



# Carbon footprint reduction potential with plant proteins at protein, product and diet level

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Hannele Pulkkinen  
Sanna Hietala  
Juha-Matti Katajajuuri

Natural Resources Institute Finland Luke



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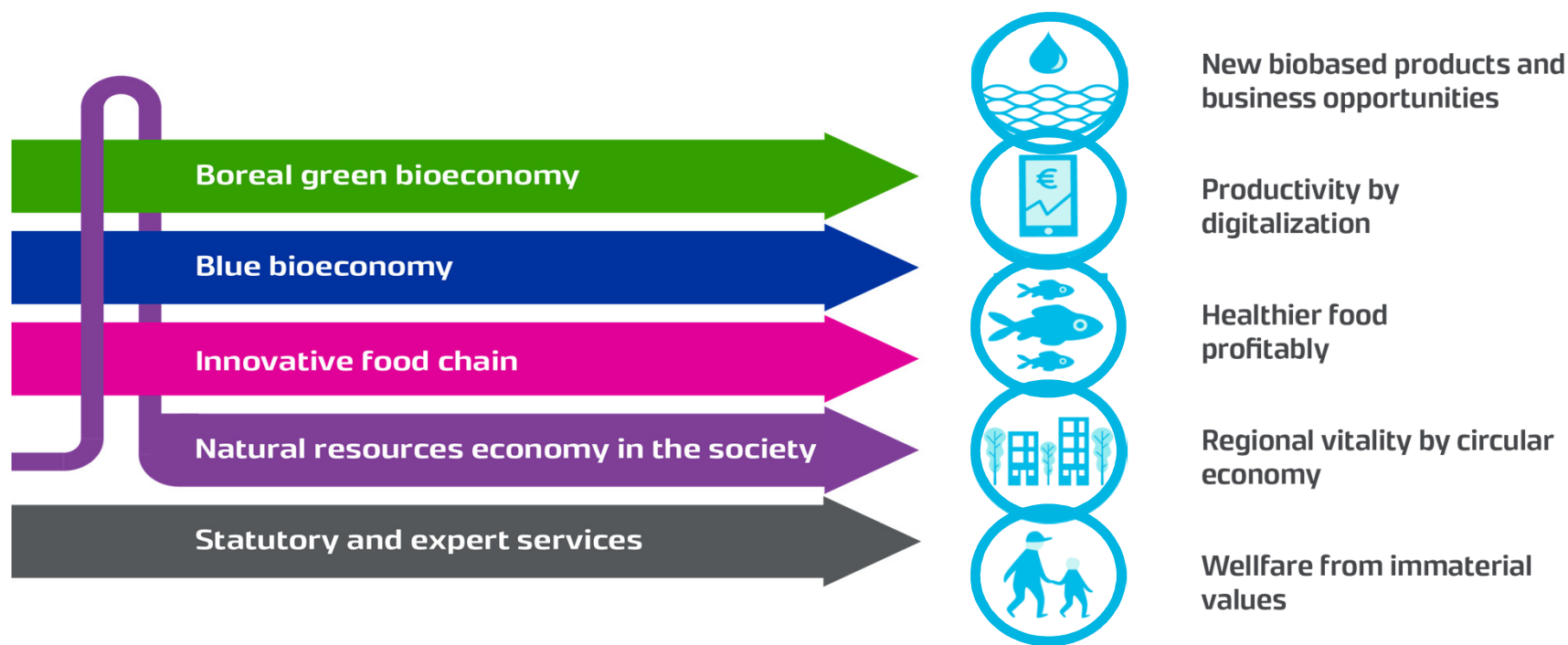


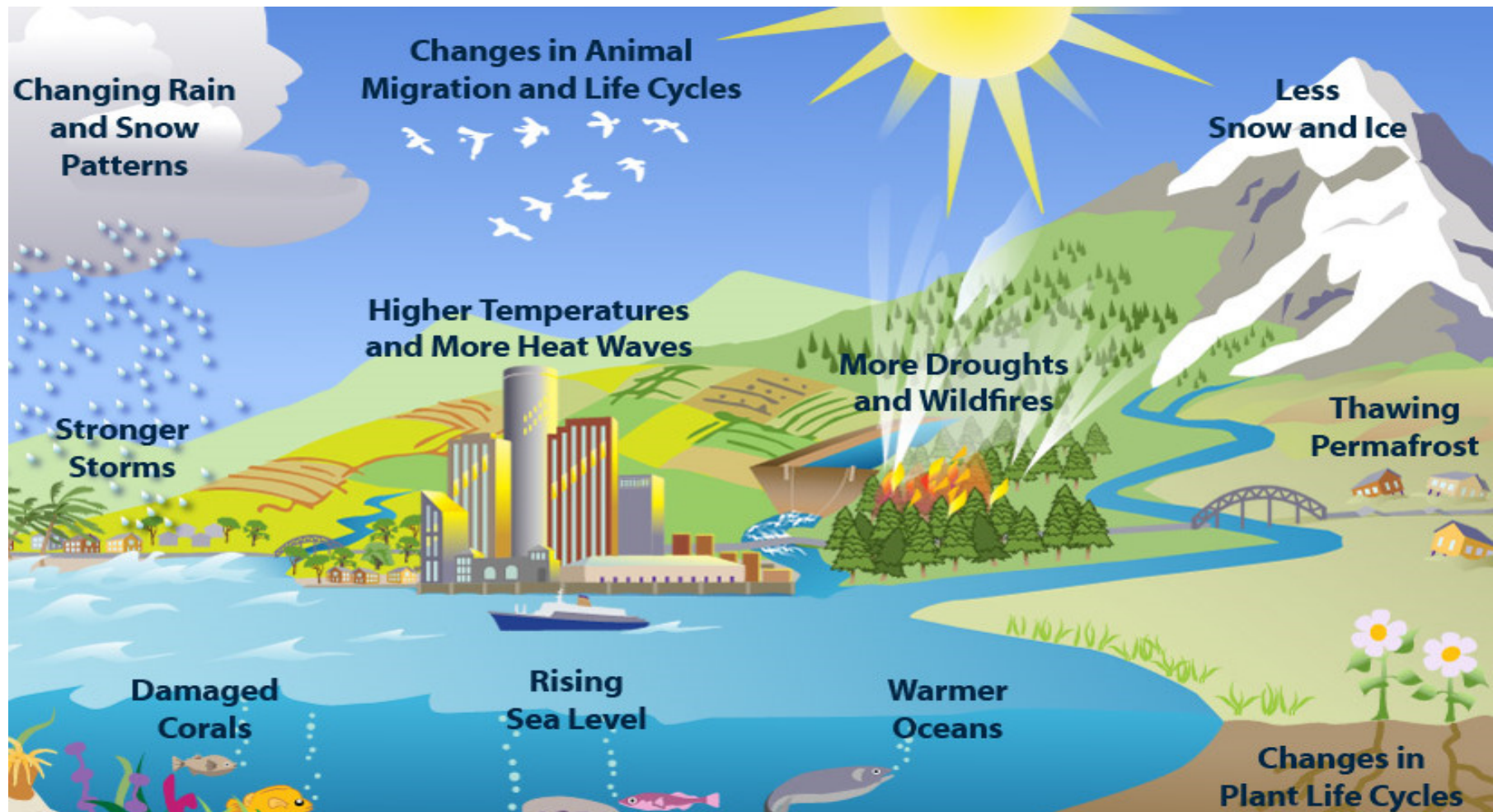
## Natural Resources Institute Finland – Luke

