26.4	28.0	5.90
B	Allflex	LW	FDX-B	26.4	28.0	5.90
C	Caisley	Multiflex	FDX-B	30.0	27.5	7.55
D	Hauptner & Herberholz	Neoflex	FDX-B	26.0	30.0	5.30

Results

<u>*Antenna reading area*</u>

A section of the reading area at half height of the antenna is reported in fig. 3 for both readers in the parallel orientation (angle between antenna coil and tag coil 0°) and the radial orientation (the tag was oriented to the centre of the antenna).

As could be seen the smaller panel have a smaller area. Due to the small dimension of piglets a smaller area of detection should result in reduced problem of tag collision as a smaller number of piglets should remain in the detection field.

In tab. 2 are reported the detection area of the two antennas, calculated by an apposite software, with respect to the four type of transponder. As stated in literature, the detection area was smaller in the case of smaller tags and, in case of equal dimensions but different protocols (tag A and B) area was smaller for HDX transponder.

Area of detection of reader G was normally smaller than that of reader E for the different type of transponder.

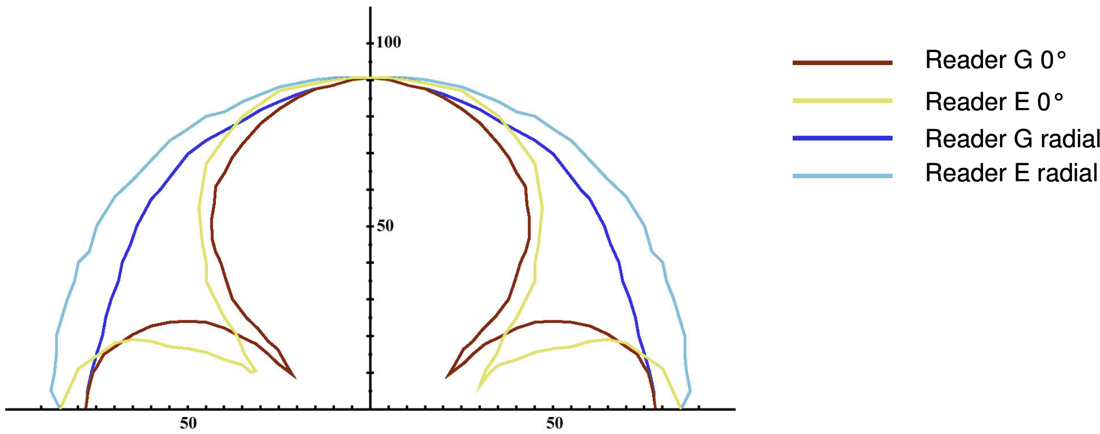

Figure 3. Antenna reading area comparison example. Area were determined using the two antennas and tag C in different orientations (see legend)

Table 2. Area of detection (cm^2) of the two panel readers determined by the four types of tag.

Orientation	radial		0°		90°	
Reader	E	G	E	G	E	G
Tag						
A	6584.8	5888.6	5565.5	5450.9	5777.6	5020.0
B	7857.5	8362.9	6132.9	6690.0	6409.5	6167.0
C	11218.4	10277.8	8627.2	8081.9	8083.0	7875.0
D	7696.0	8148.0	5758.1	5880.6	5776.0	5772.5

Dynamic reading performances of multiple transponders

Reading performance of different transponder in the reading area of the antenna was determined mounting on the trolley firstly only two transponder in all the combinations of the different type of tags mounted at increasing distance.

At small distances only one tag is detected if the two tags are both FDX while in the case of the presence of one FDX tag and one HDX tag, the two tags could be detected even if in contact (fig. 4 and 5). This situation occurred in each combination of a FDX and a HDX transponder Tag C had the best rate of detection when paired with tag B and D. Tag D was the less favoured as was not favoured when paired to tag B.

When distance among the two tags was increased, both tags were detected and a good share of both tags was obtained above 30 cm distance.

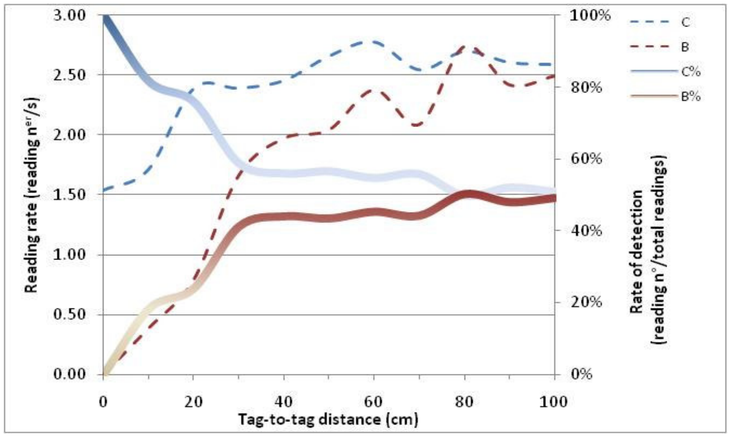

Figure 4. Reading rate and rate of detection of two FDX-B tags mounted at increasing distance

