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ProSenso.net2

Exploration of Sustainability Potentials by Using Innovative Sensor Technologies and Integrated Assessment Models in a Production Chain of Plant related Food

The goal of the joint project ProSenso.net2, funded by the German Federal Ministry of Education and Research (BMBF), is to develop innovative concepts for sensor applications in the agriculture and food-processing sector. Seven subprojects address the economically significant process chains cereal grain and fruit, vegetables, potatoes to develop methods of detecting microorganisms and mycotoxines through technologies is based on the fusion of sensors. Technology assessment is an essential part of this research work.

Technological developments have led to massive changes in the agricultural and food industry. Its sustainable development implies to consider economic, ecologic and social aims equally. However, the general accepted formula of these three columns as the basis for sustainability has to be specified in regard to the agricultural and food industry. The following aspects can be listed:

- Responsibility of the agricultural and food industry to guarantee basic nutritional supply and quality assurance for food and feed for the society as a whole
- Conservation of resources (maintenance of production bases, prevention and reduction of environmental impacts)
- Conservation of bio-diversity (with as little impairment on natural eco-systems as possible)
- Socio-economic components (securing the economic competitiveness of agricultural enterprises, preservation and creation of employment in the agricultural and food sector)
- Ethic components (ethics of the future, intergenerational justice)
- Global component of sustainable development

To this subject-matter the joint research project ProSenso.net 1 (PSn1), funded by the German Federal Ministry of Education and Research (BMBF), could be successfully completed in 2005. Based on PSn1 the succeeding BMBF-funded project ProSenso.net 2 (PSn2) was started on July 1, 2006. The participating five research institutions and eight small and medium-sized enterprises (SME) aim to work out new solutions exemplarily for two economically important value-added chains – cereal grain and fruit, vegetable, potato: Existing and new sensor systems are to be developed, optimized, and adjusted in order to monitor process and product quality at relevant points of the chains, preferably online. The verification of microorganisms is of peculiar interest both for the prevention of high decay-induced wastage within the production chain and for the inhibition of mycotoxines. In order to obtain practicable results, different sensors will be combined (sensor fusion), processes exemplarily assessed and evaluated, and research work will be cross-linked beyond the limitations of the product lines.

Transfer of the obtained results into agricultural practice is supported by an embedded socio-economic technology-assessment. It aims to quantify the effects of an application of the new sensor-based technologies in agriculture in terms of sustainability.

PSn2 subprojects

The research and development work does not cover the entire process chains (from soil to food) but will concentrate on the critical

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Keywords

Agricultural engineering, sensor development, sustainability

Literature

Further information can be called up via *www.atb-potsdam.de/prosenso*.

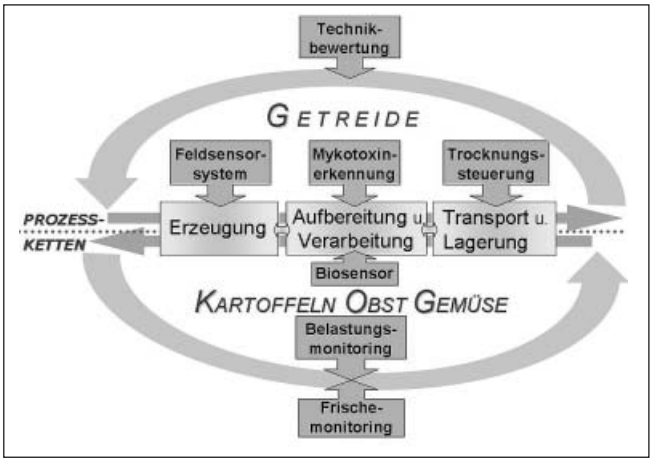

Fig. 1: Research and development tasks of the PSn2 subprojects at critical points of the process chains

points that are particularly relevant for quality and food safety matters (*Fig. 1*). The subprojects address the following subject-matters:

Process chain cereal grain
Sensor-based detection of mycotoxines producing fungi in wheat crops
Subject of the research is the detection of Fusarium spp. infections in wheat crops by the application of complex digital image analyses (hyperspectral, thermography, chlorophyll fluorescence and colour images) based on data from combined sensors. The results are expected to indicate the reliability of the new machine-vision-based approach for fungi detection in the field. Automatic detection of infected lots in the field opens the possibility of separating contaminated lots from the bulk at harvest and to use alternative post-harvest paths for the contaminated grain.

Indicators and sensor technology for the identification of mycotoxines producing fungi in the processing of grain
Food borne fungi and their toxines threaten the quality and safety of food products throughout the process chain. The post-harvest chain, i.e. storage and primary processing, is facing the demand to detect and handle contaminated charges. Objective of this subproject is to identify grain contaminated with fungi or mycotoxines in storage facilities during loading or before processing.

