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Use of a UHF transponder for simultaneous identification of fattening pigs

Currently used low frequency RFID systems for electronic animal identification can only identify animals separately rather than several animals simultaneously. Ultra high frequency systems (UHF) provide simultaneous identification. However, UHF systems are susceptible to disturbances prevailing in animal housing systems. In this field trial the suitability of a UHF system for identification of fattening pigs was examined. 22 fattening pigs were tagged with UHF transponders in the growing period. The trials showed an identification rate of 73.9 % in the finishing period. No losses or malfunctions of transponders were observed during the trial.

Keywords
Electronic animal identification, RFID, Precision Livestock Farming, transponder

Abstract
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The current standard for electronic animal identification (ISO 11785 [1]) specifies that low frequency systems (LF, 134.2 kHz) are used. Unfortunately simultaneous identification of multiple animals is not provided. The presence of several animals respectively transponders within the identification range of a reader causes data collision. Data collision inhibits data exchange and thus the identification of transponders or animals respectively [2]. Hence, animals have to be moved individually through the magnetic field of a reader.

In order to avoid data collision in RFID systems anticollision-systems have been developed. A trial with fattening pigs, tagged with LF ear tag transponders supporting an anticollision-system showed no satisfactory results for simultaneous identification [3]. High frequency systems (HF, 13.56 MHz) using anticollision-systems lead to very high identification rates up to 97.3% in piglets [4]. However, animals weren't identified in the alley as in [3] but at the feed trough. Moreover, identification rate decreased as presence of transponders within the identification range of the reader increased.

Ultra high frequency systems (UHF, 886 MHz) show very high data transfer rates. Therefore anticollision-systems can be implemented even for identification of fast-moving objects. Moving transponders can be identified reliably and simultaneously. Unfortunately, UHF systems are more susceptible to disturbances prevailing in animal housing systems than LF systems or HF systems. Electromagnetic fields of UHF readers are reflected by metals which delimitates identification of transponders in metal-rich environments [2]. Furthermore identification accuracy is restrained by liquids like body fluid of animals as they absorb UHF signals [5]. During the last years UHF transponders have been developed which are less susceptible to these disturbances. Particularly on-metal transponders are used in logistics.

In this study the usability of advanced commercial UHF transponders for identification of fattening pigs was examined. The identification rate of a UHF system implemented in an animal housing system was determined as an essential feature of performance.

Material and methods

A UHF transponder (Harting Electric, Espelkamp) was used which was developed for aviation to be identified under adverse conditions e.g. on metal. This transponder is insensitive to moisture, chemicals and mechanical stress, meets the RFID standards for UHF systems "ISO 18000-6c" and "EPC Class 1 Gen 2" and works at an operating frequency of 868 and 960 MHz. The case of the transponder (41 x 11 x 5 mm) is made of plastics and is rated IP 69K. Electronic ear tags (**figure 1**) were built by fixing 22 transponders with stainless screws to ear tags (MultiFlex U, Caisley International, Bocholt).

Two UHF readers (UDL500, Deister Electronic, Barsinghausen) were used with an operating frequency of 868 and 960 MHz supporting transponders compliant to both standards: ISO 18000-6c and EPC Class 1 Gen 2. The readers offered two operation modes: stand alone and portal mode. When operating in portal mode the readers are connected to a data concentration

