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The Use of RFID Technology for the Proof of Origin in Grain Production

The use of RFID technology is being studied as a means of proving origin in grain production in order to guarantee legally required gapless traceability back to primary agricultural production. For this purpose, a grain dummy is being developed. On a certain number of these dummies, which are distributed evenly in the grain in order to mark it clearly, origin-relevant data are recorded on the combine during the harvest. Before processing in the food- and feedstuff industry, the dummies are separated from the grain, and the necessary data are read out.

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Keywords

Radio Frequency Identification, RFID, traceability

The gapless traceability of food and feedstuff is required by European legislation. In order to fully meet this requirement, grain must be clearly marked at the time of the harvest in particular in order to guarantee traceability from the agricultural product dealer to the farmer. This is not yet possible with the technologies available today [1].

RFID technology, which has been proven in practice for decades, is very promising for this purpose. Here, in particular progress in the area of the miniaturization of the system components must be emphasized. RFID transponders having a size of a few millimetres are now available [2, 3]. This allows a system to be developed in which transponders bearing origin-relevant data are added to the kernel flow in the form of grain dummies in order to provide gapless traceability [1, 4].

Grain Dummy

In principle, the developed grain dummy consists of a RFID transponder embedded in cast resin. It can be designed such that it has no harmful effects on food, which is absolutely necessary for applications in the food sector. The transponders used are units of the type mic3®TAG 2k or mic3®TAG 16k from the company Microsensys because these are currently the only transponders which feature suitable measurements and can be used for recording. The costs currently amount to € 1 to 2 per unit. It must be emphasized that the dummies can be recycled. The shape as well as the density and mass of a grain dummy have been deliberately designed such that they are similar to a real cereal kernel (*Fig. 1*). The transponders can be used to record and read out a data volume of 2 kbit or 16 kbit several times. This corresponds to 250 or 2,000 signs. Currently, maximum reading-/writing distance is only 5 mm. In the future, however, transponders will be available whose range is far larger.

During the trials on the combine, origin-relevant data, such as GPS coordinates or the name of the farm, are recorded on the grain dummy, which is then added to the grain (*Fig. 2*). This will happen automatically using a rotating batch metering unit in the grain tank or -elevator in order to guarantee even distribution in the grain. Thus, the harvested grain is clearly marked with regard to its origin.

The number of grain dummies added to the harvested cereals per grain unit mainly depends on the unit costs of the grain dummies as well as on factors such as the structure of the individual producer region (large farms in the east, smaller farms in the west of Germany) or preferences of the buyers. The larger the number of transponders in the grain is, the more precise the entire system becomes. According to initial considerations, one grain dummy per tonne of grain is striven for. Given a grain yield of 100 dt/ha, this would not only allow one tonne of wheat to be traced back to its farm of origin, but

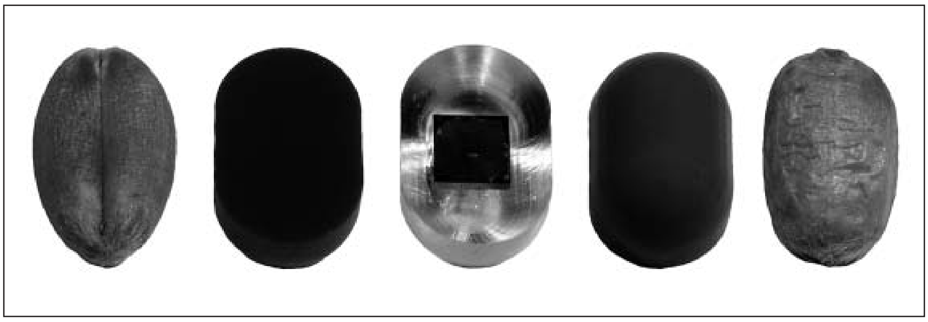

Fig. 1: Grain dummies compared to wheat kernels

theoretically also to an area of 1,000 m^2. According to initial estimates, the process costs in this case would account for less than 2% of the wheat price. In addition, the prices of RFID technology can be assumed to sink considerably in the future.

