Lutz Beplate-Haarstrich, Dieter von Hörsten and Wolfgang Lücke, Göttingen

Traceability of Plant Products through Radio Frequency Identification

Radio Frequency Identification (RFID) is a technology with which data can be stored on and read from data carriers contactlessly and without intervisibility. It fulfils federal requirements to be able to completely trace foodstuff and feed back to their beginnings in agricultural production.

M.Sc.Lutz Beplate-Haarstrich is a postgraduate research student at the „Department für Nutzpflanzenwissenschaften“, University of Göttingen, Section Agricultural Engineering, Gutenbergstrasse 33, 37075 Göttingen,
e-mail: *lbeplat@gwdg.de*
Dr. Dieter von Hörsten is is a scientist and Prof. Dr. Wolfgang Lücke is head of the section Agricultural Engineering.

Keywords

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On 1st January 2006, the so-called EU food hygiene package fully went into effect. One significant aspect of this new legislation is the continuous traceability of all food and feedstuff over all links of the process chain. In order to really adhere to the principle “ food safety: from the producer to the consumer“, new systems need to be developed in particular in the area of primary agricultural production because currently used systems, such as quantity plausibility examinations, grain documentation, sample conservation, isotope analyses, and data base systems, are time-consuming, expensive, or full of gaps.

An optimal system for the tracing of plant products should be inexpensive, largely automated and constantly work behind the scenes of daily farm business in order to put only a minimum burden on farm managers. In the ideal case, the recorded origin of the products is not the farm gate, but the field where they grew. Accordingly, this requires clear marking of the harvested crops already at the time of the harvest. None of the currently common systems can fulfill these requirements.

Radio Frequency Identification (RFID) technology, however, provides a promising approach towards the solution of many of the listed problems on the way to the continuous traceability of plant products.

Operating principle of Radio Frequency Identification Systems

RFID systems are closely related to chip cards (e.g. telephone cards). Chip cards are electronic data memories which can be read out or allow data to be recorded with the aid of a reading-/writing device. In RFID systems, the data carrier is called transponder. In order to supply it with energy and to carry out data exchange, this transponder is not contacted galvanically (in contrast to chip cards), but with the aid of magnetic or electro-magentic fields (radio frequency identification = identification by means of radio waves). Consequently, dirt, moisture, optical covers, direction and position, wear and tear have practically no importance [1].

In principle, a RFID system consists of two components: the transponder (data carrier), which is fixed to the object to be identified, and the data entry equipment, which can be designed as a reading or reading/writing device (*Fig. 1*). Reading/writing equipment generally consists of a high-frequency module (transmitter and receiver), a control unit, a coupling element for connection to the transponder (antenna), and an interface in order to be able to transfer data to a PC, for example. The transponder only consists of a microchip and a coupling element. Since it generally does not have its own energy supply, it behaves in a totally passive way. It is only activated within the range of a reading device, which can measure up to five metres depending on the design of the system [1].

One characteristic of transponders is their ability to record data. Simple transponders only allow a series number to be read out which has been invariably programmed at the time of production. Recording transponders allow data to be recorded with the aid of a writing device almost as often as desired. The supply of the transponders with energy, the operating frequency, and the resulting reading/writing distances of the system are other important features. While active transponders contain a battery which supplies the microchip with energy, this is not the case in passive transponders. They take the entire energy needed from the electric or magnetic field of the reading/writing device. Radio frequencies in the ranges LF (low frequency, 30 kHz to 300 kHz), HF (high frequency), and RF (radio frequency, 3 MHz to 30 MHz), UHF (ultra high frequency, 300 MHz to 3 GHz), and microwave (> 3 GHz) [1] are used.

The designs of RFID transponders vary greatly, and their size ranges from a few millimetres to some centimetres as a function of the transponder technology employed (*Fig.*

