Innovation for protein self-sufficiency in Finland

Emilia Nordlund
18th November 2019
VTT – beyond the obvious

VTT is one of the leading research, development and innovation organizations in Europe.
We help our customers and society to grow and renew through applied research. The business sector and the entire society get the best benefit from VTT when we solve challenges that require world-class know-how together and translate them into business opportunities.

Our vision
A brighter future is created through science-based innovations.

Our mission
Customers and society grow and renew through applied research.

Strategy
Impact through scientific and technological excellence.

Established in 1942

Net turnover and other operating income (VTT Group 2018) 268 M€

Total of personnel (VTT Group 31.12.2018) 2,049

Doctorates and Licentiates (VTT Group 2018) 31%

From the net turnover abroad (VTT Group 2018) 44%

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Public decision makers, financiers and R&D performers in Finland

Parliament of Finland

Council of State

Ministry of Education and Culture
  - Academy of Finland
  - Universities

Ministry of Economic Affairs and Employment
  - Business Finland

Ministry of Agriculture and Forestry, Other ministries and research institutes
  - Sitra, the Finnish Innovation Fund
  - Finnvera
  - Finnish Industry Investment Ltd

ELY centres
  (Centre for Economic Development, Transport and the Environment)
Food innovation accelerators in Finland

Incubator programs and funds for boosting innovations

- VTT Launchpad boosting spin offs
- Nordic Food Tech VC funding for start-ups
- Founders Institute for early state start-ups
- EIT Food FAN accelerator program mature start-ups
- Finnish Academy & Strategic research council
- Business Finland for research & innovation
- Research programs of ministries (MMM)
- ELY centres Sitra Others
- Others

Basic and applied research funding for generation of innovations

From 2016 the amount of agri-food incubator / accelerator programs has raised up from 6 to 80 at EU
**Food Ecosystems and Networks in Finland**

**“Agile Food” Ecosystem**
2020
To join cross-industry forces for reshaping the food value chain to boost innovation and impact. Whole Finland approach (VTT coord.)

**Seinäjoki-Food**
2015
Food business summit, Food Province

**Turku-Foodtech**
2019
University of Turku, AIF, Flavoria, VTT

**crEATe Ecosystem**, VTT, IBM, Fazer; Heart is the TestEat test restaurant
2018

**Food Valley – Kuopio**
2018
Aim is to create innovation ecosystem, which creates new products and consumer services; University of eastern Finland, Valio Etc. and VTT

**Local innovation activities**
Many areal co-operation projects, but not actual ecosystems

**Open Mode Helsinki**
2017
Consumer-focused, food among several services, coord. by Kauppahalli24, VTT
VYR task forces for boosting protein self-sufficiency in Finland

- Working group organized by the Finnish Cereal Committee (VYR)
- The working group focuses on cereals, legumes, oilseeds and grass, and its aim is to raise Finland's status as a model country for protein self-sufficiency and sustainable food production and as an exemplary operator in the EU.
- Operators from all sections of the supply chain are in the working group
- Task forces are organized under: primary production, feed, food and market development

MORE INFO: Hanna Helkkula (VYR) & Emilia Nordlund (VTT)
Protein self-sufficiency implementation plan Report in Finnish:
Renewal of Finnish food research strategy

• Together with key food research actors we aim to position Finland as a key actor in the transition towards a sustainable global food system, which will also create new economic growth opportunities.
• The strategy work discussions with key partners already started this year but the actual work will be done in 2020.
• Meeting with core partners (research partners and key stakeholders) will be scheduled for January to decide on the process.
• Workshops with various stakeholders (ETL, major industry actors) will be also planned.
• More information: Nesli Sözer, research Prof VTT (nesli.sozer@vtt.fi)
Boosting protein innovations
Sustainable protein and food by smart use of resources

Reforming agrifood chain
- Plant-based food design
- Boosting biodiversity
- From side-streams to main streams
- New circular concepts for food and feed production

Food without Fields
- Cellular agriculture
- Insects as feed & food
- Circular concepts with existing food systems
- Vertical farming
Three innovation paths for the sustainable food chain
Innovation path 1
New tools for primary production

- Cultivation technologies and practices
- Smart crop rotation practices
- Breeding for better tolerant plants and quality
Case CARBO: Towards carbon-neutrality in milk and meat production

- **CARBO collaboration network 2019-2021**, convened by Valio, with Atria Tuottajat, the Finnish Meteorological Institute, Natural Resources Institute Finland (Luke), University of Eastern Finland and Yara; Business Finland, total budget 8M€

- **Goals include:**
  - reducing the environmental impacts of the Finnish milk and meat chain using research data, new innovations and farm pilots
  - carbon sequestration in grass fields
  - improving profitability of Finnish agriculture and boosting export
  - responding to changes in consumer demand for more transparency and sustainability in the primary production of food

Case MULTA: Multi-benefit solutions to climate-smart agriculture

- Funded by strategic research council of Finland; Active 2019-2025
- Consortium: Finnish Meteorological Institute (coord. Jari Liski), BSAG, University of Helsinki, INAR – Institute for Atmospheric and Earth System Research, Natural Resources Institute Finland LUKE, Finnish Environment Institute SYKE, and University of Zurich.

