Fraunhofer

FRAUNHOFER LIGHTHOUSE PROJECT

COGNITIVE AGRICULTURE

FRAUNHOFER IS MAKING AGRICULTURE HIGHLY EFFICIENT AND SUSTAINABLE AT THE SAME TIME

Agricultural technology is not only a branch of industry that is essential for our society – it is also a progressive, highly innovative industry. The use of state-of-the-art information technologies has great potential for making agricultural processes even more efficient in the future. With trends such as "Precision Farming" and "Smart Farming", agriculture has recognized and made use of the possibilities offered by state-of-the-art technologies early on. However, there is still a lot of room for optimization in modern agriculture.

To date, the complex cause-effect relationships in the biosphere have only been viewed in a fragmentary manner. Agricultural planning and work processes are often still not carried out efficiently and economically. A much deeper and broader understanding of these complex cause-effect relationships could significantly optimize higher-level decision-making and work processes. At the same time, the use of future-oriented digital services can make a crucial contribution to increasing the sustainability of agricultural measures.

Our Fraunhofer lighthouse project **"Cognitive Agriculture"**, **"COGNAC"** for short, aims to identify these interrelationships precisely and to make the

results usable across the board. With **"COGNAC"**, we interlink machine data from highly automated agricultural machinery and equipment. This will allow, for example, optimized monitoring and quality assurance of agricultural production processes over longer periods of time. These will be evaluated intelligently in order to make new, sustainable control models ready for deployment.

In our new lighthouse project, eight Fraunhofer Institutes have joined forces to use innovative automation concepts and novel sensor technology to build a data-based ecosystem – an **"Agricultural Data Space"** – which shall become a milestone in digitalized agriculture.

In this way, digital technologies, new research approaches, and the problem-solving competence of Fraunhofer can become the enablers of highly efficient and at the same time sustainable agriculture of the future.

Prof. Dr. Reimund Neugebauer
President of the Fraunhofer-Gesellschaft

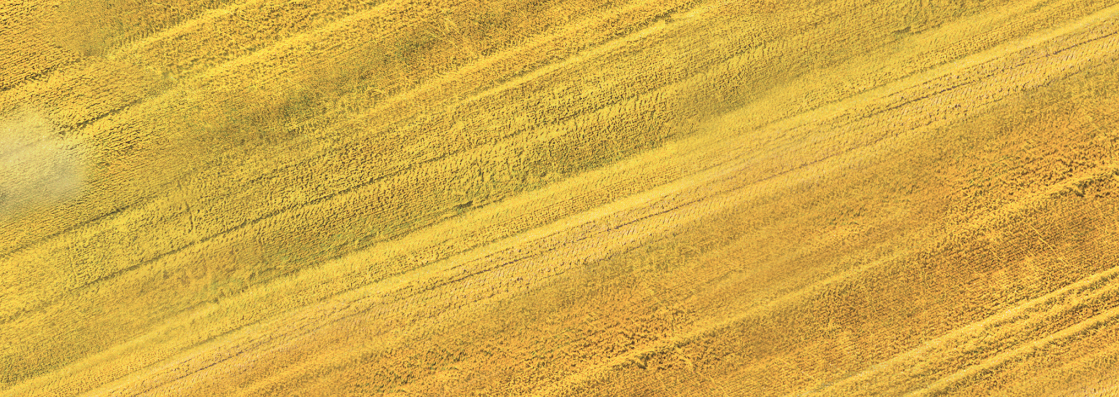
FRAUNHOFER LIGHTHOUSE PROJECT "COGNITIVE AGRICULTURE"

In the Fraunhofer lighthouse project **"Cognitive Agriculture"** (**"COGNAC"** for short), eight Fraunhofer Institutes are doing joint research on basic principles that will enable farmers to achieve high productivity in line with further goals such as sustainability, resource efficiency, or product quality in our digitalized world.

