



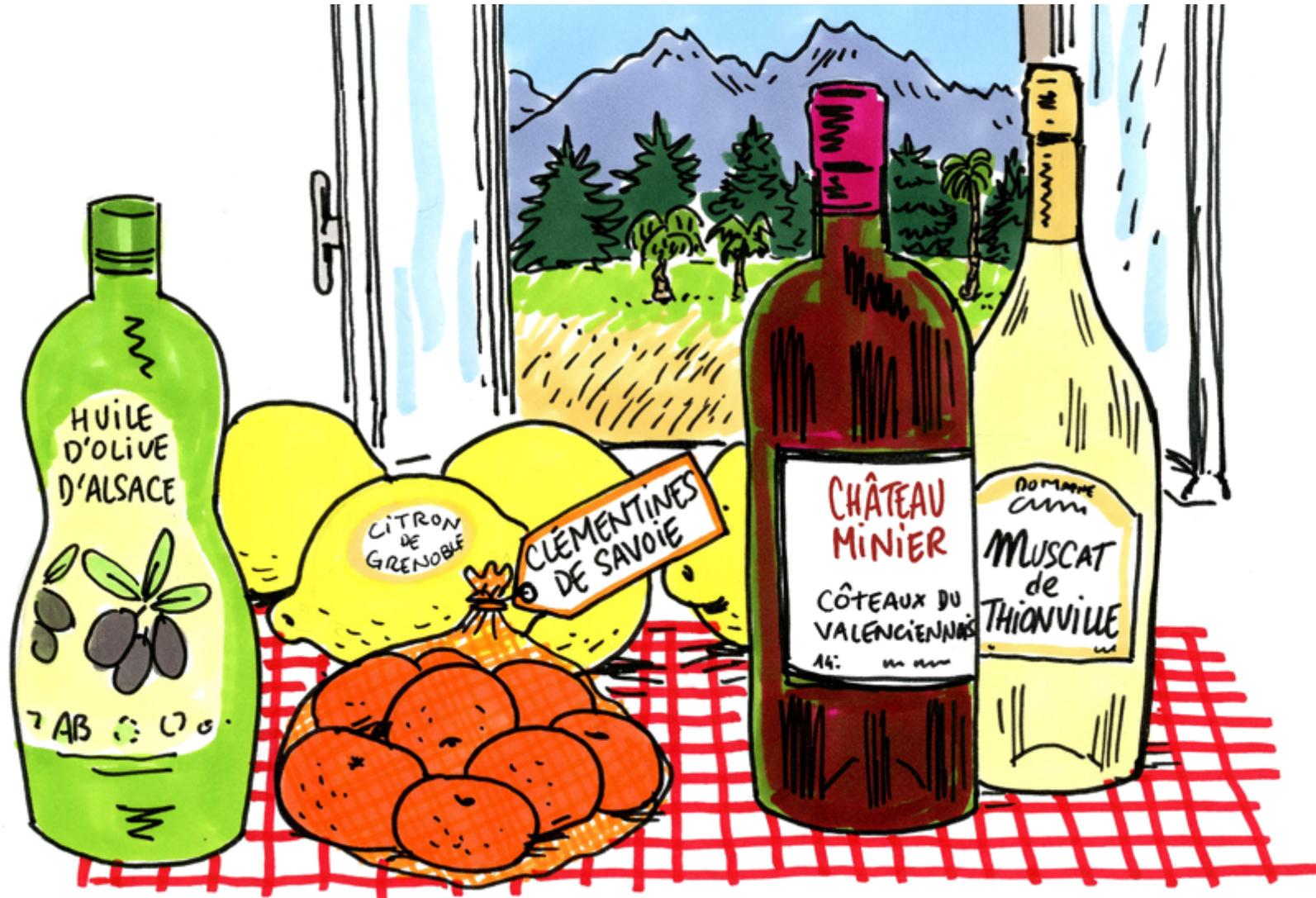
# Climate change: mitigation and adaptation

**INRAE**

Institut National de la Recherche pour  
l'Agriculture, l'Alimentation et l'Environnement

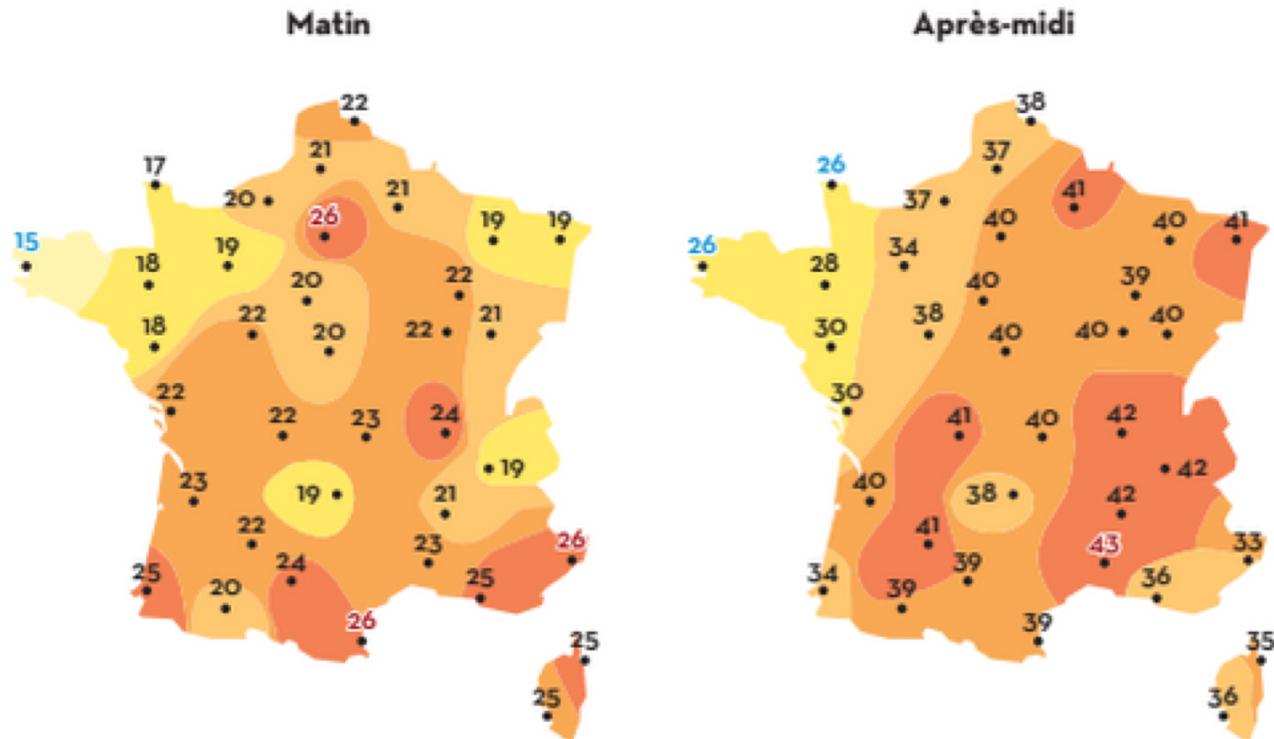
**25 september 2020 / Euragri / Christian Huyghe**