It is aimed to develop sensors for the identifation of olfactorian patterns related to mycotoxine contaminants. Furthermore, research focuses on spectroscopic properties of fungi and mycotoxines that may be used for identifying contamination. Preconditions for the development of a sensor array will be generated allowing the documentation and selective rejection of contaminated charges.

Development of a microwave-based moisture sensor for process control in grain dryers
as well as the technical realization and testing of a model-based control concept for grain dryers are tasks of this subproject. It is aimed to avoid mycotoxine-formation as well as thermal damages and sales losses due to over-drying. An existing mathematical model for the heat and mass transfer, upon which the control concept is based, will be extended to continuously operating grain dryers. The microwave sensor and the control system will be approved both on pilot and on industrial scale.

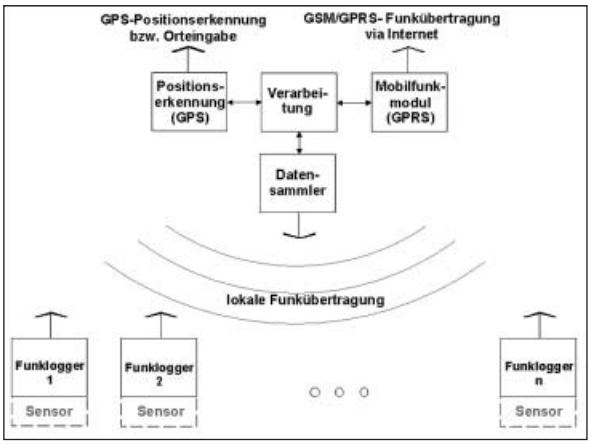

Fig. 2: Sensor-based quality control in the logistic chain: hardware structure of the modular network-based monitoring system

Process chain fruit, vegetable, potatoes
The development of a method to determine the quality and to evaluate the spoilage risk in horticultural products is one of the three major topics along the production chain of fruit, vegetable and potatoes

An innovative spectral sensing device for produce quality will successively be developed and tested. The evaluation is based on determining quality at the beginning of the production chain. On the other hand, data of mechanical and climatic stress occurring during the run of produce through the chain will be utilized, that were collected before by means of temperature data logger and a miniaturized sensor-implant for mechanical impacts. This also allows at an early stage to make an appropriate decision for utilization of the respective produce lot.

Development of biosensors for the detection of human- or phytopathogenic micro-organisms in the post-harvest chain of perishable products
After harvest, vegetables and certain fruits are often contaminated with basting substances like soil particles and organic residues. Depending on type and degree of contamination, varying concentrations of both human- and phytopathogenic microorganisms can emerge. At present, the estimation of microbial load during food processing and the monitoring of the hygiene status cannot be carried out with conventional methods on reasonable time and cost basis. Within the context of this project new tools for the specific and quantitative detection of spoilage-microorganisms shall be developed. This will allow a continuous monitoring of microbial contamination in the various washing phases during the industrial processing of vegetables. The project focuses on the development of robust and automatable applications (biosensors), based on molecular biological approaches and flow cytometrical methods, respectively, for the specific quantification of spoilage organisms. A utility model shall be constructed and tested for optimization of washing procedures in post-harvest processes.

The development of a modular system for quality monitoring in the logistic chain of perishable horticultural produce
will fulfil the need to completely supervise and to evaluate measurements of quality-relevant parameters from the producer via transportation and short-term storage up to retail.

At lower level, modular data logging units will be arranged for the measuring of air temperatures and air humidity (and for the assignment of text information) which can both be used self-sufficiently and work in a system based on internet technologies.

By target-oriented application of the system an essential contribution shall be made to improve the sustainability in the value-added supply chain. This will be shown exemplarily for the fruit and vegetable production.

Technology assessment
Chain-comprehensive technology assessment for estimating the socio-economic and ecologic efficiency
is task within a superordinated subproject. In terms of technological impact assessment it aims to measure, analyze and evaluate the effects of sensor application at all critical points of the cereal grain chain. These effects may comprise e.g. modification of production processes, improved product quality and safety, reduced envi-ronmental impacts, enhanced economic efficiency, and ameliorated working conditions.

Both producers as well as users of the sensor integrated systems will benefit from the project outcome. Results will provide planning criteria for the implementation of sensor techniques into production chains and for the necessary adjustment of processes according to the sensor-induced changed conditions. Moreover, it will grant knowledge on the economic and ecologic effects of the new technologies.