

# The Plant Protein World

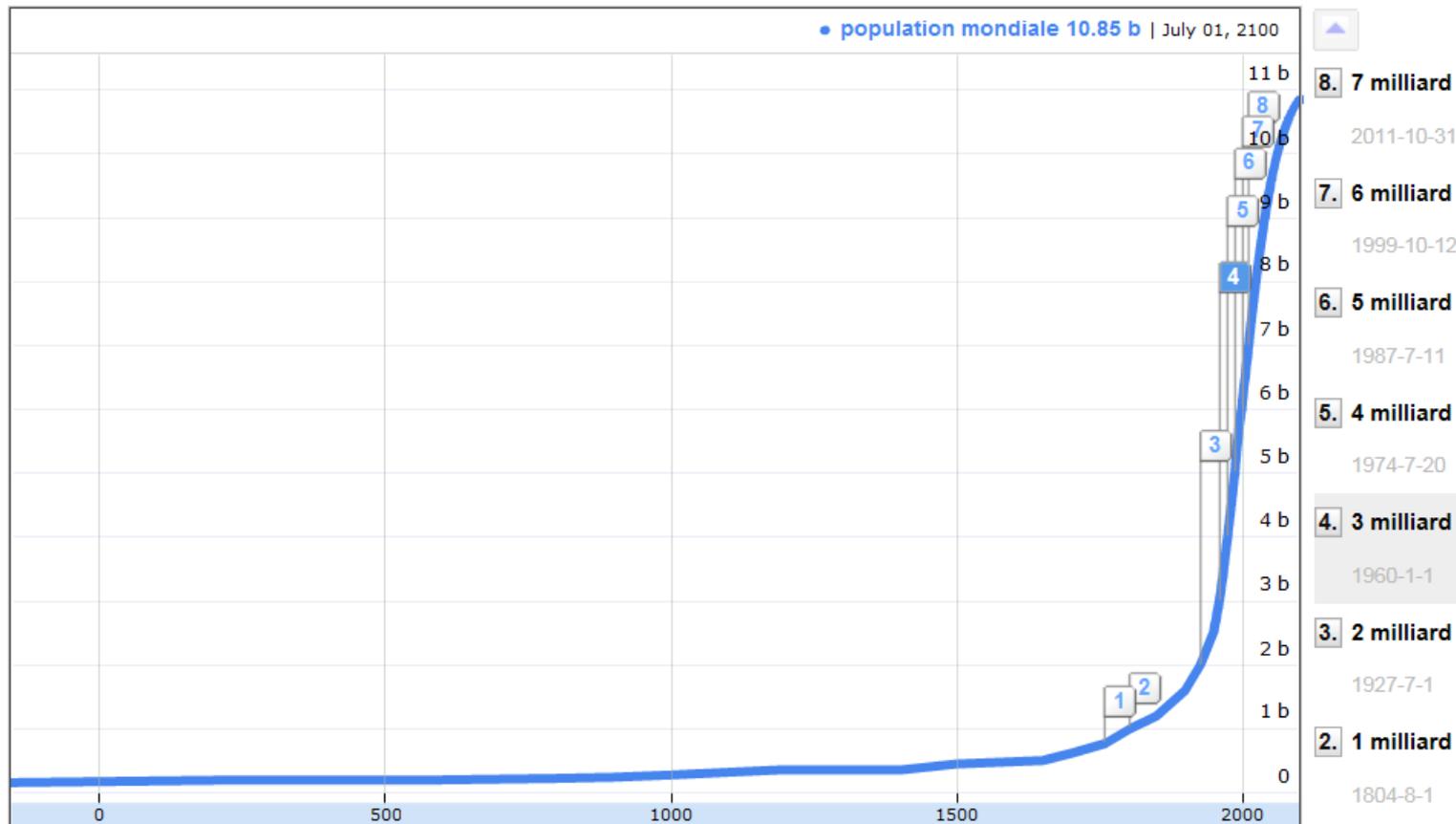
## Workshop on "Supply Chains in the EU Protein Sector"



# The world protein challenge



The world population is exploding, it took **200 000 years** to get the 1<sup>st</sup> billion humans, it will take **11 years** to get the next one!



