Tutkimuksella uudistusta ja erikoistumista: miten kasviproteiineja ja solu-maataloutta voisi hyödyntää paremmin

Emilia Nordlund

VTT builds sustainable future by the means of technology and excellence to:

- Reach a carbon neutral economy in the coming decades
- Achieve a 10-fold productivity leap from resources
- Secure society's functions, fiscal sustainability and wellbeing
- Bring about the quantum leap in computing
- Match nature's engineering skills through synthetic biology and bioinspired production

SYSTEMIC CHALLENGE

Development of Sustainable Food System

Food & Protein diversification is critical

- **Terrestial sources**
  - Plants
  - Insects
  - Animals
- **Aquatic sources**
  - Fish, seafood
  - Algae
  - Insects
  - Aquatic plants
- **Cellular agriculture**
  - Microbial biomass
  - Precision fermentation
  - Cultured meat
  - Plant cells




EIT-Food-PDTT-Policy-Brief-Accelerating-Protein-Diversification-for-Europe.pdf (eitfood.eu)

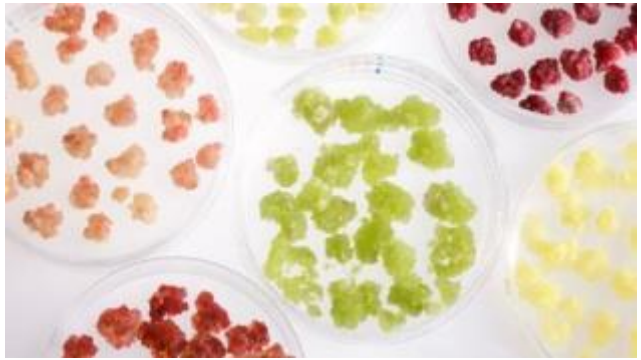
VTT focus areas for the sustainable food system development

Plant based food

More efficient use of agricultural resources by new plant based food innovations

Cellular agriculture

Production of food ingredients by microbes and other cell cultures



Three integrated platforms for innovation

Plant based food

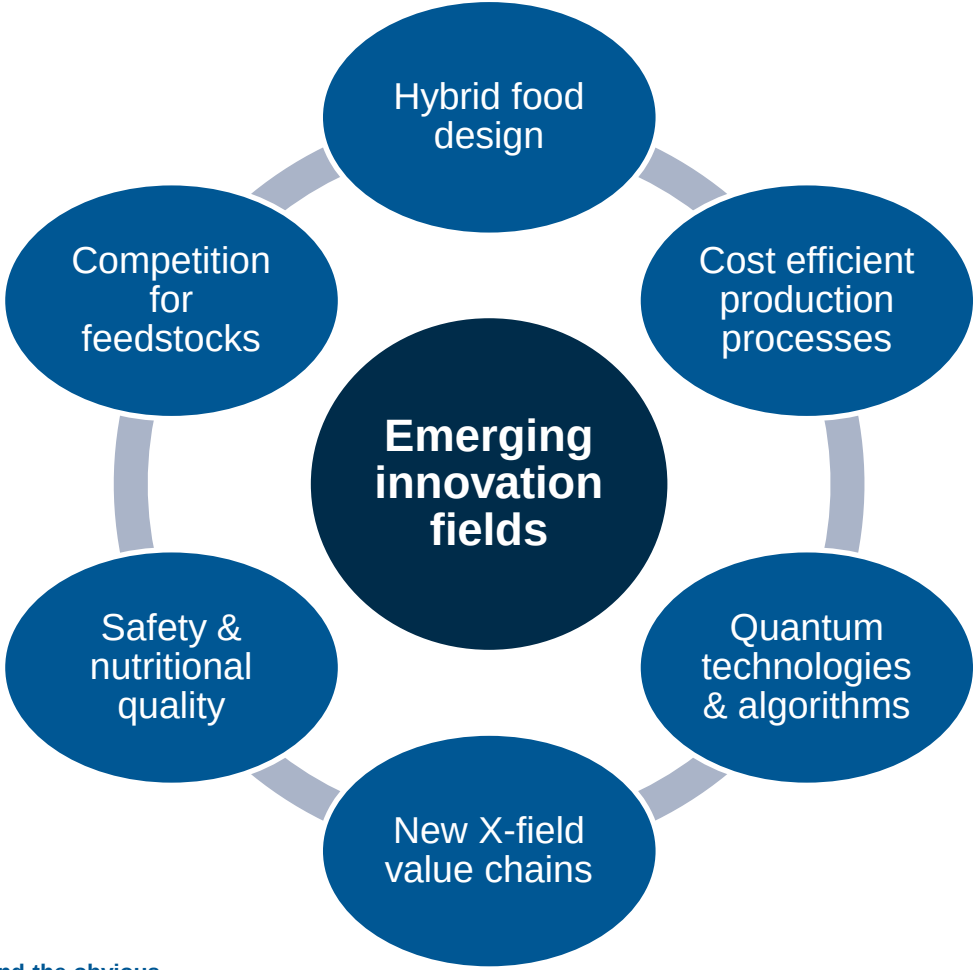
- Cascading use of raw materials
- Ingredient separation technologies
- Dairy and meat alternatives
- Hybrid food design

