Horizon 2020 of European Union: Call 2016, SFS 44 : "A joint plant breeding programme to decrease the EU's and China's dependency on protein imports"

This project has received funding from the European Union's Horizon 2020 Programme for Research & Innovation under grant agreement n°727312.

Agriculture and land use for climate and biodiversity

EUC LEG

Breeding forage and grain legumes to increase EU's and China's protein self-sufficiency

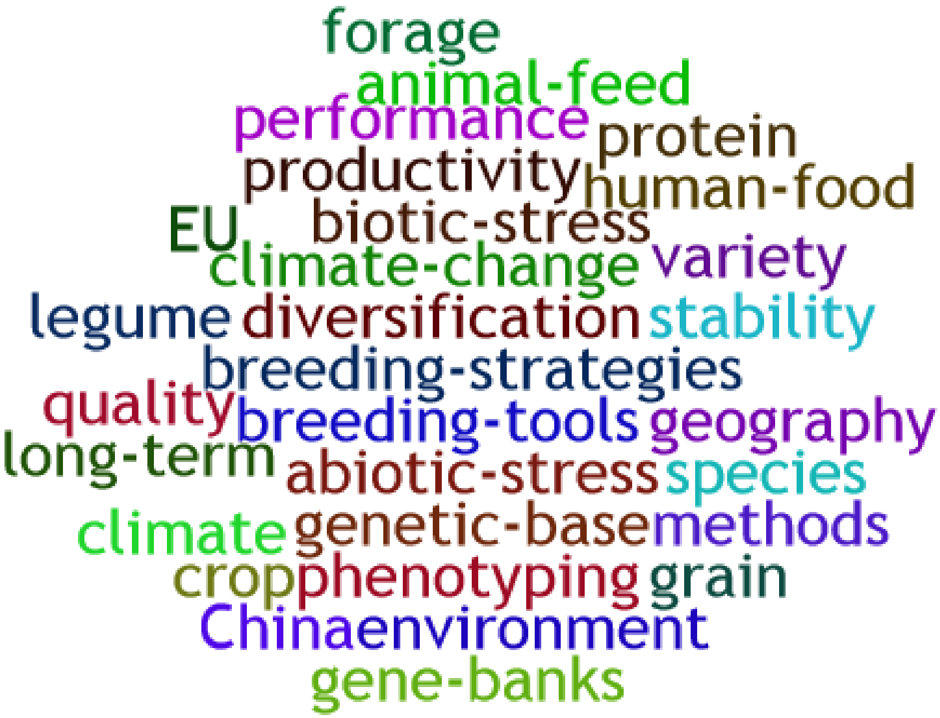
Bernadette Julier

www.eucleg.eu

Horizon 2020
European Union Funding
for Research & Innovation

Horizon 2020 of European Union

Call 2016, SFS 44 : “A joint plant breeding programme to decrease the EU's and China's dependency on protein



INRAE

From Nitrogen (N_2) to proteins

- Dinitrogen: very stable molecule, 78% of the atmosphere $N \equiv N$
- N is a component of proteins, vital molecules
- Two ways to transform N_2 into reactive Nitrogen:
  - Industrial chemical synthesis