# Nutritional transitions

## 1st nutritional transition

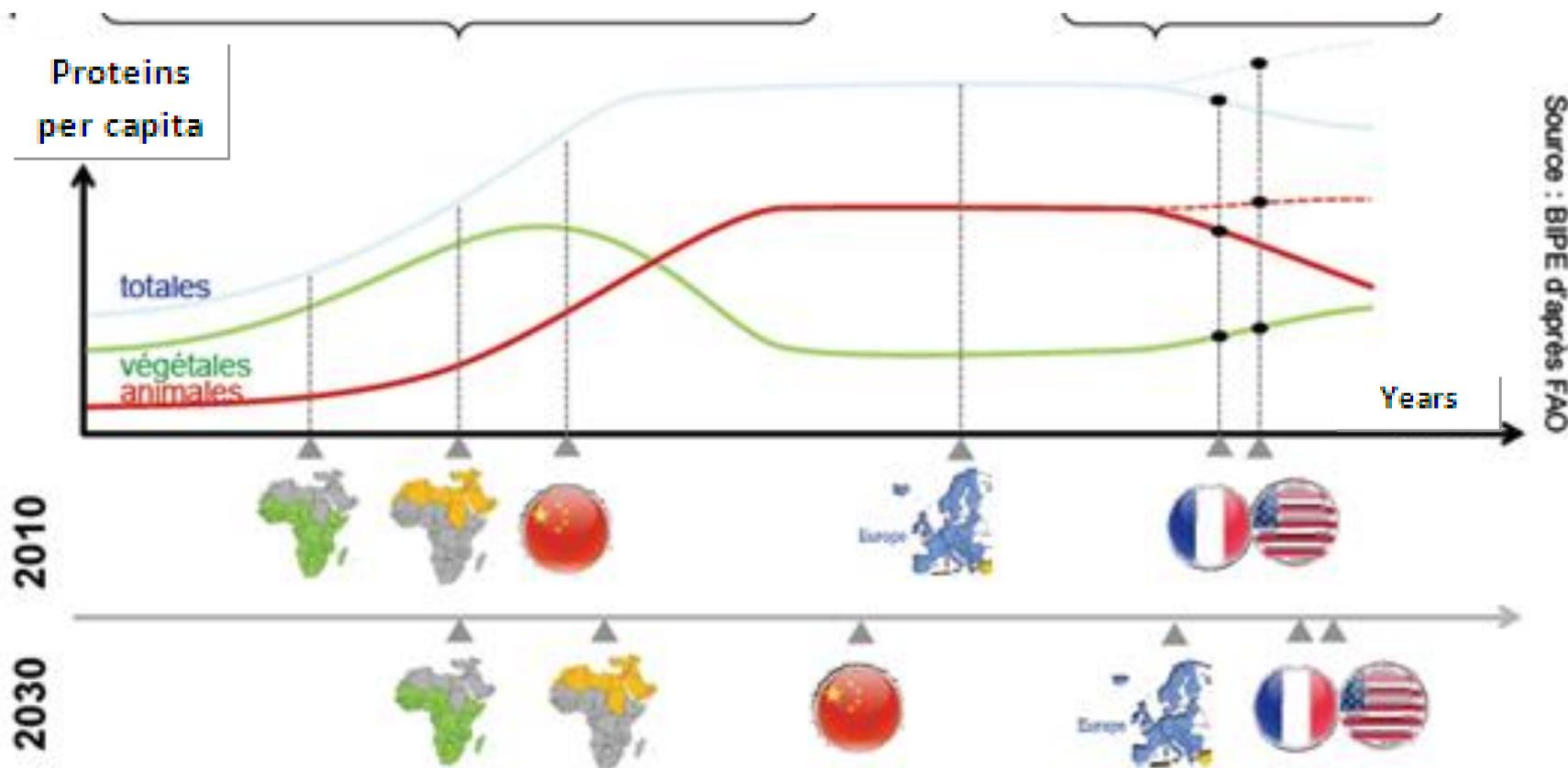
**Phase 1 :** increase of total proteins demand, based on plant sources complemented with animal sources.

**Phase 2:** stabilisation of the total demand with a switch from plant to animal proteins

## 2nd nutritional transition

Increase of the plant proteins demand following 2 models  
 "American" observed in USA, UK, Germany, Finland Sweden

