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Sustainability Aspects of Protein Crops for Food Production

The Future of Oilseeds: Prospects for Plant-based Proteins?
24.10.2023, Frankfurt

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Short introduction of ifeu - Overview

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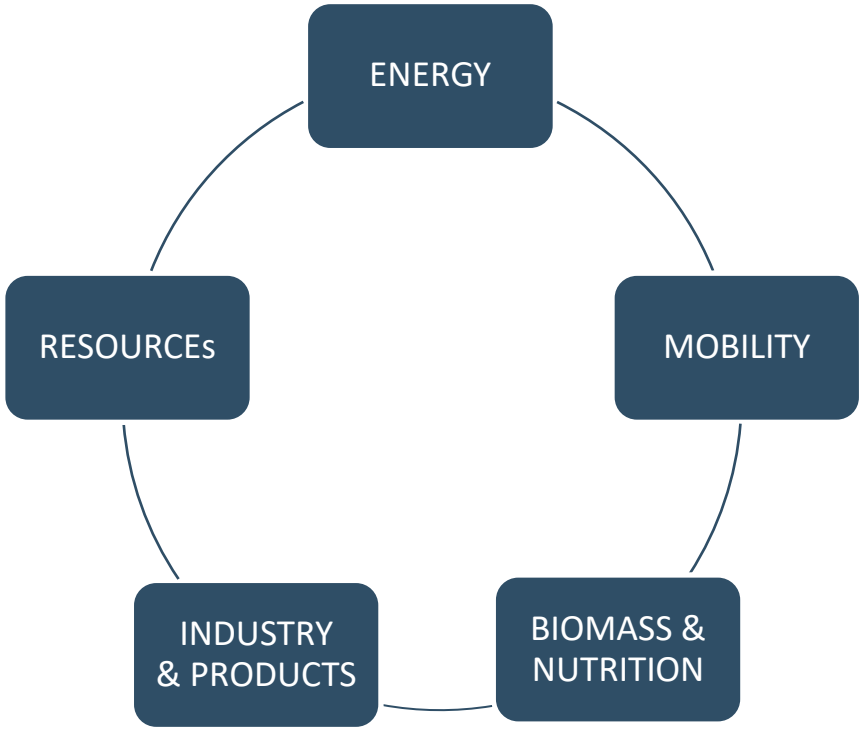
- Independend Research and Consultancy for more than **40 years**
- **gGmbH (= non for profit LLC)**
- More than **100 employees**
- Located in: **Heidelberg and Berlin**



Short introduction of ifeu - Selected projects

- **Protein2Food (funded under EU-H2020)**

  Sustainability Assessement of innovative protein-rich products from legumes and pseudocereals grown in Europe (www.protein2food.eu)

- **Life Cycle Assessment „Organic Chicken Feed“ (commissioned by Evonik)**

  Organic feeding of hens and broilers with supplemention of D,L-Methionine

- **Climate and Energy efficient School Kitchens (funded by BMBF)**

- **New Food Systems – Pr:Ins (funded by BMBF)**

  Holistic Evaluation of sustainability, economic viability, consumer acceptance, marketability, quality and safety as well as the legal aspects of innovative food products using insects as an example

  https://newfoodsystems.de/projekte/ganzheitliche-bewertung/

- **New Food Systems – Sustainability Data for Protein Database (funded by BMBF)**

  Complementation of NFS protein database with sustainability profiles for a variety of protein ingredients from different protein sources

  https://newfoodsystems.de/projekte/nachhaltige-proteinzutaten/

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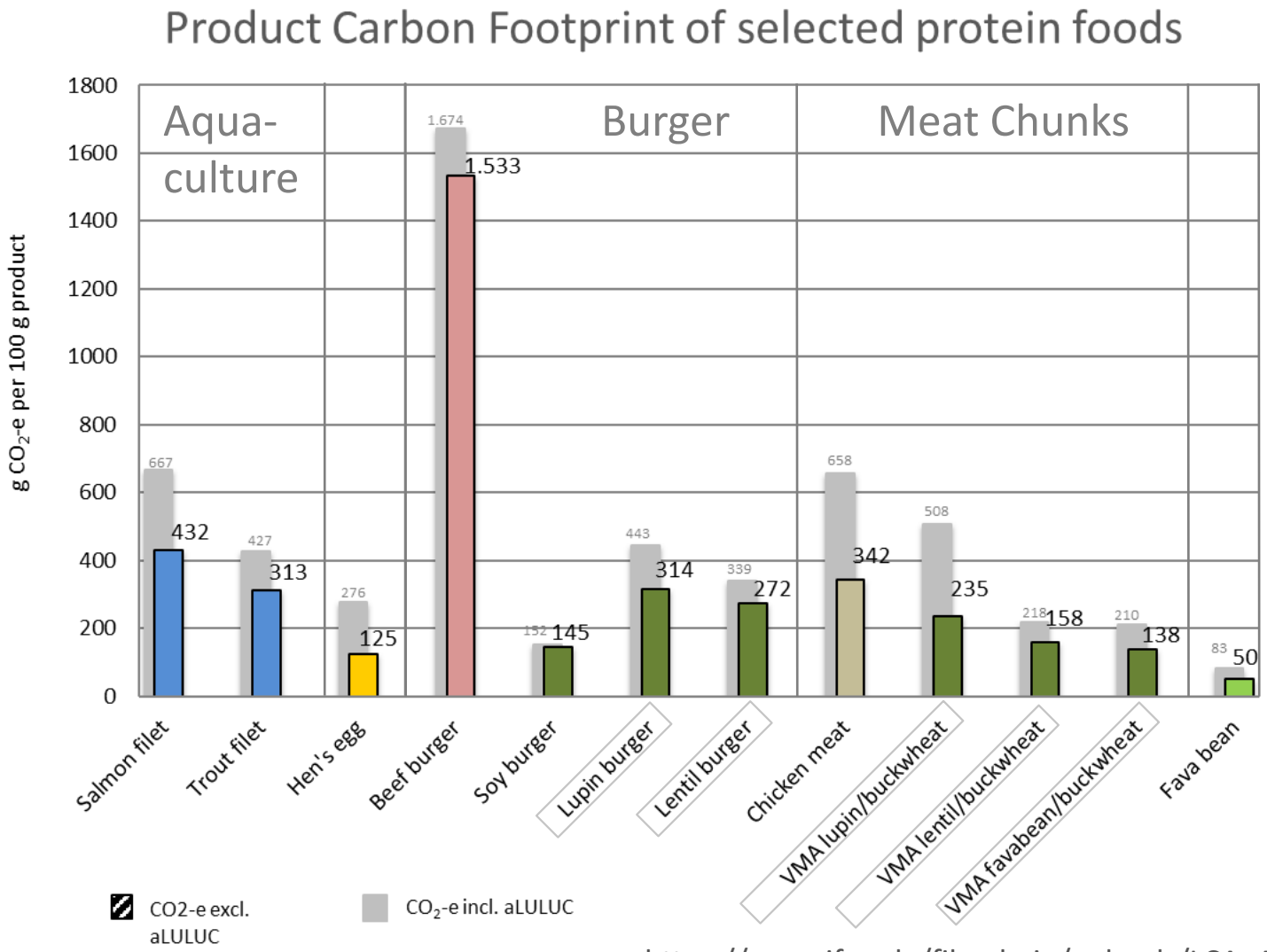
Environmental Footprints of Protein Foods