$$N_2 + fossil\ energy \xrightarrow[process]{Haber-Bosch} NH_3$$

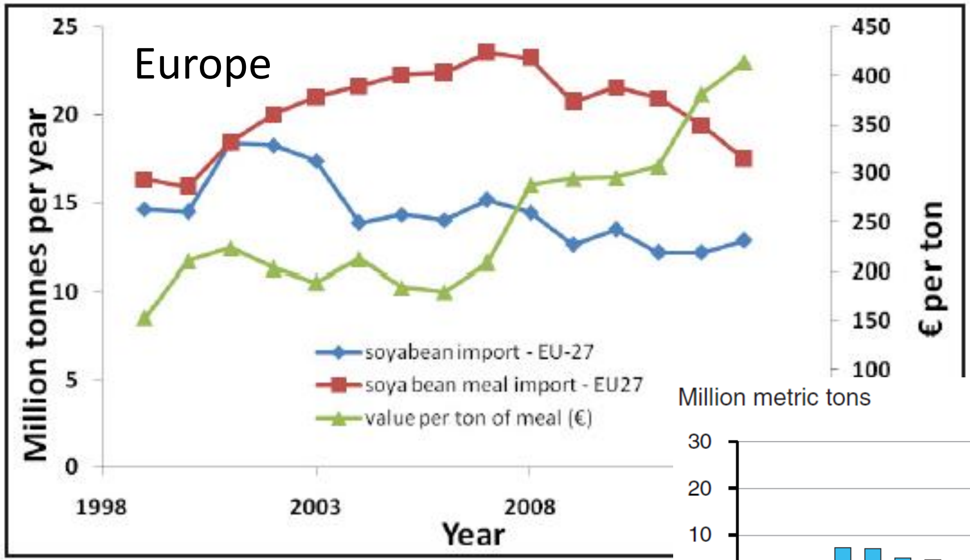
  - Symbiosis plant + *Rhizobium*

$$N_2 + plant\ energy \xrightarrow{Nitrogenase} NH_3$$

→ Plant amino acids → Plant proteins

Legume species (*Fabaceae*)

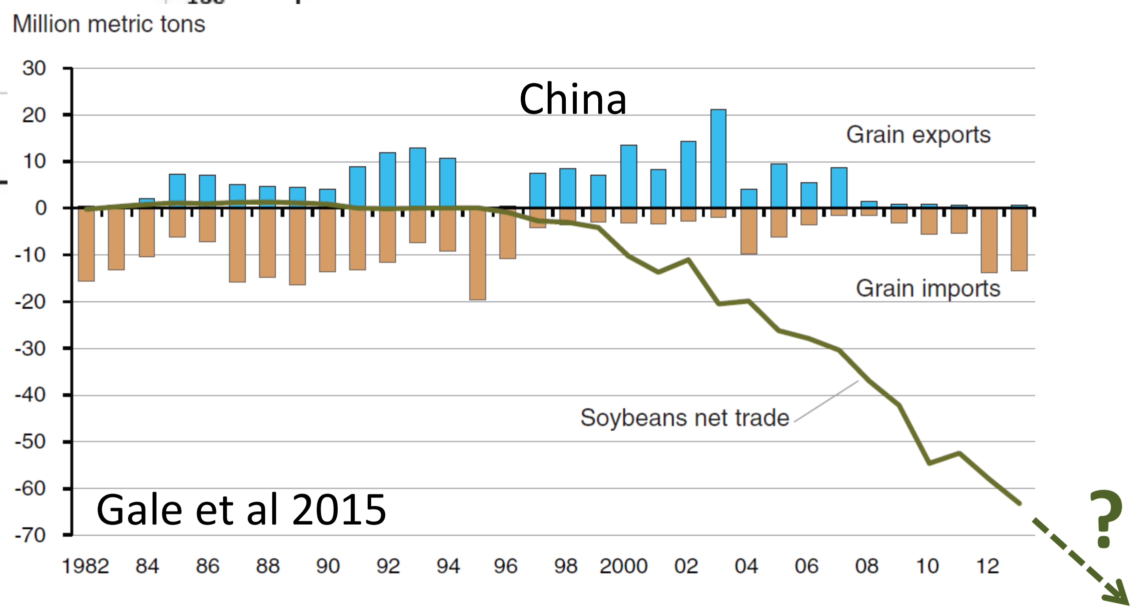
Protein imports in Europe and China



De Visser et al 2014

Europe:

69% protein dependency

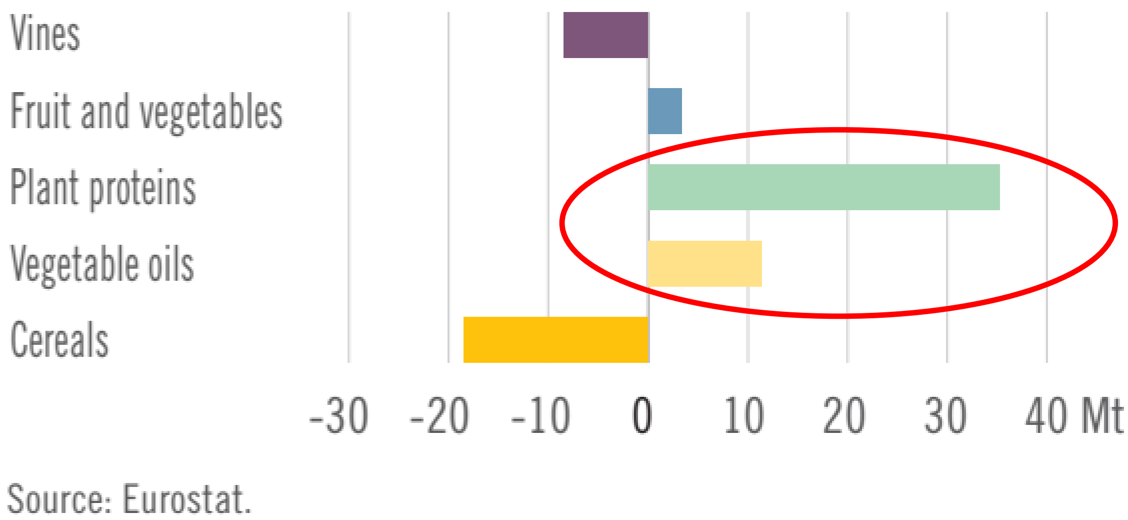


Notes: Cereal grains include wheat, rice, corn, barley, and sorghum. Net trade equals exports minus imports.

Source: USDA, Economic Research Service analysis of China Customs Administration (1984-1995) and the Global Trade Atlas (2014).

2014: China imported 60% of world market trade

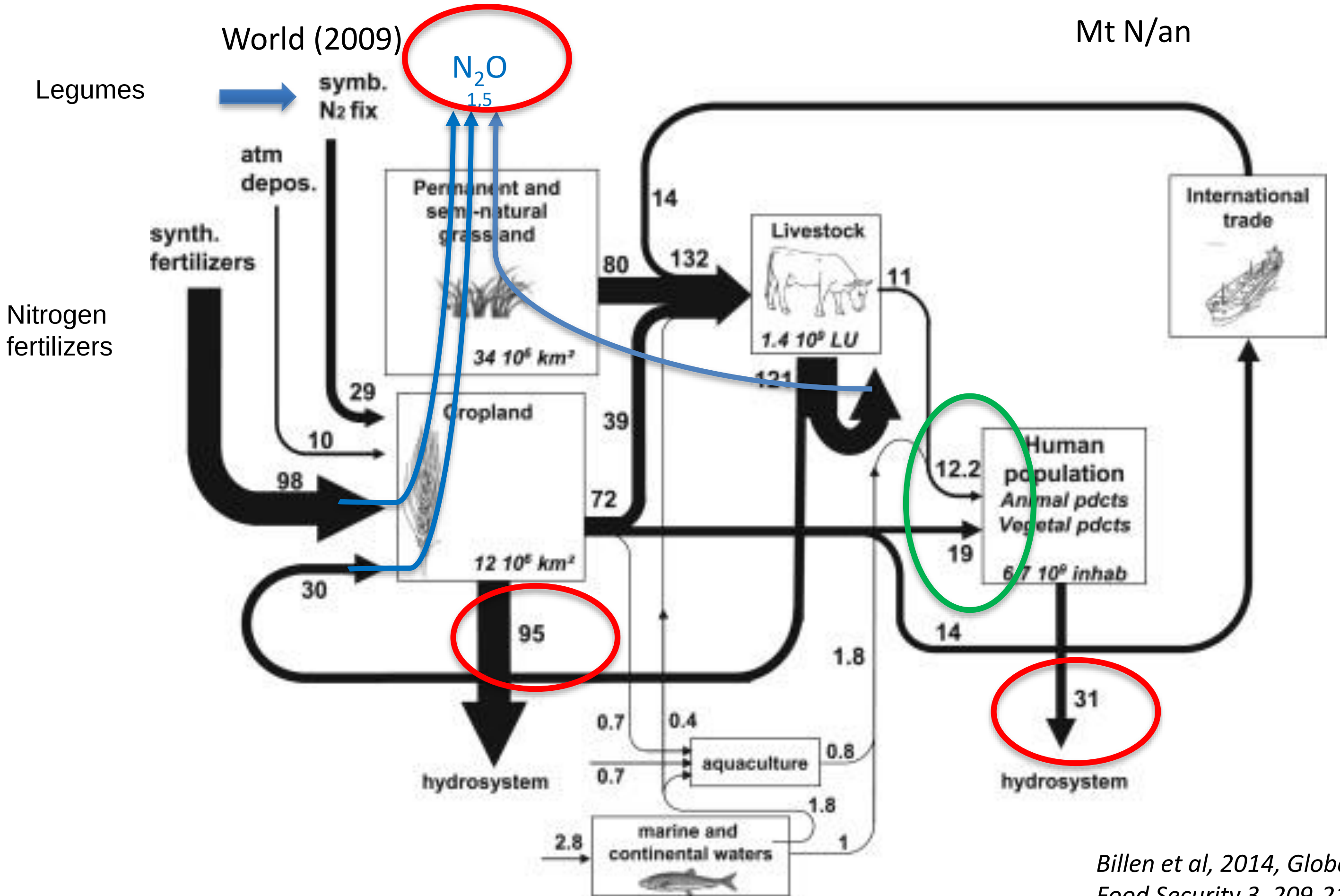
Import/export balance for EU food products in 2010