"European" observed in Norway, Denmark, Austria, France



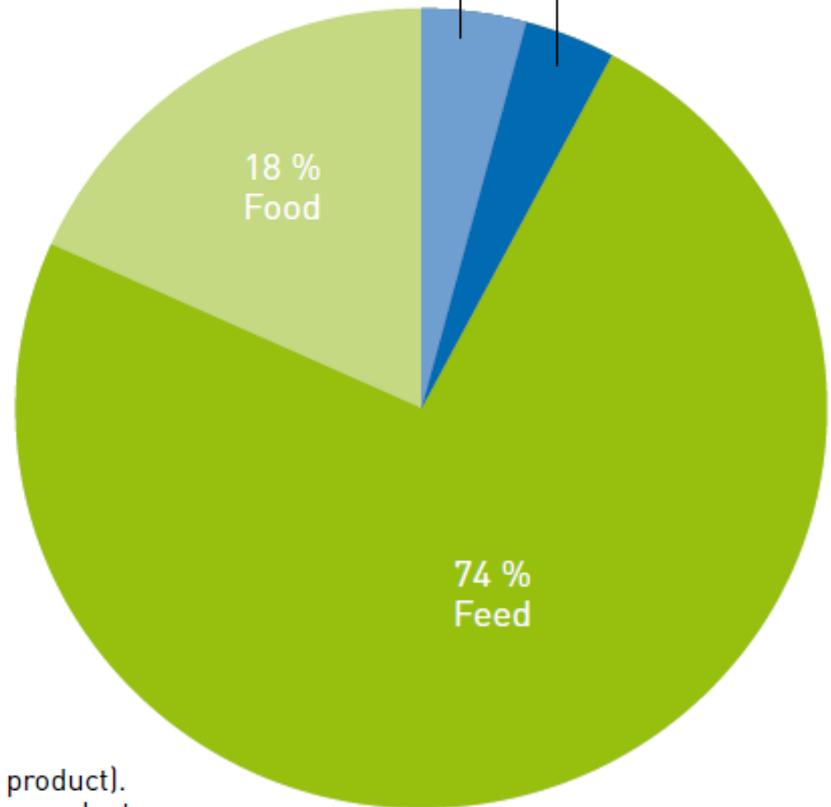
# Agricultural resources usages

*Use of harvested agricultural biomass worldwide (2008)  
(source: nova-Institute)*

Total biomass ca.  
10 billion tonnes

Biomass for  
industrial material  
use 4,3 %

Biomass for energy  
use 3,7 %



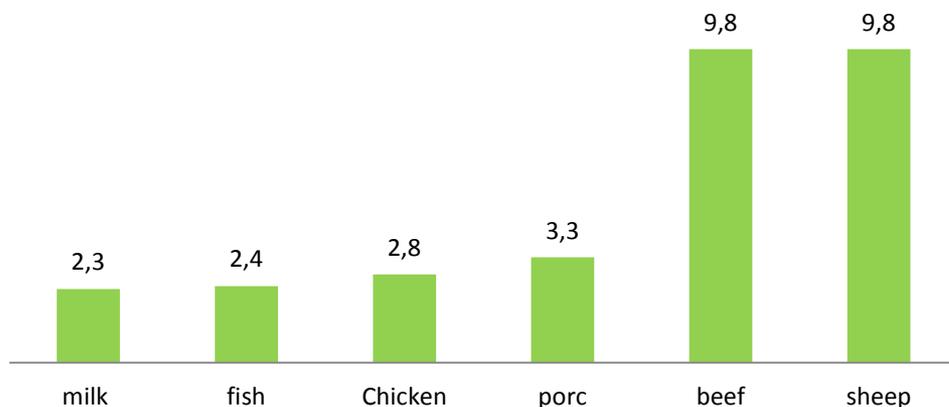
- **Usages dominated by feed**
- **50% of the world population is using less than 25 g of animal proteins/day**
- **18% of the world population is using more than 60 g of animal proteins per day**

Allocation of biomass to production target (main product).  
Respective amounts include raw materials and by products,  
even if their use fall into a different category.



# How do we utilize proteins?

## Proteins conversion ratio kg/kg



Animal proteins production <i>FAO 2013</i>	Production	Proteines
	MT	MT
meat	296	59,2
eggs	69	5,5
milk	724	22,7
cheese	22	2,0
fish aquaculture	75	15,0
<b>total</b>	<b>1 111</b>	<b>104</b>
wild fish catch	75	15,0
<b>TOTAL</b>		<b>119</b>