Climate change  
Agriculture change  
Food change



# Possible weather in France in 2050

Weather forecast for August 18th, 2050



**RECORD NATIONAL DE CHALEUR BATTU**

GALLARGUES-LE-MONTUEUX (30)  
**45,9 °C**  
LE 28 JUIN 2019 À 16H20

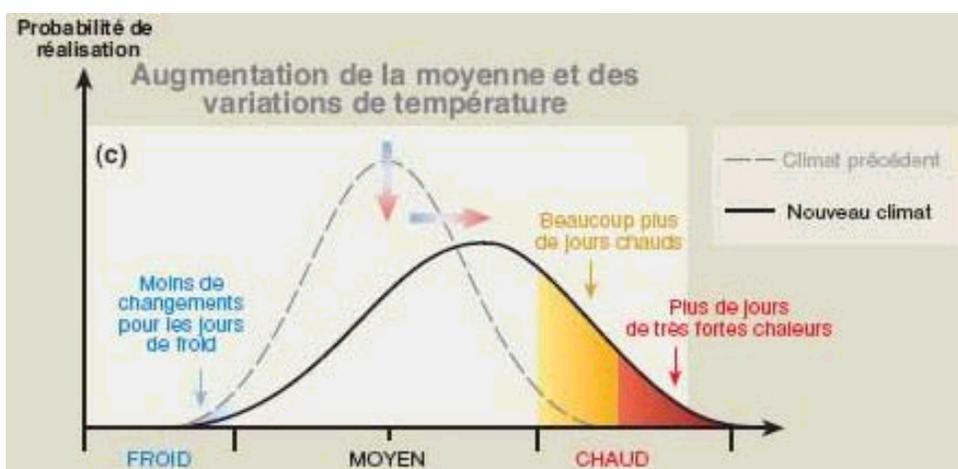
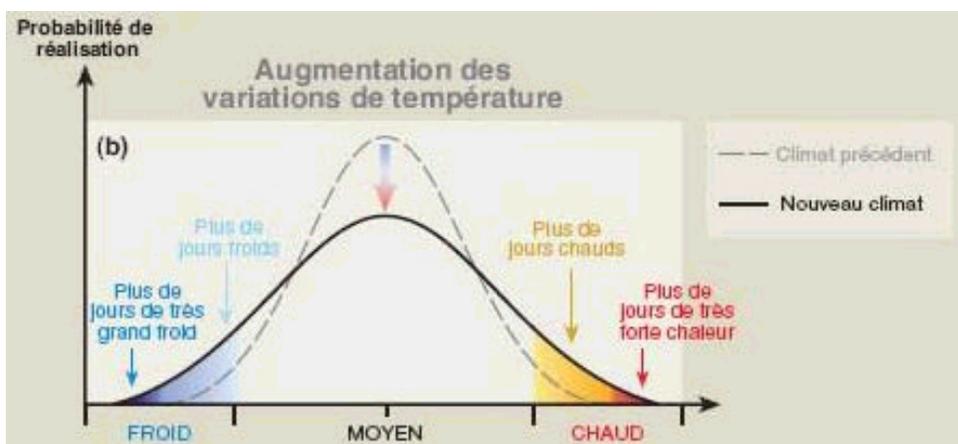
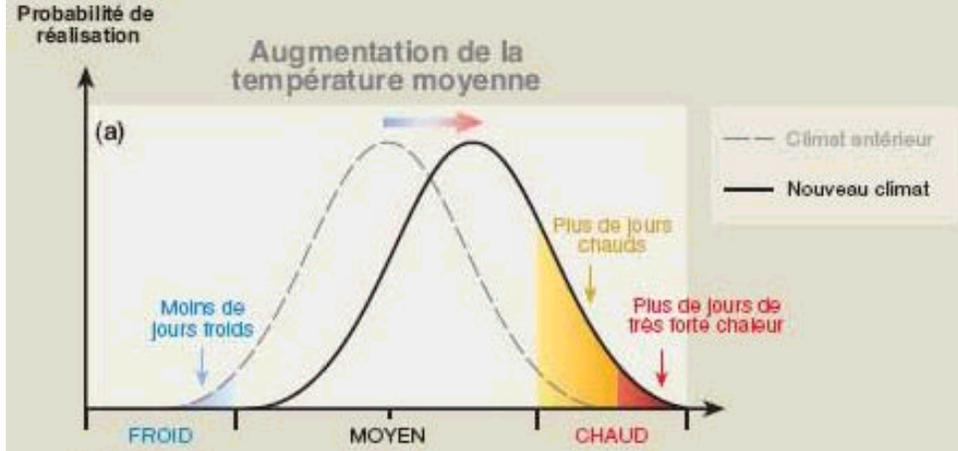
C'est la température la plus chaude jamais mesurée en France, tous mois confondus.