Digitally available data from the agricultural enterprise shall support decisions regarding these key aspects. For this purpose, data on factors related to the agricultural enterprise and to the environment must be collected automatically with state-of-the-art sensor technology and must be evaluated, analyzed, and processed cognitively in agricultural work and business processes in order to make sustainable, fact-based decisions regarding both crop production and livestock farming.

In the lighthouse project **"COGNAC"**, the participating Fraunhofer Institutes are designing an integrated platform for information-based (cognitive) agriculture and testing it in field tests. The goal is to demonstrate ways to connect the numerous isolated solutions and make them usable as a whole from end to end in order to achieve maximum productivity and sustainability. The value chain begins with crop production and lifestock farming, but also includes further process and processing steps in the long term.

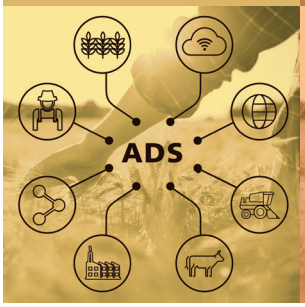
The project is therefore expected to deliver crucial innovations in the three areas "Networked Ecosystem", "Sensor Technology", and "Autonomous Field Robotics".



INNOVATION AREAS

AGRICULTURAL DATA SPACE

Easy data exchange in an **agriculture-specific, digital ecosystem** that enables multivalent use and linking of complex agricultural data volumes in secure data spaces while supporting cognitive services.



NOVEL SENSOR TERCHNOLOGY

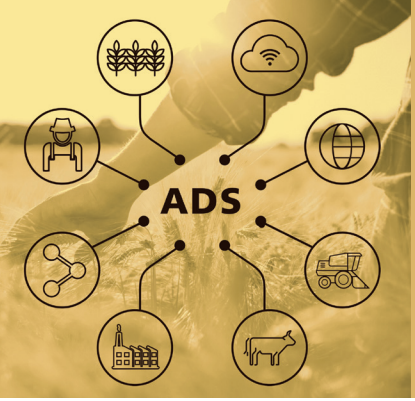
Automated **acquisition, integration, and interpretation** of multi-channel measurement data from novel drone- and robot-supported sensor systems to support information-based decision-making.

INNOVATIVE AUTOMATION CONCEPTS

Autonomous field robotics for plant-specific field work via a lightweight and electrified robotic platform with specific sensor systems.

Piloting and Demonstration

In pilot applications, the interaction of the solutions will be demonstrated on fields and the benefits for agriculture will be evaluated. For example, with autonomous mechanical weed control by small.electrified units, an alternative method is being evaluated to which all three innovation areas contribute and which can make a contribution to environmentally friendly and sustainable agriculture.



AGRICULTURAL DATA SPACE

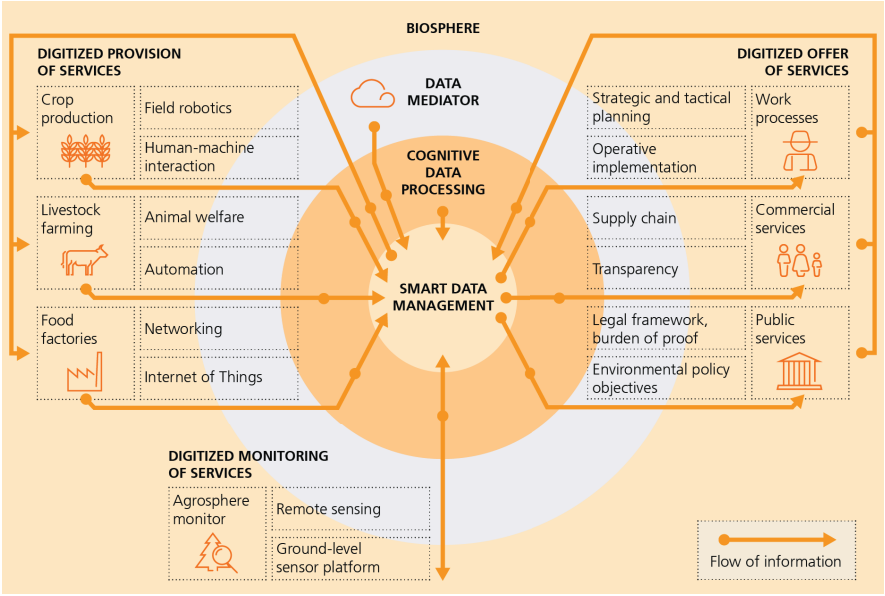
The automated support of work and business processes requires easy and fast access to the corresponding information. To this end, an "Agricultural Data Space" ("ADS" for short) is being designed and implemented prototypically that enables secure, overarching data usage.