Use in the Process Chain

In the process chain, grain goes through many cleaning-, transfer-, and transport processes (*Fig. 2*). Therefore, it must be guaranteed that the dummy is stable enough and remains in the grain. This means that it does not separate or de-mix from the grain flow. This goal is intended to be reached by making the physical properties of the grain dummy similar to those of the cereal kernel. Studies on material properties and pouring behaviour will be carried out soon. During the processes which follow the harvest, such as drying, storage, or transfer, other data are generated which are relevant for traceability and can also be interesting for later quality evaluation. They include the duration of ventilation, moisture, or the falling number, for example. On the individual farm, these data can be recorded on the grain dummy with the aid of a writing device, which is installed at an appropriate place on the farm, i.e. at grain elevators or conveyor belts. However, the transponder must pass the reading-/writing device at a very close distance in order to guarantee reliable data transmission. An optimal opportunity for this process step always arises when the grain must necessarily pass one of these points while it is being transported or hauled away. However, this updating of process data will only become possible in the future when the required miniaturized RFID technology has a sufficient reading-/ writing range of some centimetres (*Fig. 2*).

Theoretically, the development of such transponders is possible even though the range of the small RFID chips is restricted due to narrow physical limits. For cost reasons, the development of a new transponder is not planned as part of this project. Instead, existing technologies available on the market will be used. Due to the small range of the transponders, the data are no longer updated in the experiments as soon as the dummy is placed in the grain (*Fig. 2*, grey area). The development of a grain dummy which can transmit data over several metres is excluded for physical reasons.

Before final processing in the food- and feedstuff industry, the grain dummies must be completely separated from the grain, and the data must be read out. This is done by means of magnet separation or opto-electronic selection. These are systems which are widely used in the food- and feedstuff industry and have proven themselves in practice. Therefore, the complete removal of the dummies from the grain does not require any new developments. For the acceptance of this technology in the food- and feedstuff sector, complete removal is a fundamental prerequisite.

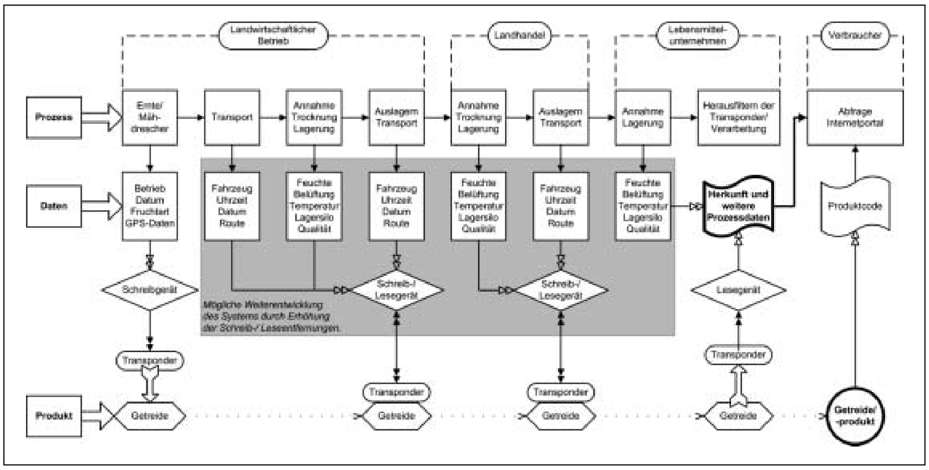

Fig. 2: Process chain of cereals

After the transponders have been read out, the data can be integrated and used in the individual company-internal quality management system. Process data security over the course of the process chain, i.e. the prevention of unauthorized writing- or reading access, can be guaranteed by means of appropriate data encoding. For this purpose, micro-controllers are integrated into the transponders of the new generation.

During the grain process chain, lot mixing and, hence, the mixing of grain dummies from different origins cannot be prevented. In the future, transponders will not allow grain kernels in a mixed lot to be traced back to a certain origin. It will be possible, however, to trace different origins back to a sample if the sample is large enough in relation to the transponder density in the grain to ensure a great likelihood of finding a grain dummy. In the event of damage, this would enable the circle of those who might be responsible to be restricted if one takes the potential number of origins of the content of a large silo into consideration. Accordingly, the number of samples which must primarily be examined closely could be reduced even though samples will remain indispensable. In the case of damage, this allows valuable time and money to be saved.

Conclusions

In the future, the use of RFID technology will be able to provide the legally required gapless proof of origin in grain production. In particular, it will be possible to reach the goal of transparent production demanded by the consumer everywhere in the form of a code printed on the product packing which shows the complete life of a product after it has been entered into an internet portal. Before, however, additional studies on process technology and expenses will be necessary.

Literature

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