New Protein Crops for Denmark

PROTEIN 2FOOD

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PIONEERING CROPS FOR FUTURE GENERATIONS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

PROTEIN 2FOOD

PIONEERING CROPS FOR FUTURE GENERATIONS

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Project objectives

Objective: Develop innovative, high quality, protein-rich food crops, to sustain human health, the environment, and biodiversity

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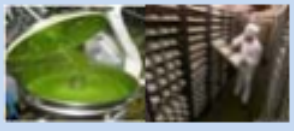
P2F Work Packages (WP)

WP5. SUSTAINABILITY ASSESSMENT

WP1. CROP PRODUCTION



WP2. PROTEIN EXTRACTION AND FRACTIONATION

WP3. FOOD PROCESSING

WP4. MARKET ANALYSIS

WP6. DISSEMINATION. COMMUNICATION AND SOCIAL INNOVATION

WP1: Crop Production

- **Cultivar screening** of food crops, knowledge of genetic markers for plant breeding
- **Agronomic adaptability** to different European environments, response to abiotic stresses
- **Sustainable agronomic interventions** in the selected protein crops

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Screening trials

N°	Species tested	# Acc
1	Quinoa (*Chenopodium quinoa*)	12
2	Amaranth (*Amaranthus* spp.)	7
3	Buckwheat (*Fagopyrum esculentum*)	16
4	Lentils (*Lens culinaris*)	40
5	Chickpea (*Cicer arietinum*)	5
6	Fava beans (*Vicia faba*)	5
7	Beans (*Phaseolus vulgaris*)	1
8	Pea (*Pisum sativum*)	10
9	Lupin *(Lupinus* spp.)	12
10	Soybean (*Glycine max*)	11

Table 4 Cooperation with breeders established by P2F WP1 for the growing season of 2019

Species	Accession	Breeder name	Contact name	Contact date	Notes
Quinoa	Jessie, Riobamba, Atlas, Pasto	Quinoa Company	Andrés Torres Salvador	Feb	MTA
Buckwheat	Panda, Kora	Hodowla Roslin	Stanislaw	Feb	EC
	Bamby	SZG	Johanna Winkler	Feb	
Pea	Pinochio, Eso, Atlas, Nitouche	DLF	Christian Frigaard Mogensen		
	Svensk stor gråært	Nordisk Råvara	Tomas Erlandsson	Feb	
Lupin	Dieta	Soya-UK	David McNaughton	Feb	EC
	Boros, Butan	HRS MOLICE-PL	Stanislaw Stawinski	Feb	EC
	Boregine, Mirabor, Probor, Haags Blue	Saatzucht steinach	Gabriele Thurner	Feb	
	Primadonna, Iris	DLF	Christian Frigaard Mogensen		
	Regent	Prograin Zia	Jan Krause	Feb	
Soybean	Merlin, Abelina, Regina, SG-Anser	SAATBAU	Josef Matuschka	Feb	EC
	Bohemians, Moravians, Silesia, Royka	Prograin Zia	Jan Krause	Feb	EC
	Vilshanka	Soya-UK	David McNaughton	Mar	EC
Faba bean	Sampo	Boreal	Pertti Parsinen	Feb	EC
	Tiffany, Taifun, Fuego	NPZ	Alberto Pagan	Feb	
	Colombo	DLF	Christian Frigaard Mogensen		
	Gracia, Alexia, Julia	SZG	Johanna Winkler	Feb	EC
Lentils	Anicia, Rosana, Santa, Flora	Agri-Obtentions	Nelly Elbaz/Joel Blot	Mar	
	Gotlandslins, Rosana	Nordisk Råvara	Tomas Erlandsson	Mar	
	Itaca, Gaia, Elsa	Agroservice SPA	Daria Scara	Feb	

MTA: Material Transferred Agreement refreshed for 2018 – 2019 period; EC: Existing contact from previous years

Source: J. Svensgaard

Faba beans - Hestebønne

- Almost 25,000 ha in DK (2018) [SEGES, 2019]
- Feed: established market
- Food: growing market
- 83% vegetarians → plant based ingredient

[Dansk Vegetarisk Forening, 2019]

Trial Results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, Denmark.

Cultivar	Yield (kg/ha)	Protein (%)	TKV (g)
Alexia	3063	28.4	508
Gracia	3031	28	514
Julia	2876	28.3	485
Colombo	2329	28.8	498
Fuego	2101	27.1	486

The table shows average results in Taastrup over 5 years, however 6.1 t/ha was the maximum yield.