VMA: Vegetable Meat Alternative
=> textured; based on wet extrudates

- Animal-based protein foods can have quite different carbon footprints if compared among each other
- Protein foods in the form of grains (here: fava bean) have the smallest carbon footprint of the plant-based foods compared
- Eggs have the smallest carbon footprint of the animal-based foods compared
- On the larger picture there are overlaps between plant-based and animal-based protein foods

https://www.ifeu.de/fileadmin/uploads/LCA_Aquakultur.pdf

Environmental Footprints
Protein2Food-Prototypes vs. Animal-Based Products

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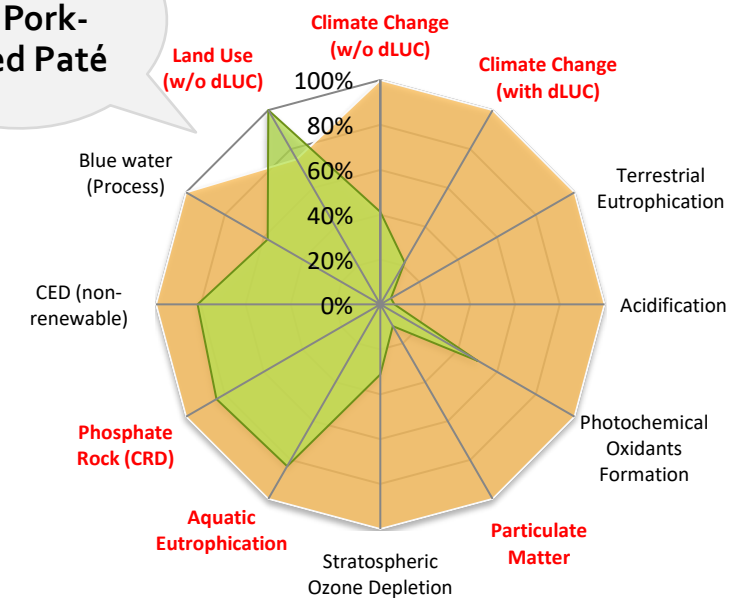
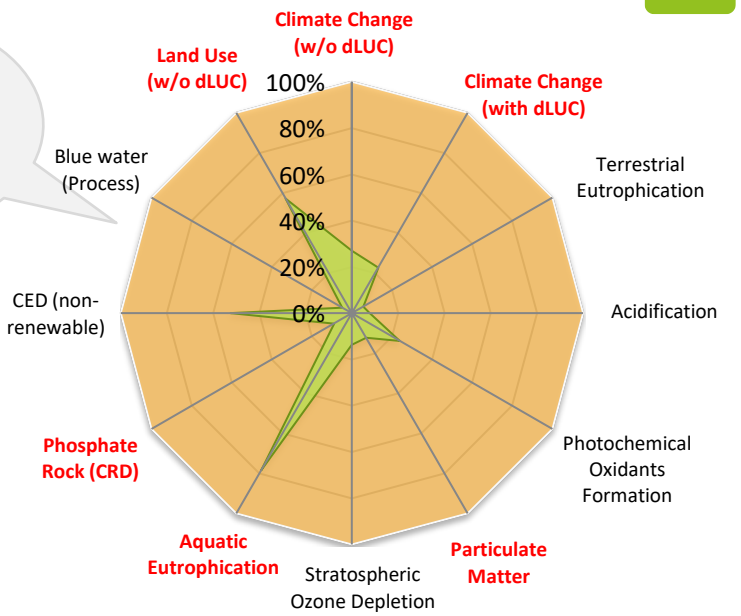
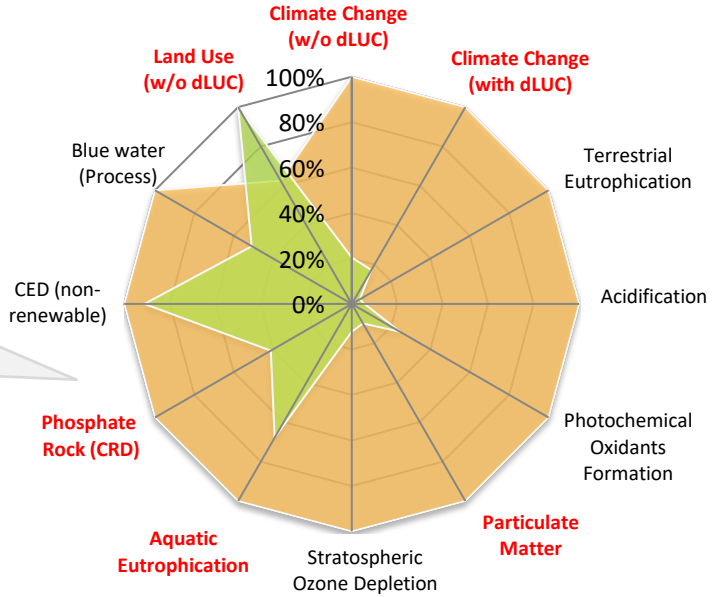
VMA-Paté vs. Pork-based Paté



Plant burger vs. Beef Burger



Vegetable Drink vs. Cow Milk



P2F-Prototype

Animal-Based

Functional unit: protein content

Environmental Footprints of Protein Foods

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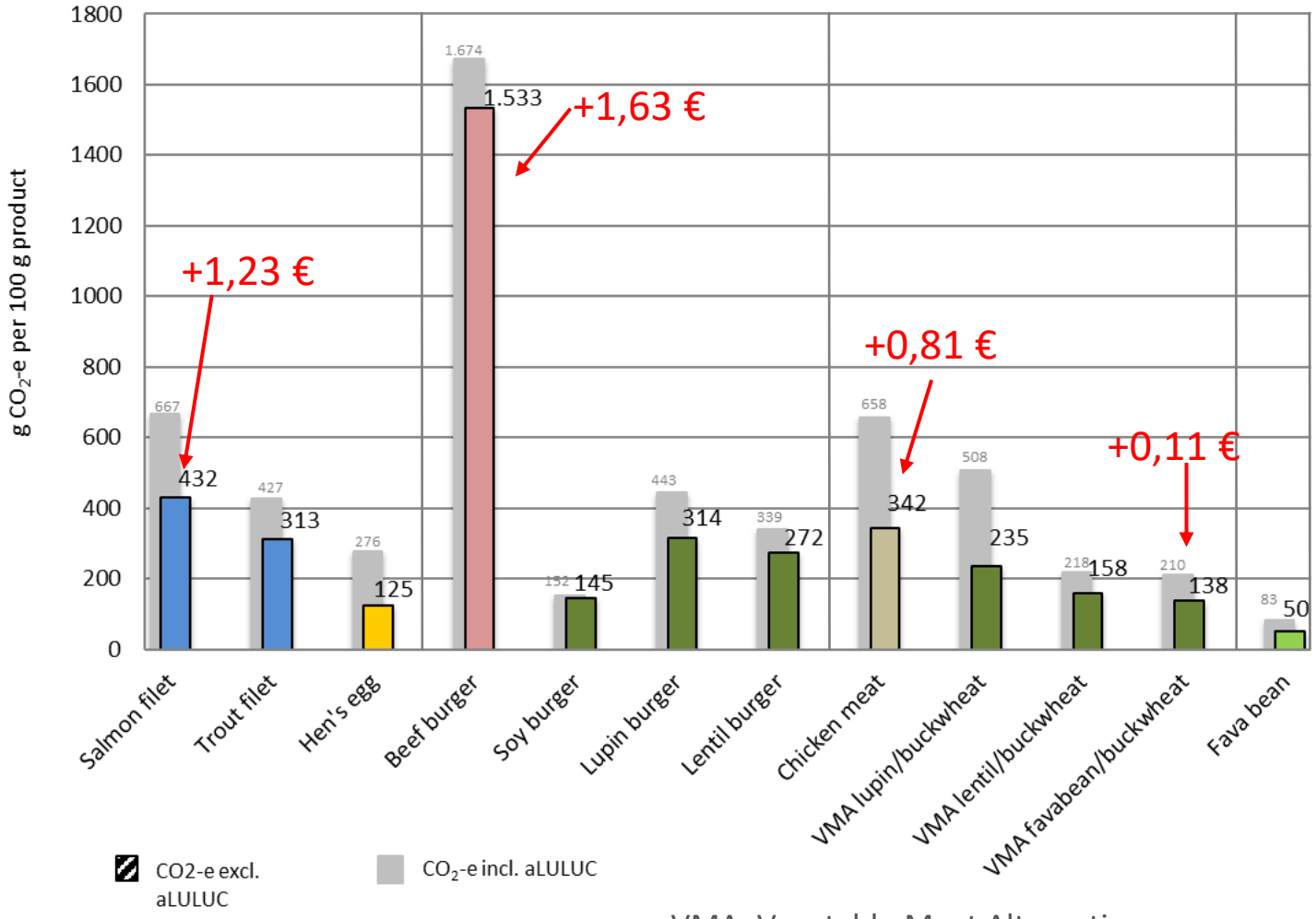
Environmental Costs of selected protein foods