Fig. 1

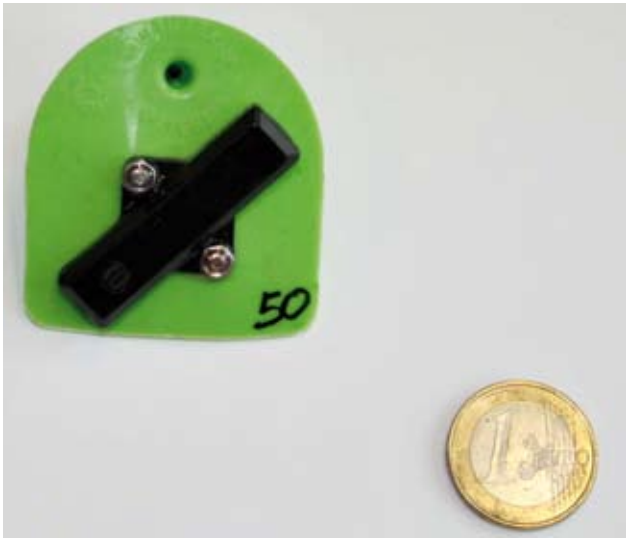

Fig. 1: UHF transponder ear tag

Fig. 2

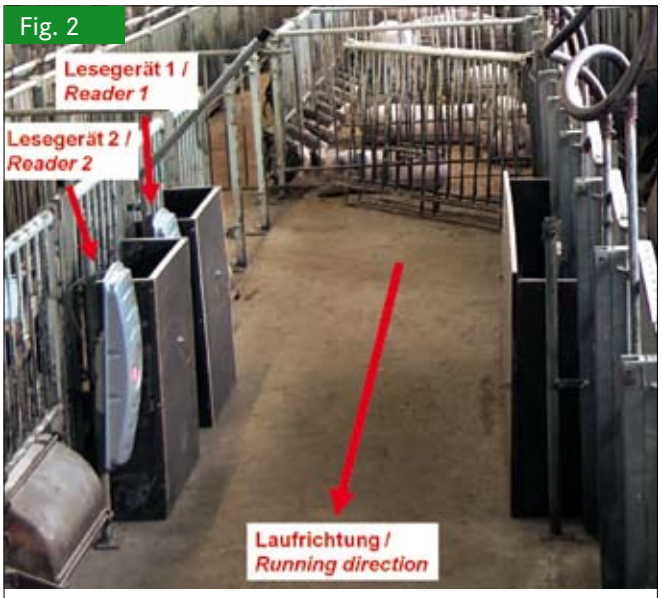

Fig. 2: Readers right hand in running direction (reader array A)

unit (DCU1, Deister Electronic, Barsinghausen) which synchronises the readers and transmits transponder data filtered to a host computer. The anticollision-system of the readers used the slotted ALOHA procedure. This procedure allocates transponders to time slots for data transmission when other transponders are muted [5].

Field trials were conducted at the Research Station for Animal Husbandry, Animal Breeding and Small Animal Breeding of the University of Hohenheim "Unterer Lindenhof" to determine the identification rate of the UHF system. The manufactured electronic ear tags were tagged to the right ear of 22 growers (∅ 38.7 kg BW) which were housed in two groups of eleven animals. A 1.1 m wide gateway was installed in the alley of the piggery using the two UHF readers in portal mode. Three reader arrays were examined:

- Reader array A: Both readers right hand in running direction with horizontal spacing of 100 cm (**figure 2**)
- Reader array B: A reader right hand in running direction and a reader left hand in running direction with horizontal spacing of 100 cm (**figure 3**)
- Reader array C: Readers one above the other right hand in running direction. The upper reader tilted by 45° towards the alley (**figure 4**)

The two readers were installed upright in running direction of the animals. The centre axis of both readers was 55 cm above the floor except reader array C where the centre axis of one reader was 115 cm above the floor.

Fig. 3

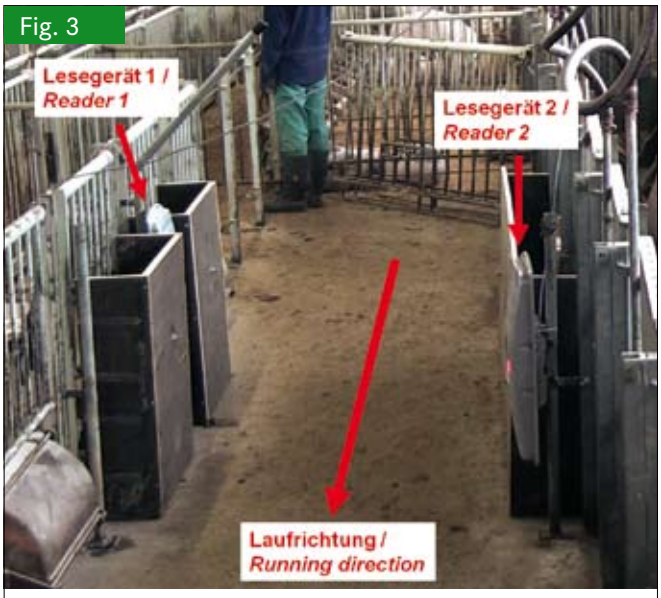

Fig. 3: A reader right hand in running direction and a reader left-hand in running direction (reader array B)