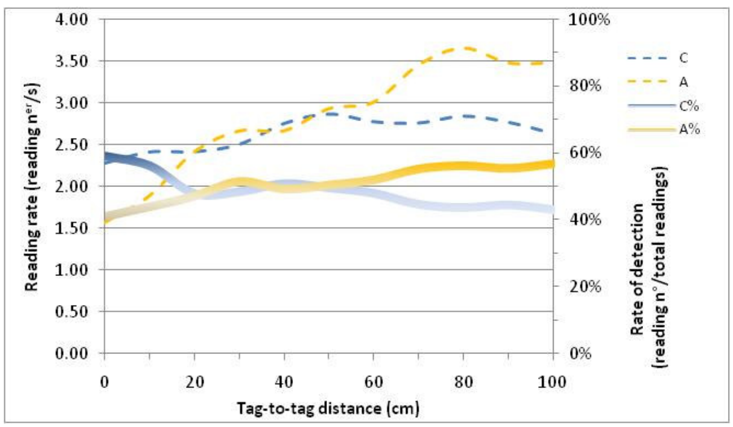

Figure 5. Reading rate and rate of detection of one FDX-B tag (C) and one HDX tag (A) mounted at increasing distance

Then, four transponder of the same type were mounted on the trolley at increasing distances. This is the situation that more often occurs in the farms as usually breeders tend to buy tag of the same brand. In Fig. 6, 7, 8 and 9 shares of detection of the four tags are reported, different colours meaning tag of the same brand but with different codes.

In all cases two of the four transponder have almost all the share of readings and, analyzing the code of the transponder and the order in the series we have noticed that these were the first and the last tag to pass in front of the antenna. These two tags, in fact, remain for a short time in the area of detection without interference with other transponders. The second and third positions were the less favoured at reading.

In the case of four HDX tags only three of the four transponders were detected.

In any case less favoured transponders were detected only if placed at a minimum distance of 20 cm.