ANCIEN RECORD ABSOLU  
**44,1 °C**  
CONQUEYRAC (30)  
LE 12 AOÛT 2003

METEO FRANCE

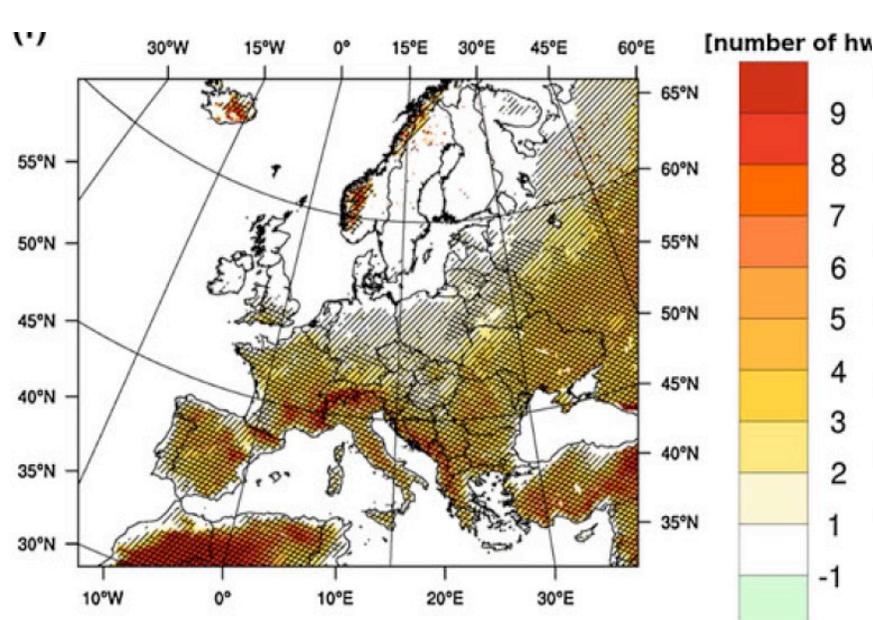
Source : Météo France/TF1 - World Meteorological Organization, 2014.

# Climate in France in 2050

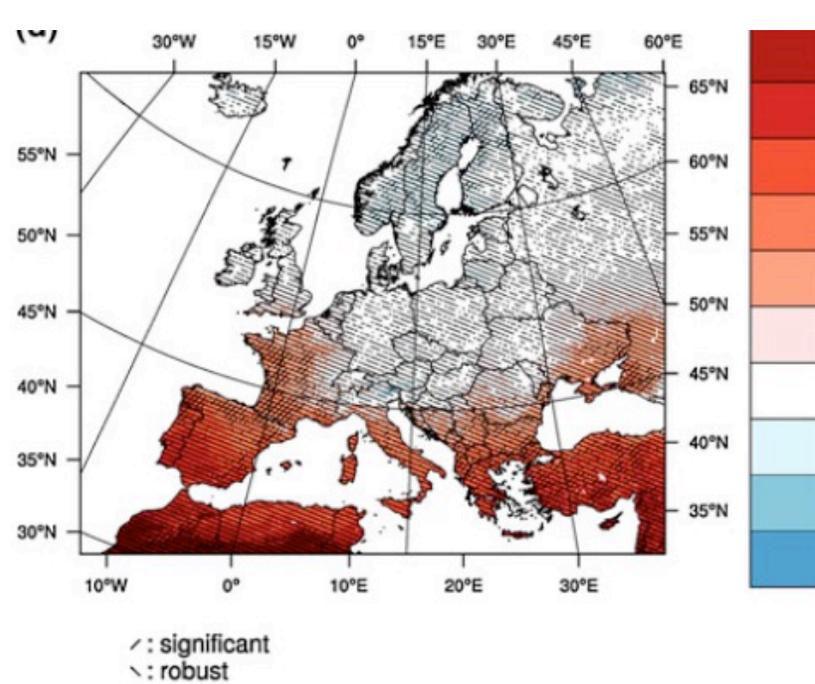


Climatic variations are likely to increase with more heat waves, more drought periods, more floodings

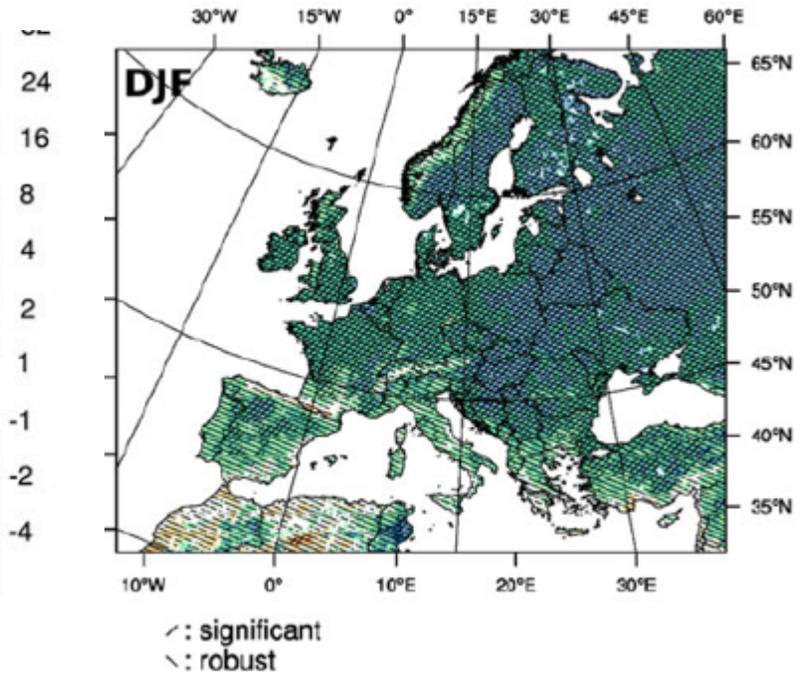
# Increasing frequency of heat waves, droughts and intense rainfalls, at the end of the century, under a scenario of rapid climate change (RCP 8.5)