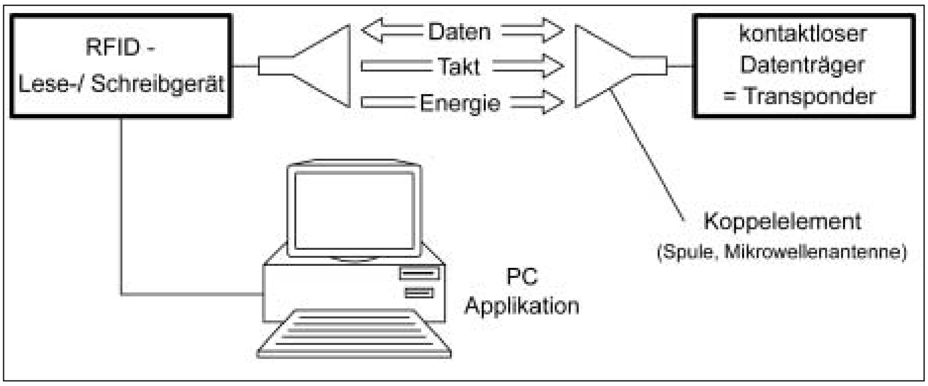

Fig. 1: Basic Modules of a RFID-System acc. to [1]

2). Transponders are available as injectable units, in plastic casings, as coins, key chains, watches, etc. There is a suitable form for virtually every application [1].

Possibilities of application in practice

For years, radio frequency identification has been used not only in industry, but also in agriculture for animal identification [1, 2]. Therefore, the question arises whether this technology could also be used to trace plant products in the future.

Without any doubt, this is a great challenge because agricultural plant products are generally mass-, bulk, or unit materials, which undergo many processes of mixing and processing on their way to the consumer.

Tracing from the consumer back to the food- and feedstuff industry is relatively unproblematic. The traded goods are packed and clearly identifiable by means of lot- or batch marks. Tracing from the food- and feedstuff industry back to the primary producer, the farmer, however, is more problematical because mixing processes are generally unavoidable in agricultural trade when many small lots are registered during delivery by the farmers and when raw goods are sold. Not every delivery can be transported to a different store. For this reason, it is sometimes impossible to determine the exact composition of a sold lot. Consequently, all conserved samples which might possibly belong to a lot would have to be examined in the case of damage in order to find the source, which is time-consuming and costly. The search for the source can be far more specific if the plant products bear their origin and a lot thus contains the exact history of its development. This also allows the legally required duty of documentation to be fulfilled.

This could become possible with the aid of RFID technology: during the harvest, a statistically sufficient total number of transponders is added to the plant product on the combine, for example. This guarantees clear marking already at the time of the harvest. In these transponders, all data relevant for the origin are recorded. In the later course of the process chain, the data are updated e.g. with information about transport and storage by the agricultural trade. Shortly before processing, the transponders are separated from the plant product, and after the data carriers have been read out, the origin can be traced back precisely.

For this purpose, certain conditions must be fulfilled: First, the transponders must be able to withstand environmental influences, and their size and form must be adapted to the material to be marked in order to allow for optimal identification. It must be guaranteed that the transponders are reliably mixed in with the harvested crops and separated from them later. In addition, the required number of transponders per plant product unit as well as the relevant data to be recorded must be determined. In order to enable the transponders to be contacted without any problems for reading and writing, the range of the system must be sufficient for the individual application. In order to protect the data against manipulation, they must be secured against unauthorized changes. The far-reaching automatization of the system guarantees that the process runs smoothly in daily farm business. The costs of such a technique mainly depend on the number of transponders needed per unit of plant product. According to initial estimates, they are within a financeable range.

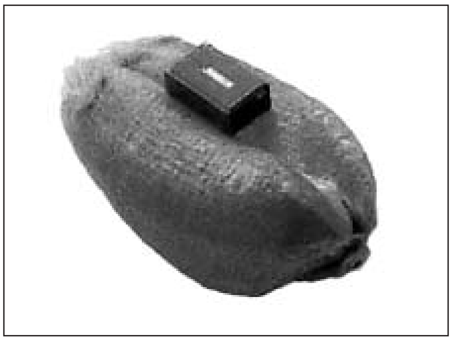

Fig. 2: Size of a RFID-Transponder (mic3®TAG, microsensys, Erfurt) compared to a wheat grain

Conclusions

The use of RFID technology is a promising concept for the optimization of the traceability of plant products. This particularly applies to bulk materials, such as grain crops as well as fruit, vegetables, and potatoes because these products are generally handled loose and in large quantities with the above-described consequences for continuous traceability. For grain crops, the development of a “grain dummy”, which contains a transponder and is mixed in with grain, peas, or beans, for example, is conceivable [3]. However, studies which examine the above-described conditions for practical application in more detail are necessary before implementation in process chains.

Literature

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