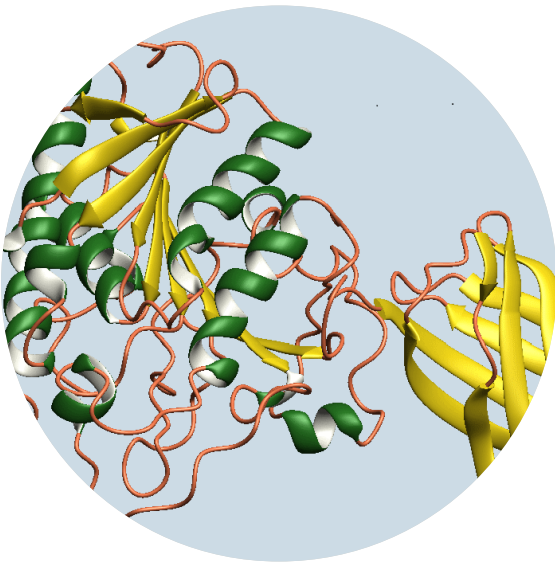


# Protein-driven Biorefining – Sustainable Biomass Use for Food and Non-food

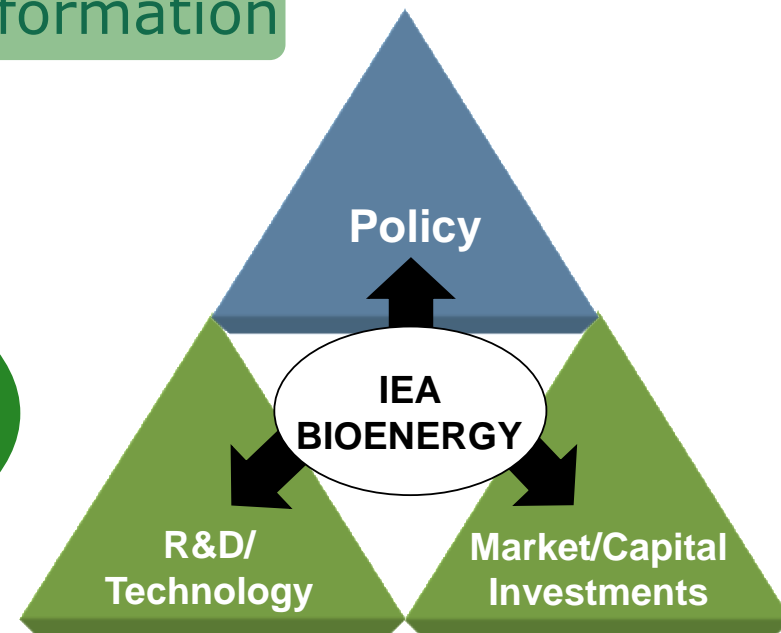
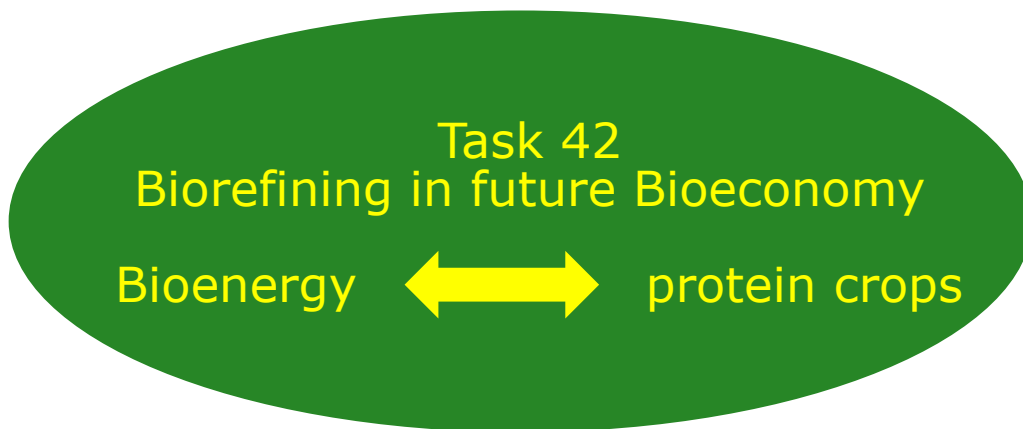
EUBCE, Amsterdam, 6 June 2016