- Luke is a research and expert organization with expertise in renewable natural resources and sustainable food production.
- We provide innovative solutions for new business opportunities based on natural resources.
- Our strengths are in sustainable production and use of natural resources and knowledge of bio-based raw materials.



## Focus areas of Luke research

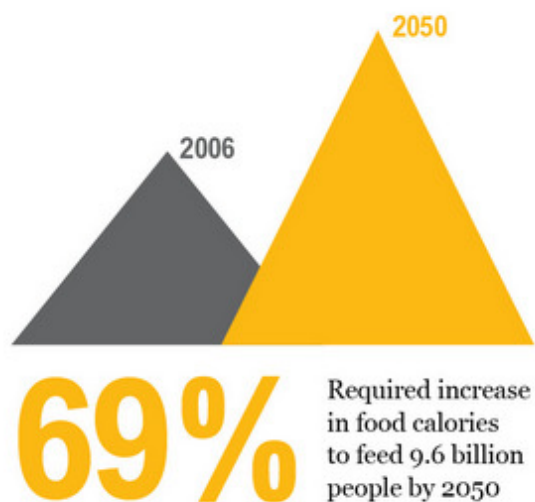




## THE GREAT BALANCING ACT

The world must achieve a “great balancing act” in order to sustainably feed 9.6 billion people by 2050.