Cellular agriculture

- Precision fermentation
- Whole cell microbial solutions
- Plant cell cultures for foods
- Bioprocesses with sustainable feedstocks

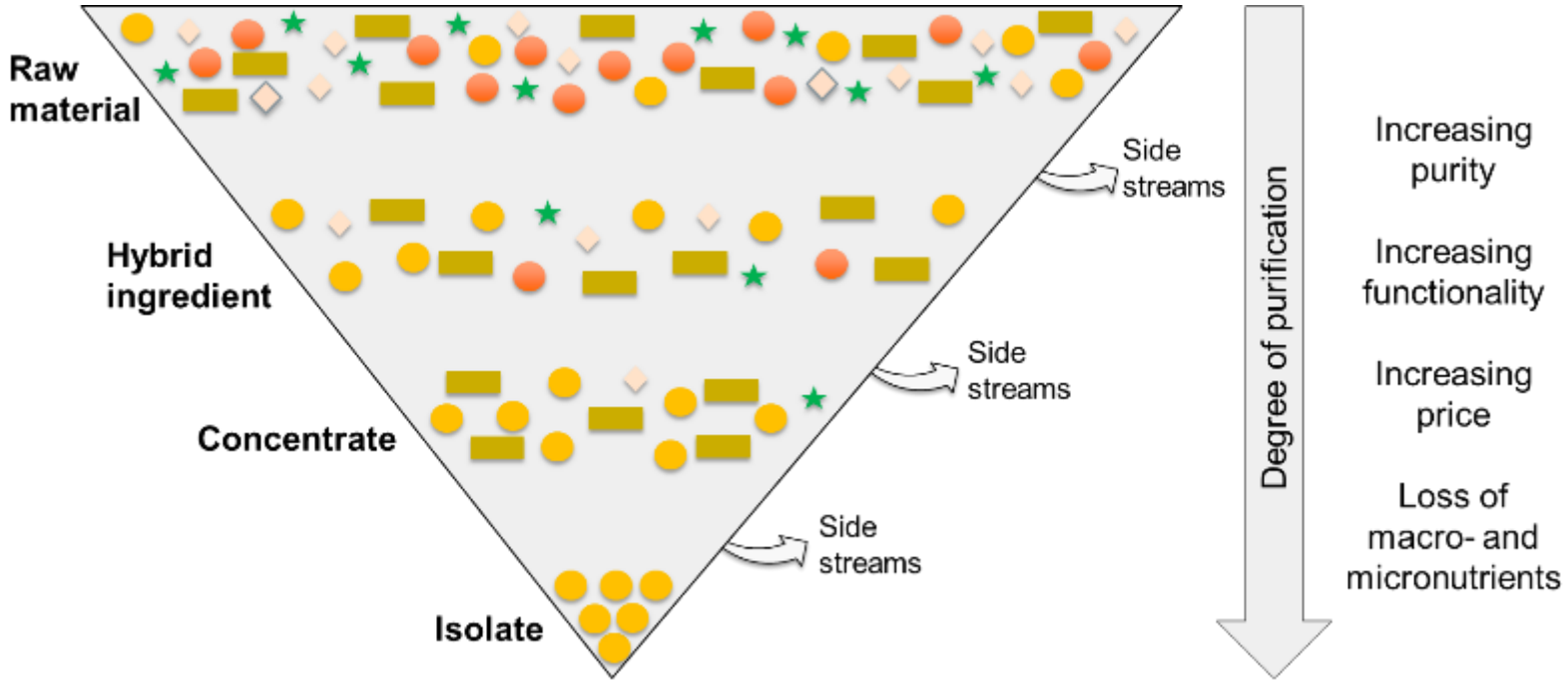
Agile data-driven design & manufacturing