Wim Mulder



# IEA BioEnergy

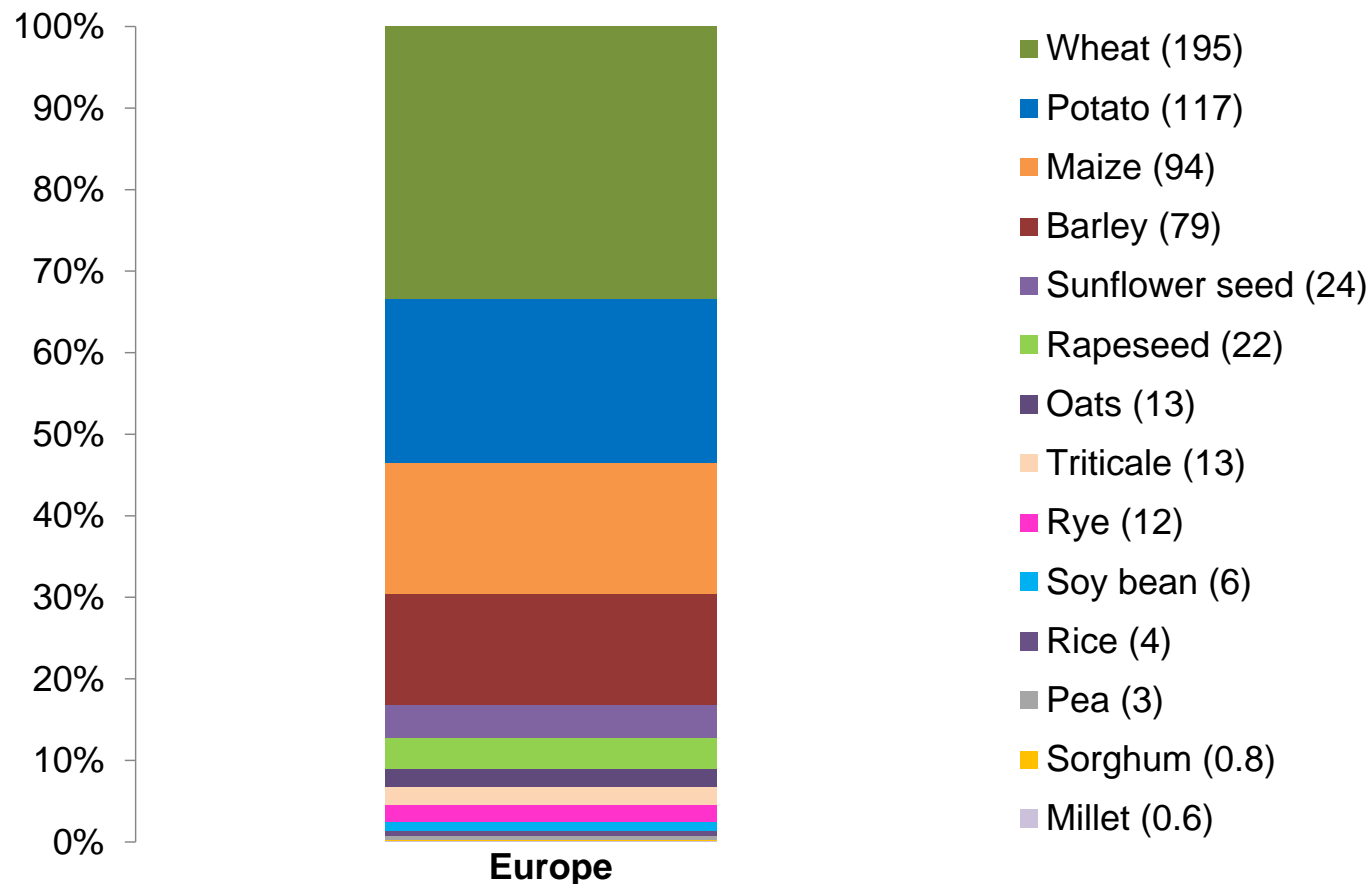
- Feedstocks for fuels and substitutes for petrochemicals and other energy intensive products
- Increase the dissemination of information