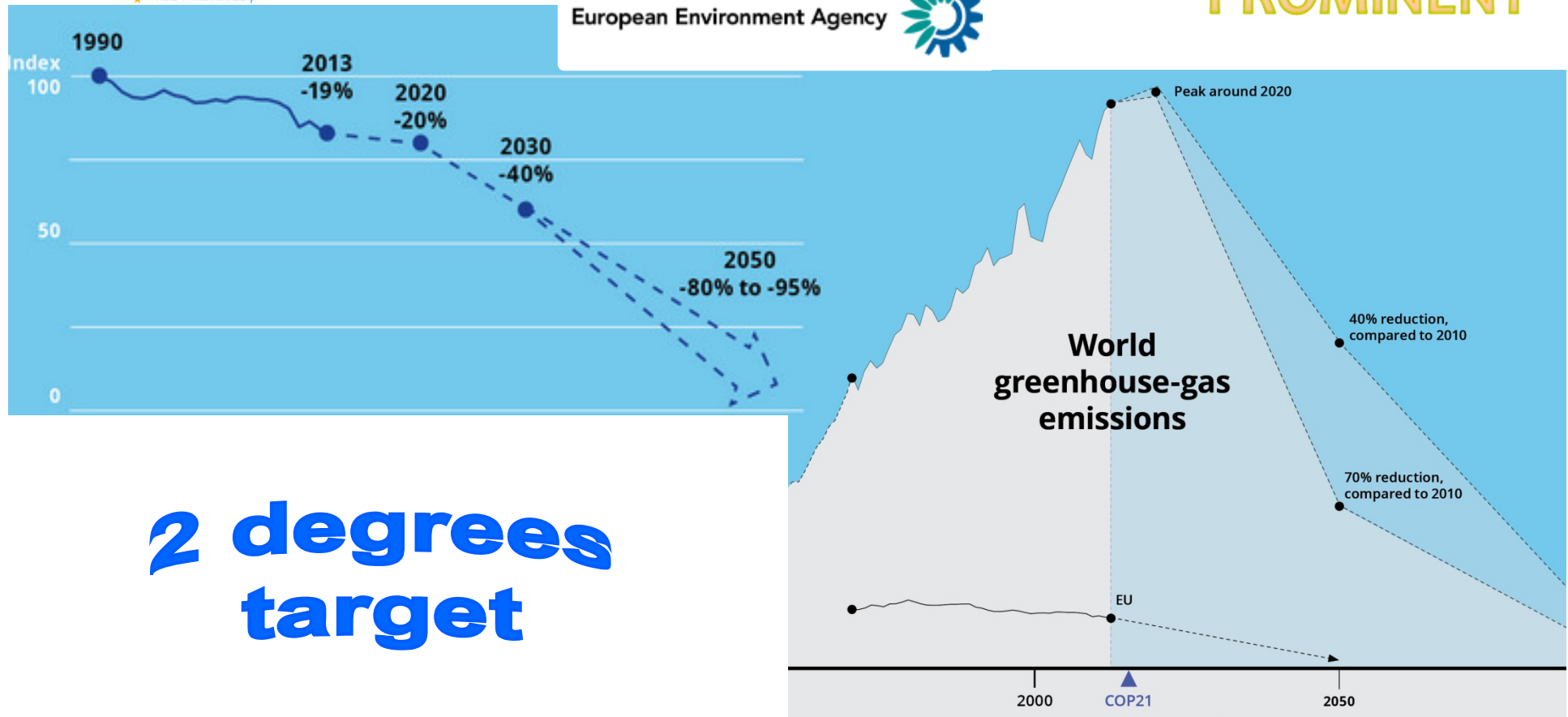
### CLOSING THE FOOD GAP



### REDUCING ENVIRONMENTAL IMPACT



Source: World Resource Institute



## Where are the environmental limits of valorizing plant based side streams to plant protein?

- A limit also to the amount of processing energy we can put into valorizing side streams
- Thus, the question from environmental perspective:

Are

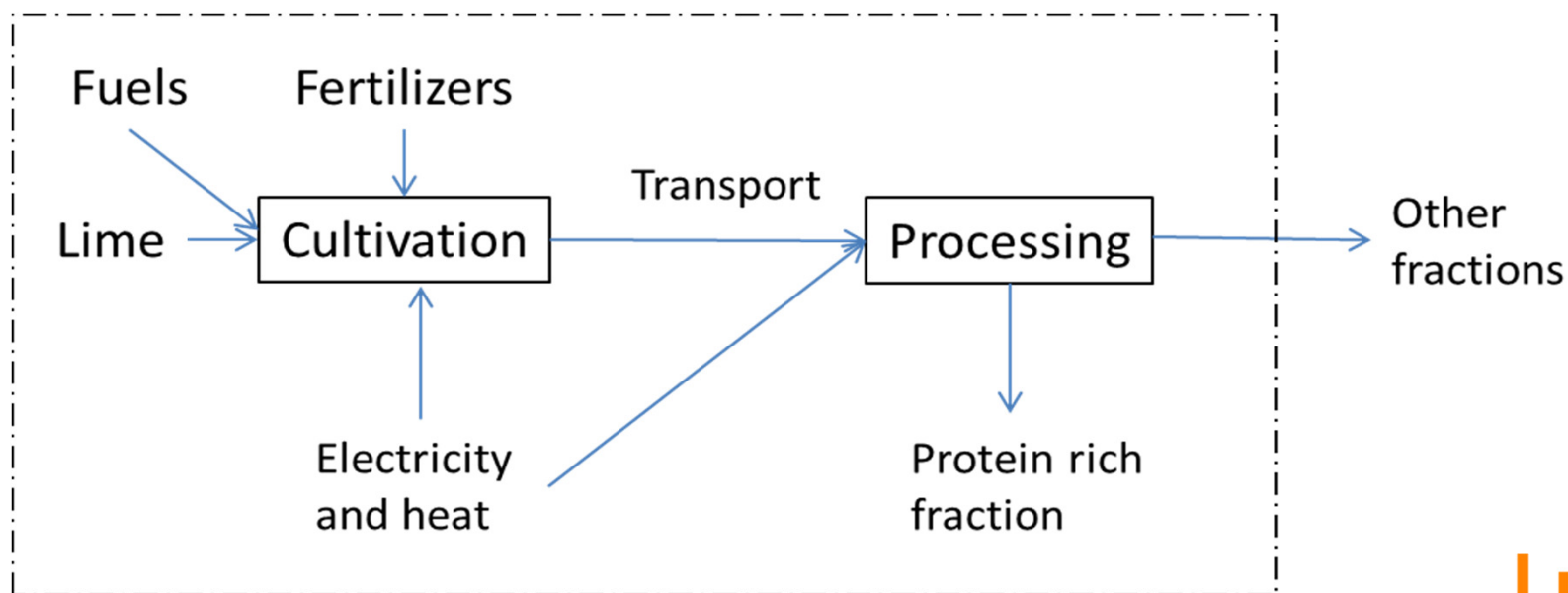
- 1) plant protein ingredients,
  - 2) food products enriched with them and
  - 3) their use in diets
- surely more environmentally friendly compared to animal products naturally high in protein?

## How environmental impacts of products are assessed?

- Life Cycle Assessment is internationally scientifically and politically accepted method to estimate environmental impacts of products and services
  - Assessment of whole production system from raw material production to final consumption and waste management
  - Different environmental impacts: Climate, water, nutrients etc.
  - ISO standards, EU Product Environmental Footprint guidelines etc.