A question for economic sustainability

Poux & Aubert 2018, TYFA, IDDRI

Protein and N cycle at the world level



A question for environmental sustainability

Billen et al, 2014, Global Food Security 3, 209-219

a clear illustration of open nutrient cycles with huge losses

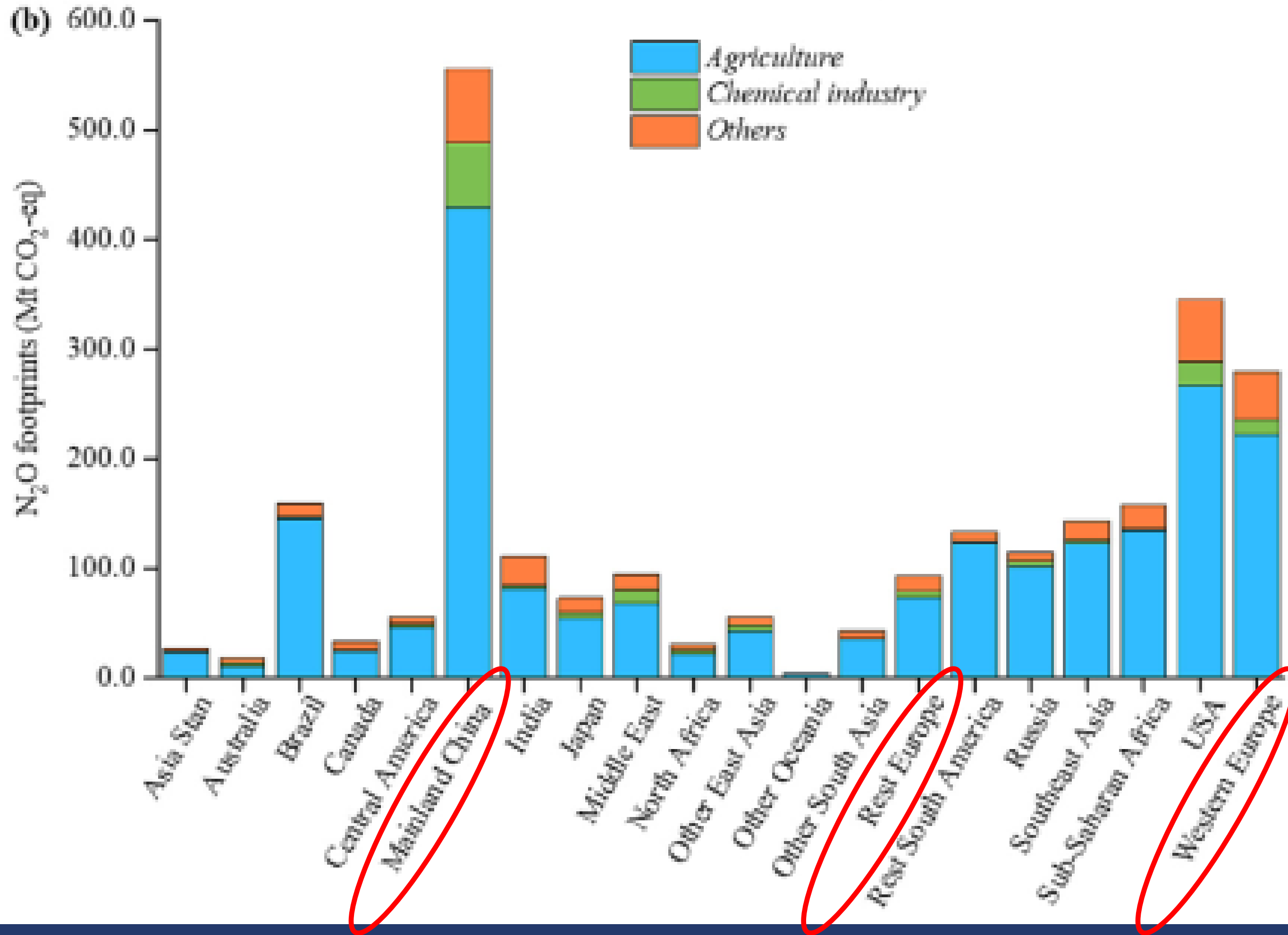
More figures on N fluxes…

N fluxes TgN/year)	Europe 0.53 10^9 inhab.	China 1.4 10^9 inhab.	World 6.7 10^9 inhab.