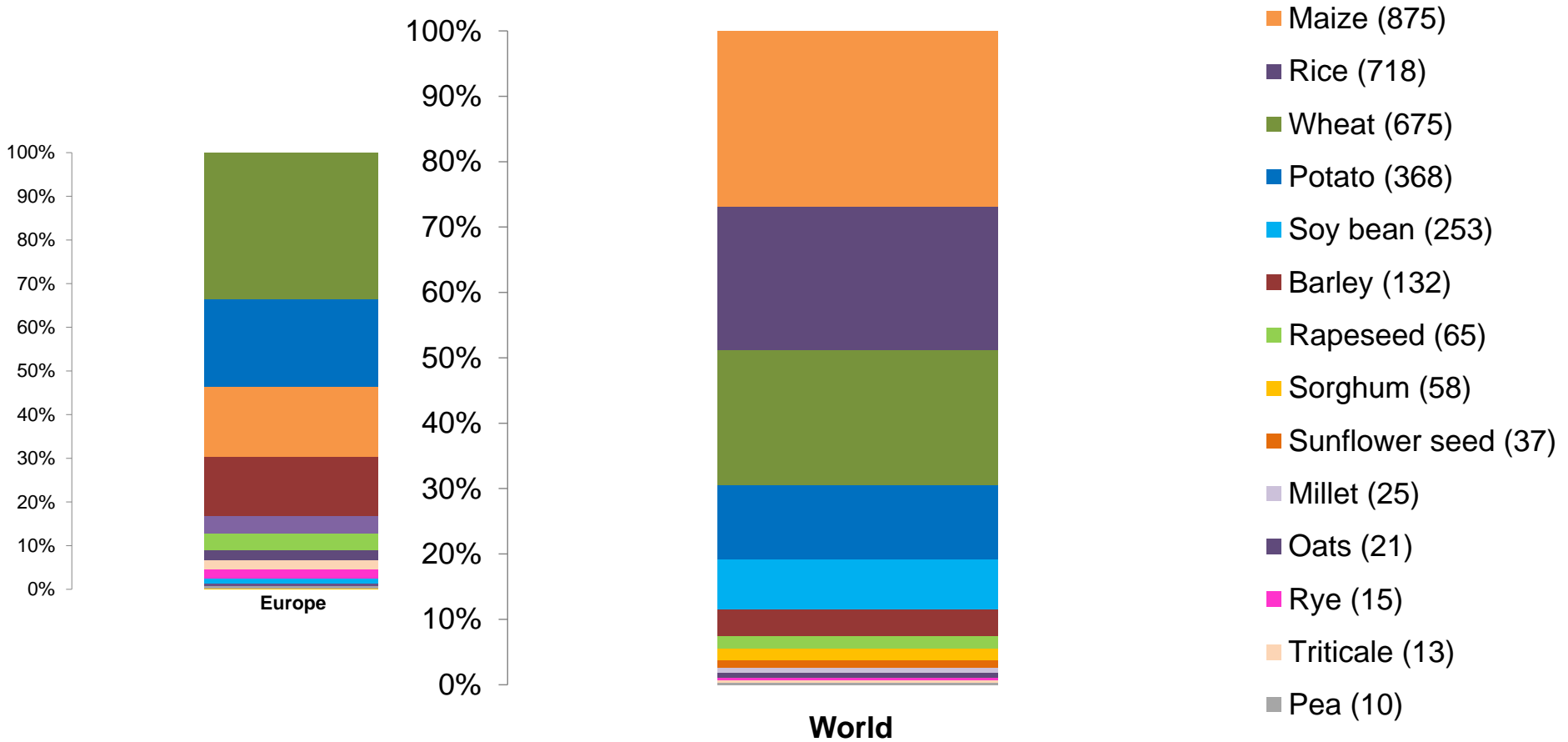
# Need for a sustainable protein supply



# Production (million tons) protein-rich crops



# Production (million tons) protein-rich crops



# Commercial production of protein isolates

Plant origin

Cereals

Oil  
crops

Legumes

Plant  
tuber

Wheat  
Maize

Soy

Pea  
Lupine

Potato

Animal origin

Blood

Milk

Egg

Meat

plasma,  
haemo-  
globine

Casein  
Whey

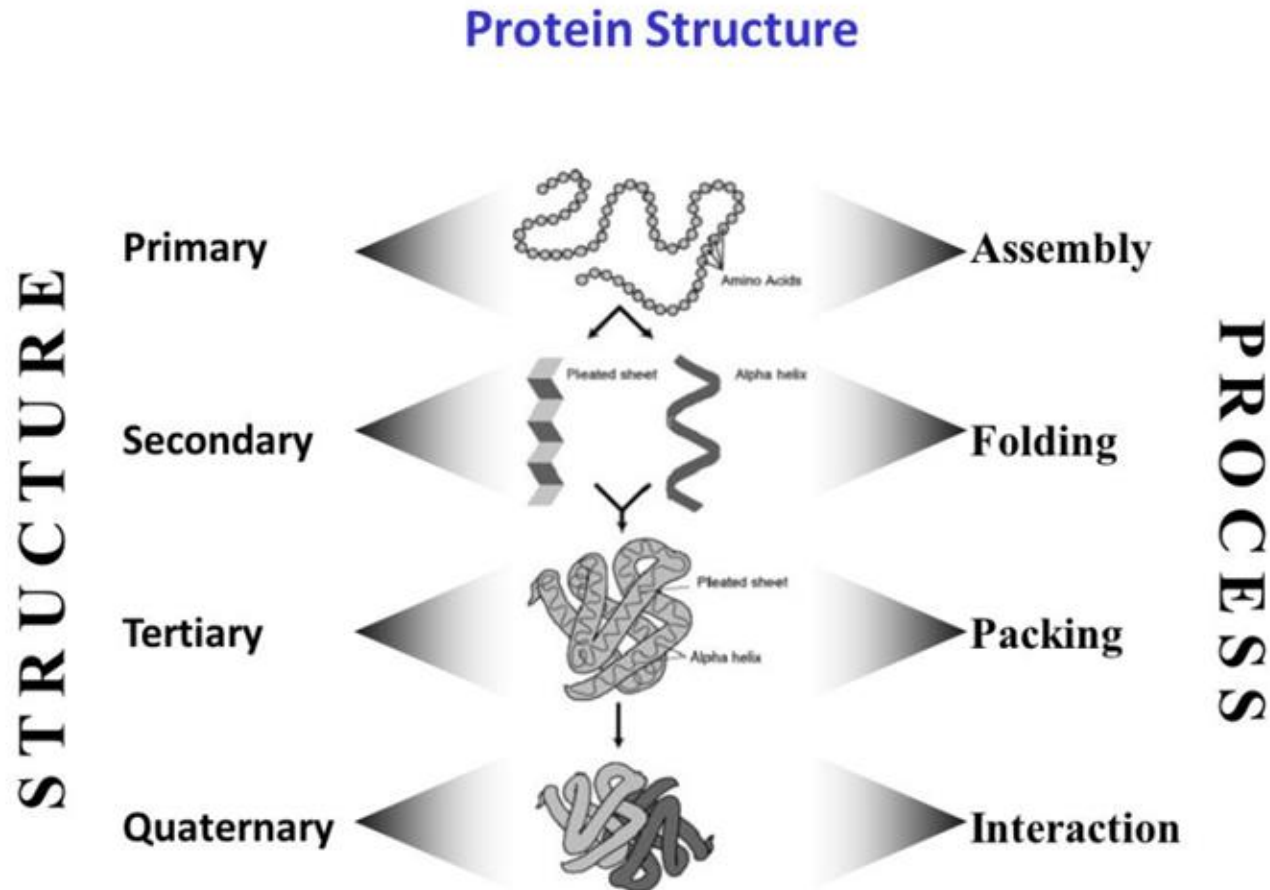
White  
Yolk

Broad  
range

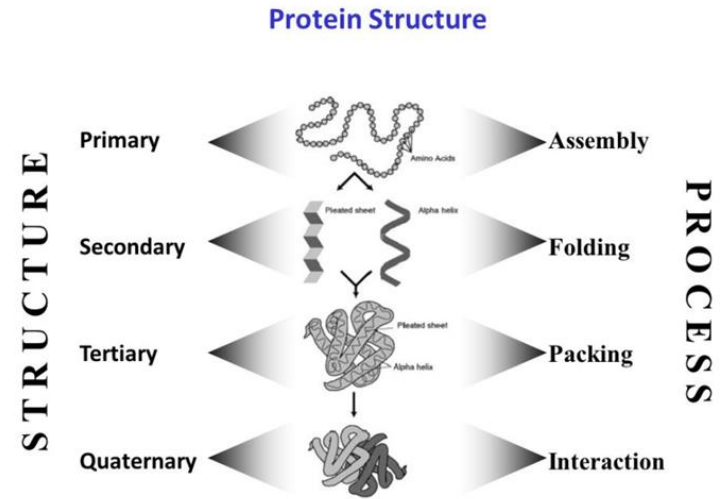
# Food Protein prices [€/kg]: high functionality

Vegetable proteins		Animal derived proteins	
Soy meal (40% protein)	0.8	Gelatine (low quality)	2
Soy concentrate	2	Gelatine (high quality)	4-6
Soy isolate	3	Collagen	4-6
Pea concentrate	2	Egg white powder	6-8
Pea isolate	3	Egg yolk powder	4-6
Lupine concentrate	2-4	Plasma powder	3-5
Potato protein (feed)	0.8	Haemoglobin powder	1
Potato protein (food)	>3	Milk powder	2.2
Wheat gluten	1.2	Whey concentrate (30% protein)	1.6
Maize gluten feed	0.12	Whey concentrate (80% protein)	5.5
Zein	25	casein/caseinate	6.5

# Functionality related to structure



# Protein functionality



You're so hot, you denature my proteins.