Heat waves

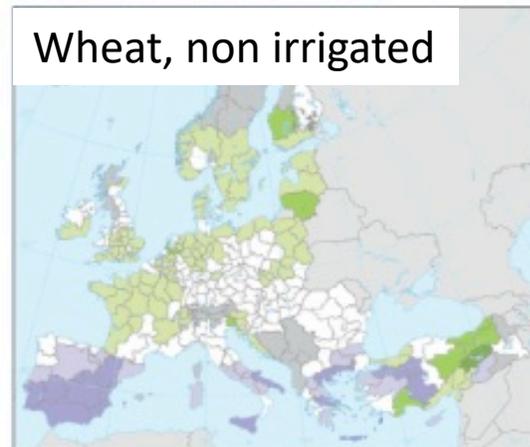
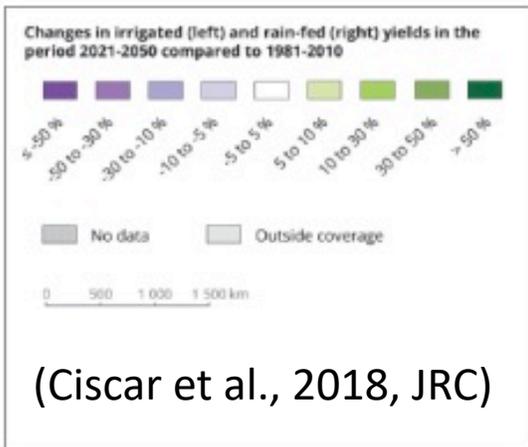
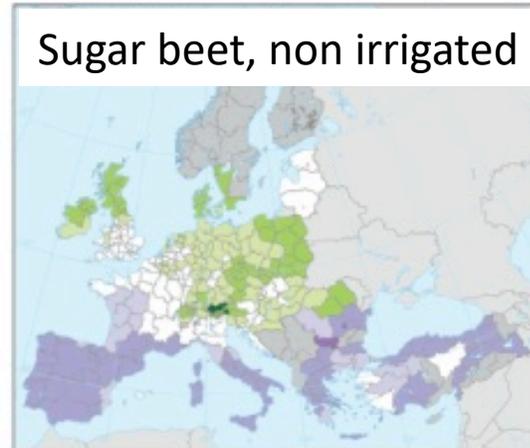
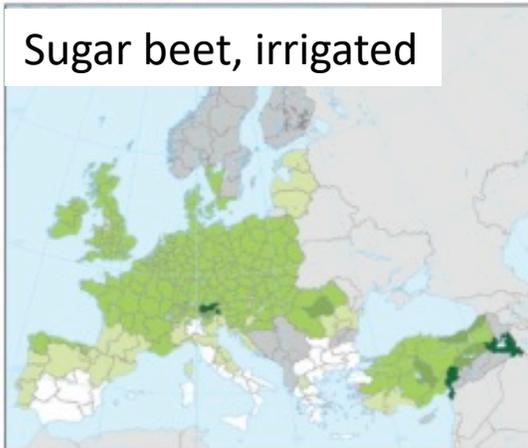
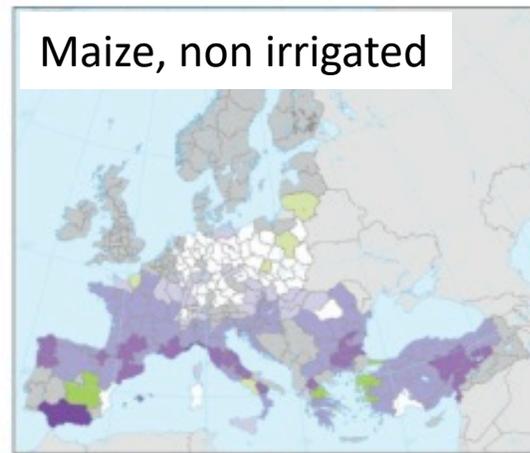
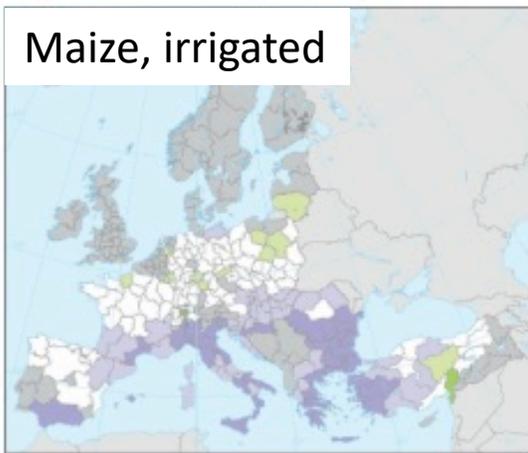


Drought



Heavy winter rainfalls

(Source : Jacob et al., 2013; Eurocordex)



# Impacts on yields in 2050 ?

Mean effects of climate change on yields in 2021-2050 compared to 1981-2000.