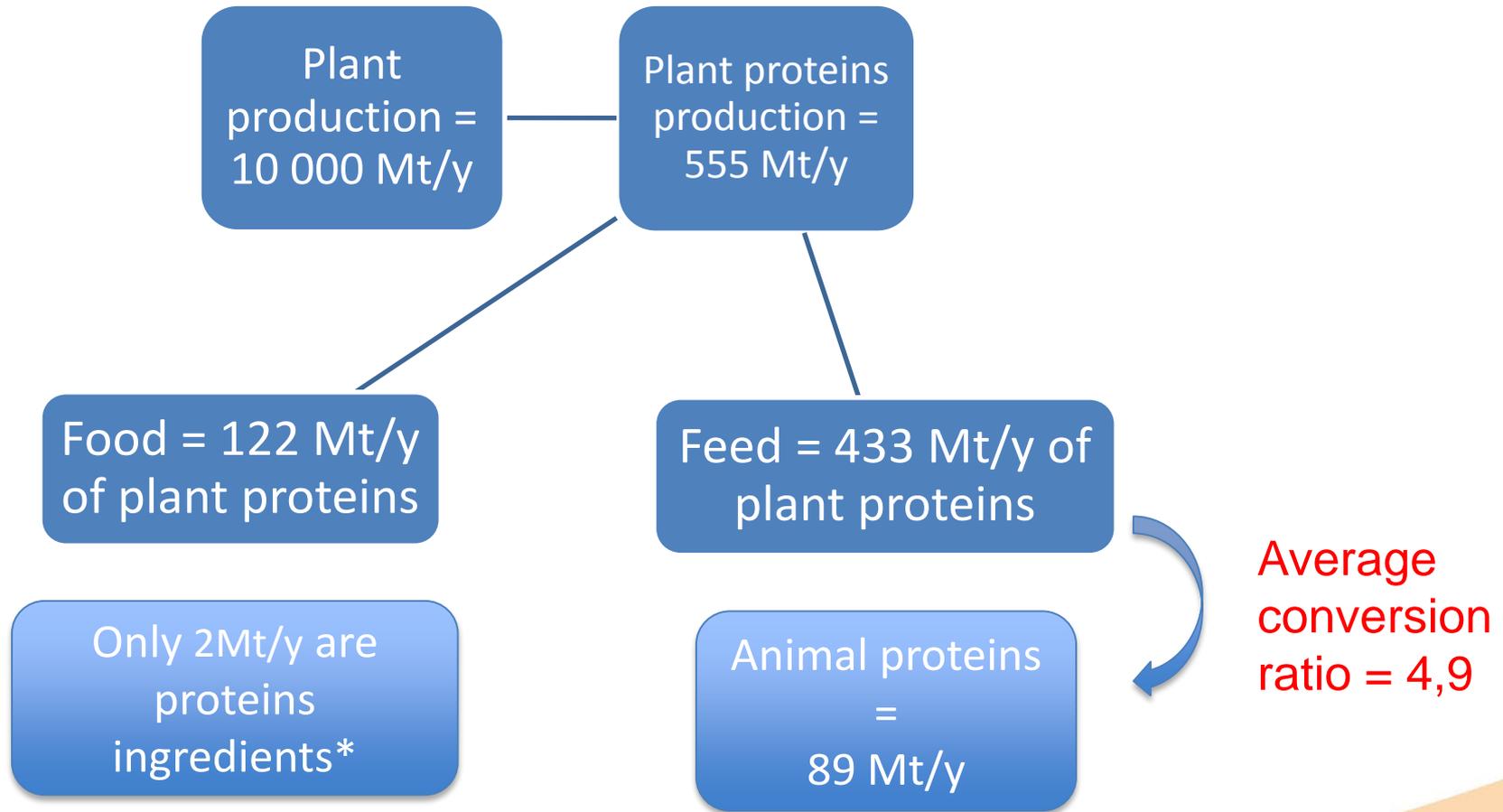
## World agro-production

plant origin	Production	Proteines
<i>FAO 2013</i>	MT	MT
Soya	260	98,8
Corn	883	88,3
Wheat	704	77,4
Rice	722	57,8
Oil seeds without Soya	203	50,8
Barley	134	17,4
Pulses	69	17,3
Legumes	1 044	10,4
Sugar cane	1 794	9,0
Fruits	608	6,1
Potato	374	3,7
Other roots	374	3,7
Nuts	13	3,3
Others	2 818	111,3
<b>Total</b>	<b>10 000</b>	<b>555</b>



# How do we utilize proteins?

## World proteins balance:



- 56% from soy, 43% from wheat and less than 1% for pea, rice, potatoes, rape seeds faba beans, lupine, sun flower, algae's, ....