The aim of the "Agricultural Data Space" is to make available all the data that is necessary for making decisions in agriculture while maintaining full data sovereignty. The intention is to cover a diversity of value-adding processes and the interaction with the biosphere. As for data interoperability, data analysis, and data sovereignty, the lighthouse project relies on innovative methods that use proven concepts from other domains for "Agriculture 4.0".

For the design of the "ADS", Fraunhofer can draw on experience from the reference architecture model of the "Industrial Data Space" and will use existing solutions for orientation or integrate such solutions.
The project aims to create an information-based ecosystem for the agricultural sector, which, for example,

- offers farmers a basis for decision-making across all levels, from soil conditions to market situation,
- enables machine manufacturers to implement optimal automation solutions based on the underlying data,
- enables manufacturers of seed or crop protection products to flexibly support the selection and dosage of their products,
- allows service providers to offer data-based services, and
- enables cooperatives and government agencies to make informed decisions based on data and to digitalize their processes that relate to farmers.

SOLUTION CORE DIGITALIZATION: “AGRICULTURAL DATA SPACE”



NOVEL SENSOR TECHNOLOGY

For a more comprehensive understanding of cause-effect relationships, different scales regarding both spatial distances and the periods of time considered must be integrated. This is the only way to identify and describe local and remote as well as direct and delayed changes in the biosphere.

This purpose requires the collection, interpretation, and aggregation of comprehensive data. However, information needed to better understand interrelationships is frequently missing. With appropriate sensors and cognitive analytics, it will be possible to close this gap in the future. In the context of this project, methods and sensor concepts are therefore being developed for soil and plant parameters that could not be measured to date, or only with great effort, but which are crucial for the planning of agricultural activities.

This includes, for example, the use of drone- and robot-supported agricultural sensor technology for

- seismic imaging of soil compaction,
- analysis of soil nitrogen content, as well as
- monitoring of soil areas and vegetation by hyper- and multi-spectral optical methods.

The data of these sensors will be combined with data from existing measurement systems as well as with additional remote sensing, weather, and yield data into semantic field maps in the "Agricultural Data Space". This will provide a comprehensive amount of data for automated interpretation and decision support for different time horizons.

In combination with innovative field robotics, this enables individual treatment of plants in a sustainable, efficient, and high-yield agriculture, for example in the form of chemical-free weed control.

INNOVATIVE AUTOMATION CONCEPTS

Automation via field robotics enables continuous and local acquisition of sensor data for the optimization of agricultural work processes. The goal of this lighthouse project ist the development of two field robots for applications for different crops. Using chemical-free weed control, it is demonstrated how these robots as sensor platforms support the acquisition of data for the "Agricultural Data Space". In addition, an energy supply infrastructure concept for autonomous field robots acting in swarms is being developed. In the context of this project, methods are therefore planned to be developed and implemented for

- automated recharging of the electrical energy storage device using a mobile charging interface,
- modular sensor integration,
- autonomous navigation, as well as
- integration into the cognitive process automation from the "Agricultural Data Space"

Fraunhofer can contribute its long-time expertise in the areas of robotics, drive technology, and quick-charging technologies. An efficient interplay of technologies supports the agricultural work processes. For example, individual plant treatment can significantly reduce the negative effects of large-scale application of chemicals.