- Predictive tools, monitoring technologies & data analytics for process and product design


Hybrid food design
Cost efficient production processes
Quantum technologies & algorithms
New X-field value chains
Safety & nutritional quality
Competition for feedstocks
Emerging innovation fields

Innovation in Plant Based Food

Pyramid of ingredient production – optimizing quality and resource efficacy



Plant based food cases by VTT

New patented cost-effective extrusion-aided separation process for plant proteins (protein >70%)

Less water, no chemicals

High performance plant based ingredients with high protein and dietary fibre content

Valorisation of undervalued fish with addition of plant proteins by high-moisture extrusion cooking

Hybrid food design

Tasty meat products by combining plant-based ingredients with lipids produced by microbes

New innovation case: Extrusion-based protein separation method

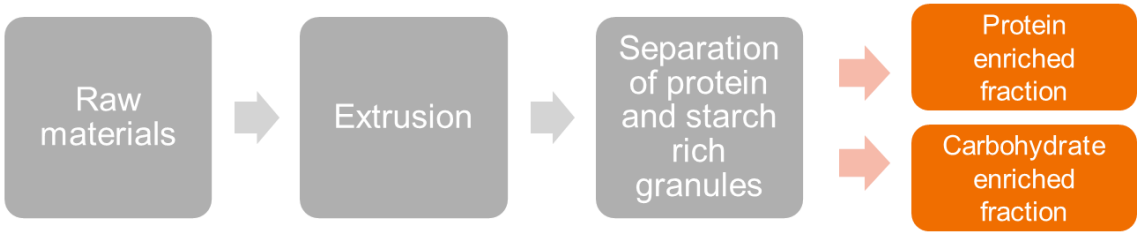
There is a need for cost-efficient environmentally sustainable methods to produce high quality protein ingredients

Current methods:

- **Dry fractionation -** Energy consumption moderate, proteins and other compounds in native state; BUT: Concentration to isolate level is not possible, it is applicable only for selected raw materials
- **Wet separation -** Isolates possible; BUT: High energy consumption (14 MJ/kg protein vs. 2 MJ/kg in dry fractionation), denaturation, use of chemicals, sustainability challenges

A patented extrusion-based fractionation method to produce high quality plant protein

- By the novel method, it is possible to obtain heterogenous extrusion output consisting of protein and carbohydrate enriched granules
- The process overcomes limitations in current wet and dry fractionation, and is capable of fractionating various raw materials, even those containing lipids