# Relation protein functionality - application

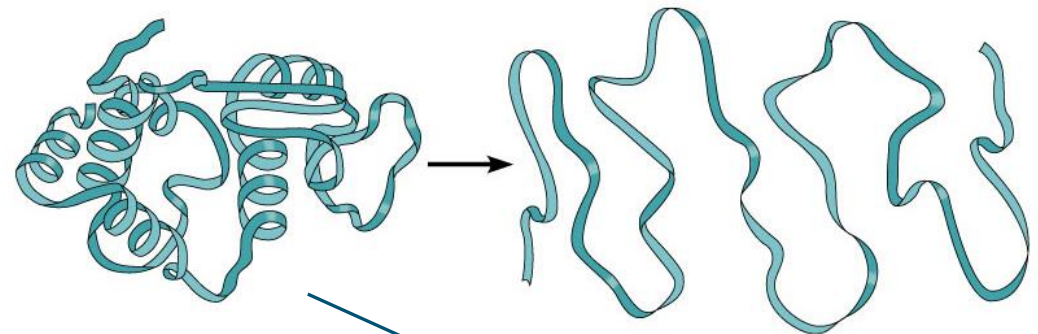
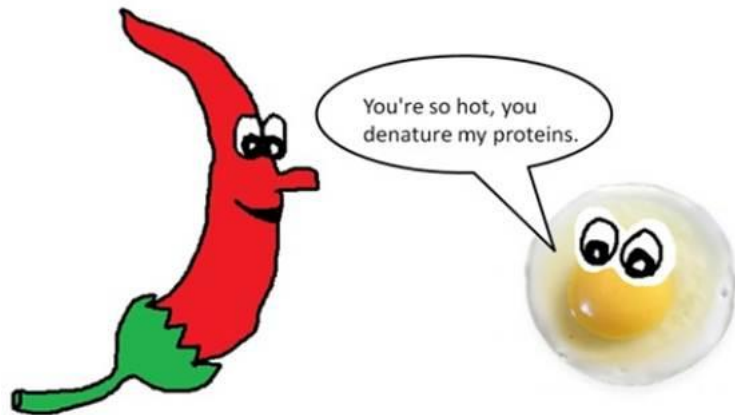
Feed

Biobased

Food

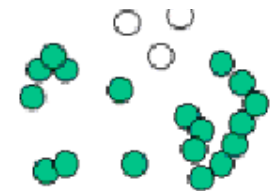
Pharma

- Anti biotic
- Anti ageing
- Capsules



Active (functional)  
protein

Denatured protein



Peptides and free amino acids

IEA Bioenergy

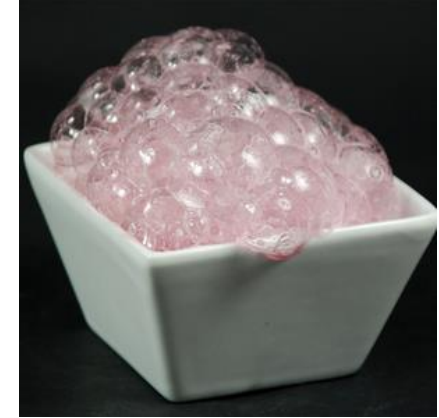
Task42 Biorefining

Protein  
concentrates  
and isolates  
in food

Functional  
properties



Solubility



Foaming



Emulsification



Gel forming

# Relation protein functionality - application

## Feed

- Amino acid composition
- Addition essential amino acids
- Digestibility

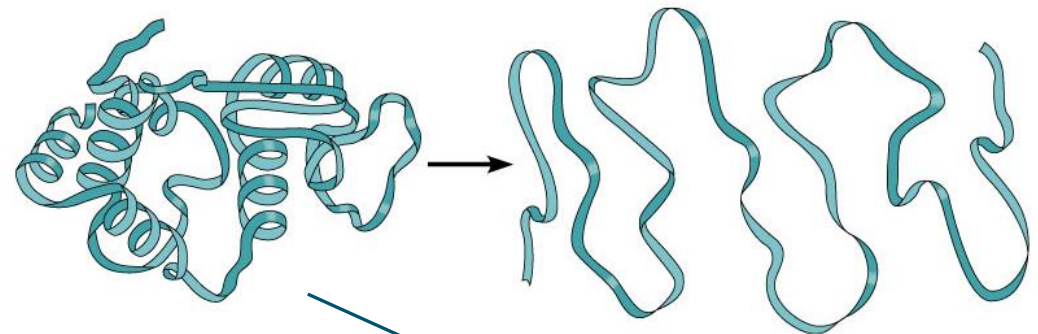
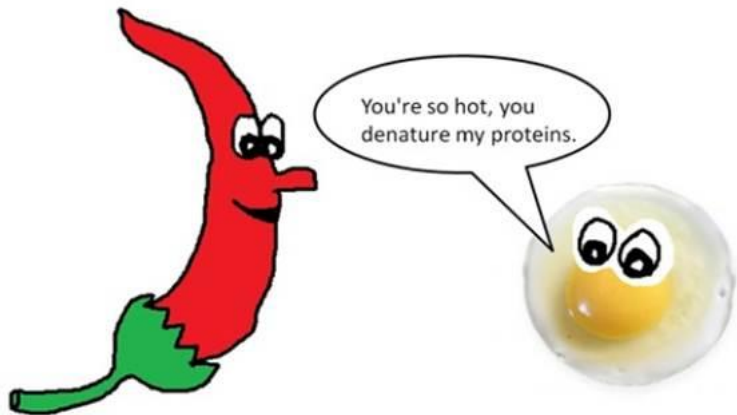
## Biobased