# 4 complementary ways to characterize protein

Nutritional

Functional

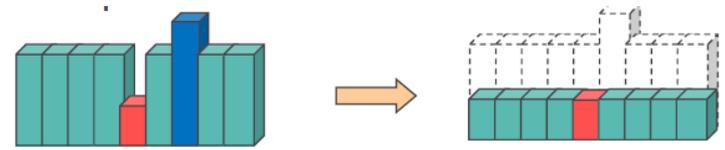
Organoleptic

Claim &  
Labelling

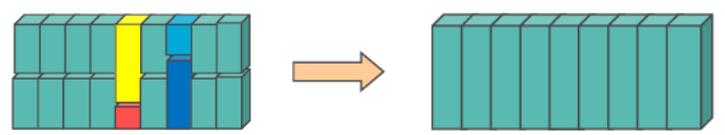


# Nutritional properties

## Essential AA balance



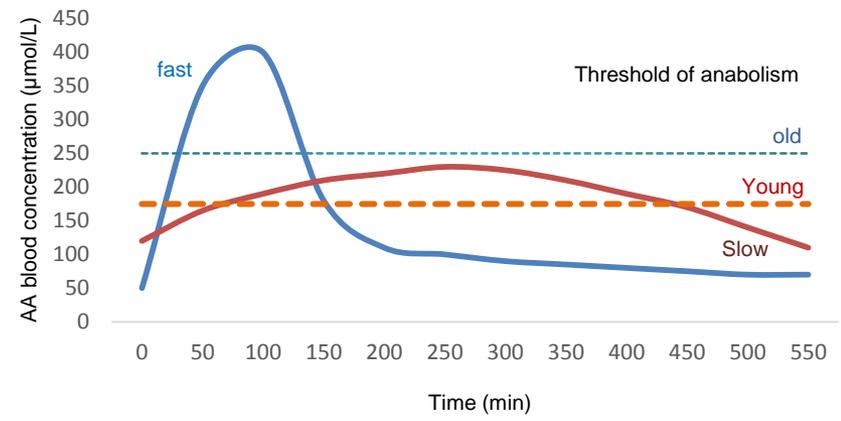
Unbalanced diet leading to AA oxidation



Well balanced diet leading to an optimal protein anabolism

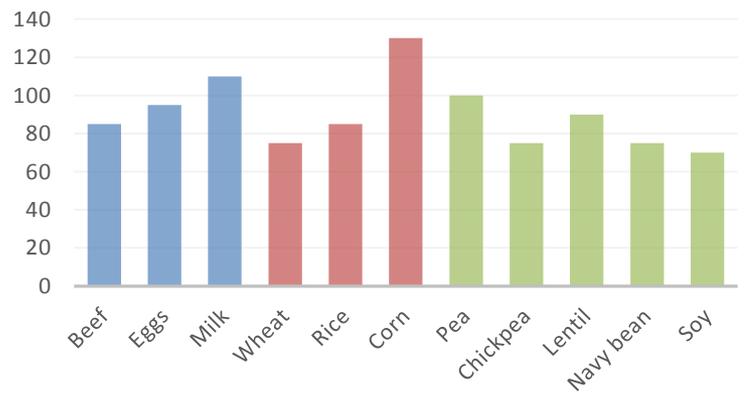
## Protein digestibility: PDCAAS

### Protein digestion speed

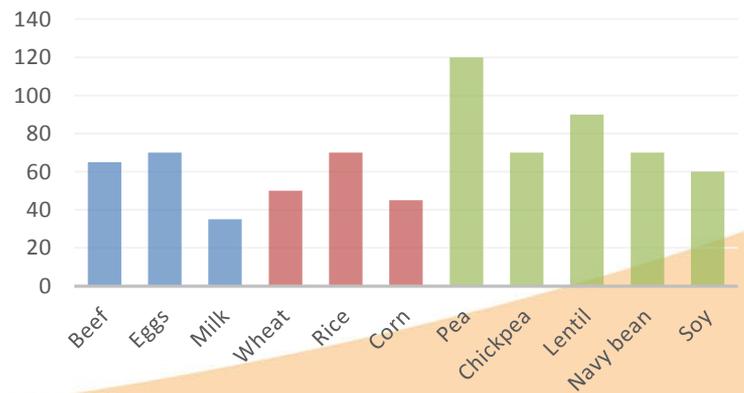


## AA having messenger function

Leucine is known to stimulate protein anabolism  
mg Leu / g protein

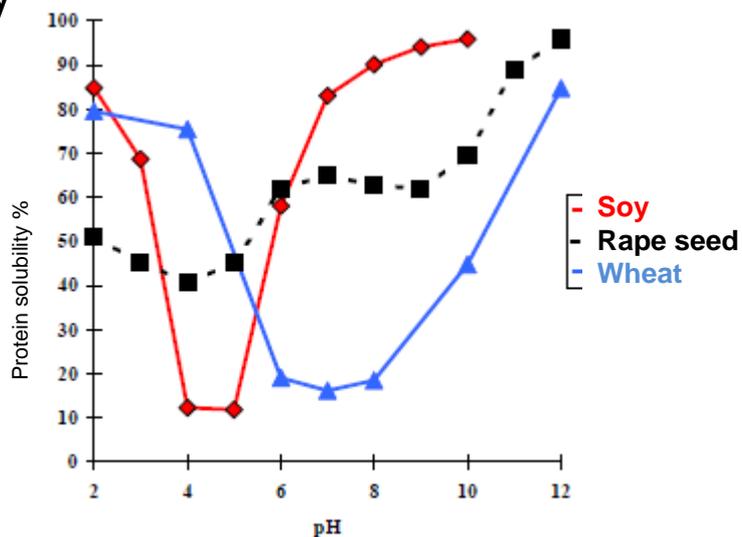


Arginine is known to reduce blood pressure  
mg Arg / g protein



# Functional properties (30%)

## Solubility



## Dispersibility



## Viscosity

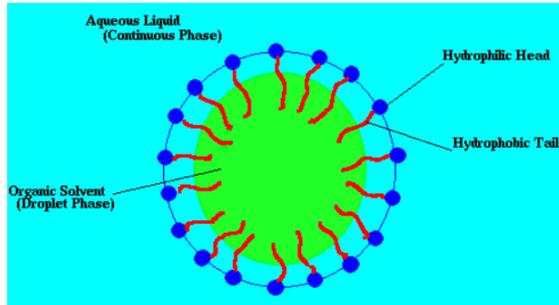


## Gelling



# Functional properties

## Emulsifying



## Foaming



## Binding (water or oil )



## Texturizing



## Heat Stability



# Organoleptic properties



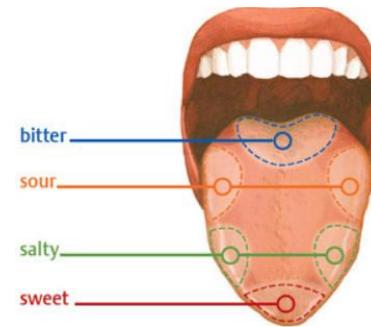
Flavor is a combination of

- **Taste**
  - Non volatile compounds
  - 8 (or more?) basic tastes: sweet, bitter, sour, salty, pungent, metallic, umami, astringent
- **Aroma / Smell / Odor**
  - Volatile compounds
  - More than 10 000 different aromas