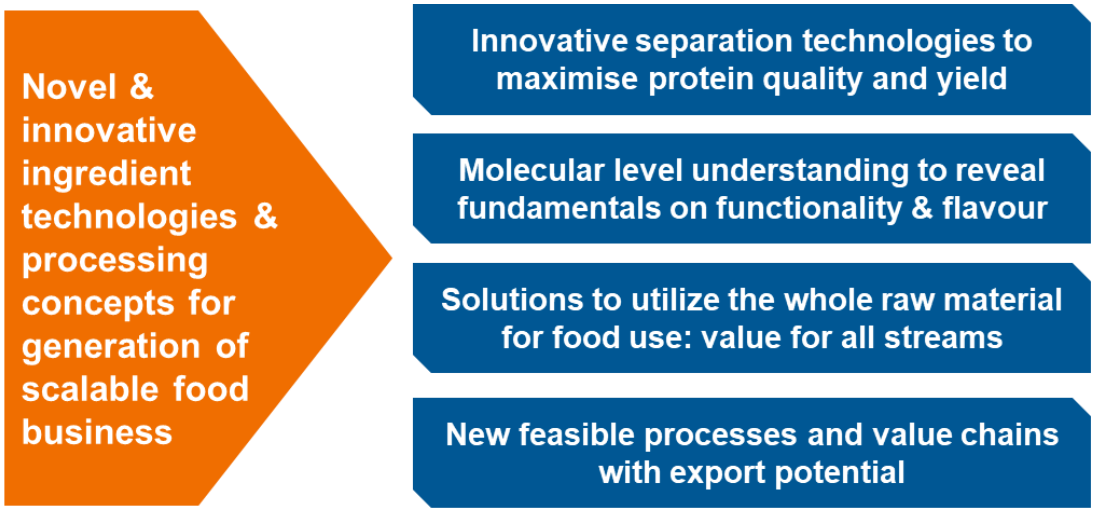


Process and product facts

- Technology successfully tested with cereals and legumes (e.g. pea, oats, faba bean, cowpea, chickpea)
- Cost effective and sustainable process based on conventional extrusion
- Protein concentration with the tested raw materials in the range of 65-80% and protein yield is up to 85% of raw material protein
- Process significantly decreases the beany and intense flavour of the legume raw materials
- Both protein and carbohydrate fractions have functionalities required for high quality food ingredients

New ingredient technologies to boost the Finnish plant protein business / BF-CI-RETHINK

- A public 3-year co-innovation project funded by Business Finland and VTT (to small extent by industry)
- Duration: June 2023 - May 2026
- Research project budget: 2M€
- Research partner: VTT (Respons. leader Emilia Nordlund, PM Pia Silventoinen-Veijalainen)
- Industry partners: Anora, Apetit, Fazer, Helsingin Mylly, Raisio, Valio, Viking Malt, 5 companies have their own parallel projects



Innovation in Cellular Agriculture

Cellular agriculture cases by VTT

Case Solar Foods
VTT spin-off

www.solarfoods.com

enifer Brewing the original mycoprotein

Case eniferBio
VTT spin-off

www.enifer.com

Case Onego Bio
VTT spin-off

Fungus as a host to produce functional egg proteins

90%
Reduced land use

72%
Less GHG

https://www.onego.bio/

Case Cell Coffee
by VTT R&D

Production of coffee cells in a bioreactor through cellular agriculture

The innovation can help to make the production of coffee more sustainable

Sustainable coffee grown in Finland – | VTT News (vttresearch.com)

What’s cooking

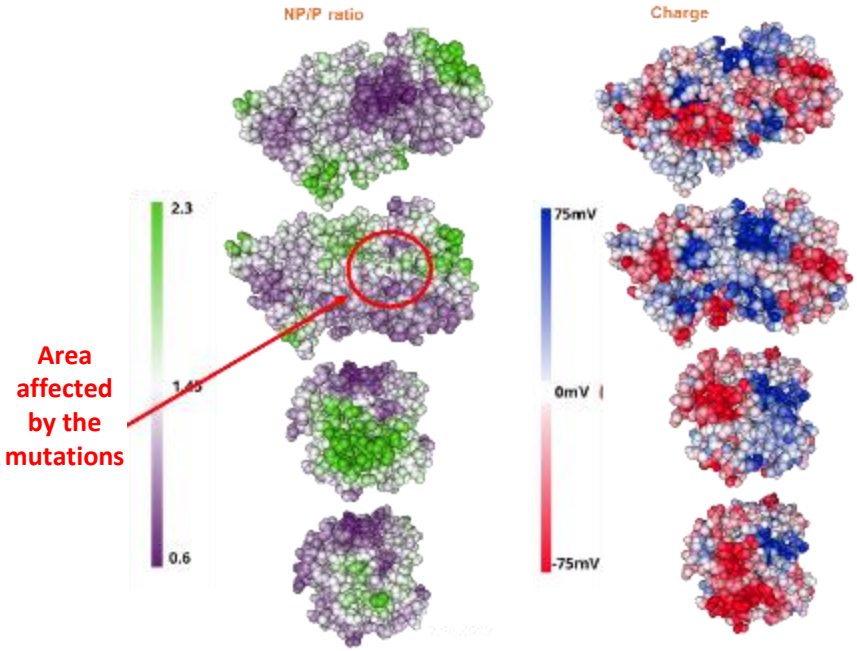
VTT – beyond the obvious

Microbial lipids make the alternative meat sizzle

- While fat typically comprises a smaller fraction of food products, it is a key determinant of flavor, texture and nutrition
- Unsustainable coconut and palm oil are the main fat sources in many products
- VTT is developing microbial strains having e.g. cocoa butter or beef like fatty acid profile
- Up to 60% lipid yield per biomass can be generated