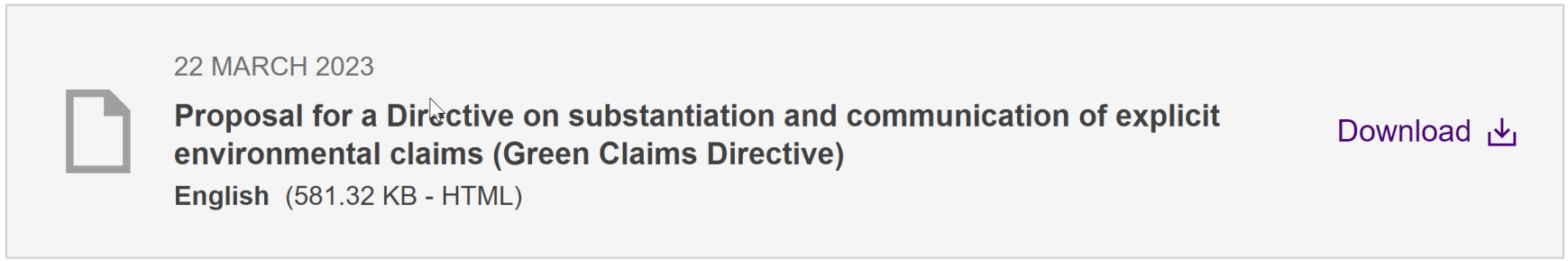
VMA: Vegetable Meat Alternative

NFS Pr:Ins - Environmental Cost Calculator

Kategorie	Emission		Wert	Einheit	Kosten (€/t Emission) MF	Jahr	Region	Umweltkosten	Bemerkungen
Kohlendioxid- und andere Treibhausgasemissionen		CO2-Äquivalente	0,863	kg CO2 äq.	0,195	2020	DE	0,168	Reine Zeitpräferenzrate 1%: Schäden Generation (in 60 Jahren) zu 55% RZPR= 1% -> Proxy für praktische Poi
Luftschadstoffe	Feinstaub	PM2.5	0,011	kg PM2.5	62	2020	DE	0,691	
		PMcoarse	0	kg Pmcoarse	1	2020	DE	0,000	
		PM10	0	kg PM10	43,3	2020	DE	0,000	
	Stickstoffoxide	NOX	0,008	kg NOX	19	2020	DE	0,150	Modellierung nach dem im EU-Proje
	Schwefeldioxid	SO2	0,005	kg SO2	15,8	2020	DE	0,079	v1.3 (Preiss et al. 2008). Die dargest
	flüchtige organischer Verbindungen ohne CH4	NMVOC	4E-04	kg NMVOC	2,2	2020	DE	0,001	Schätzung der Schadenskosten durch
	Ammoniak	NH3	0,001	kg NH3	33,7	2020	DE	0,035	spezifischen Informationen zu den Er
	Methan	CH4	0,001	kg CH4	16,575	2020	DE	0,023	
	Distickstoffmonoxid	N2O	7E-04	kg N2O	80,2	2020	DE	0,053	
Emissionen in Oberflächengewässer	Stickstoff	N	0,037	kg N	21	2020	DE	0,763	Diese Werte sind anzuwenden, wenn
	Phosphor	P	0,008	kg P	154	2020	DE	1,172	dies bekannt sein, wenden Sie bitte e
					Gesamt			3,09466355	€
					je			250 g Lebensmittel	
								Betrachtetes LM	

Alternative Wording:
Environmental = External = True Costs

Future Requirements for Green Claims in the EU



The Directive will be part of the implementation of the European Green Deal with the objectives:

- to ensure that consumers are empowered to make informed choices in the ecological transition
- to tackle false environmental claims
- to ensure reliable, comparable and verifiable information
- to ensure the substantiation of environmental claims on the basis of environmental impacts along products' life cycles

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NFS Protein Database

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The NFS protein database compiles data on a large number of protein samples

Chemical Composition

- Crude protein content
- Ash content
- Dry matter
- Starch content
- Fat content
- Molecular weight
- Amino acid composition
- pH in suspension

Nutritional Properties

- Chemical Score

Physico-chemical Properties

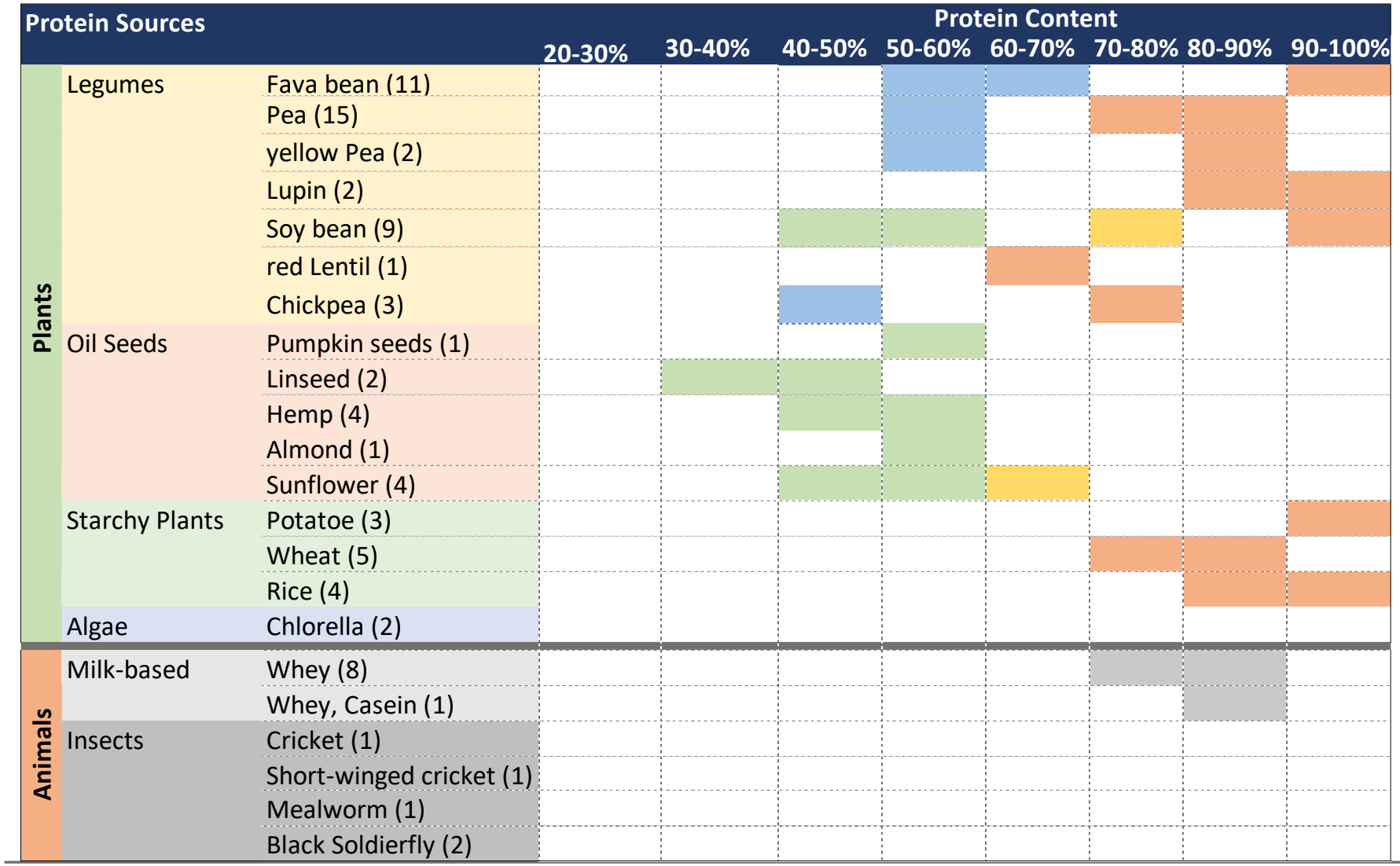
- Water binding capacity
- Oil binding capacity
- Protein solubility
- Emulsifying properties
- Colour
- Foam formation properties
- Zeta-Potential
- Gel forming properties
- Particle size distribution