Flavor is strongly influenced by

- **Texture**
  - Smoothness, coarseness, hardness, thickness, slipperiness, viscosity...
- **Trigeminal responses**
  - Heat of spices, cooling of menthol
  - Astringency: a dry sensation in the mouth caused by interaction with salivary protein and mucins → loss of lubrication



# Organoleptic properties

## Plant proteins

- **Often associated with off notes**
  - Astringency
  - Bitterness
  - Beany, hay, cardboard aroma
- **5 strategies to deal with off-notes**
  1. Selecting favorable **raw material** (variety selection, storage conditions...)
  2. **Prevent** using an appropriated processing (dehulling, enzymes deactivation, microbio control ...)
  3. **Eliminate** by post processing (flash under vacuum, extraction...)
  4. **Masking**
  5. **Formulate**
- What is perceived is most of the time a combination of aroma and taste.



# Claim & Labelling

Items for communication	raw material	process
Food Allergens (8 in USA, 14 in Europe, 27 in Japan...)	✓	✓
Anti nutritional factors	✓	✓
Bio activities (more than 30 linked to peptides)		✓
Clean label		✓
GMO free	✓	
Organic	✓	✓
Plant origin	✓	
Protein purity		✓



# Plant protein diversity

 Protein can be extracted from many different raw materials

- Seeds (Pulses; Cereals; Oilseeds)
- Roots
- Algae's
- Leaves
- Coproducts from the agro-industry
- Microorganisms
- Alternative animal sources
  - Insects
  - Sea food / krill
  - Animal byproducts
- ...

 Processes need to be adapted accordingly



# Protein ingredients

Protein can enter the food chain in different forms mainly linked to concentration:

- Flour
- Protein concentrate
- Protein isolate
- Protein hydrolysate

They are more than 1000 different protein isolate or concentrate on the market world wide.