The project's major contributions include:

- continuous acquisition of measurement data to generate digital services,
- increased envrionmental friendliness through reduction of chemical crop protection,
- introduction of future-oriented drive technology in agriculture, as well as
- reduction of soil compaction due to small, lightweight units.

SUPPORTERS AND PROJECT PARTNERS SOUGHT

The "Agricultural Data Space" developed in the Fraunhofer lighthouse project **"Cognitive Agriculture"** and the technology demonstrators will be open to companies and interested research groups in order to allow them to share solutions in their own projects or to contribute their own issues.

Support for overarching application scenarios mapping complex interrelationships of the biosphere in a networked data-based ecosystem requires the involvement of additional stakeholders.

Support our project!
You can do this in different ways:

- As an **associated partner**, you can be directly involved and be a First Mover.
- As a **participant in the project forum**, you can share your questions and experiences and participate in the results at an early stage.

CONTACTS AT THE PARTICIPATING INSTITUTES

Fraunhofer Institute for Experimental Software Engineering IESE
Ralf Kalmar
ralf.kalmar@iese.fraunhofer.de
Phone: +49 631 6800-1603

Fraunhofer Institute for Manufacturing Engineering and Automation IPA
Kevin Bregler
kevin.bregler@ipa.fraunhofer.de
Phone: +49 711 970-1317

Fraunhofer Institute for Factory Operation and Automation IFF
Prof. Dr. Udo Seiffert
udo.seiffert@iff.fraunhofer.de
Phone: +49 391 4090-107

Fraunhofer Institute for Physical Measurement Techniques IPM
Prof. Dr. Jürgen Wöllenstein
juergen.woellenstein@ipm.fraunhofer.de
Phone: +49 761 8857-134

Fraunhofer Institute for Ceramic Technologies and Systems IKTS
Dr. Ingolf Voigt
ingolf.voigt@ikts.fraunhofer.de
Phone: +49 36601 9301-62618

Fraunhofer Institute for Industrial Mathematics ITWM
Dr. Michael Burger
michael.burger@itwm.fraunhofer.de
Phone: +49 631 31600-4414

Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB
apl. Prof. Dr. Thomas Längle
thomas.laengle@iosb.fraunhofer.de
Phone: +49 721 6091-212

Fraunhofer Institute for Transportation and Infrastructure Systems IVI
Dr. Julia Osten
julia.osten@ivi.fraunhofer.de
Phone: +49 351 4640-811

About "Cognitive Agriculture"

In the lighthouse project **"Cognitive Agriculture"**, eight Fraunhofer Institutes are conducting joint research on basic principles to produce agricultural products that are as environmentally friendly and resource-saving as they are highly efficient. Solutions include sensor technology for data collection as weil as digitalization and automation of agricultural processes. The idea is to make the analysis of highly complex interactions between biosphere and production usable in a digital ecosystem of networked data and services ("Agricultural Data Space") and to have it provide decision support.

Participating Institutes
Fraunhofer IESE (project management), Fraunhofer IFF, Fraunhofer IKTS, Fraunhofer IOSB, Fraunhofer IPA, Fraunhofer IPM, Fraunhofer ITWM, Fraunhofer IVI

Do you need further information or are you interested in collaborating with us? Please feel free to contact us!

Contact Person
Ralf Kalmar
ralf.kalmar@iese.fraunhofer.de
Phone: +49 631 6800-1603
www.iese.fraunhofer.de

Project Management
Prof. Dr.-Ing. Peter Liggesmeyer

Fraunhofer Institute for Experimental Software Engineering IESE
Fraunhofer-Platz 1
67663 Kaiserslautern
Germany

www.cognitive-agriculture.de