WELCOME TO THE
5TH FRAUNHOFER GREEN DEAL WEBINAR

2 December 2021 | 15:00 – 16:00 CET

Combining efforts –
Alternative Proteins and Smart Farming for Europe's sustainable food production
15:00  Moderation by Verena Fennemann  
Head of Fraunhofer EU-Office Brussels  
Welcome and introduction by Prof. Dr. Stefan Schillberg  
Member of the Institute Management and Head of Division Molecular Biotechnology, Fraunhofer IME

15:10  Setting the scene by Norbert Lins  
Patron of the webinar; Member of the European Parliament

15:20  Expert presentation I "Digitization of food production and agricultural value networks“ by Ralf Kalmar  
Head of Business Development, Fraunhofer IESE

Expert presentation II "FutureProteins – Coupled Agricultural Systems for a Resilient and Sustainable Production of High-quality Food Proteins“ by Susanne Naumann  
Food Process Development, Fraunhofer IVV

15:45  Discussion

16:00  End of the event
Welcome and introduction

by Prof. Dr. Stefan Schillberg

Member of the Institute Management and Head of Division
Molecular Biotechnology
Fraunhofer Institute for Molecular Biology and Applied Ecology IME
The Fraunhofer-Gesellschaft at a Glance

The Fraunhofer-Gesellschaft undertakes applied research of direct utility to private and public enterprise and of wide benefit to society.

29,000 staff

75 institutes and research units

2.8 billion

€2.4 billion

Finance volume

2020

Contract Research

Major infrastructure capital expenditure and defense research

Almost 30% is contributed by the German federal and states Governments

More than 70% is derived from contracts with industry and from publicly financed research projects.
Horizon 2020 projects with the participation of the Fraunhofer-Gesellschaft

- **demeter**
  - Promotes digitalization in the agriculture and food sector

- **ATLAS**
  - Development of an open interoperability network for agricultural applications and to build up a sustainable ecosystem for innovative data-driven agriculture

- **PHOTOBOOST**
  - Improving photosynthetic performance and productivity of C3 crops under diverse environmental conditions
  - [www.photoboost.org](http://www.photoboost.org)
2020: For the first time in history, there is more man-made matter than biomass on Earth (>1100 GT)
The European Green Deal
Achieving climate neutrality in 2050
Challenges in agriculture
A global mission

Consumption of resources, land- and crop loss

Measures for sustainable agriculture

- Reduction of food loss and waste
- Change in dietary habits
- Technological and management improvements

% of green house gases

- Over-fertilization: 20%
- Pesticide use: 30%
- Deforestation: 10%
- Soil erosion: 70%
- Extra CO₂ transport: 12%

Food chain management

Modern breeding methods

Smart Farming

Contained agriculture

Smart processing and products

Modified based on: Urban farming in the city of tomorrow, Fraunhofer IAO
"Springmann et al. 2018 Nature 562, 519-525
Fraunhofer Lighthouse Projects
Addressing challenges in agriculture

- With its flagship projects, the Fraunhofer-Gesellschaft sets strategic priorities to develop concrete solutions for the benefit of industry and society. The aim is to quickly turn original scientific ideas into marketable products.

- COGNAC – Cognitive Agriculture
  Analysis of highly complex interactions between biosphere and production to create an »Agricultural Data Space«

- Sustainable, resilient and safe production of alternative protein sources in contained agricultural systems
Expert presentation I

“Digitization of food production and agricultural value networks”

By Ralf Kalmar

Head of Business Development

Fraunhofer Institute for Experimental Software Engineering IESE
A digital ecosystem encompasses different levels of abstraction and multiple stakeholders.

- **Political and societal constraints**
- **Business processes and value networks**
- **Work processes**
- **Agricultural production systems**
- **Biosphere / agricultural production environments**

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**Interoperability and Trust: Two elements, which must be established.**

Automation through Software and IT

Data Space

Data and Sensor Systems

Cognitive Services
Digital Twinning of all Assets can create an Interoperable Basis

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<tr>
<th>Stakeholder</th>
<th>Information Needs</th>
<th>Added Information</th>
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<tr>
<td>Farmer</td>
<td>Weather</td>
<td>Field Data (soil type, geometry, ...)</td>
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<td>Seed Producer</td>
<td>Position</td>
<td>Nutrition Status Log</td>
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<td>Agrochemical Business</td>
<td>Supply Chain Origin and Destination</td>
<td>Race Weight, Certificate of Origin</td>
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| Warehousemen | Food Data         | Production process Food Certificate |
| Forwarders   | Race Data         | Production process Food Certificate |
| Warehousemen | Race Data         | Production process Food Certificate |
| Stores       | Race Data         | Production process Food Certificate |
| Groceries    | Race Data         | Production process Food Certificate |
| Markets      | Race Data         | Production process Food Certificate |
| Consumers    | Race Data         | Production process Food Certificate |
| Restaurants  | Race Data         | Production process Food Certificate |

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<th>Production process</th>
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The Fraunhofer lighthouse project COGNAC is developing solutions for an integrated domain ecosystem „agriculture“ and optimized farming processes – **Smart Farming**.