35 different raw material

138 different producers

66 distributors

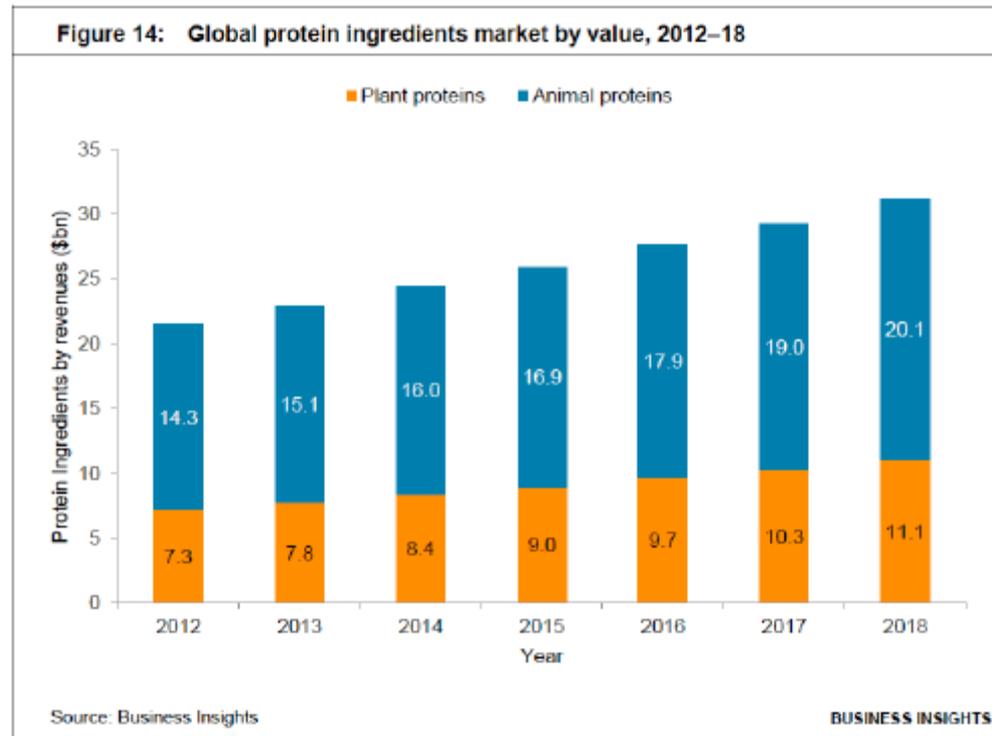


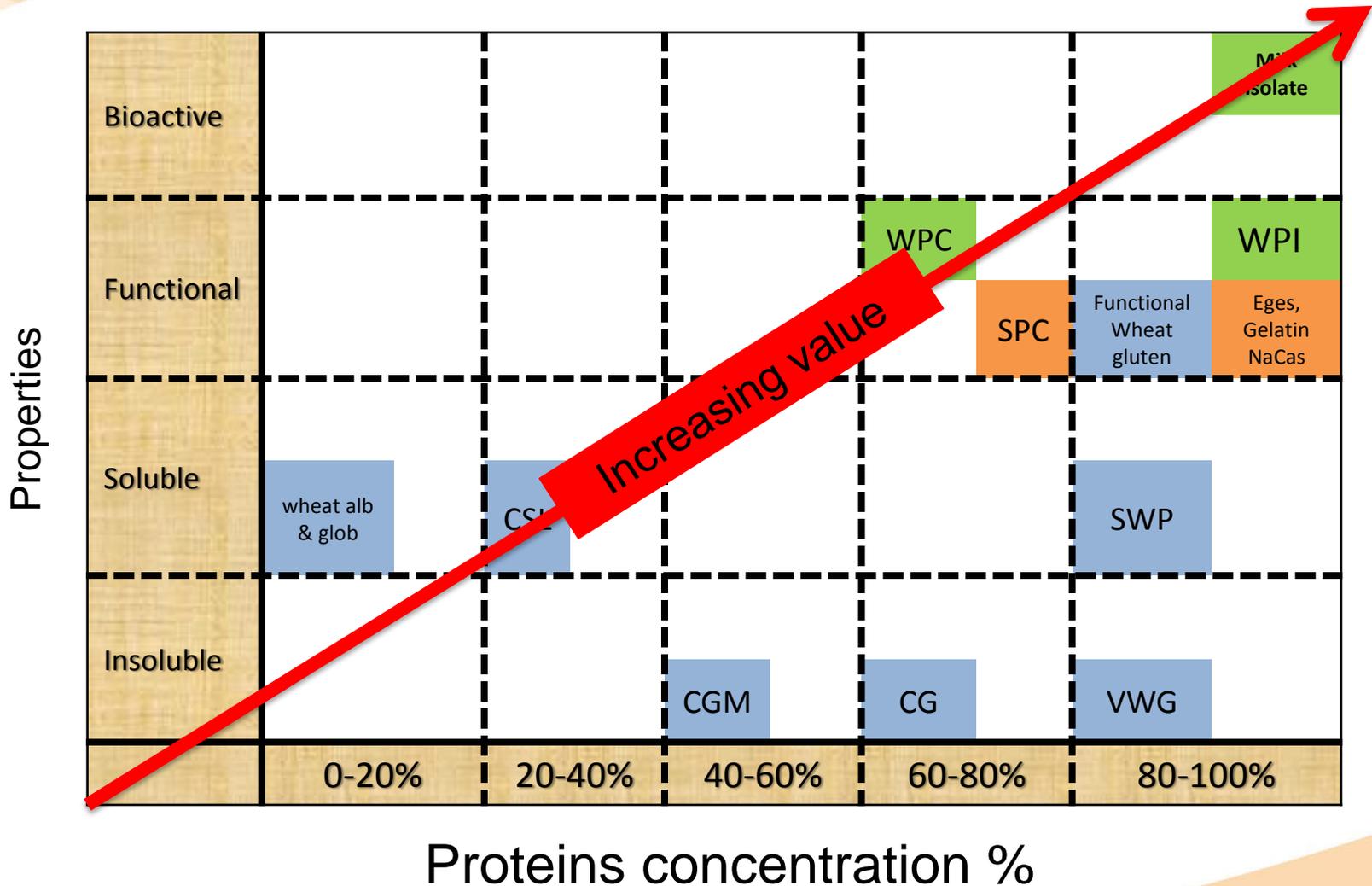
# Protein ingredients

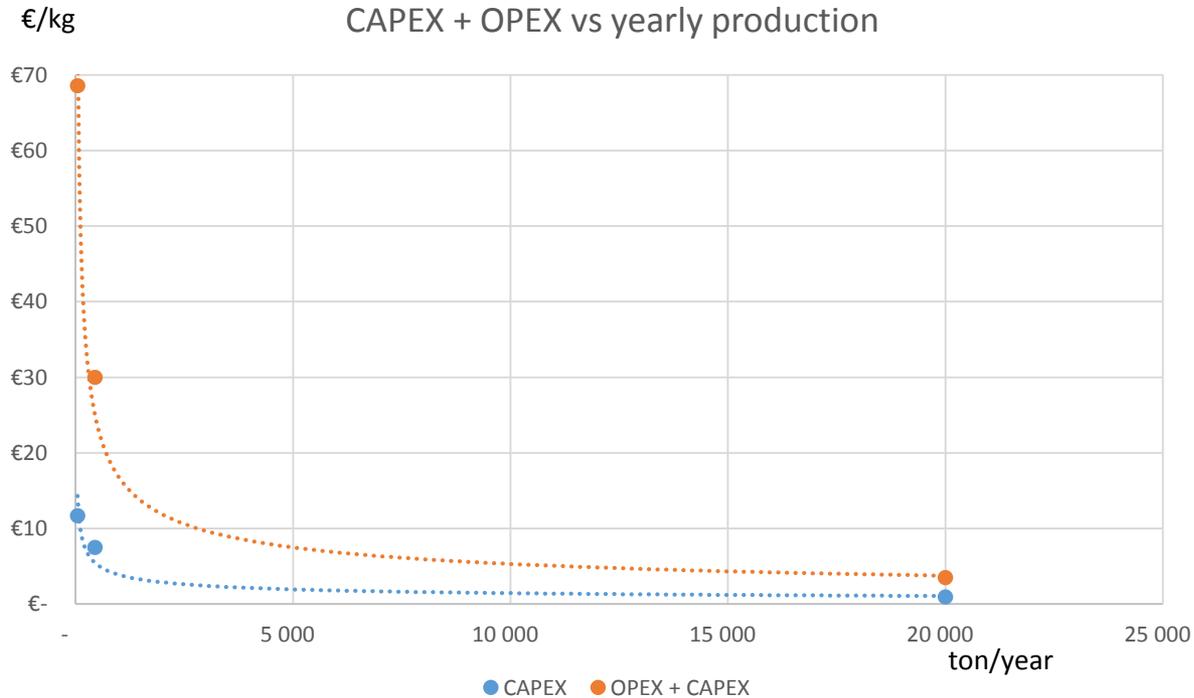
Raw material	Nb of references	Raw material	Nb of references
<b>Total</b>	<b>1019</b>	<b>unidentified</b>	<b>4</b>
<b>soy</b>	<b>465</b>	<b>alfalfa</b>	<b>3</b>
<b>pea</b>	<b>134</b>	<b>Lentil</b>	<b>3</b>
<b>wheat</b>	<b>123</b>	<b>microorganisms</b>	<b>3</b>
<b>rice</b>	<b>85</b>	<b>oat</b>	<b>3</b>
<b>yeast</b>	<b>42</b>	<b>black bean</b>	<b>2</b>
<b>Hemp</b>	<b>20</b>	<b>chia</b>	<b>2</b>
<b>potato</b>	<b>20</b>	<b>mung bean</b>	<b>2</b>
<b>pumpkin</b>	<b>16</b>	<b>sesame</b>	<b>2</b>
<b>plant proteins</b>	<b>13</b>	<b>broadbean</b>	<b>1</b>
<b>algae</b>	<b>12</b>	<b>carob</b>	<b>1</b>
<b>almond</b>	<b>9</b>	<b>chickpea</b>	<b>1</b>
<b>corn</b>	<b>9</b>	<b>coconut</b>	<b>1</b>
<b>faba bean</b>	<b>9</b>	<b>cottonseed</b>	<b>1</b>
<b>lupin</b>	<b>8</b>	<b>flaxseeds</b>	<b>1</b>
<b>rapeseed</b>	<b>8</b>	<b>mankai</b>	<b>1</b>
<b>sunflower</b>	<b>8</b>	<b>psyllium</b>	<b>1</b>
<b>sacha Inchi</b>	<b>5</b>	<b>water lentils</b>	<b>1</b>



# Protein ingredients







 It is key to know which market is targeted in order to define the size of the project



# Protein ingredients



## Out of 1019 products

- 39% claim to be functional
  - 12% emulsifying
  - 3% foaming
  - 6% gelling
  - 6% adding viscosity
  - 14% water / fat binding
  - 14% good solubility
  - 15% texturizing
- 29% claim to be nutritional