Additional Aspects

- Sensoric Properties
- Environmental and socio-economic data

NFS Protein Database Project

Protein samples contained in Protein Database / Classification by processing Methods



Classification by Processing Method
Pre-Treatment (De-Fatting/De-Hulling/Grinding)
Dry Fractionation
Extraction
Iso-electric Precipitation
Membrane Filtration

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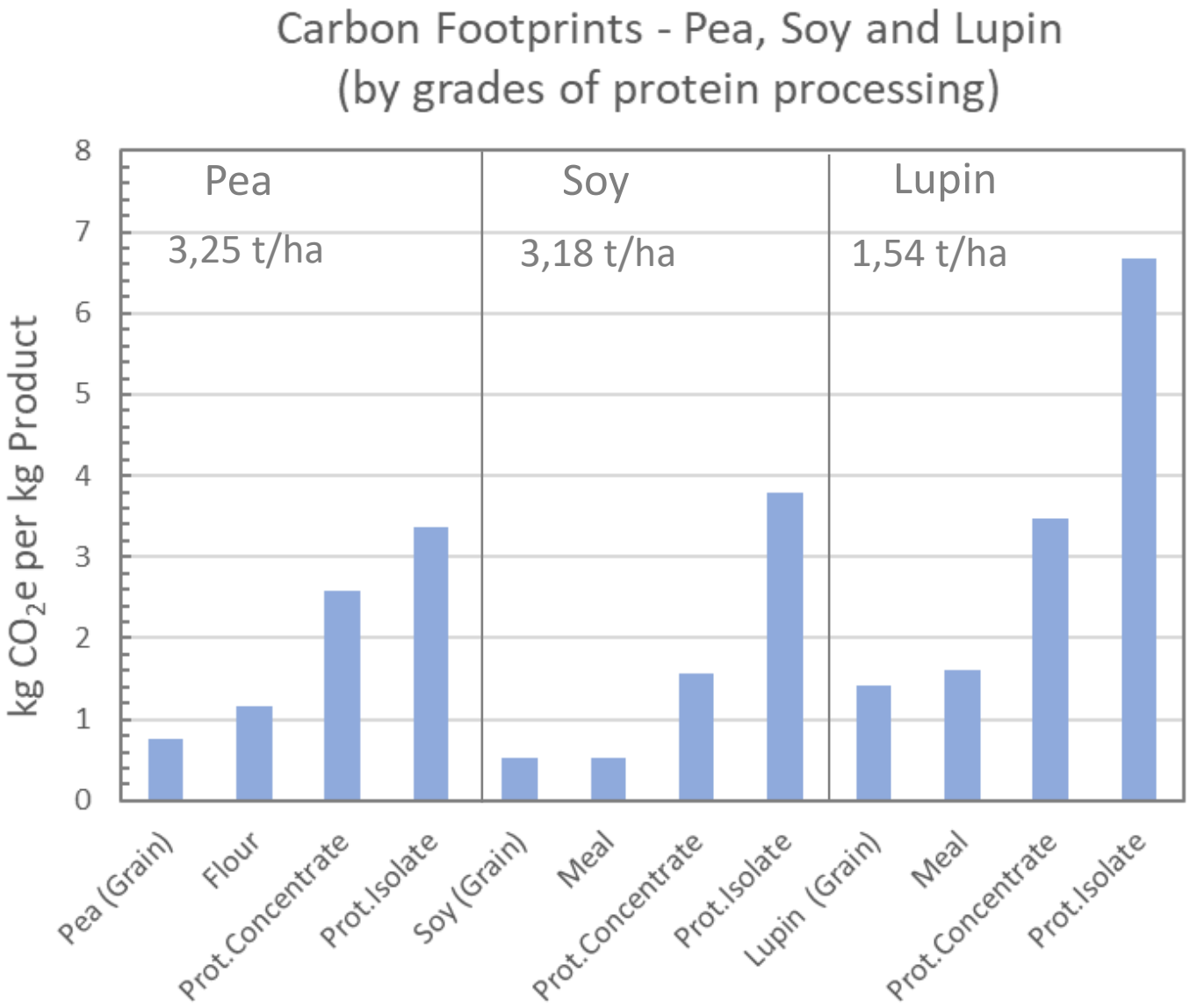
Carbon footprints by level of processing



Important: this analysis is completely done with datasets available (via Simapro) in the Agrifootprint-Database 6.0

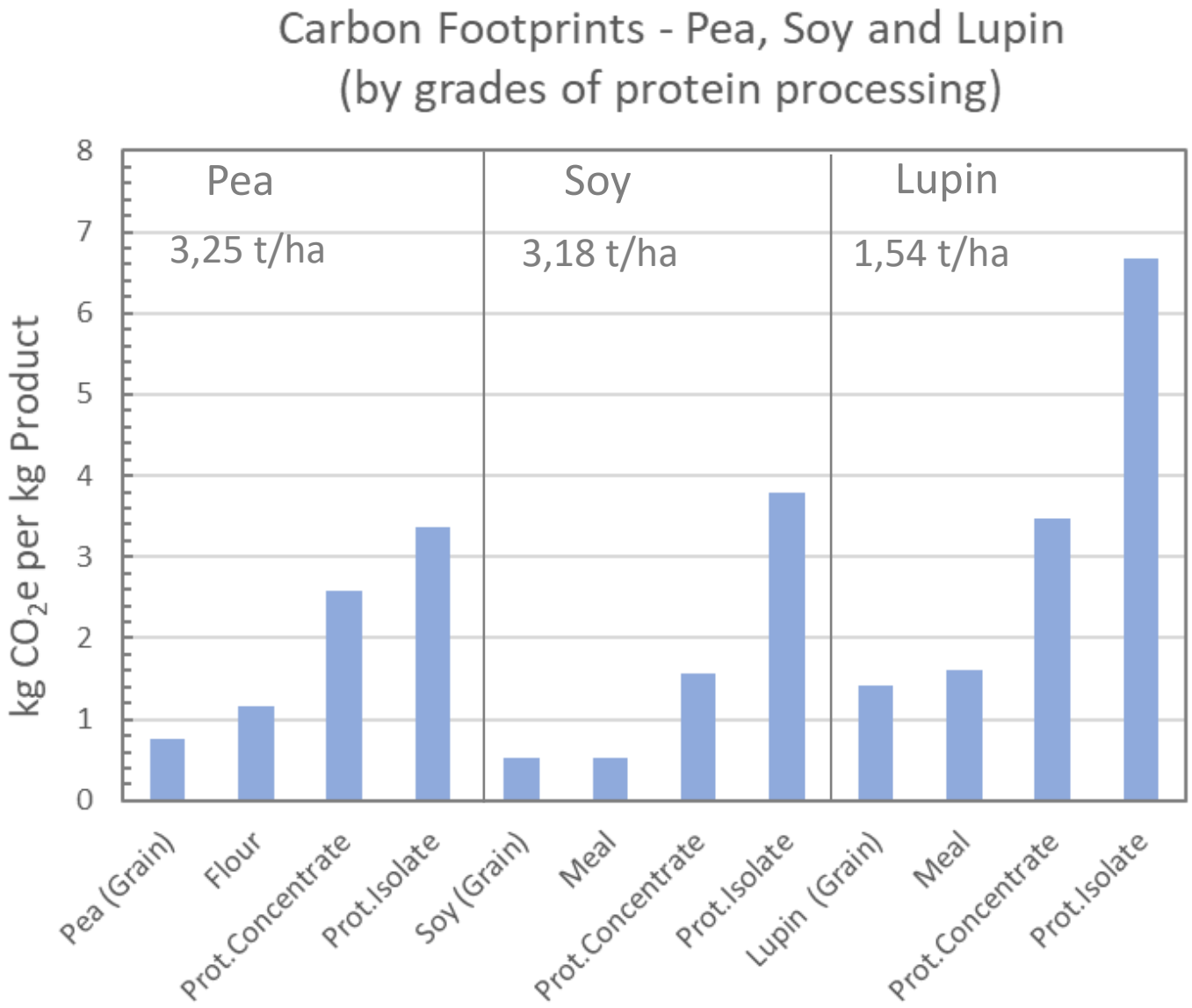
<u>Processing steps by grade, ex. soy</u>
(in database mostly aggregated)