- **MULTA studies and develops:**
  - processes of carbon sequestration and climate impacts focusing on knowledge gaps
  - how these processes can be enhanced using farming practices and how implemented on farms
  - methodology for verifying carbon sequestration and the climate impacts
  - policies and economics that support climate-smart farming

Innovation path 2
Plant-based food design

- Development of ingredient and food technologies for delicious plant based food
Case OatHow – boosting oat-based innovations

Co-Innovation project funded by Business Finland; From Jan 2019 to Dec 2020; Partners: Research: VTT (coord.), Luke, University of Helsinki, University of Turku; Industry (in total 13 companies); Budget: 2.0 M€

- Genomic approach (with proximate compositional analysis)
- Processing approach (with detailed physico-chemical and quality analysis)

New technologies and methods
- to predict the behaviour of oat raw materials in the processes
- for successful selection of oats for various processes
- for efficient breeding of high quality oats
- for quality indicators to facilitate product innovations for export

Case LEG4LIFE - Legumes for sustainable food system and healthy life

- Project funded by strategic research council of Finland; Active during 2019–2025
- Consortium: University of Helsinki (coord. Anne-Maria Pajari), National Institute for Health and Welfare, and Natural Resources Institute Finland
- System-level project with focus on grain legumes (pea, faba bean, and lupin) that are feasible to be cultivated in Finland
- Promotes legume-supported agriculture, tasty and healthy legume foods for food services and individual consumers
- Studies the effects of increased legume production

Case Hybrid Ingredients

- Hybrid ingredients by dry fractionation: sustainable, resource efficient
- Technological and nutritional benefits various components of plant materials
- High protein and fibre foods with a single ingredient
Hybrid ingredient Case 1: Wheat bran fraction functional in baking

Wheat / rye bran → Hybrid Ingredient

Wheat bran hybrid ingredient

Foaming properties

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<th>Wheat bran raw material</th>
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Crackers enriched with wheat bran hybrid ingredient

- Increased protein and fibre content
- Crispier
- Richer in flavour
Hybrid ingredient Case 2: Rapeseed press cake fraction functional in wet-extrusion

Formation of a fibril structure with a single ingredient
• 22% protein, 14% dietary fibre

High moisture extrusion
Innovation path 3
Emerging technologies for protein production

- Food without Fields technologies can enable using more of the cultivated land for food production
Biobased streams are versatile nutrient sources, but not always for human use

Can we utilize those streams for protein production via bioconversion and circular concepts?
Food without Fields - Cellular agriculture

- Using single cell organisms and bioreactors for production of food ingredients
- They turn simple feedstocks into complex products
Cells as Food Products is not new

Tradition for using single cell organisms as food exists

Microalgae, such as *Spirulina platensis* has long history as food

**Pekilo** - *Paecilomyces variotii* was grown for food and feed in Finland in the 70’s

**Quorn** is produced from *Fusarium venenatum fungus* and it is widely available on the market

http://www.fao.org/docrep/f1360e/f1360e03.htm#TopOfPage
Food from Air is new!
Case Solar Foods

Gas Fermentation to produce microbial biomass for food

*Rhodococcus opacus* sequesters carbon dioxide and oxidizes hydrogen for energy

When hydrogen is provided using photovoltaics, it turns sun light into biomass more efficiently than algae or plants

http://www.solarfoods.fi/
Case INNOFEED - Biorefining ensiled grass into inventive feed products

Project:
- Defined the best grass cultivars for protein rich silage production
- Developed technologies for feed production from silage
- Tested Pekilo fermentation for boosting protein in feed
- Verified processes by techno-economic evaluation & nutrient LCA
- Tested the feed prototypes in pig and dairy cow feeding
- Evaluated the export and commercialization possibilities

Funded by Business Finland; Duration 2015-2018; Partners VTT, Luke and FIN industry
Production of Acellular components for food manufacturing is neither new

Enzymes (food processing aids), and additives (flavours, vitamins, etc.) are produced in cell factories
Production of high performance food proteins is new!
Case Animal proteins

Egg without Chicken
Trichoderma reesei was used as a host to produce chicken ovalbumin – egg white protein

Functional testing has been done to confirm that it forms gel structures and foams

Milk without Cow
Beta-lactoglobulin (BLG), whey protein from T. reesei

BLG has similar structure and emulsions compared to bovine BLG

4 g Productivity per litre
Case Insects: From food waste to feed

- Worldwide every year **1.3 billion tons** food is lost – impact 1 billion dollars
- What if, we could convert it to ~**232 million tons** of insects?

- **Black soldier fly** is uniquely positioned as the most efficient insect that can be reared in large scale
- Larve composition is similar to soybean
- Waste management + production of feed in one solution

READ MORE:
Rethinking the food production – again!

Where Have All the Oats Gone?

(And What Happens to Ag Jobs When Alt-Protein Rises?)

As 1987 USDA report put it: “Oats remained a major crop in the United States until about the midfifties when acreage and production began to decline. Replacement of horses by tractors, trucks, and cars greatly reduced the population of a major consumer of oats.” Consequently, the decline in oat production coincided with a sharp increase in those crops, which to this day have maintained a virtual hegemony in U.S. feed crop production. In other words: farmers still farmed, just different crop…

https://medium.com/@PaulShapiro/where-have-all-the-oats-gone-4eaeb679cb1b?sk=326259eb0ee1f02a177e71b2d84ae2ca
Let’s venture beyond the obvious

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