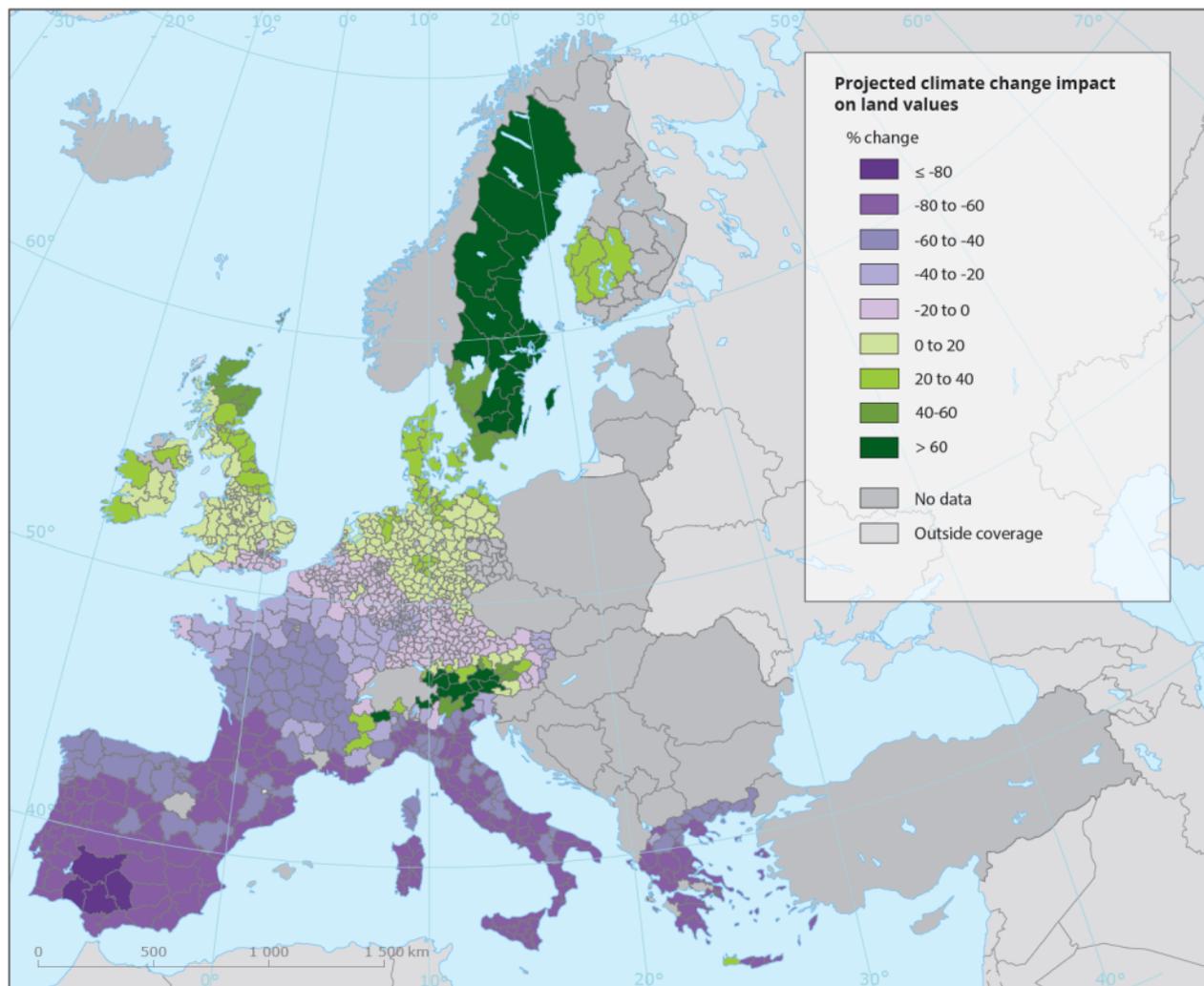
- Generalized negative effects on the Mediterranean region
- The agronomic potential of maize is strongly reduced (drought, CO<sub>2</sub> effect)
- Increasing wheat yield potential for bread wheat in the Atlantic regions and Northern Europe
- General increase for irrigated sugar beet

**Under the hypothesis of no change in practices and varieties**

**Water resources and irrigation become critical**

(Ciscar et al., 2018, JRC)

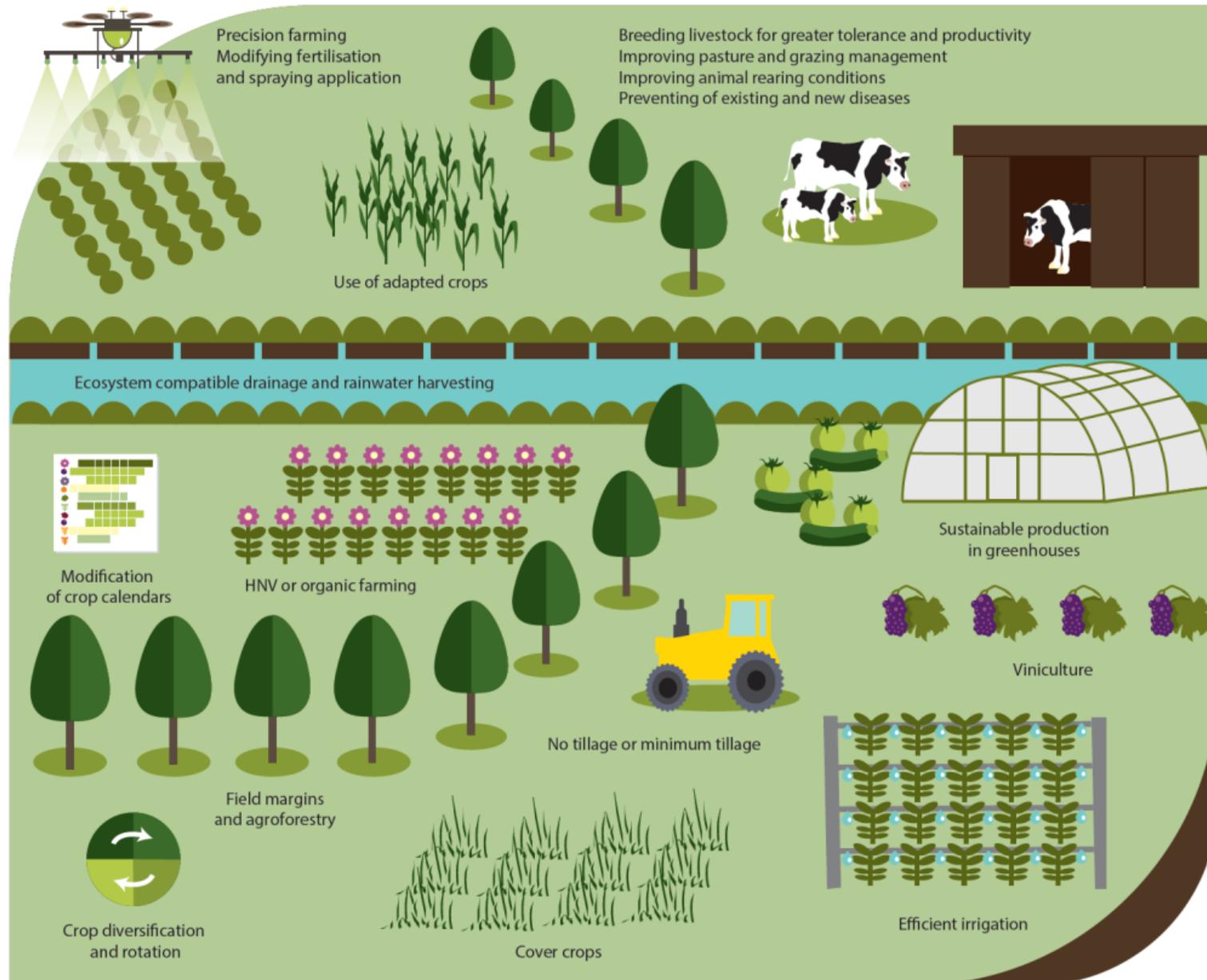
# Without agriculture adaptation, what are the impacts on land prices?