Synthetic fertilizer	8.3	35	98
Symbiotic N2 fix	1.7	3	29
N for livestock feed	11.7	19	132
Loss from cropland	7.4	35	95
Loss from human pop	3.3	7.6	31

Billen et al, 2014, Global Food Security 3, 209-219

More figures on N_20…

N_2O footprints of the 20 world regions by emission source category in 2012



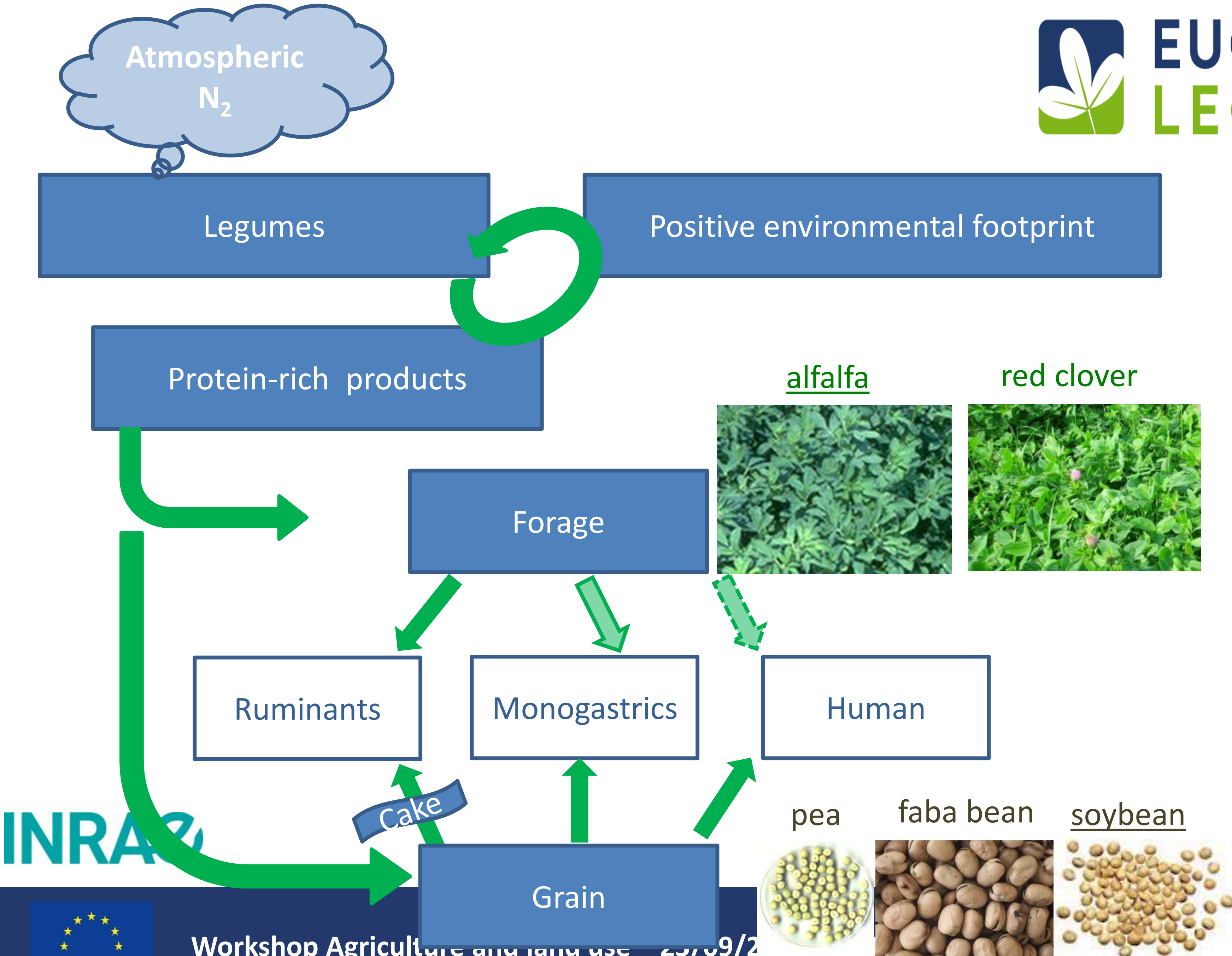
W. Tian et al. (2019) Journal of Environmental Management 251, 109566