Computational approach for designing new & better food proteins

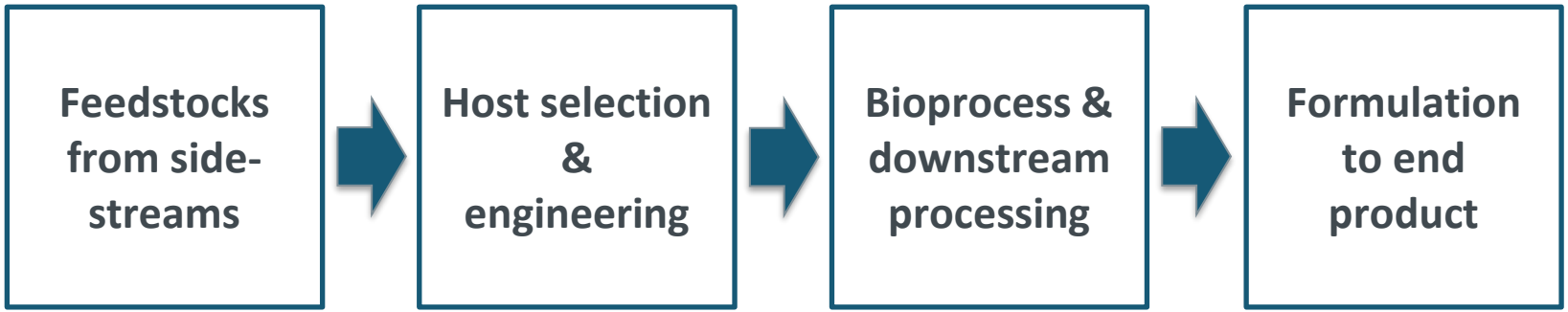
- Exploring the translation between DNA sequence and protein function, e.g. foaming of ovalbumin
- Based on the surface charge and other properties, relevant parts of the protein sequence alerted by a machine learning
- The resulting 3D structures checked with AlphaFold to ensure the adequate folding
- Finally, the new ovalbumin sequences were expressed in *Aspergillus oryzae*