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Faba beans - Hestebønne

- **Fuego and Tiffany**:
  - best cvs (4300 kg/ha with CI: 2100 – 6400 kg/ha in clay soil)
- Tiffany: low vicine/convicine
- **Winter fava beans**:
  - Yields: 4.8 – 6.9 t/ha;
  - Genotypes withstand: -12°C
- **Breeding: tolerance to diseases, antinutrients**
- **Øk: aphid control**

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Peas - Ært

- 6000 ha *3: dry, fresh and silage
- 43% area increase since 2015
- 30% Organic [SEGES, 2019]
- Absence of anti-nutrients → Food
- 84% vegetarians → plant based ingredient

[Dansk Vegetarisk Forening, 2019]

Source: https://www.naturli-foods.dk/produkter/minced/

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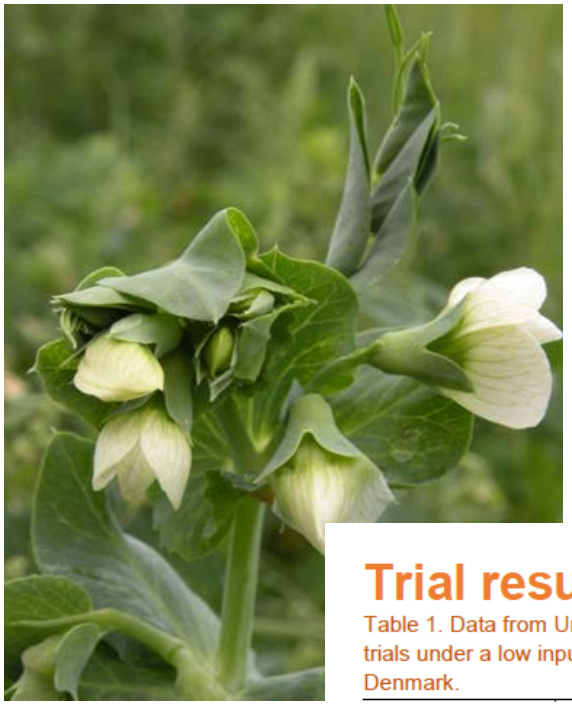
Peas - Ært

- Well suited to Danish environment
- Included in crop rotation with cereals
- High yields
- **Breeding: higher protein levels**



Trial results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, Denmark.

Cultivar	Yield (kg/ha)	Protein (%)	TSW (g)
Eso	3212	19.8	204
Atlas	2740	19.7	280
Nitouche	2504	21.7	253
Lollandske Rosiner	2288	21.5	286

The table shows average yields over 5 years in Taastrup, however maximum yields were 5.7 t/ha.

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Lupin

- 346 ha
- 53% area increase since 2015 [SEGES, 2019]
- Feed: established market
- Food: high potential
- 33% vegetarians → plant based ingredient

[Dansk Vegetarisk Forening, 2019]

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Lupin

- Good tolerance to drought: Blue lupins (*L.angustifolius*)
- **Anti-nutrients (alkaloids)**

Trial Results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, Denmark.

Cultivar	Species	Yield (kg/ha)	Protein (%)	TKV (g)
Boregine	*L. angustifolius*	3332	32	204
Probor	*L. angustifolius*	3255	36	149
Regent	*L. albus*	3149	34	169
Dieta	*L. albus*	3140	40	341

The table shows *mean* yields over 5 years in Taastrup, however maximum yields were 4.47 t/ha.

2018 Spp	Cultivar	Yield (kg/ha)		Protein (%)	
		Clay	Sandy	**Clay**	Sandy
Lupin	Boros	1210 d	498 c	38,1 b	39,7 a
	Butan	1700 c	762 b	41,4 a	41,2 a
	Iris	**2746** a	**1485** a	34,3 c	34,2 b
	Primadonna	**2440** b	**1267** a	32,3 c	32,5 b

Lentils - Linser

- Research Sweden
- Good properties for:
  - Bread, pasta
  - Infant food [P2F, 2019]
- No anti-nutrients
- 90% vegetarians → plant based ingredient
  [Dansk Vegetarisk Forening, 2019]

Photo: High-protein Bread and Pasta: UCC

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Lentils - Linser

- Materials can adapt to Danish environment
- Good for intercropping
  - Lentils + Oats
  - 74 – 81% weed reduction
  - LER>1 (LER=1.2)
  - Easier harvesting
- **Breeding: adapted materials to Nordic environment**

Trial results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, Denmark.

Cultivar	Yield (kg/ha)	Protein (%)	TSW (g)	Seed colour
Gotlandlins	1264	28	28	Brown
Morena	1131	27	36	Brown
Eston	1024	27	31	Green
Pardina	1142	25	36	Brown
Anicia	978	28	30	Green

The table shows mean yields over 5 years (2015-19) in Taastrup, however maximum yields reached 2.1 t/ha. Other trials indicate yields of 1-1.4 t/ha in DK [1].