- A **Data Space** concept for interoperable management of data and services using the digital twin concept.
- **Data Sovereignty** rules and data usage control tied to **digital twins**.
- **Cognitive Services** for decision support and process automation
- **Novel sensor technologies** to yield new insights regarding soil and agricultural processes (e.g. N2O).
- Automation concepts for **safe autonomous robotics**, e.g. for chemical-free weed-regulation

**Digital Transformation in Ag can be used to support and achieve the Green Deal Goals**
We need a solution for **interoperability** of data between platforms.

- Linking the value network from farm to fork using digital twins would add an abstraction layer for it
- Tying physical assets to virtual representations would also ease data governance and sovereignty, thereby establish trust

**Food quality aspects** should be captured consistently along the value network.

- This would, for example, allow comparison of traditional and alternative food production aspects
- Interesting data to be tracked could be: CO2 footprint, nutrition facts, sustainability index
Expert presentation II

“FutureProteins – Coupled Agricultural Systems for a Resilient and Sustainable Production of High-quality Food Proteins”

By Susanne Naumann
Food Process Development
Fraunhofer Institute for Process Engineering and Packaging IVV
Future Proteins

Project focus & partners

- Vertical Farming
  - Alternative protein plants

- Insect Farming
  - Edible, pathogen-free insects

- Single-cell Protein
  - Alternative fungal strains

- Microalgae
  - New microalgal strains

Fraunhofer

IME IGB IVV IOSB

Processes engineering
systems engineering
bio-technology

Assessment
IVV UMSICHT IGB IME

IWU UMSICHT

© Fraunhofer IME
Future Proteins

Project goals

**Vertical farming**
- Alternative protein plants: Alfalfa, wheat, potato
- Hybrid illumination

**Insect farming**
- Automated insect culture systems
- Molecular detection system for insect and food pathogens

**Single-cell protein**
- Submerged cultivation of Basidiomycetes
- Cost-efficient culture media

**Microalgae**
Compact photobioreactor with improved light and protein yields

© Fraunhofer IME (Vogel, Schillberg 2018 EP17173370)
Future Proteins

Closed agricultural systems

Protein production systems

Water Nutrients

Plants

Residual biomass as nutrient source

Insects

CO₂ Excreta as fertilizer

Fungi

Residual biomass as nutrient source

Algae

CO₂ Biostimulants

Heat

Sidestream recycling

Water re-use

Nutrients CO₂

Process water treatment

Biogas plant

Biomass

Direct marketing

Processing

Proteins

Co-products e.g. starch

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Future Proteins

Processing of alternative proteins

- **Protein recovery**
  - Raw material preparation (peeling, milling, pressing)
  - Fractionation
  - Cell disruption (ultrasound, high pressure)
  - Protein extraction (salting, alkaline extraction)
  - Protein recovery (precipitation, filtration, drying)

  **→** Side streams (e.g., peels)

  - **→** Starch, Lipids, etc.

  - **→** Side streams (e.g., permeate)

  **→** Alternative protein

- **Protein modification: Enzymatic hydrolysis, Fermentation, Extrusion**
Future Proteins

Product development for alternative protein applications

- **Development targets**
  - Antinutrients
  - Bioavailability of proteins & essential amino acids
  - Texture & Mouth Feel
  - Off-Flavour

- **Development strategies**
  - Protein combinations
    - Nutritional complementation
    - Interaction effects on functional and sensory properties
  - Model foods
    - Dairy alternatives
    - Meat alternatives
    - Sausage surrogates
    - Baked goods and pasta

- **Functionality & Application**
  - Solubility
  - Emulsification
  - Foaming
  - Gel forming
Alternative proteins for dairy products

- Dairy alternatives are one of the fastest-growing product groups (CAGR 14%)
- Needed functionality
  - Emulsifying capacity
  - Gel formation
  - Foaming capacity
- Modified functionality
  - Aroma formation and degradation
  - Degradation of antinutritive substances
Future Proteins

Alternative proteins for meat alternatives

- **Texturization processing**
  - **High moisture extrusion**
    Texturing in a long cooling nozzle to form a fibrous network \(\rightarrow\) lean meat-like products
  - **Thermoplastic low moisture extrusion**
    Texturing to a porous, floating network \(\rightarrow\)
    Texturates are used to generate firmness and juicyness
Future Proteins

Alternative proteins: Sausage surrogates & baked goods

- Production of sausage surrogates with vegan Basidio protein
- Production of ‘liver sausage’ from mealworms
- Baked goods
  - Gluten-free bread making
  - Egg replacement

© Fraunhofer IME
Muffin: © Fraunhofer IVV
Challenges and recommended actions

**Challenges**

- Collaboration throughout the value chain
- Translation into commercial application
- Administrative effort
- Accelerated translation of novel technologies

**Recommended actions**

- Close the gaps between research areas: raw material – processes - application
- Provide tools for entrepreneurial thinking and action
- Reduce and simplify administrative procedures
- Guidelines/support for e.g. new breeding technologies and novel foods
THANK YOU FOR ATTENDING THIS FRAUNHOFER GREEN DEAL WEBINAR

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Fraunhofer EU-Office: Fraunhofer Green Deal Series

Combining efforts – Alternative Proteins and Smart Farming for Europe's sustainable food production