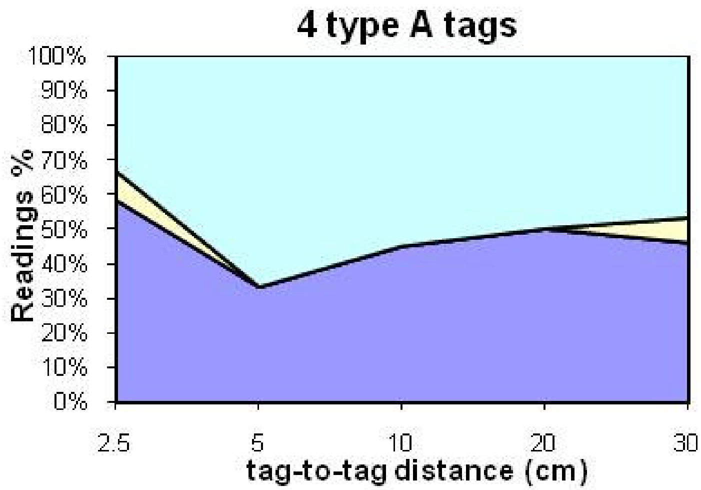

Figure 6. Shares of detection of four transponders type A

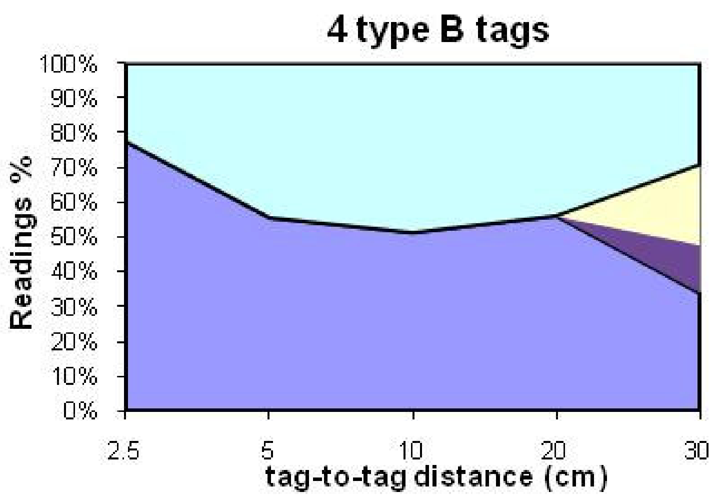

Figure 7. Shares of detection of four transponders type B

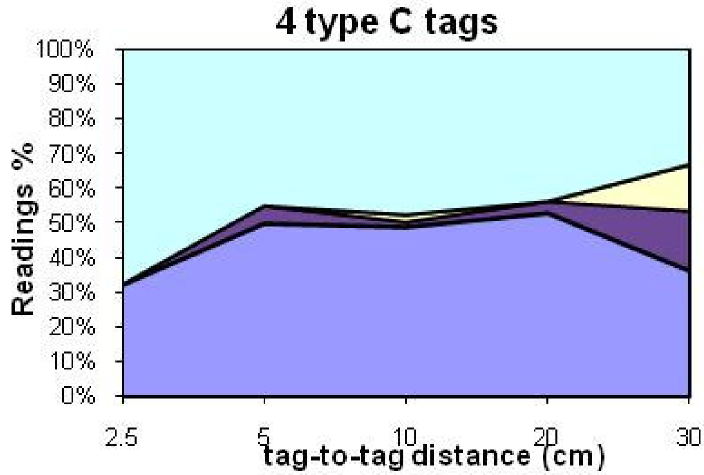

Figure 8. Shares of detection of four transponders type C

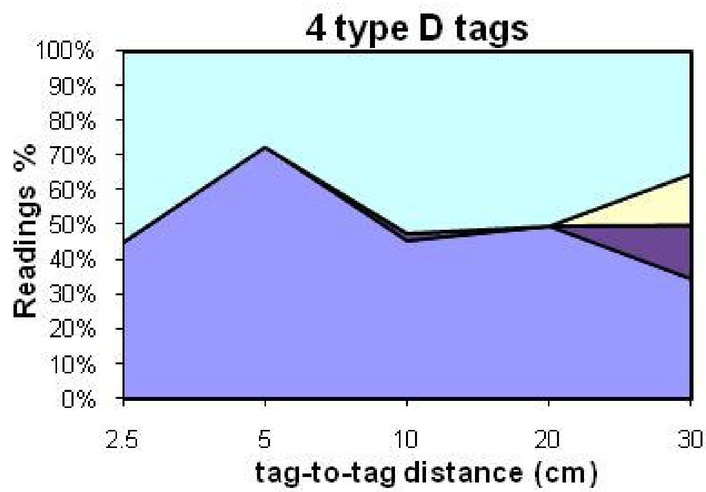

Figure 9. Shares of detection of four transponders type D

In all the above figures different colours represent tag of the same brand but with different code.

Dynamic reading performances of transponders applied to piglets

When dynamic reading was performed on tagged piglets at weaning with a narrow passage (20 cm) a dynamic reading efficiency of 85% was obtained with reader E, while in the case of reader G, the percentage of correct readings was higher and reached 95%. On the basis of laboratory data, the higher performance could be due to the smaller area of detection which could have avoided part of the transponders collisions (tab. 3).

Table 3. Dynamic reading performances of the two readers on the whole lot of piglets.

Reader	Transponder read	Readable transponders	DRE %
E	267	315	85
G	300	315	95

However, the reading of the whole lot of the piglets identified was not reached in both cases.

Conclusions

When an RFID system has to be integrated in a traceability system for animal identification, animal shape has to be related to reading area of the antenna and probability of collision among tags has to be considered.

The availability of information about the whole reading areas and of the dynamic reading performances are fundamental to integrate RFID systems in real traceability application. In the case of piglets or small animals like hens, where the collision problems are more severe, some authors have envisaged the use of HF RFID systems (Thurner and Wendl, 2007, Hessel et al., 2008) which could use anti-collision protocols. These systems could overcome the problems encountered in multiple reading of LF transponder but should be more widely tested and allowed for animal identification as, for example, HF transponders are nowadays not allowed for cattle, sheep and goats from the European Union.

Another way to solve the problem could be the use of antennas of smaller size and the synchronization of more than one antenna.

References

Caja, G., Conill, C., Nehring, R., Ribo, O. 1999. Development of a ceramic bolus for the permanent electronic identification of sheep, goat and cattle. Computers and Electronics in Agriculture, 24: 45-63,

Gay P., Giuffrida M.P., Piccarolo P., Ricauda Aimonino D., Tortia C. 2007. Livestock and Farm Management Improvement using RFID Technologies. XXXII CIOSTA Congress: Advances in labour and machinery management for a profitable agriculture and forestry. Nitra, Slovakia, 17-19 September.

Hessel E. F., Reiners K., Böck S., Wendl G., van den Weghe H.F.A. 2008. Application of high frequency transponders for simultaneous identification of weaned piglets. AgEng 2008 Congress: Agricultural & Biosystems Engineering for a Sustainable World. Hersonissos, Crete, 23-25 June.

Thurner S., Wendl G. 2007. Identification reliability of moving HF-transponders with simultaneous reading. Landtechnik, 62, 2, 106-107.