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Quinoa

- 159 ha in 2018
- 6 ha in 2015 [SEGES, 2019]
- Gluten-free crop
- Wide acceptance with consumers
- Expanding market
- 80% vegetarians → plant based ingredient

[Dansk Vegetarisk Forening, 2019]

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Quinoa

- Cvs bred for Danish conditions
- Registered cvs in EU
- **Saponin in grain, postharvest, market**

Trial results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, Denmark.

Cultivar	Yield (kg/ha)	Protein (%)	TKV (g)	Notes
Titicaca	1093	16.1	2.95	Bitter Early maturing
Puno	833	17.6	2.05	Bitter White grain
Jessie	691	15.9	2.23	Sweet White grain
Riobamba	688	15.7	1.98	Sweet Late maturing
Vikinga	594	12.3	2.10	Sweet
Atlas	434	14.7	2.44	Sweet Late maturing
Pasto	337	15.6	2.09	Sweet Late maturing

Note: bitter=high saponin level, sweet=low saponin level.

The table shows average yields over 5 years of trials, however maximum yields were 2.5 t/ha. Similar KU trials had yields of 1.5-2 t/ha in Livø, DK [6].

Amaranth

- High quality protein grain
- Gluten-free
- Grain present in DK supermarkets
- 43% vegetarians → plant based ingredient

[Dansk Vegetarisk Forening, 2019]

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Amaranth

- Can be consumed both as leaf and grain
- 50% leaf harvest does not damange grain production
- Leaf harvest moment can be nutritionally tailored
- **Seen as weed, seeds, develop markets**

Trial Results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, DK.

Line name	Yield (kg/ha)	Protein (%)	TKV (g)	Seed colour
Maria	1377	17.5	0.82	Black
Katia	1235	15.0	0.81	Black
Cecilia	943	19.0	0.59	Red
Francoise	836	15.4	0.83	White

The table shows average results in Taastrup over 5 years, however 2 t/ha was the maximum yield achieved. Other trials in Aarhus University in 2012 achieved similar yields of 2 t/ha [6].

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Buckwheat - Boghvede

- 43 ha in 2017
- 7 ha in 2018 [SEGES, 2019]
- Gluten-free crop
- Many products already in DK (flour, flakes)
- Crop with potential
- 71% vegetarians → plant based ingredient

[Dansk Vegetarisk Forening, 2019]

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Buckwheat - Boghvede

- Long flowering = beneficial for bees and biodiversity
- High-quality protein grain
- **Scarce breeding**

Trial results

Table 1. Data from University of Copenhagen field trials under a low input production system in Taastrup, Denmark.

Cultivar	Yield (kg/ha)	Protein (%)	TKV (g)
Panda	1810	28.7	13.7
Kora	1792	27.3	12.4
Mancan	1779	23.2	14.1

The table shows average yields over 5 years in Taastrup, however maximum yields reached 5.1 t/ha.

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Screening results (2015 – 2018)

Summary

Crop Species	Yield (t/ha)	Protein (%)
Quinoa	0.5-2.2	12-18
Amaranth	0.9-1.6	14-20
Buckwheat	0.5-2.4	12-14
Peas	1.2 - 2.9	20-28
Lentils	0.2-1.1	17-32
Lupin	0.7-2.9	31-50
Fava beans	1.6-2.8	27-30
Soy beans	0.3-1.1	33-39