**Variation in % of land prices  
2071-2100 / 1961-1990**

(Source : Van Passel et al., 2017)

# Possible adaptation measures at farm level?



# Plant variety adaptation (production and quality) in annual grain crops, in fruits and vegetables, in vineyards: large research programs

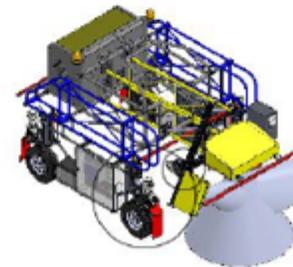
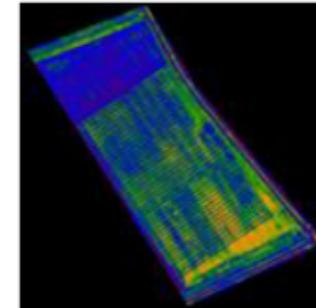
Collaborative public-private projects for varieties adapted to climate change



Infrastructures for high-throughput phenotyping



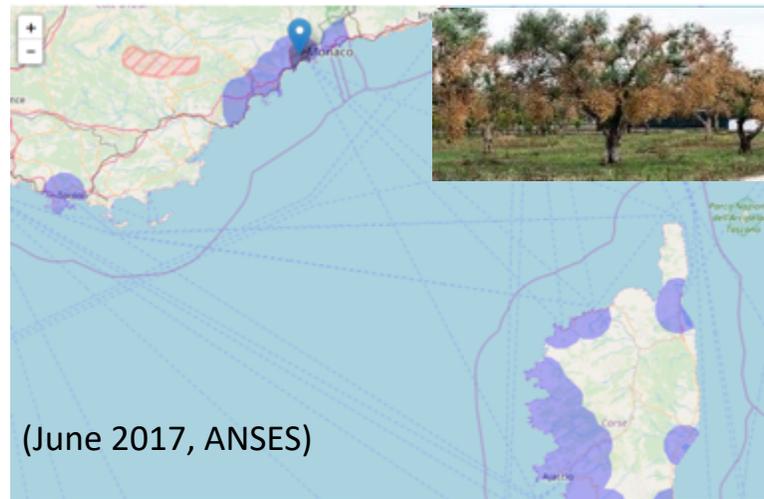
**PHENOME**  
Réseau Français  
Phénomique végétale  
F P P N



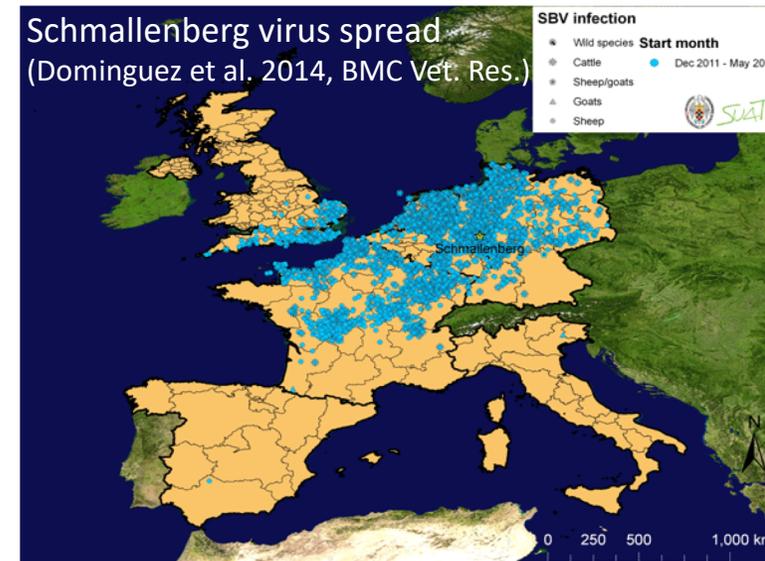
# Emergence of diseases in plants and animals, partly due to climate change

- Adaptation to climate change must consider the increasing sanitary risks, also associated with increasing international trade
- Disease survey systems should include factors related to environment and trade