## Food

- Nutritional value
- Solubility
- Emulsification
- Foaming
- Gel forming

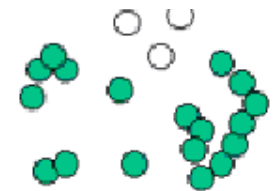
## Pharma

- Anti biotic
- Anti ageing
- Capsules



Active (functional) protein

Denatured protein



Peptides and free amino acids

# Relation protein functionality - application

## Feed

- Amino acid composition
- Addition essential amino acids
- Digestibility

## Biobased

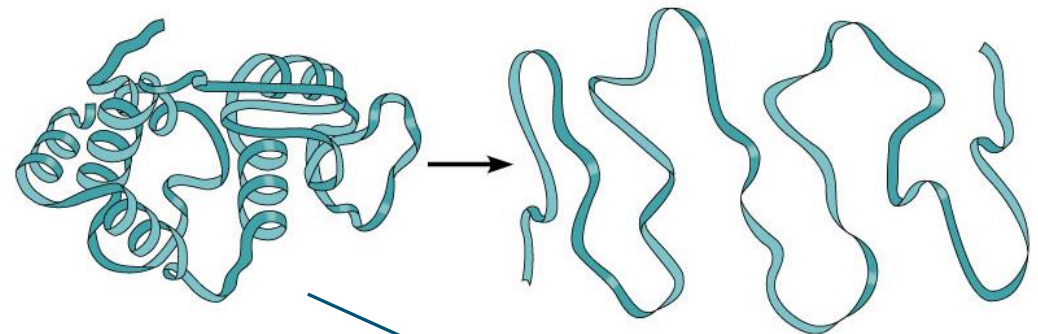
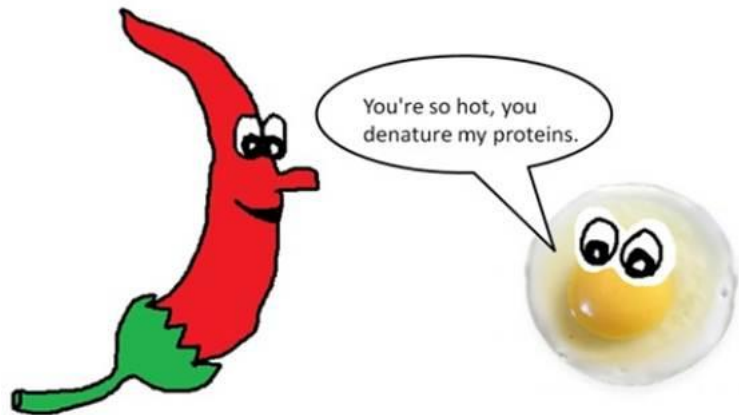
- Film forming
- Adhesion
- Surface active

## Food

- Nutritional value
- Solubility
- Emulsification
- Foaming
- Gel forming

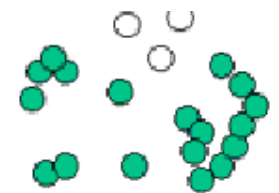
## Pharma

- Anti biotic
- Anti ageing
- capsules



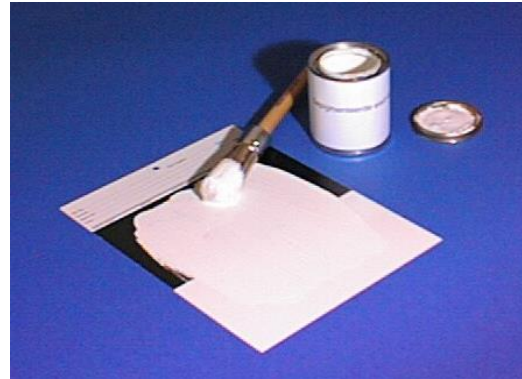
Active (functional)  
protein

Denatured protein



Peptides and free amino acids

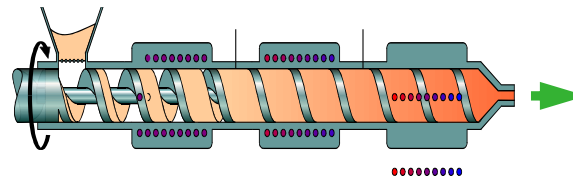
# Examples of technical applications



IEA Bioenergy

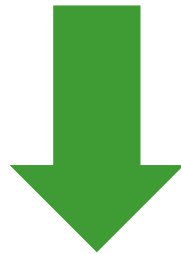
Task42 Biorefining

Coatings  
Adhesives  
Surfactants  
Bioplastics



# Motivation for biobased applications

Restriction in food due to EU Legislation on safety:  
Novel Food Regulation (EC No 258/97)



Applicable to foods not used for human consumption to  
a significant degree in the EU prior to 15 May 1997

# Potential new sources

## ■ Food

- Amaranth, Quinoa, macro and micro-algae, leaf proteins, insects

## ■ Feed

- Lucerne (alfalfa), beet leaves, herbaceous agroresidues, algae, duckweed, meal worm, housefly, house cricket

## ■ Bio-based

- Aquatic, “green” biomass, side streams from oil, bio-ethanol and meat industry

# Use of proteins

- Feed (EU) ca. 60 Mtons
- Food (EU) ca. 20 Mtons
- Concentrates and isolates (World) ca 1500 ktons
- Biobased applications (EU) ca. 200 ktons