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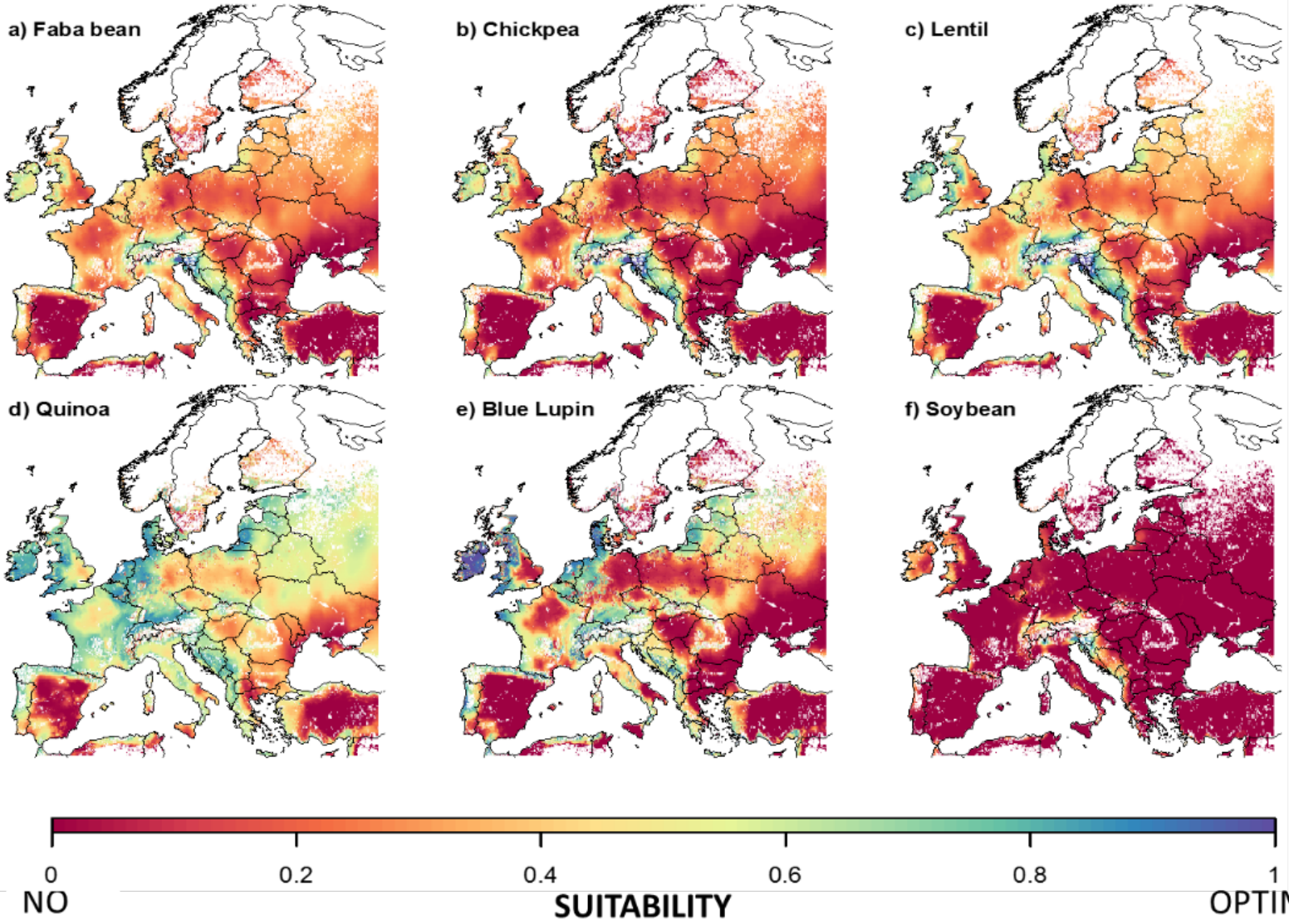
EU Protein crop suitability under climate change (year 2050)



Deliverables - Protein2Food

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- Scientific Publications
- Two-pagers
- Interactive Infographic
- Crop Leaflets

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Deliverables

On this page you will find all the public **deliverables** related to PROTEIN2FOOD. Deliverables are additional outputs (*i.e. information, special reports, technical diagrams, brochures or other building blocks of the project*) that have to be produced during the project's timeline.

Crop Production

Deliverable 1.1: Adaptability of different crops in Europe

Deliverable 1.4: Protein quality and quantity transcriptomes available for target crops for further use in developing SNPs

Deliverable 1.7: Effects on soil fertility,

Protein Extraction and Processing

Deliverable 2.1: Raw materials for protein fractionation

Deliverable 2.2: Report on dry milling methods

Deliverable 2.5: Ingredient selection

Food Processing

Deliverable 3.3: Optimised processing conditions for protein-rich bakery products and extruded cereals and snacks

Deliverable 3.4: Optimized processing conditions for dairy alternatives

/www.protein2food.eu/crop-leaflets/

Crop Leaflets - Protein2Food

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DENMARK

Peas

Danish version of leaflet

Quinoa

Danish version of leaflet

Lupin

Danish version of leaflet

Amaranth

Danish version of leaflet

Buckwheat

Faba Bean

Lentil

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Conclusions

- ✓ **Screening and production practices were useful to identify potential crops**
- ✓ **For Denmark: Spring and Winter Faba beans, peas, lupins, lentils, Quinoa, amaranth, buckwheat.**
- ✓ **We identified potential practices for these crops**
- ✓ **Amaranth: double purpose crop**
- ✓ **Lentils: intercropping with oats**
- ✓ The **project achieved 10% increase of arable land** with **protein crops** in **Denmark**
- ✓ **SMART PROTEIN Project**

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THANK YOU!!

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