*Xylella fastidiosa* - Delimited zones



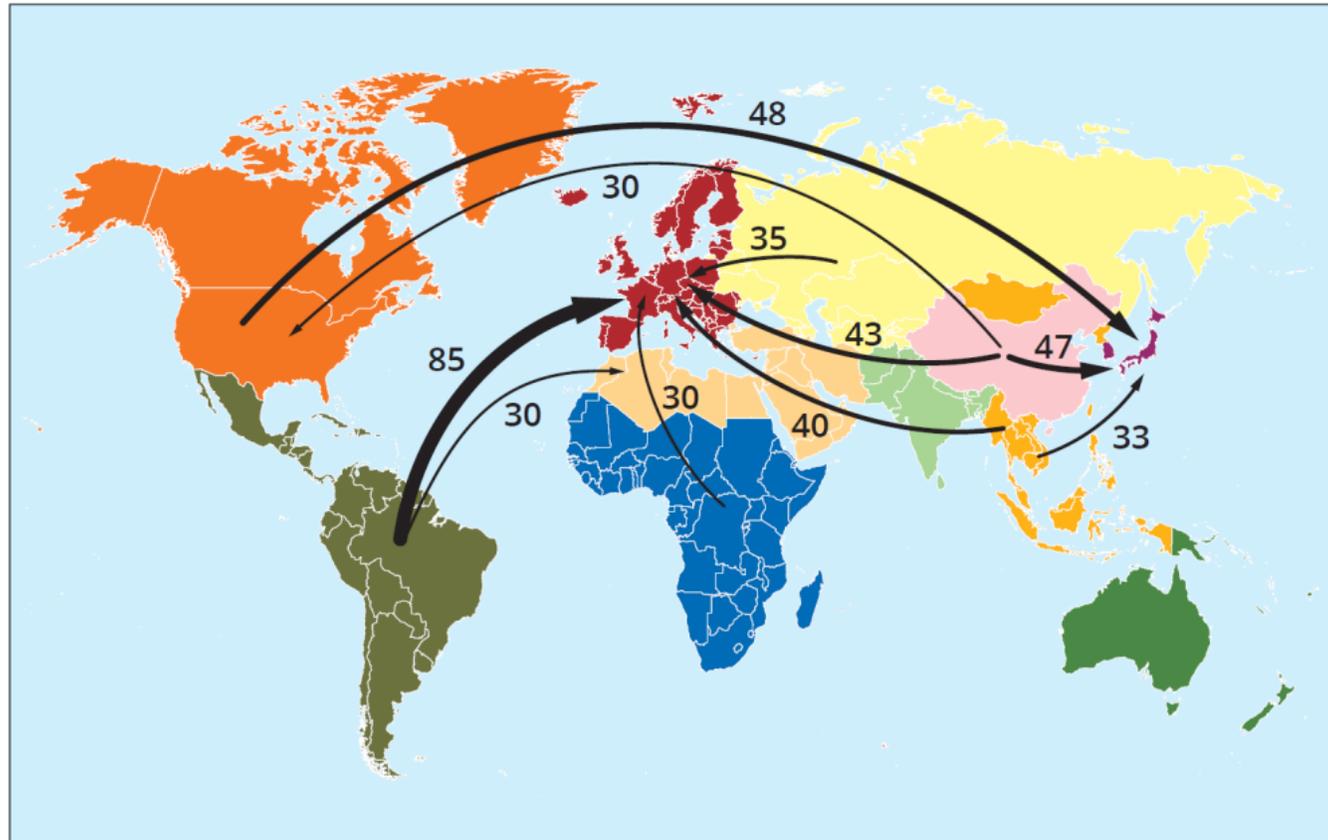
(June 2017, ANSES)



# Increasing resilience of agricultural production

- Precision agriculture and breeding
  - Anticipating risks (teledetection), and adaptation of practices,
  - Breeding for tolerance to drought, heat and floodings (without loss on yield potential ?)
  - Precision irrigation (saving water?)
  - Animal breeding for thermotolerance
  - Plant and animal health (biological invasions, emerging diseases)
- Conservation of water and soils
  - Integrated management of water at the scale of the watersheds,
  - Soil conservation (reduced tillage, intermediate and companion crops),
  - Mixed farming (grasslands at stake), agroforestry (microclimate)
- Diversification: resilience to climatic variation
  - Rotations, cultivars, temporary grasslands,
  - Grass-legume mixtures, mix of varieties (key question for the downstream industry)
  - Agroecological infrastructures and diversified landscapes (lower parasite pressure)

# Europe uses a significant part of world lands (virtual acreage >> actual acreage)



Top net trade displacements of land use

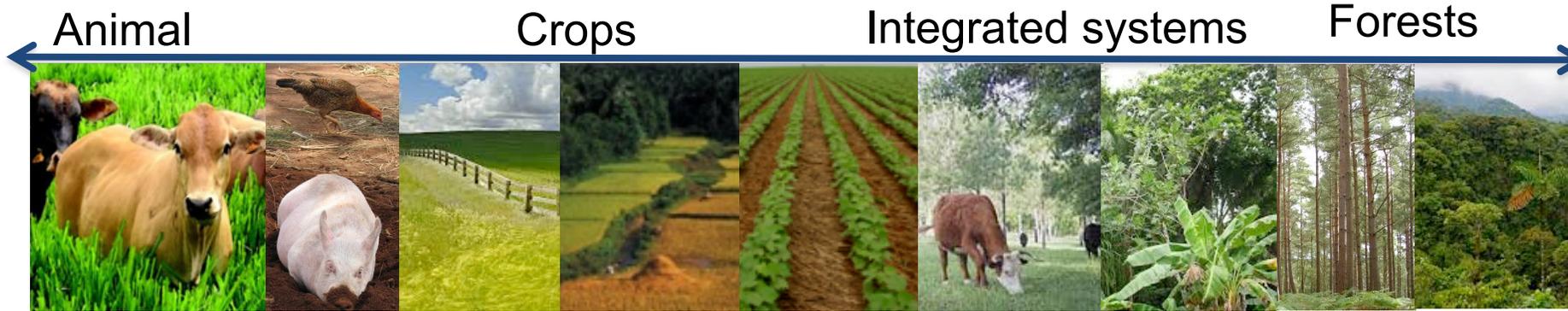
Ecological footprint (gha/year)