## Simplified system boundary of Life Cycle Assessment of plant protein production



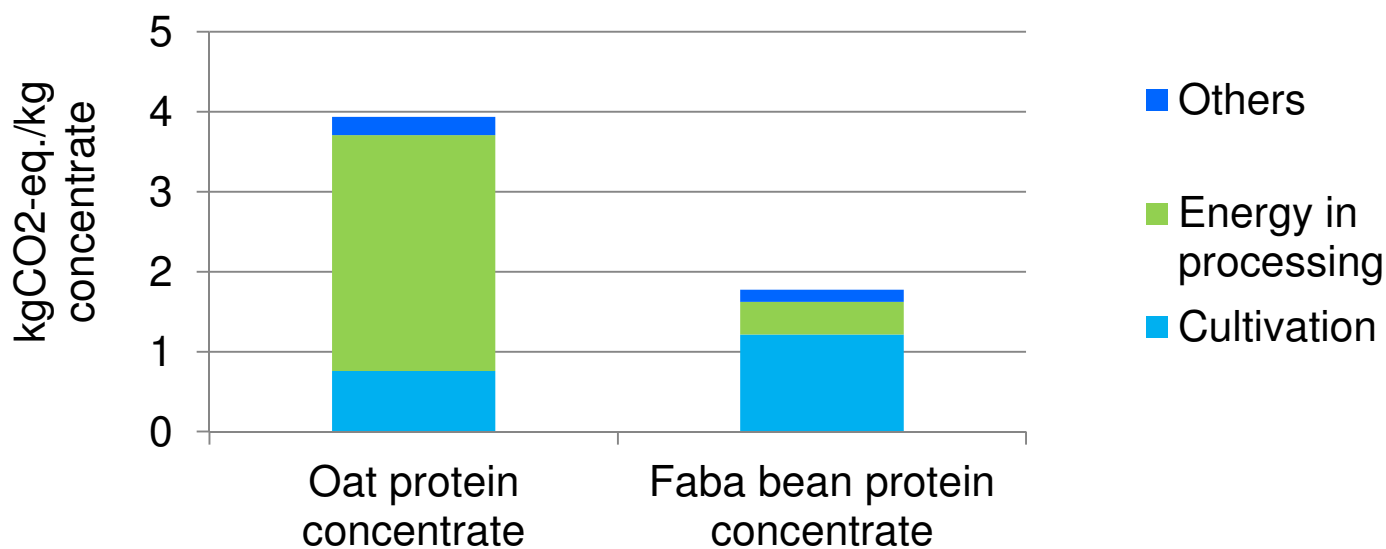
## Environmental impacts of plant proteins

- Main differences of plant protein regarding their environmental impact
  1. Naturally protein rich plants, such as legumes
  2. Plant protein ingredients requiring little processing, such as legume protein concentrates
  3. Protein isolates from protein rich plants
  4. Proteins derived from side stream valorization
    - Possibly very complex production system with various end products to different applications
  5. Plant proteins from plants cultivated in circumstances which cause serious environmental burdens
    - On deforested land, in areas of high water scarcity etc.

## Environmental impacts of plant production

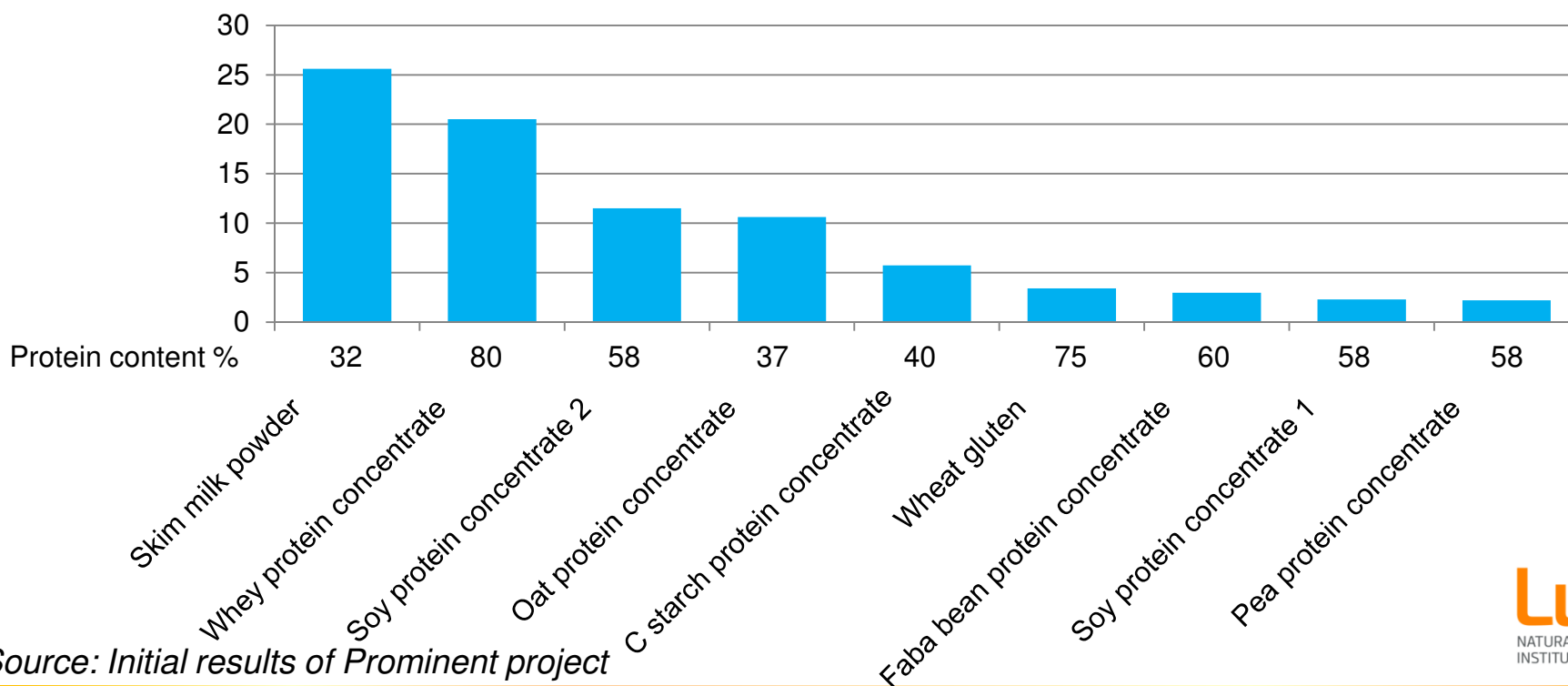
- Usually the environmental impacts of plant products are low, with the exception of
  - heavily processed products
  - products requiring significant energy inputs in cultivation (e.g. greenhouse vegetables in winter in North Europe)
  - Products transported by plane (not as common as thought)
  - Products with very low yields (oil seed crops in North Europe etc.)
  - Products cultivated in circumstances creating environmental impacts (deforested land, water scarcity etc.)