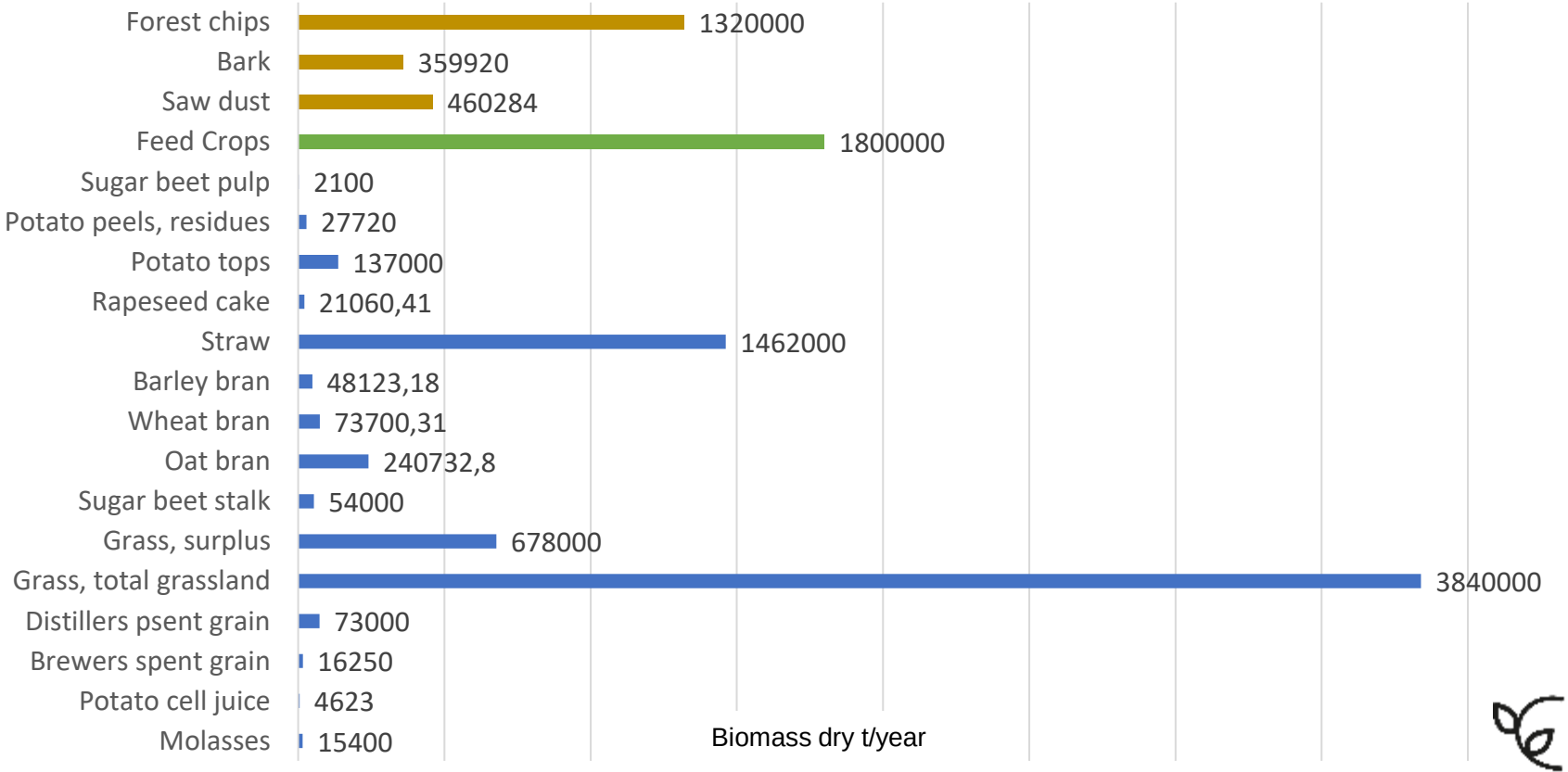
Beyond microbes –

How to build feasible cell factory processes for food production

Critical parts of the value chain for efficacy and safety



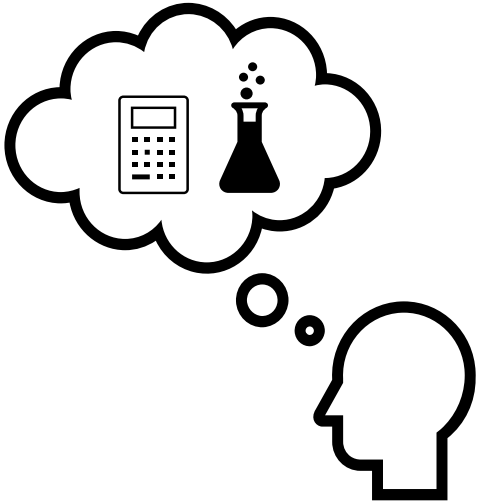
Agri & forest based biomass streams in Finland



Volumetric potential of Finnish agri-food industry side-streams as a carbon source for microbial protein production