Soy meal: Drying + De-Oiling

Soy protein concentrate (SPC):
- Drying + De-Oiling (Hexan)
- Extraktion (Ethanol)
- Drying

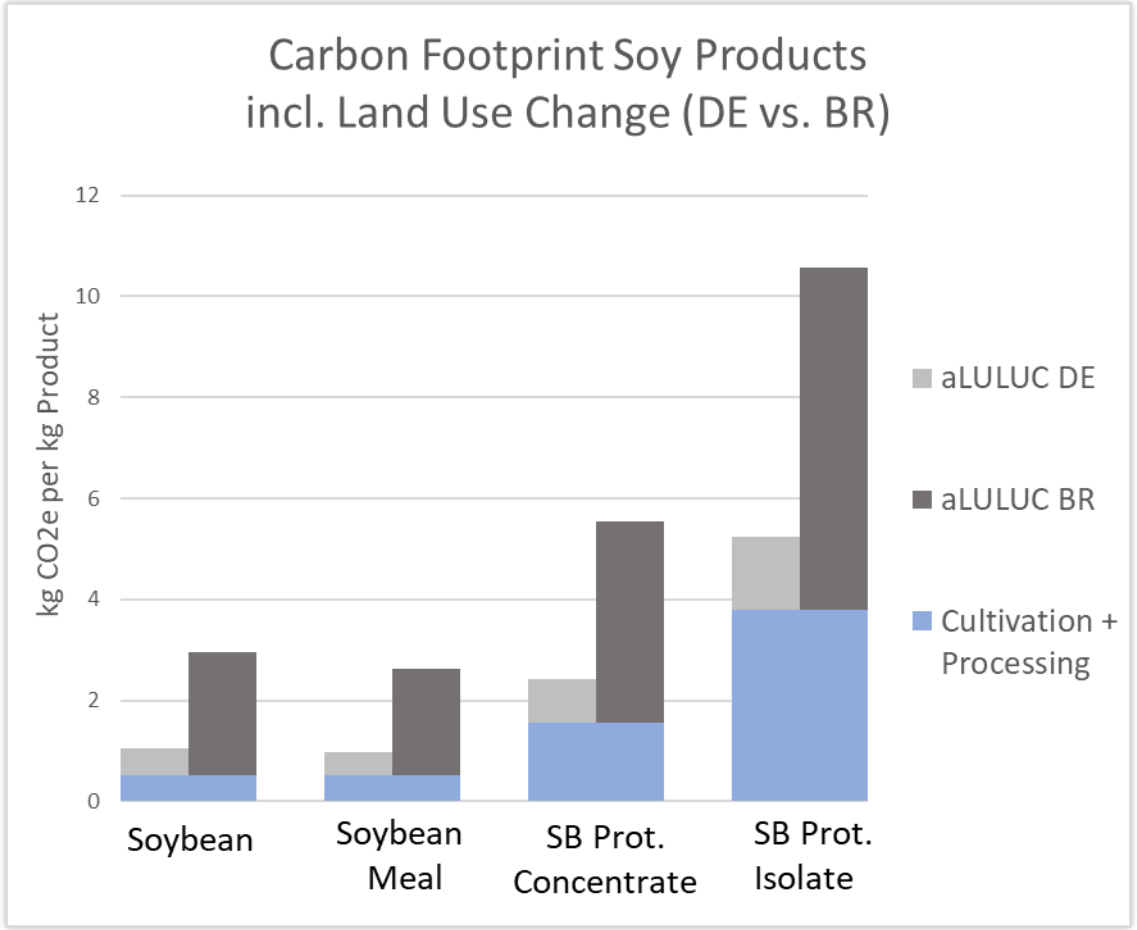
Soy protein isolate (SPI):
- Drying + De-Oiling (Hexan)
- Iso-electric precipitation
- Spray-Drying

Carbon footprints by level of processing



- Each processing step increases the carbon footprint of the individual protein-containing ingredients
  Exemption: Soy, due to the fact that the extracted oil carries with itself a substantial part of the environmental burden
- Lupin meal (in the dataset) seems not to be de-oiled
- Correlations: the carbon footprint is influenced by
  - Crop yield
  - Protein content of the grain
  - Amount (the less the better) and economic value (the higher the better) of the by-products
  - Efficiency of protein processing

Impact of Land Use Change on Carbon Footprint



Land use change refers to the conversion of an area of land by humans from one state to another. It is a collective term used in international climate policy and includes the emissions released when e.g. land is converted from grassland or forest to cropland

- LUC from forests and grassland to cropland currently still happens in many countries
- LUC associated with soy cultivation in Brazil and the USA is assumed to be particularly large
- A full carbon footprint should include LUC related carbon

Remark: Overseas (and maybe also other) soy producers most probably in the near future will be trying to having their soy products for food and feed production accounted for as being free from LUC.

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Food Consumption: Planetary and Health Boundaries