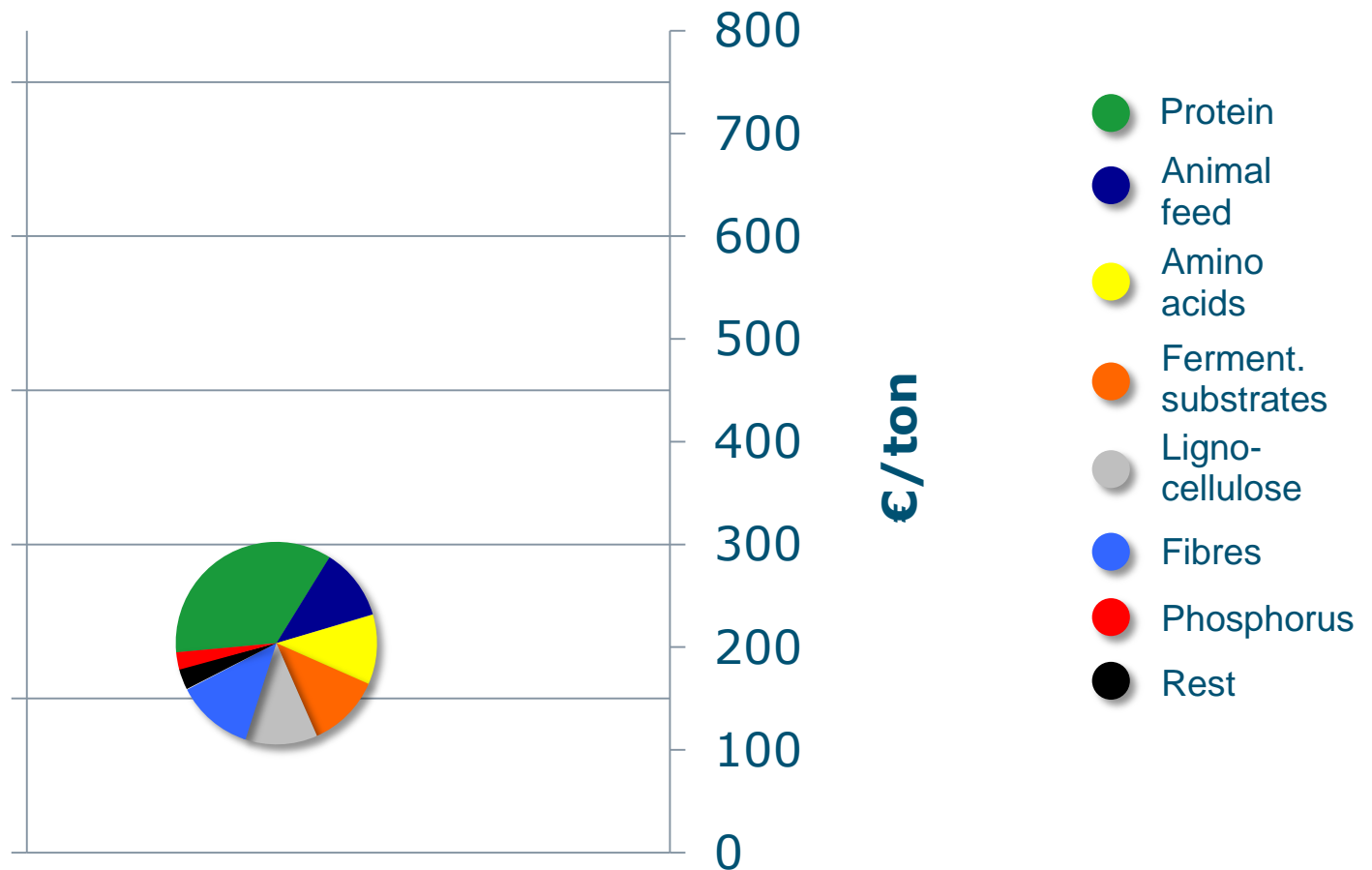
# Biorefining in energy sector

- Energy sector deals with big amounts
- Feed uses large amounts of protein containing biomass

Balance between amounts AND functionality AND price

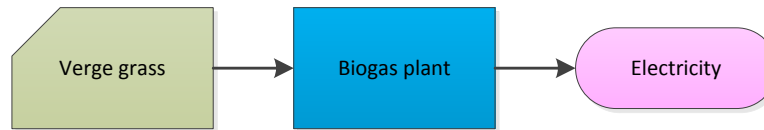
- Interesting biorefinery concepts:
  - Bioethanol production
  - Biogas production
  - Oil seeds refinery (e.g rapeseed)