Fig. 4

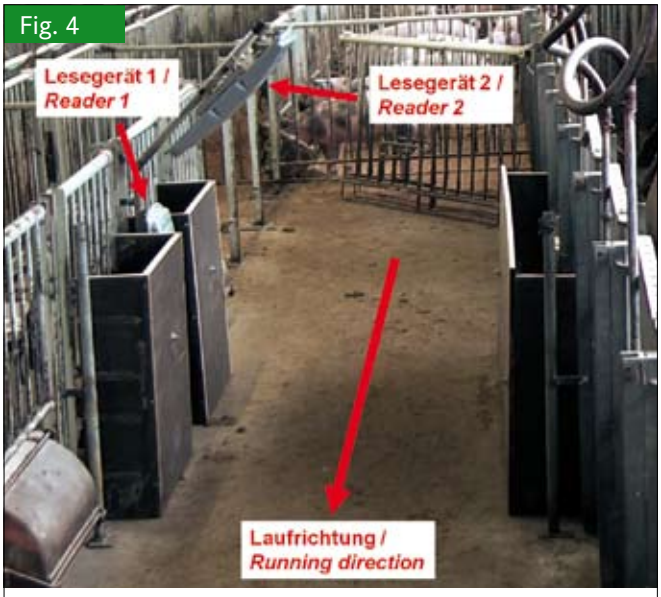

Fig. 4: Readers one above the other and right hand in running direction (reader array C)

The trials were conducted once weekly within three consecutive weeks of the finishing period (21.09.2010, 30.09.2010, 08.10.2010 / ∅ 98.7 kg BW, ∅ 105.6 kg BW, ∅ 110.2 kg BW). Preliminary to every trial individual body weight of all animals was recorded as well as loss and function of their electronic ear tags. Afterwards the animals of both groups were moved jointly through the gateway in order to determine the identification rate. The reader array varied between A, B and C. Eight repetitions per reader array were carried out i.e. one trial consisted of 24 trial runs. The sequence of the reader arrays was randomised.

When analysing the results both animal groups were regarded as one. The ratio of "lost tags" and "broken tags" respectively to "electronic ear tags used for tagging" resulted in the loss rate and the malfunction rate of the UHF system. The identification rate was calculated from "tags identified per trial run" and "tags functional prior to the trial run". For statistical analysis R (Version 2.12, The R Foundation for Statistical Computing, Vienna) was used.

Results

The identification rate over all trials averaged 73.9%, the standard deviation was 10.2%. Between the three reader arrays identification rate did not significantly differ (P = 0,094). Identification rate of reader array A averaged 73.1%, B averaged 71.2% and C averaged 77.5% (**figure 5**). Standard deviations were 11.1% (reader array A), 9.8% (reader array B) and 8.9% (reader array C). No losses or malfunctions of electronic ear tags were observed during the trial. Hence, the loss rate and the malfunction rate of the UHF system was 0.0%.

Fig. 5

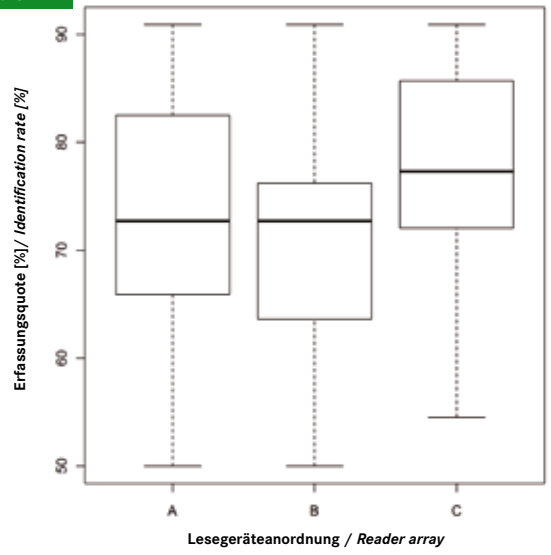

Fig. 5: Identification rate of the UHF system in trials with finishing pigs depending on reader array

Conclusions

The use of UHF systems for animal identification was considered unsuitable so far [5].The results of this study demonstrate the potential of advanced UHF systems adapted for this application: As loss rate and malfunction rate show the transponders used are able to withstand the harsh environment of a piggery where chemical stress and mechanical stress prevail. Furthermore it is possible to reliably identify transponders although reflections and absorption are disturbing UHF signals. On average 73.9% of the transponders can be identified under such conditions. However, the identification rate as well as the standard deviation is not yet sufficient for UHF applications in animal husbandry. Further developments are required to enable the use of UHF systems for animal identification.

Literature

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