Climate Change

Land System Change

Freshwater Use

Nitrogen Cycling

Phosphorus Cycling

Biodiversity Loss

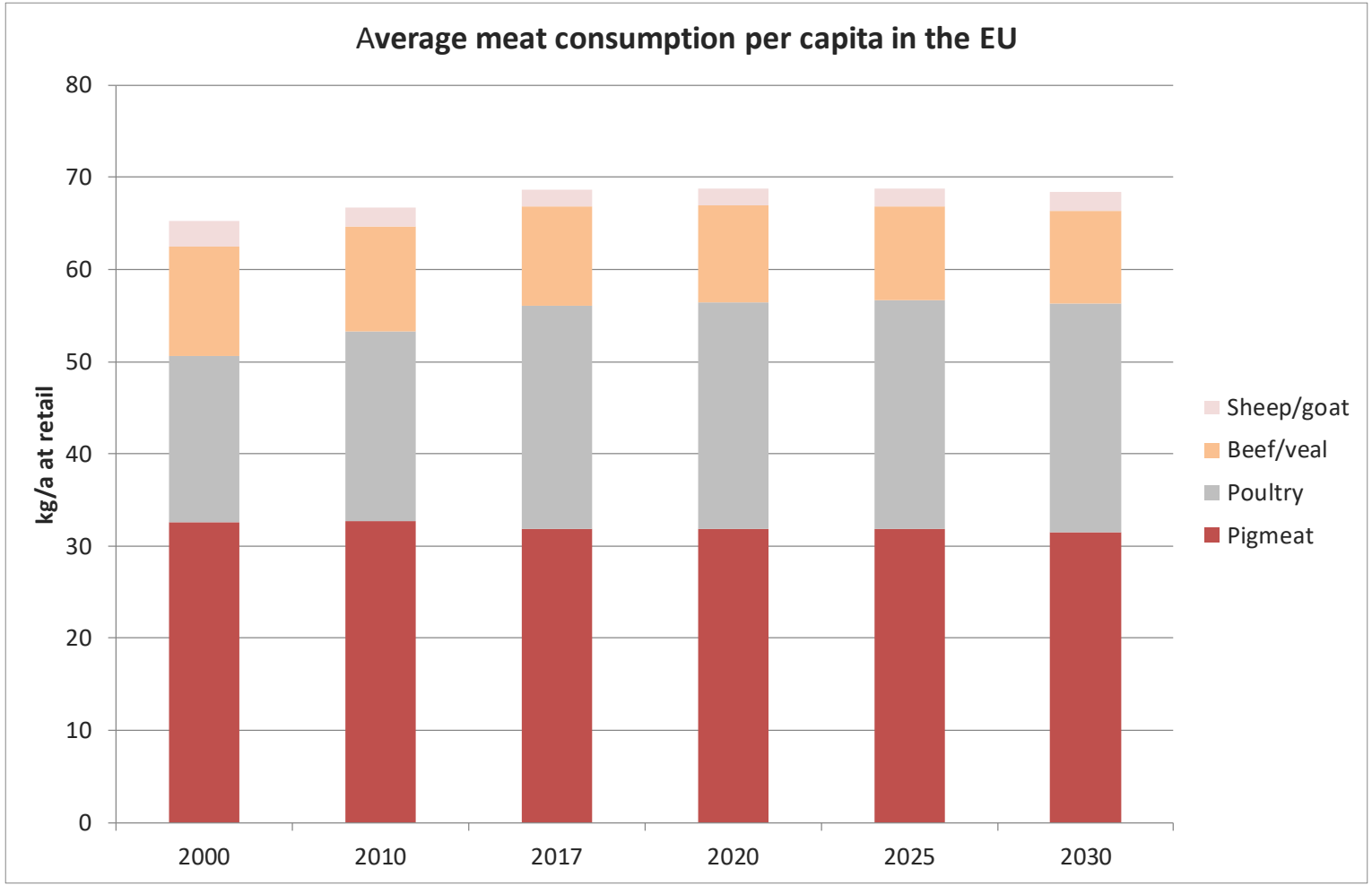
„Global food production is the largest pressure caused by humans on Earth, threatening local ecosystems and the stability of the Earth system“

Eat-Lancet Report, 2019: Healthy Diets From Sustainable Food Systems

„Planet Health Diet“

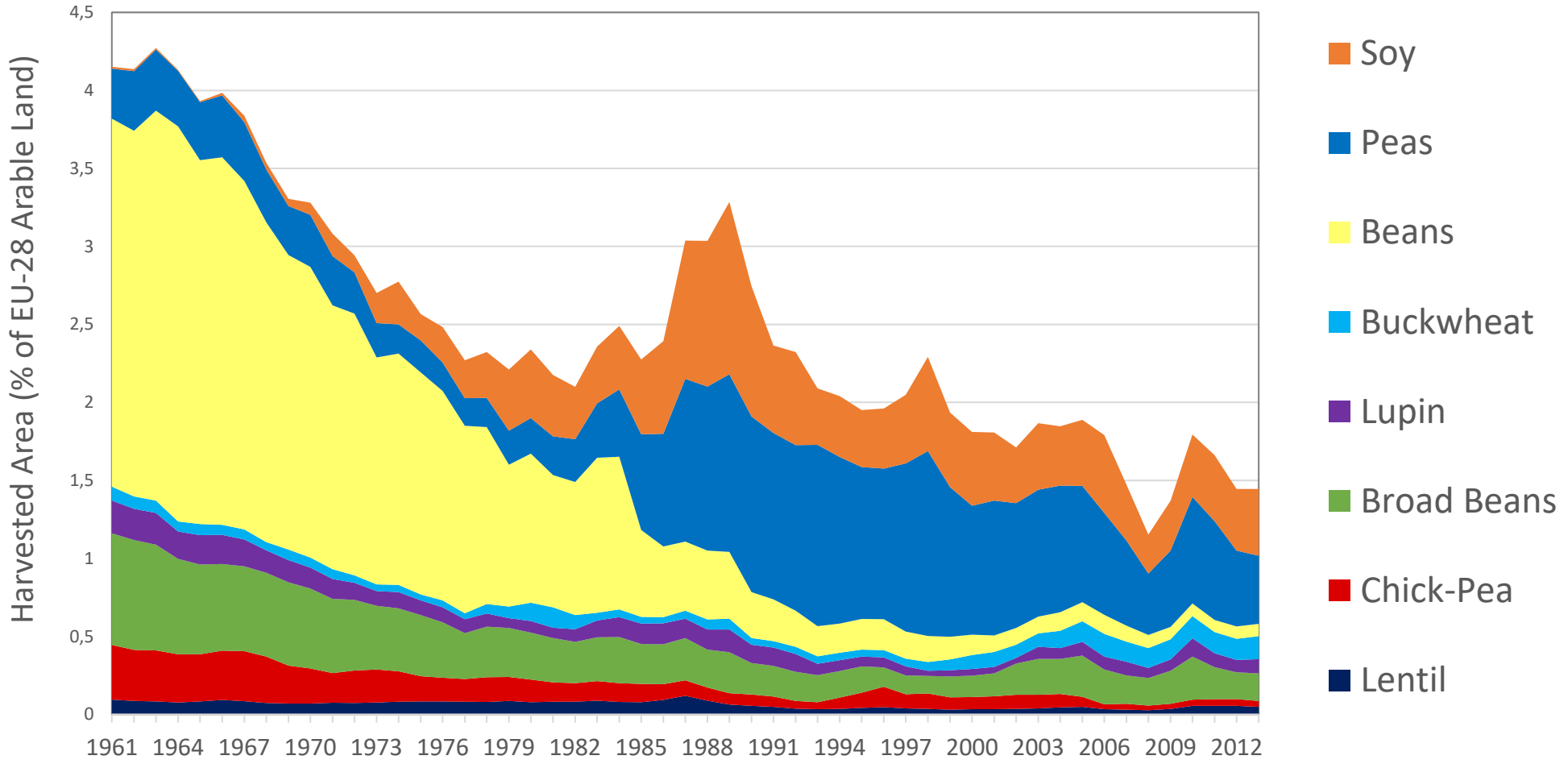
g/cap/d	*EU-28 Av.*	*EatLancet*
Meat (in total)	***146***	***43***
Pigmeat	61	7
Poultry Meat	38	29
Bovine/Mutton/Goat	25	7
Other Meat	22	0
Animal fats	***11***	***5***
Dairy	***433***	***250***
Fish, Seafood	25	28
Eggs	***25***	***13***
Cereals (ex beer)	190	232
Starchy Roots	111	50
Sugar	63	31
Treenuts	***8***	***25***
Pulses	***7***	***50***
Oilcrops	***9***	***50***
Vegetable Oils	47	40
Vegetables	182	300
Fruits (ex. Wine)	155	200

Projection on Future Meat Consumption in the EU



Source: P2F, Deliverable 4.3 based on EU Agricultural Outlook
https://cordis.europa.eu/project/id/635727/results/de