# Biorefinery of rapemeal increases value components

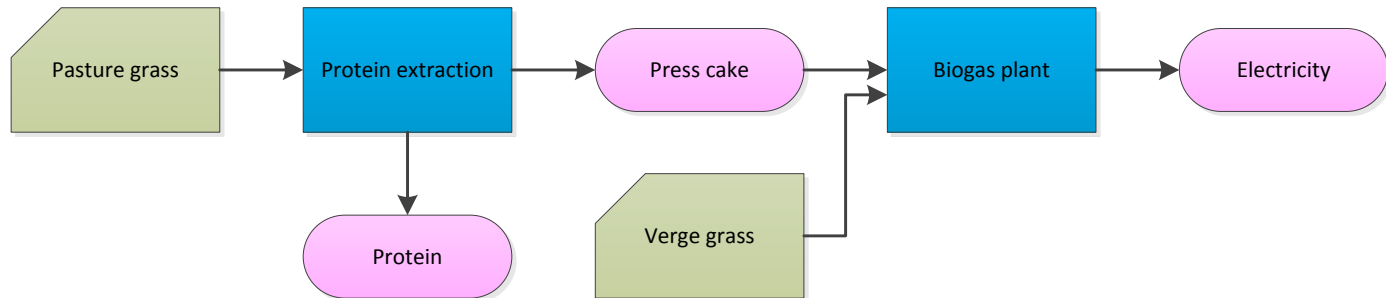


# Co-digestion optimisation by upstream protein isolation and valorisation

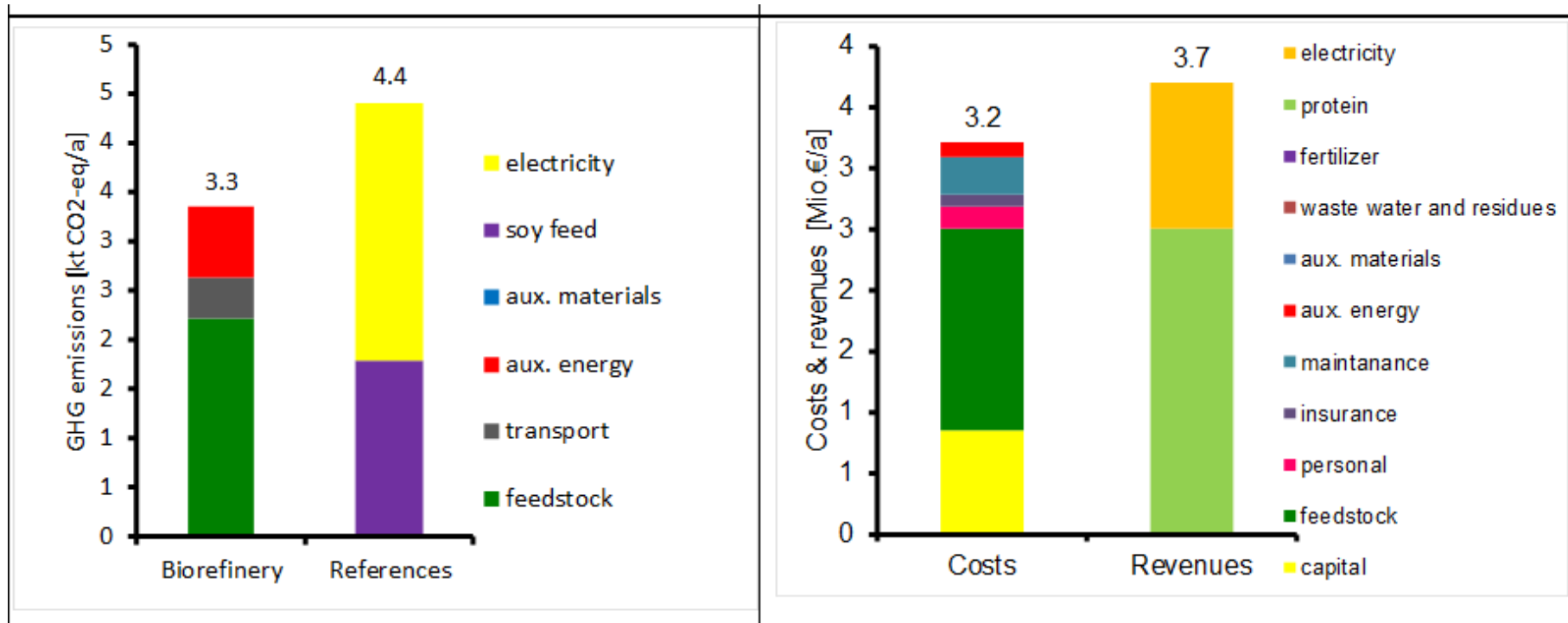
Case



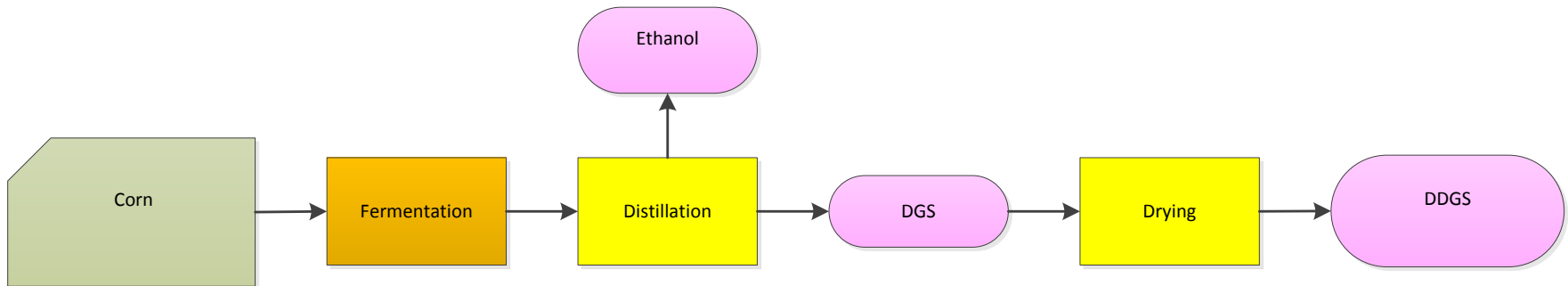
Adapted case



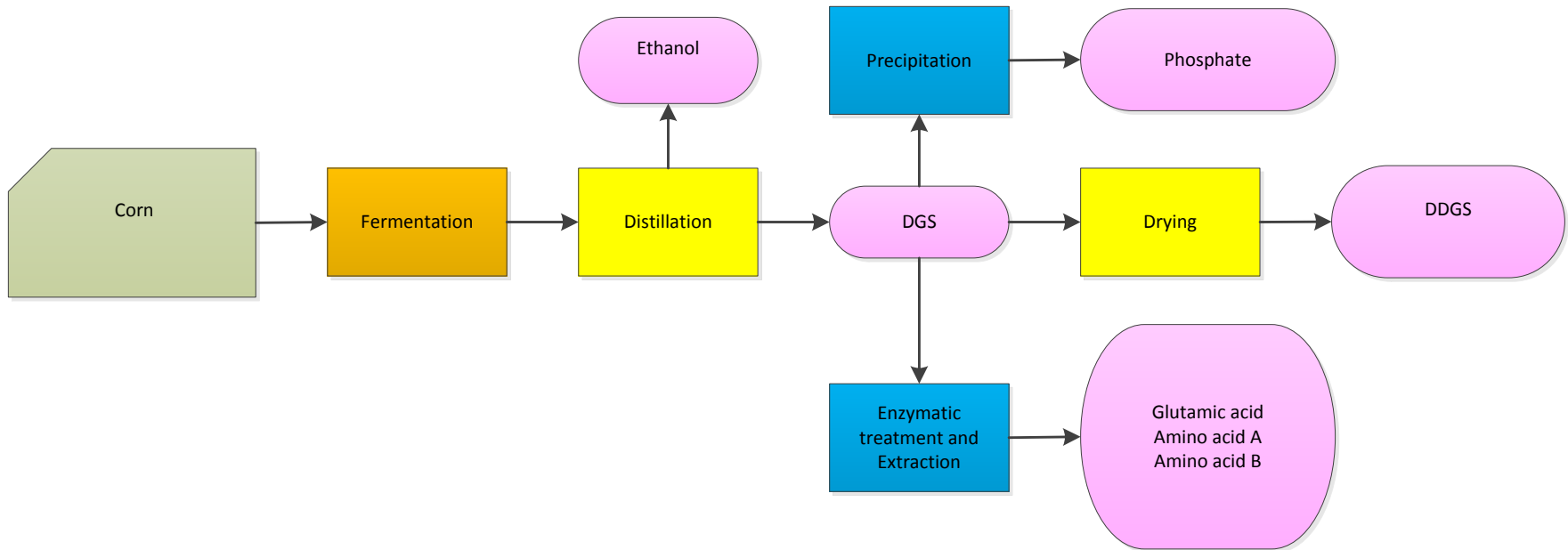
# GHG gasses, costs and revenues



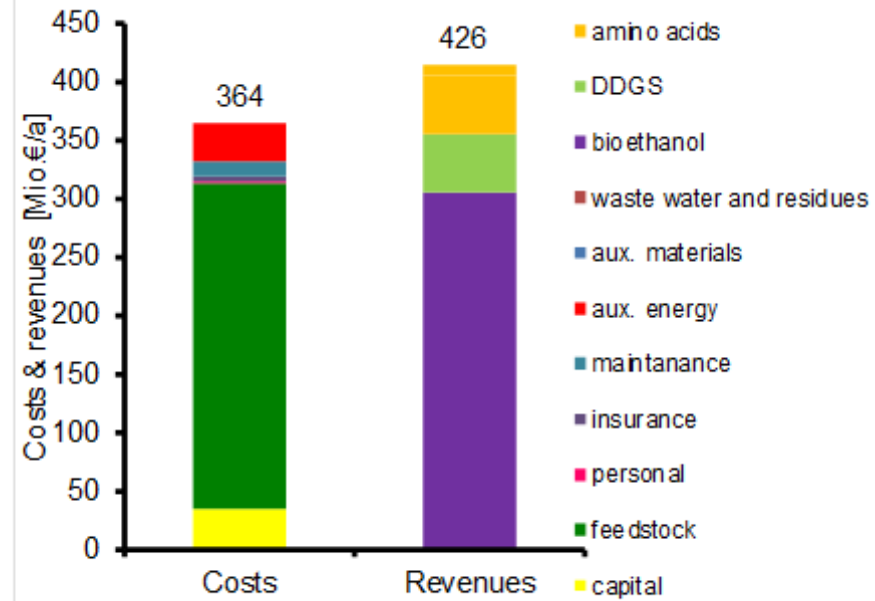
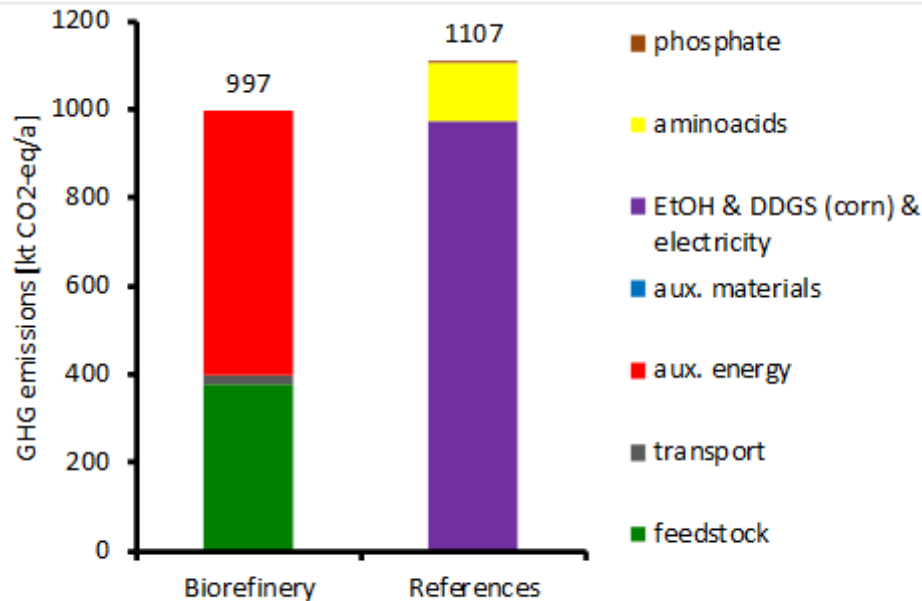
# Fermentation optimisation by upstream protein (and phosphate) isolation and valorisation



# Fermentation optimisation by upstream protein (and phosphate) isolation and valorisation



# GHG gasses, costs and revenues



*Biorefining is THE approach for the efficient and sustainable use of the huge potential protein-rich sources to synergistically co-produce food, feed and biobased products (chemicals, materials, fuels, energy) as part of the Circular Economy.*

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Task42 Biorefining



# Further reading

Report available july 2016

Contact:  
wim.mulder@wur.nl