A global statement

- A need to expand plant protein production
- A need to increase nitrogen fixation

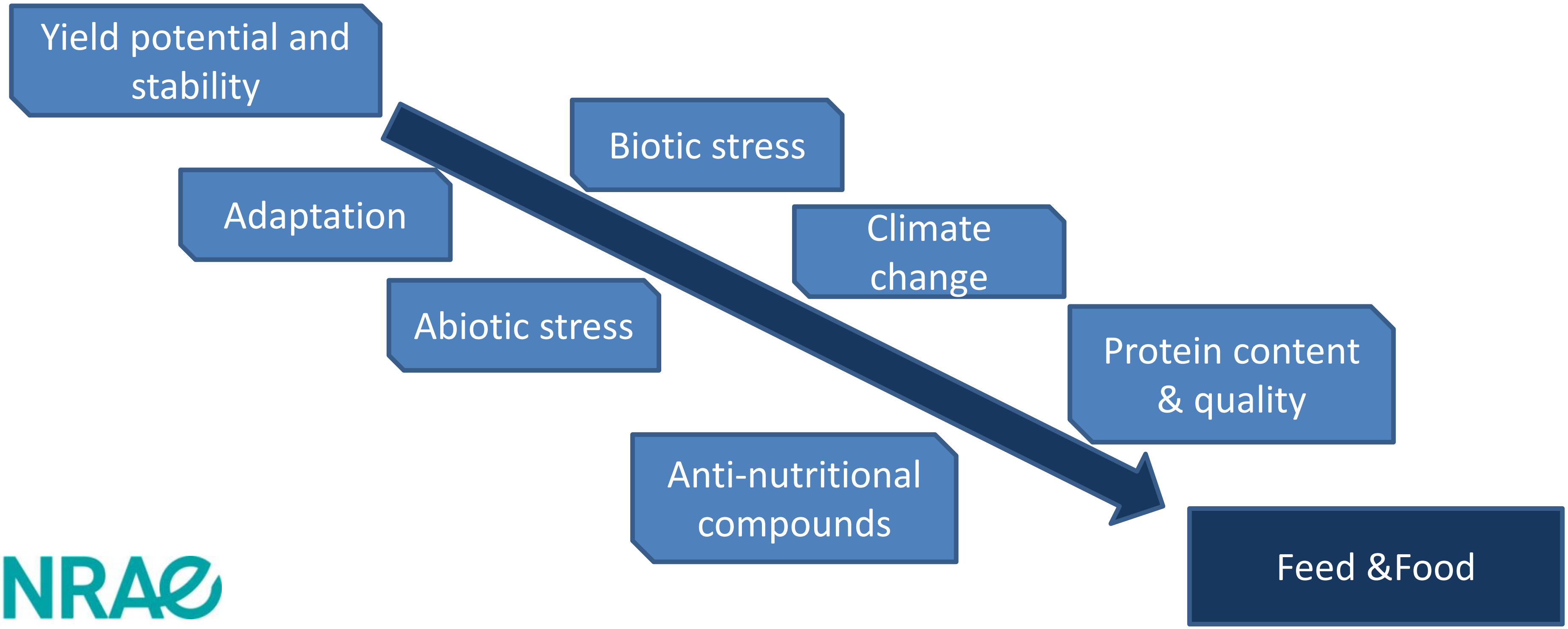
→ To grow more legume species

$$N_2 + plant\ energy \xrightarrow{Nitrogenase} NH_3$$


Atmospheric N_2
Legumes
Positive environmental footprint
Protein-rich products
alfalfa
red clover
Forage
Ruminants
Monogastrics
Human
Cake
pea
faba bean
soybean
Grain