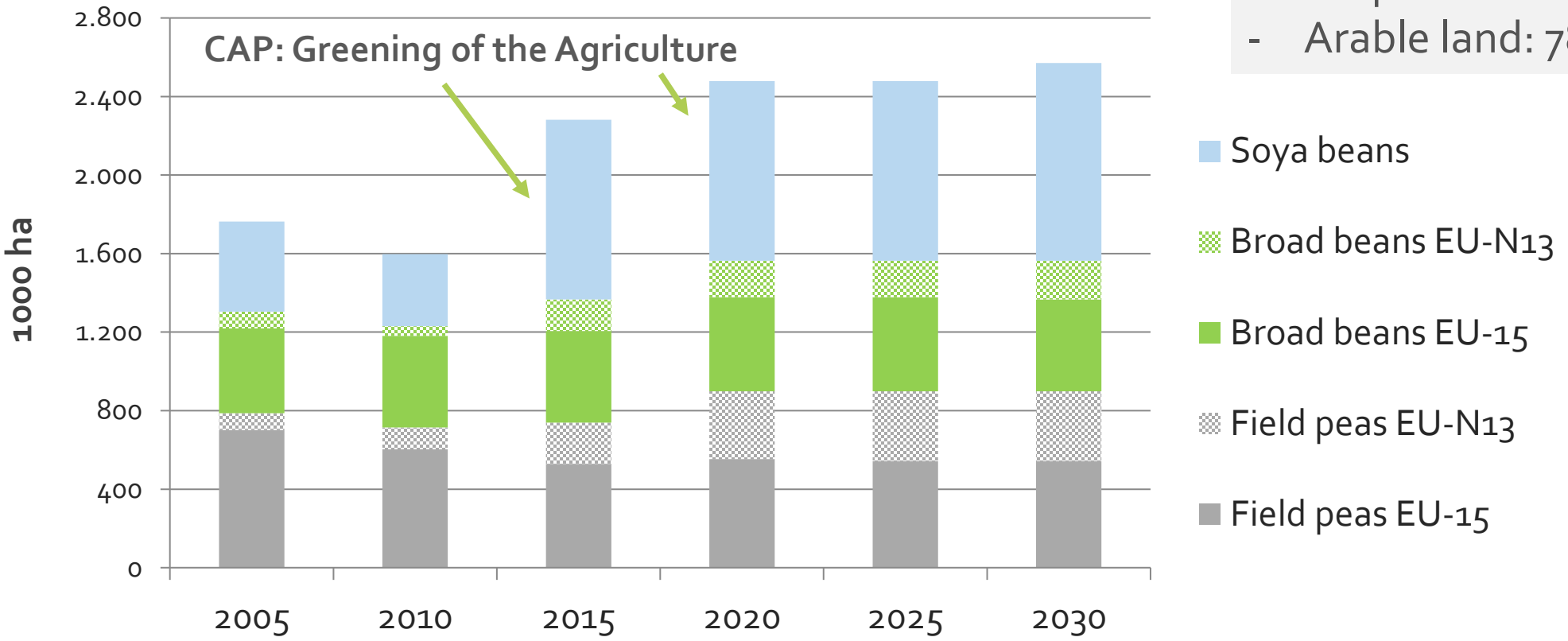
EU-Production of Protein Crops (Agricultural Area)



Source: P2F, Deliverable 4.3 based on FAO Statistics; https://cordis.europa.eu/project/id/635727/results/de

EU-Projection: Future Growth of Protein Crop Area

EU totals:
- Crop land: 110 Mio ha
- Arable land: 78 Mio ha



Source: P2F, Deliverable 4.3 based on EU Agricultural Outlook; https://cordis.europa.eu/project/id/635727/results/de

Food Intake Reference Data

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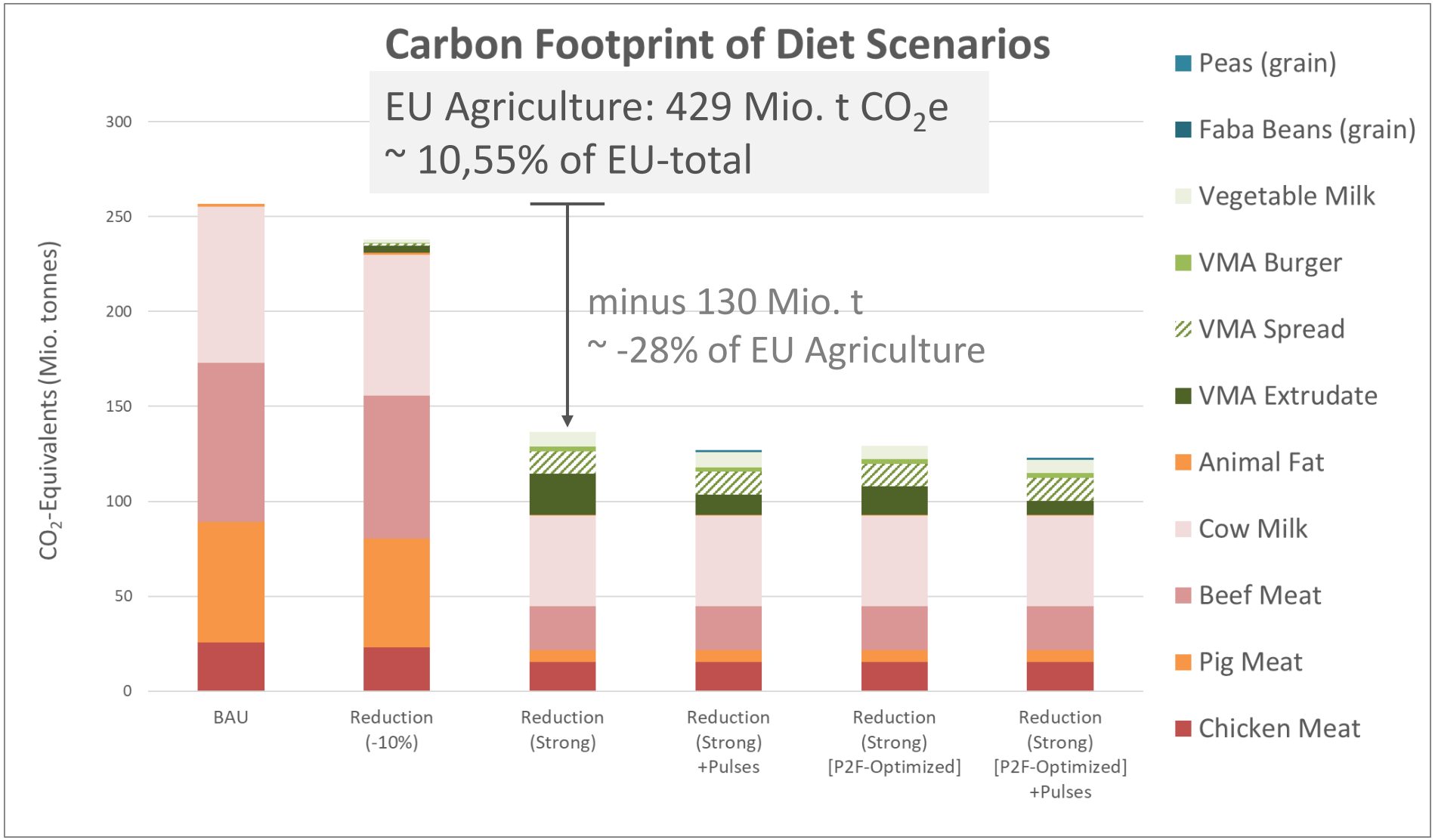
Diet Scenarios