- 30% claim to have a positive organoleptic impact
- 19% are GMO free
- 7% are organic

**Once can claim more than one criteria !**



# What's IMPROVE SAS ?

- IMPROVE was founded in July 2013 by 4 major French Agrofood companies and some academic partners like Amiens' University and INRA.
- IMPROVE is a private R&D center, services provider of technical and scientific expertise, focused on proteins.
- IMPROVE is a fast growing company, working in confidential contractual research for food and feed innovation, Intellectual Property is 100% for customers.
- IMPROVE offers the best of 23 brains and diversified technologies with 1200m<sup>2</sup> of laboratories, and pilot facilities (from pilot scale to pre industrial samples / grams to few tons of feedstock ).
- IMPROVE is your incubator for food innovation based on our expertise in proteins processing and our network.



# Our offer

- ❖ A single entry point to access to a wide range of technologies and competences, dedicated to proteins.
- ❖ Extraction, fractionation, purification, concentration and drying of proteins by using wet and dry process.
- ❖ Physico-chemical, biological and functional proteins characterization.
- ❖ Optimization of a specific unit operation, design of global new process, production of pilots lots and test productions.
- ❖ Strategic support for innovation (audit & brain storming).



**IMPROVE can help you to make  
Alternative Protein strong again!**

**Thanks**



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