## Difference of carbon footprint of oat protein concentrate as a side stream of beta glucan production and plant protein from pulses (minor processing)



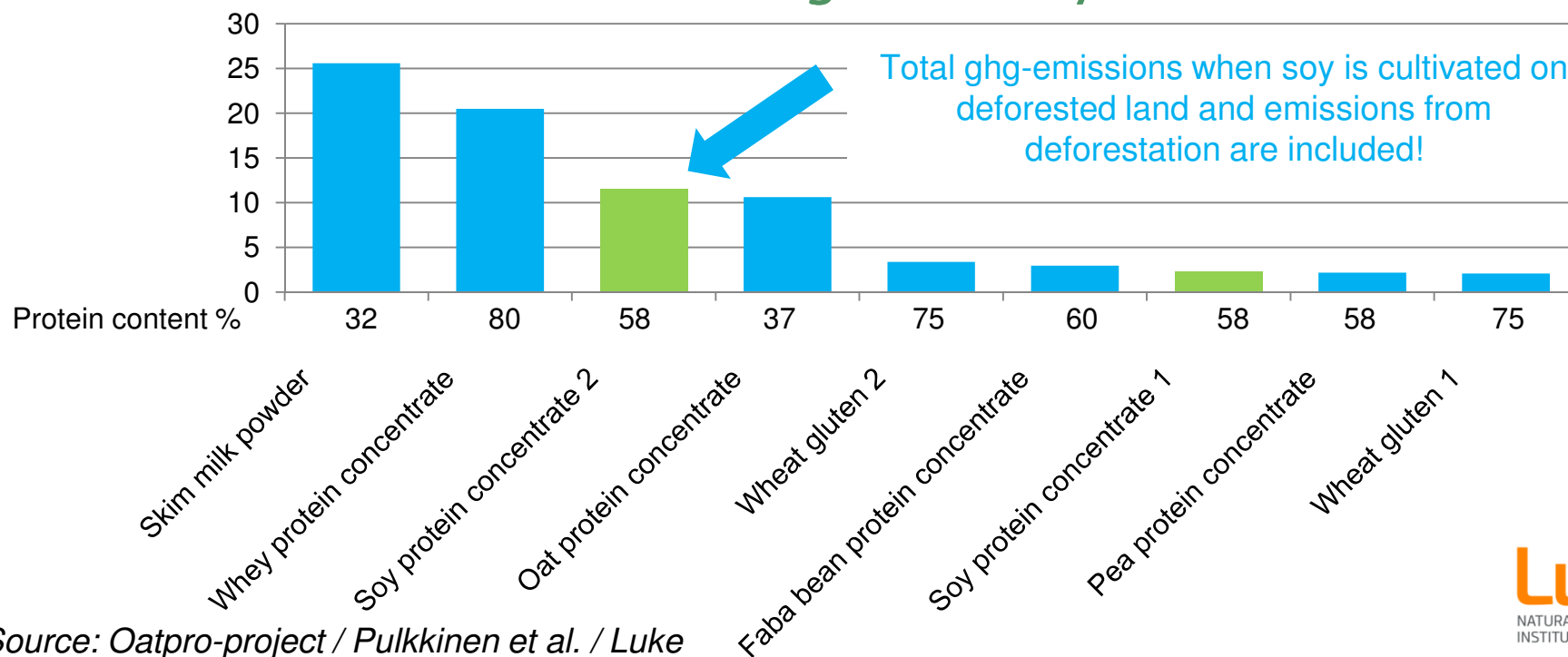
Source: Oatpro-project / Pulkkinen et al. / Luke