- **Business-as-usual ("BAU") Scenario**
- **Minus 10%-Meat Reduction Scenario**
- **Strong Meat Reduction Scenario (Low Meat Model, Eat Lancet)**
- **Strong Meat Reduction Scenario + Pulses**
  => Substitution with processed protein food
  + beans/peas as cooked grains
- **Strong Meat Reduction Scenario (Optimized)**
- **Strong Meat Reduction Scenario (Optimized) + Pulses**
  => Substitution with optimized protein processing
  + beans/peas as cooked grains

Projection on Future Meat Consumption in the EU



https://www.europarl.europa.eu/news/de/headlines/society/20180301STO98928/treibhausgasemissionen-nach-landern-und-sektoren-infografik

EU Agricultural Area and Protein Transition

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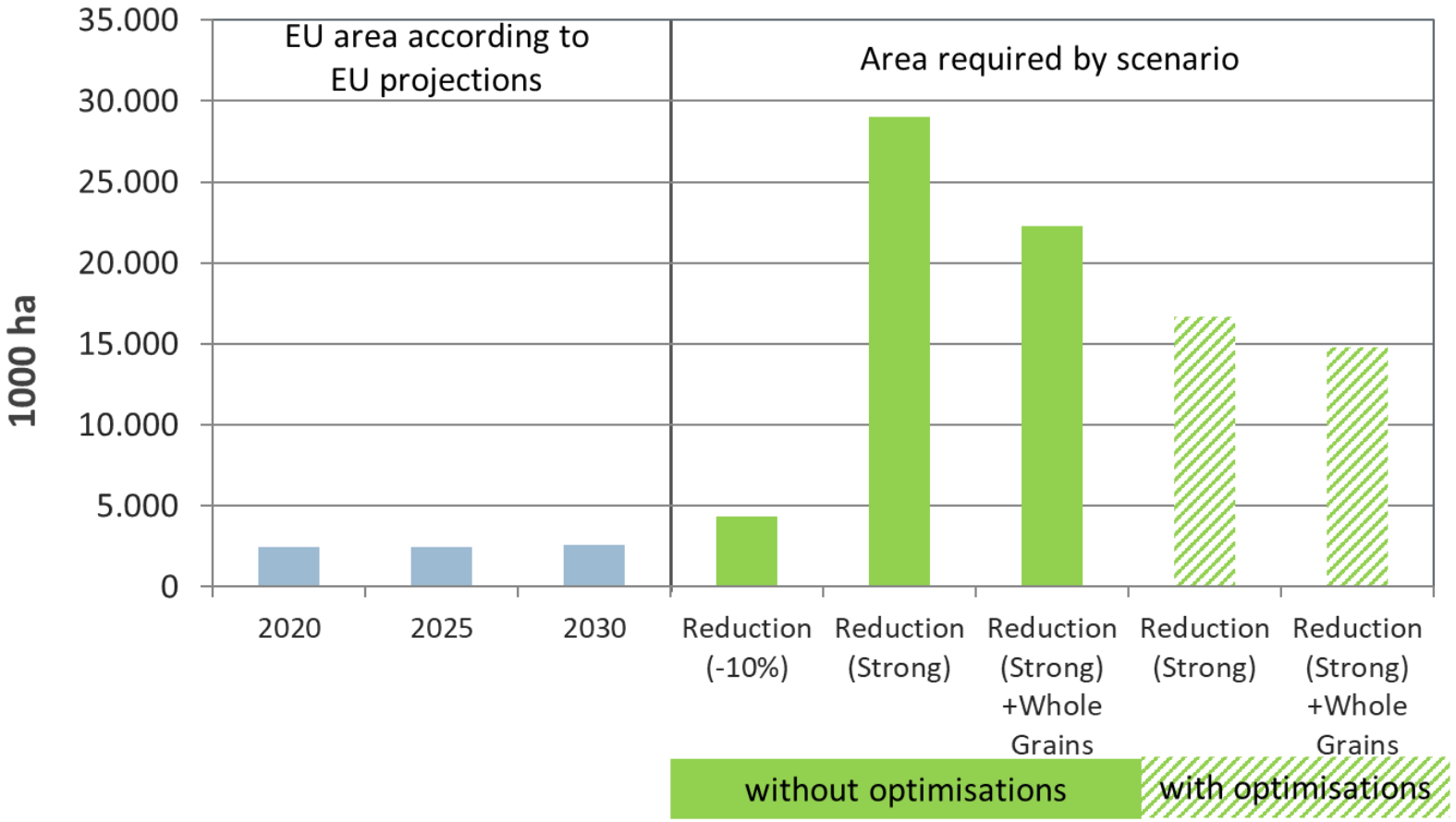
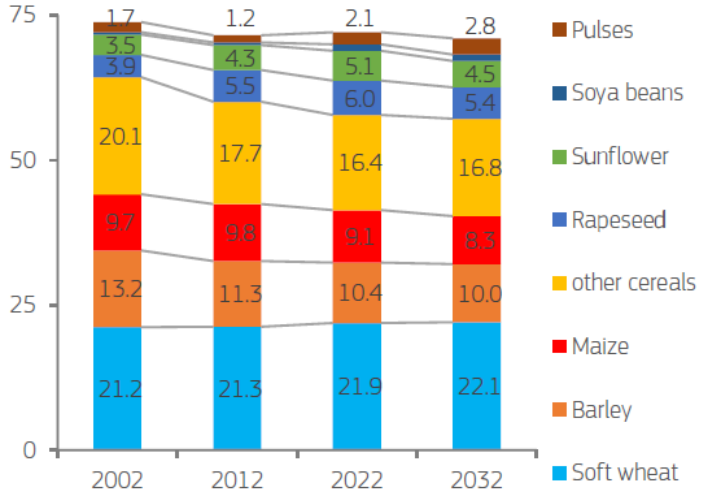
Area for pulses in the EU

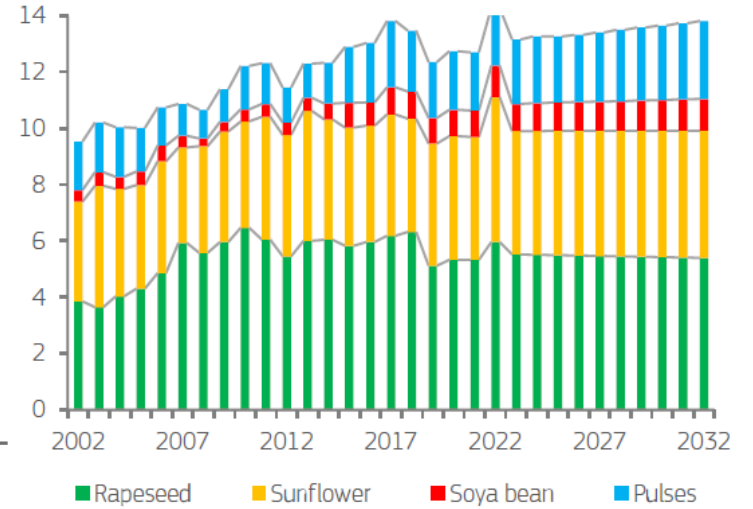
EU projections versus additional requirements



GRAPH 2.2 EU cereal, oilseed, and protein crop area (million ha)



GRAPH 2.9 EU oilseed and protein crop area (million ha)



Conclusions

- An increased consumption of plant-based proteins as a meat and milk alternative has the potential to significantly contribute to a reduction of the environmental footprint of agriculture and foodproduction
- The trend towards highly-processed protein foods potentially counteracts larger reduction targets
- A promissing (politicy-backed and in practice adoptable) strategy towards a substantial increase of production of Europe-grown legumes and oilseeds seems yet to be missing
- Public availability of good quality data for modelling of actual supply chains of decidated plant-based protein foods is still limited
- Environmental claims on products / product labels will be under scrutiny in the future and more supply-chain specific data will have to generated to comply with upcoming EU regulations

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Thank you for your attention!

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