Main assumptions for the microbial protein production

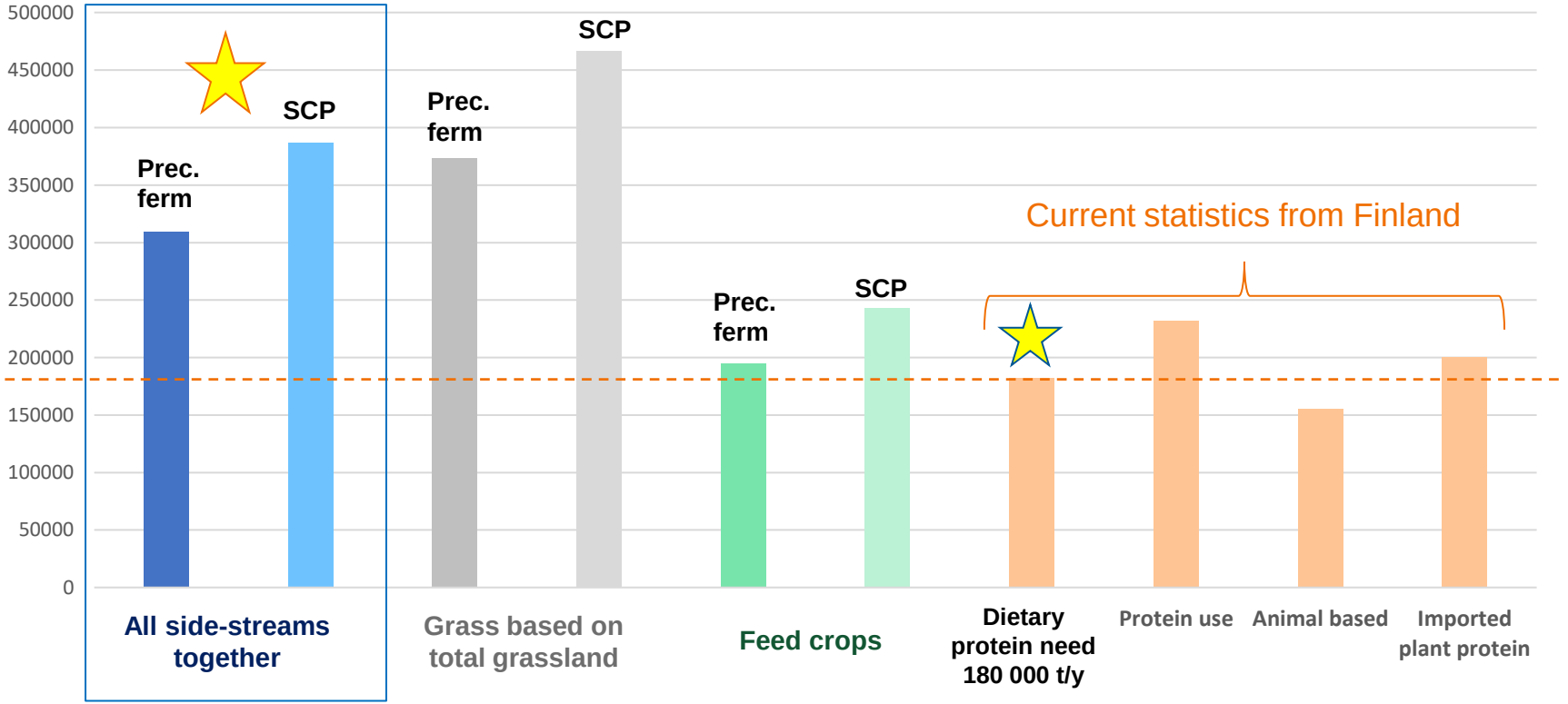
- **Pretreatment efficiency** (sugar yield from side-streams)
  - 100% for liquid streams
  - 90% for solid streams
- **Recombinant protein production** (precision ferm.)
  - Yield from sugar to protein 0.2 g protein / g sugar
- **Microbial biomass (SCP) production**
  - Yield from sugar to SCP cells 0.5 g/g sugars
  - SCP protein content 50%



Food without Fields project funded by Catch the Carbon program of the Ministry of Agriculture and Forestry of Finland (2021-2023)