## Carbon footprint of protein concentrates, per kg of protein



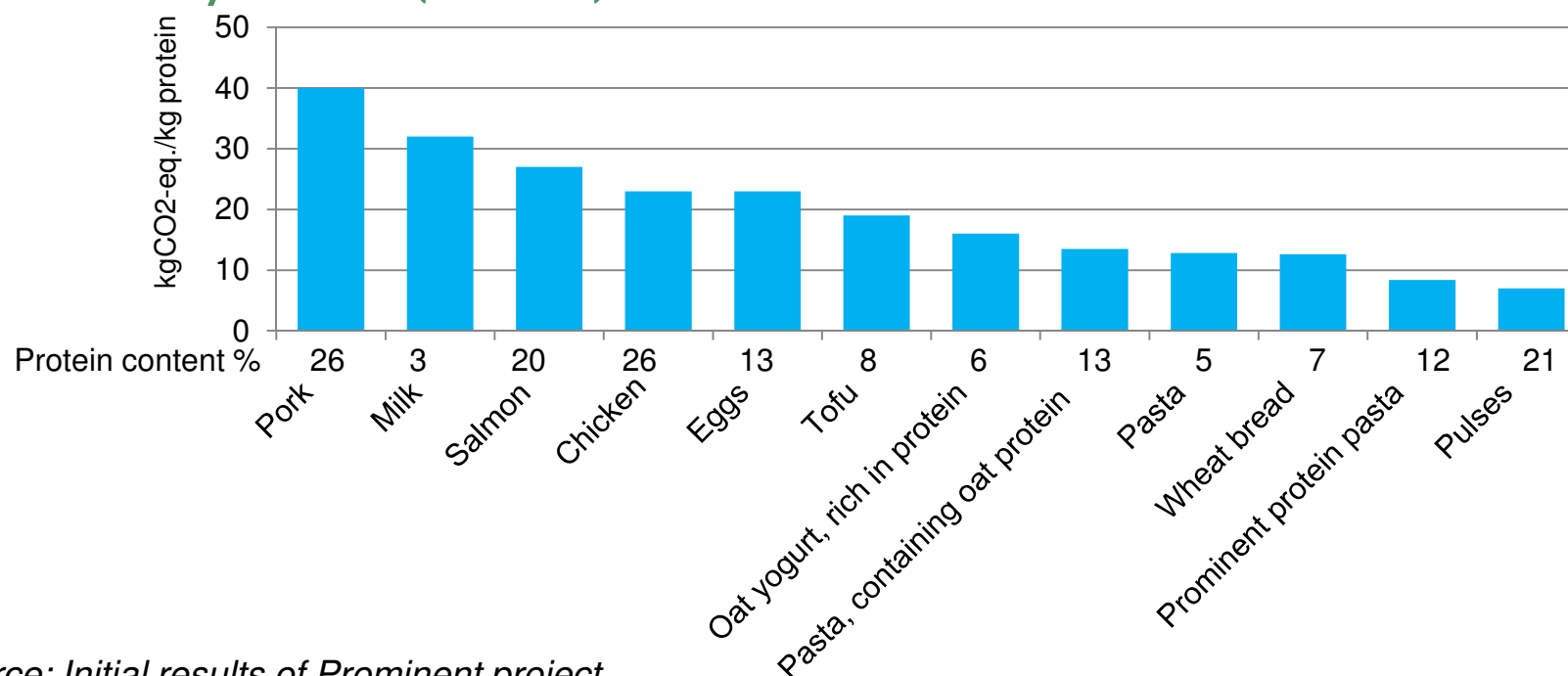
Source: Initial results of Prominent project

## Carbon footprint of protein concentrates, per kg of protein – the environmental challenge with soy



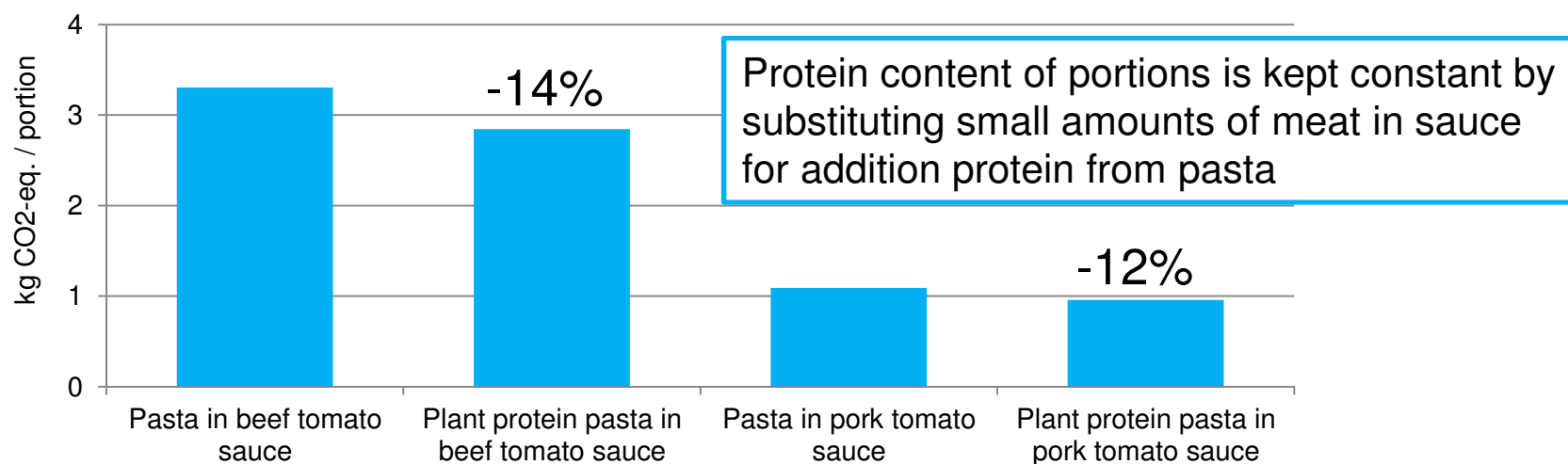
Source: Oatpro-project / Pulkkinen et al. / Luke