IEA Bioenergy

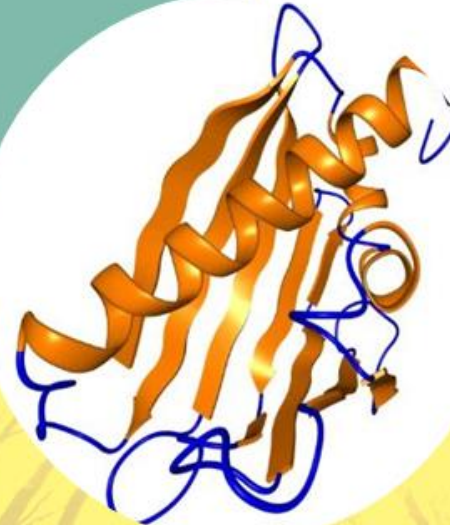
Task42 Biorefining



**WAGENINGEN UR**  
For quality of life

## Proteins for Food, Feed and Biobased Applications

*Biorefining of protein  
containing biomass*



IEA Bioenergy

IEA Bioenergy Task 42 Biorefining

*NEW Report IEA Bioenergy Task42*

Available free of charge from July 2016

@

[www.iea-bioenergy.task42-biorefineries.com](http://www.iea-bioenergy.task42-biorefineries.com)

Thank you for  
your attention!

Gerfried Jungmeier

Carola van der Peet-  
Schwering

Nam-Phuong Hua

Johan Sanders

Koen Meesters



# Protein content

Biomass can be classified according to their protein content into 5 groups. The top groups contain a lot of cellulose and hemicellulose, and therefore interesting for biorefinery processes.



# Biorefining in energy sector

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Balance between amounts AND functionality AND price

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  - Oil seeds refinery (e.g rapeseed)



# Protein functionality