Estimated protein production potential based on agrifood sidestreams

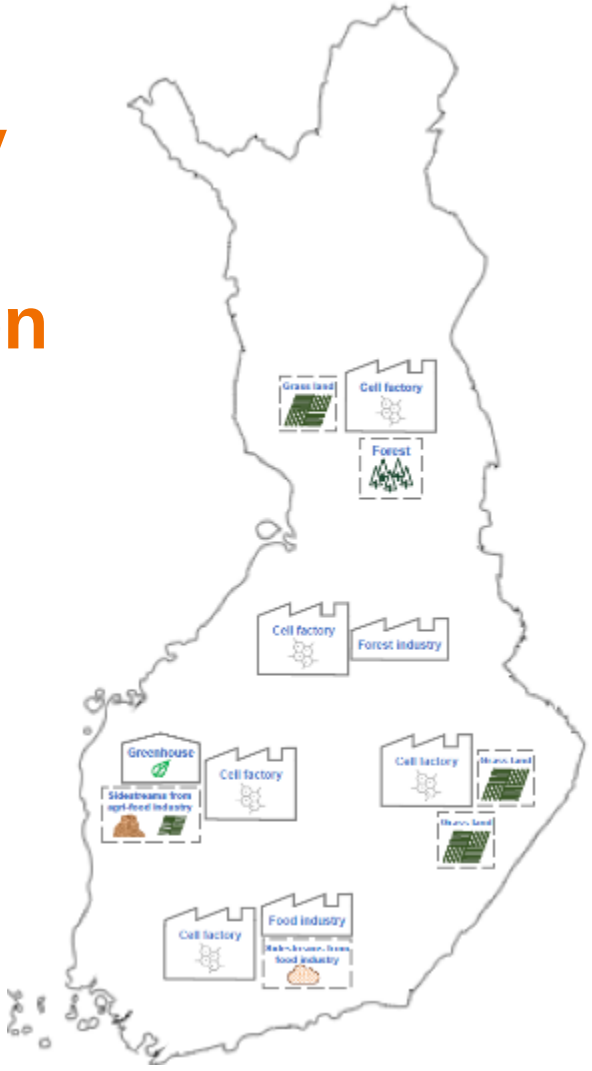
Side-streams together result in **310 000 tons/y precision ferm** protein, or **390 000 tons/y SCP** protein



Harnessing biotechnology could enable more distributed food production

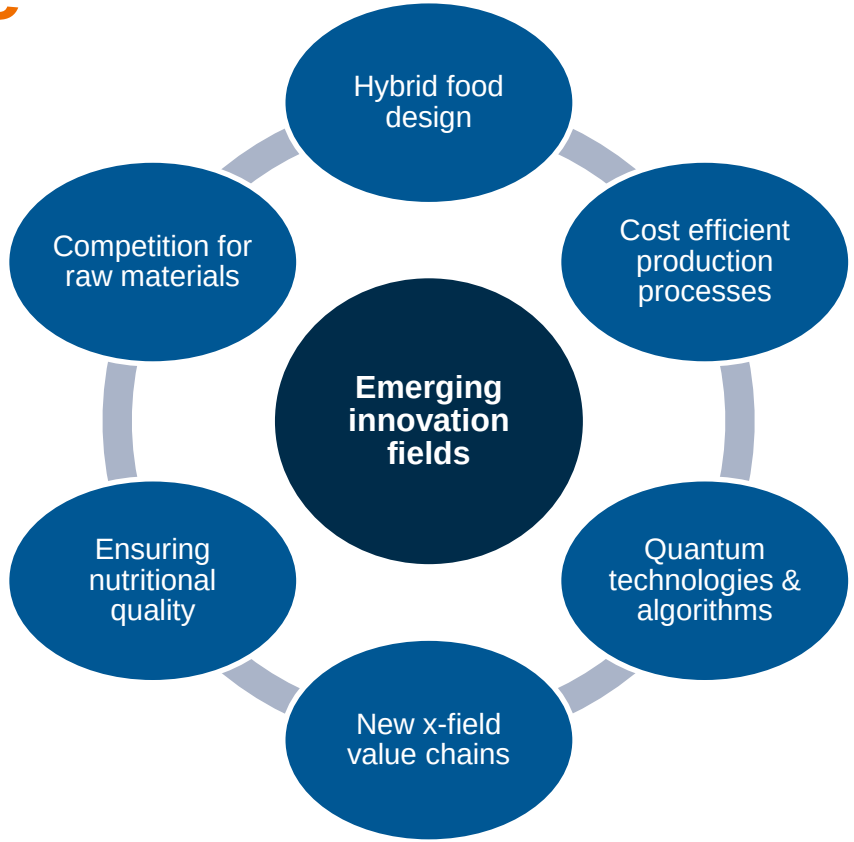
New biorefinery concepts

New X-field value chains



Take home message

Innovations emerge from collaboration, and at the interface of the different research and industry fields



VTT

beyond

the obvious

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