## Carbon footprint of food products per kg of protein as ready-to-eat (cooked)



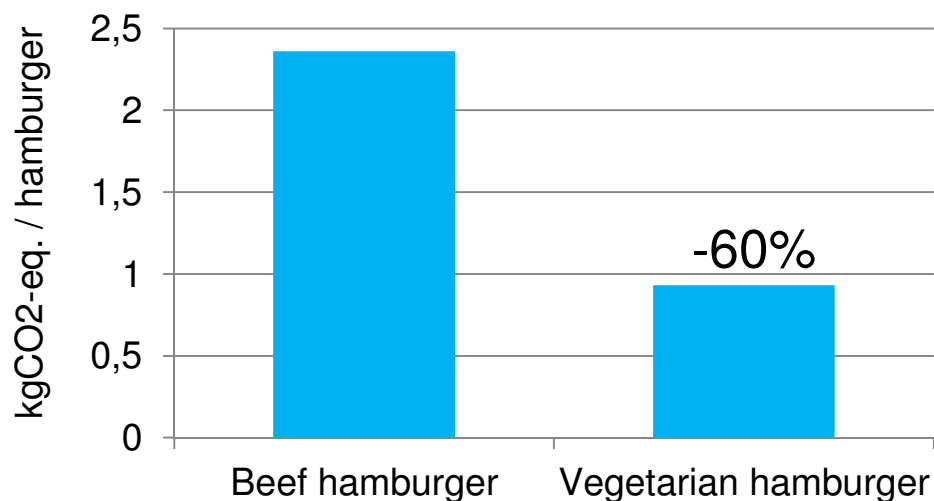
Source: Initial results of Prominent project

## Carbon footprint reduction potential at meal level using pasta rich in plant protein from side stream valorization and substituting meat from sauce





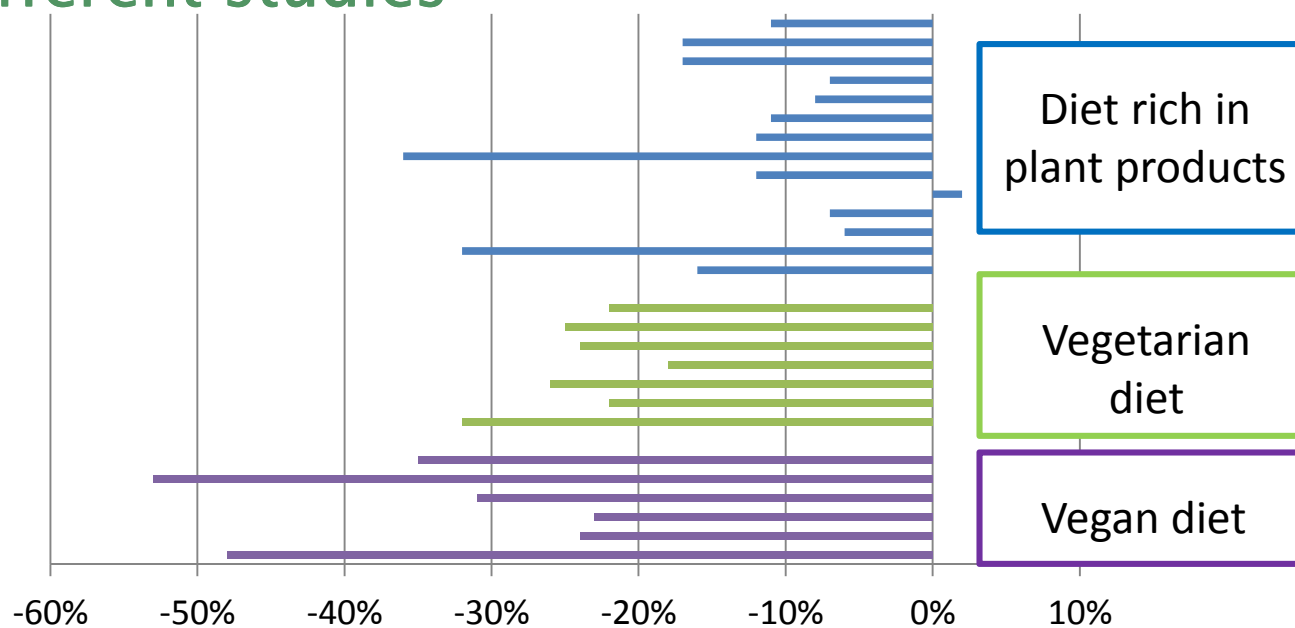
## Carbon footprint reduction potential at meal level using vegetarian hamburger steak containing plant protein from side stream valorization



<https://www.impossiblefoods.com/>

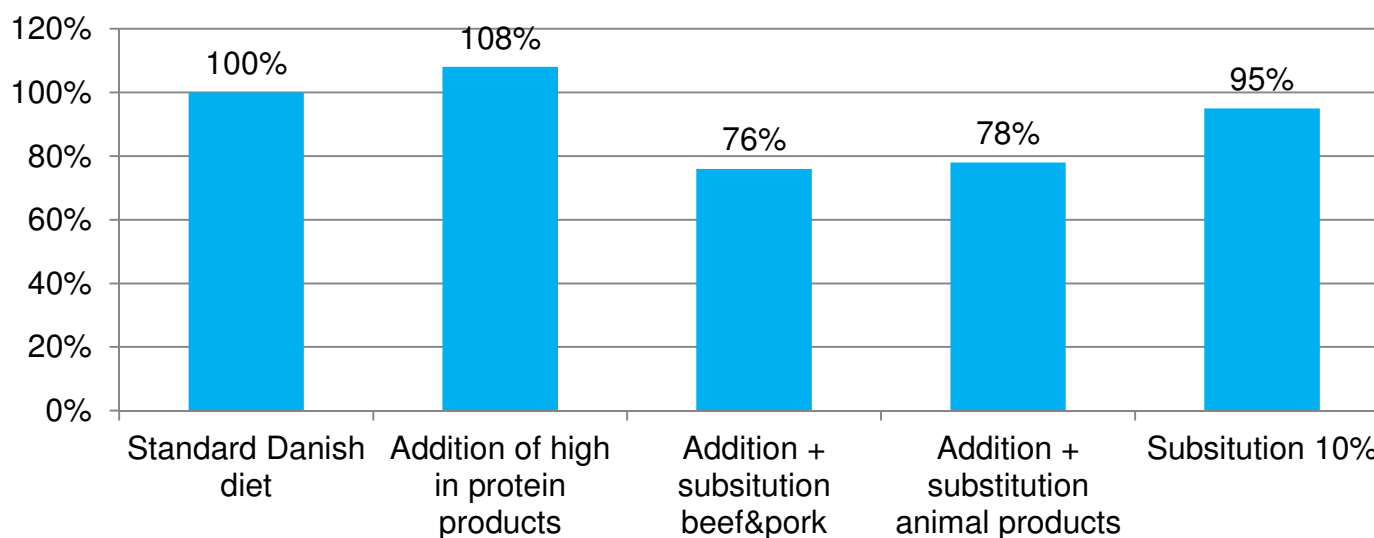
Source: Initial results of Prominent-project modified from Goldstein et al. 2017