Eucleg impacts

- To increase protein production where legumes are already grown
- To increase adaptation of legumes to more pedoclimatic regions



EUCLEG: Genetics as a lever

Genetic resources

Elite material

Phenotypic evaluation

Molecular tools

Methodology

Breeding

New varieties

EUCLEG: Genetics as a lever

At the scientific level:

- **Broaden the genetic base of legume crops and analyse the genetic diversity** of European and Chinese legume accessions using phenotypic traits and molecular markers
- **Analyse the genetic architecture of key breeding traits** using association genetics (GWAS)
- **Evaluate the benefits brought by genomic selection** (GS) to create new legume varieties

At the technological level:

- **Develop searchable databases** containing passport data, as well as agronomic and genetic features
- **Develop molecular tools and data**

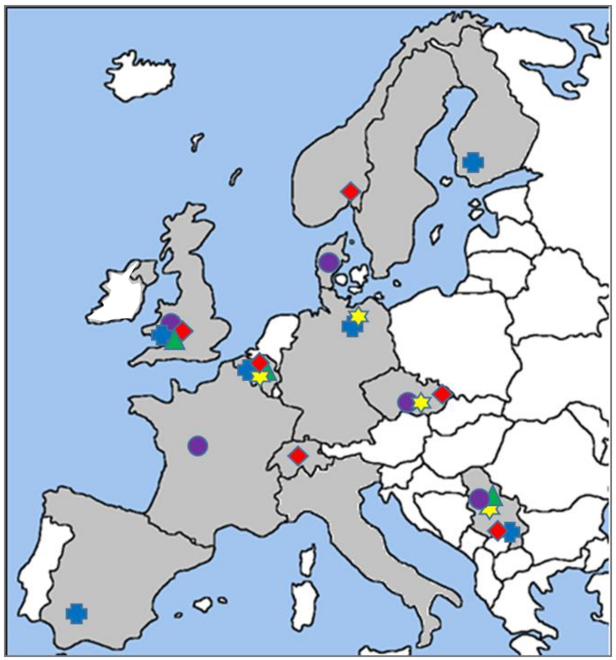
At the applied level (breeding):

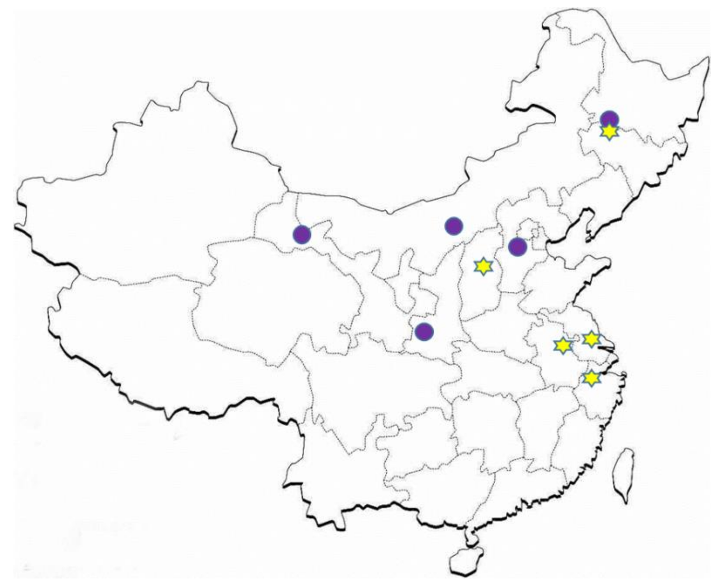
- **Develop tools for genotyping**
- Implement **data management and analysis**
- **Explore** the potential for **new uses of forage species for human nutrition**

Partnership

38 partners :

- 26 European partners: including 9 breeding companies and 1 SME
- 12 Chinese partners: including 1 breeding company





European Countries participating in EUCLEG project

Field trials:

Alfalfa Red clover Pea Faba bean Soybean

Conclusion

- Legumes as key species to reduce fossil energy consumption (CO_2 emission)
  - And to reduce N_2O emission (GHG)
- New legume varieties adapted to:
  - All needs (feed, food)
  - All regions
  - Considering climate change
- Legumes as diversification of cultivated species
  - Resilience
  - C storage (in roots)
  - Hosts for wild life (pollinators, birds, small mammifers…)

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