## Carbon footprint reduction potential at diet level in different studies



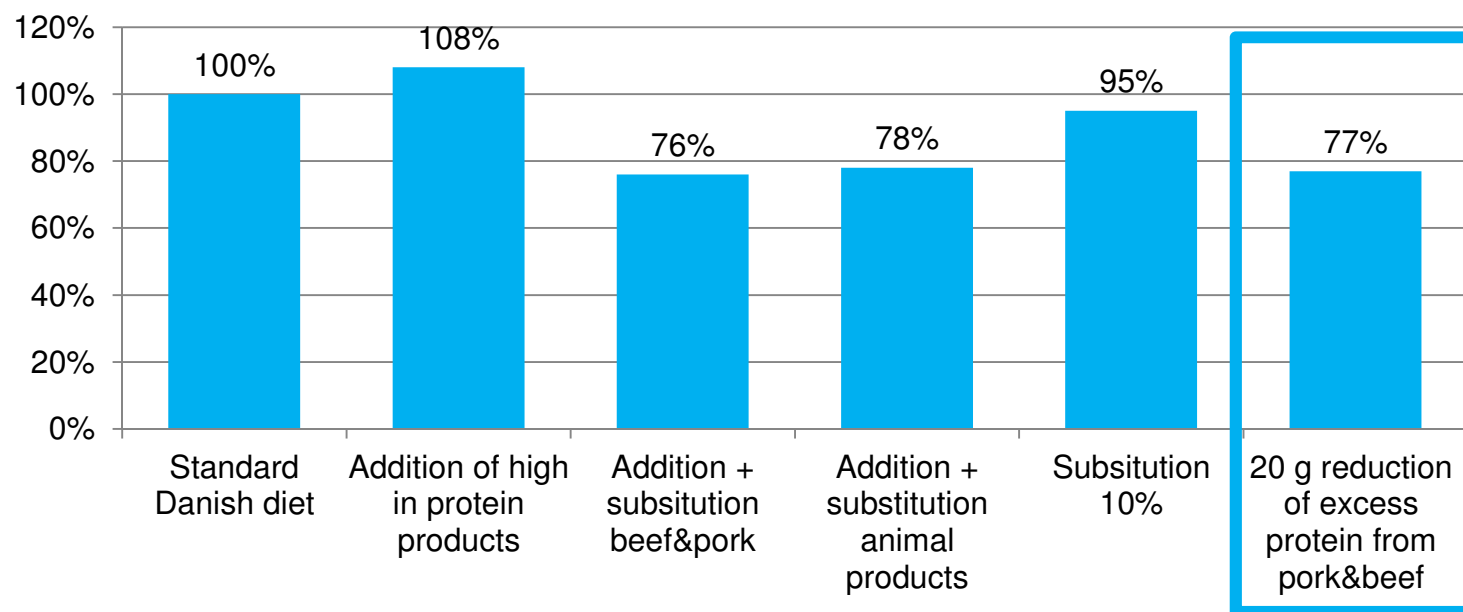
Source: Modified from Hallström et al. 2015 (*J. Cleaner Production*)

## Carbon footprint reduction potential at diet level using food products rich in oat protein concentrates (pasta, bread, yogurt) to substitute animal proteins



Source: Oatpro-project / Mogensen et al. / Aarhus University

## Carbon footprint reduction potential at diet level when NOT eating excess protein from pork and beef



Source: Oatpro-project / Mogensen et al. / Aarhus University

## Conclusions 1 / 3

- Already with current technologies, processed plant based proteins from side stream valorization seem good to replace animal proteins
- Food products rich in plant proteins seem good to replace animal products, at product and at diet level
- Still, the carbon footprints of plant proteins from side stream valorization might be higher than naturally protein rich legume proteins
- Current technologies of plant protein production are still evolving heavily and their related impacts decreasing
  - In animal production mitigation potential already smaller

## Conclusions 2/3

- Life Cycle Assessment used to estimate environmental impacts is still an evolving field
- Creates uncertainties in the assessment of the complex circular bioeconomy production systems
- Still, the difference to animal proteins seems rather clear with current knowledge

## Conclusions 3/3

- Substitution is the key: Environmental impacts are reduced only when animal protein and animal products are replaced with novel plant proteins
  - Substitution in food products replacing animal protein ingredients with plant proteins
  - Substitution between food products / diet level
- Products containing additional plant protein are in particularly suitable for:
  - Elderly and other groups who need foods rich in nutrients
  - Vegans who lack protein
  - Vegetarians who want 'easy' protein sources
  - Flexitarians who worry about adequate protein intake



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Thank you!



Pulkkinen, Hietala & Katajajuuri

<http://www.prominent-protein.eu>