Source : EEA, 2019

# Reducing greenhouse gas emissions

## AGRICULTURAL PRODUCTION



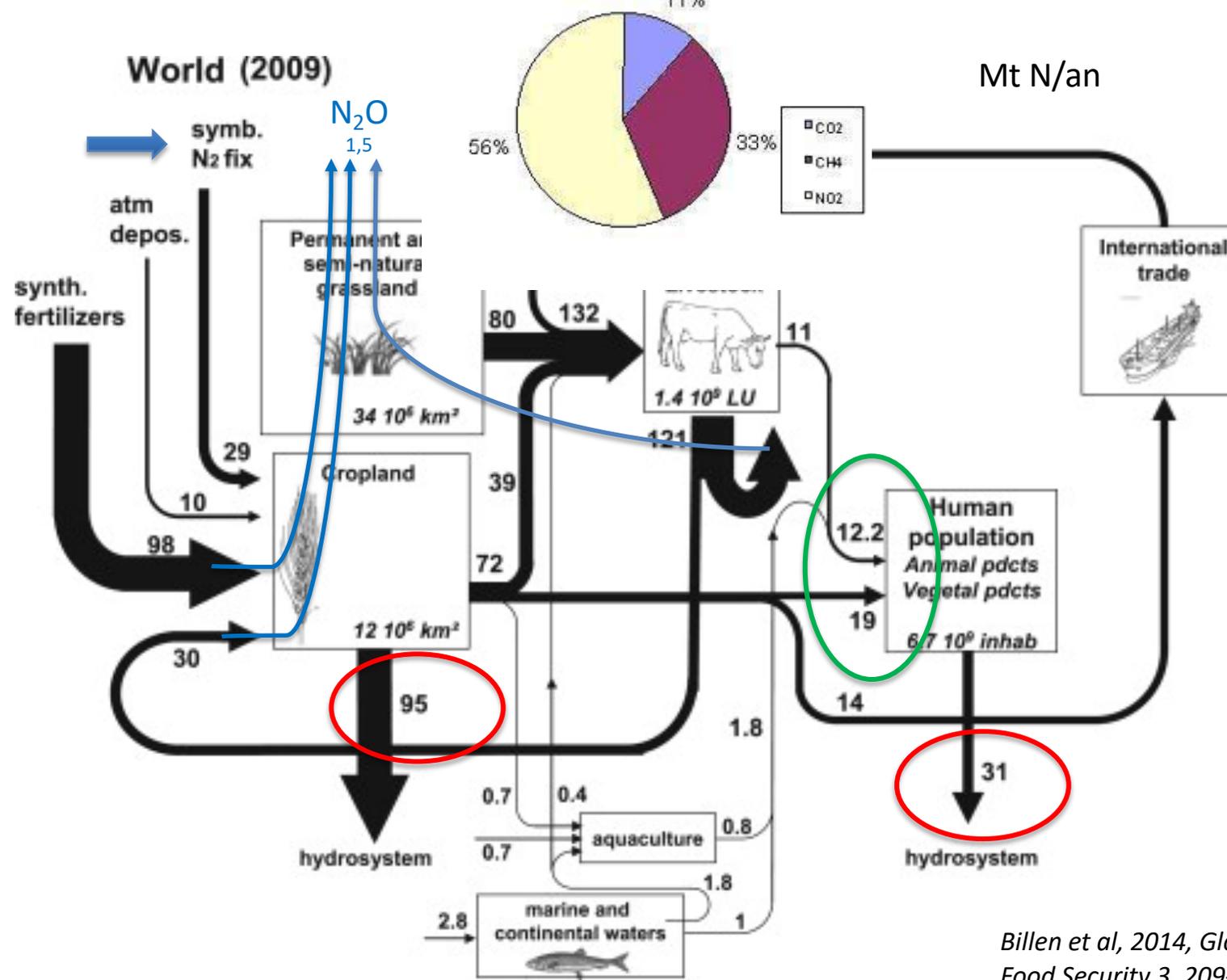
... and bioenergy



## FOOD DEMAND



Reducing wastes and losses  
Food transition (less animal products)  
Use of wood products



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

Example of N and proteins cycle at the world level: an illustration of open cycles with huge nutrient losses

# A significant potential for C storage in cultivated soils

## French example

30 millions tons CO<sub>2</sub> equi/year  
(= 3.3/1000 for year on agricultural lands)

A contrasting potential among regions (higher in soils where initial stocks are low)

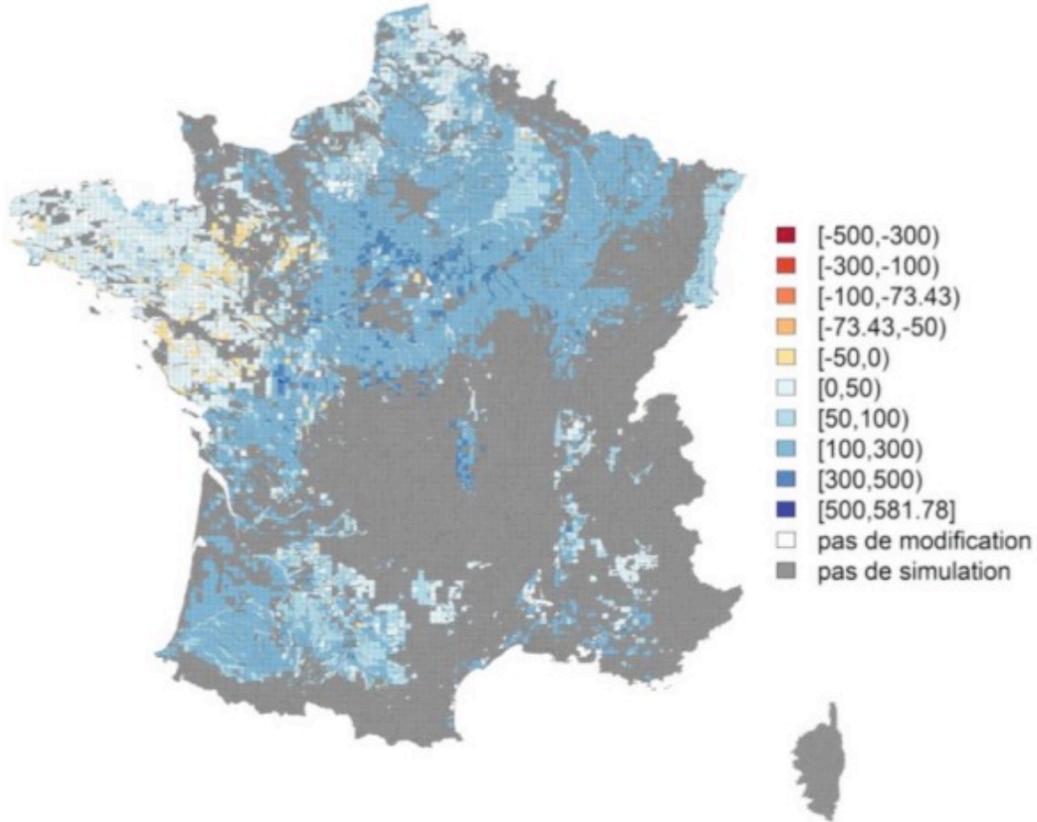
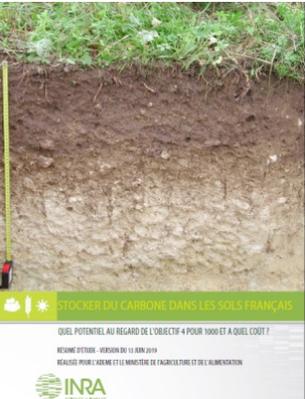
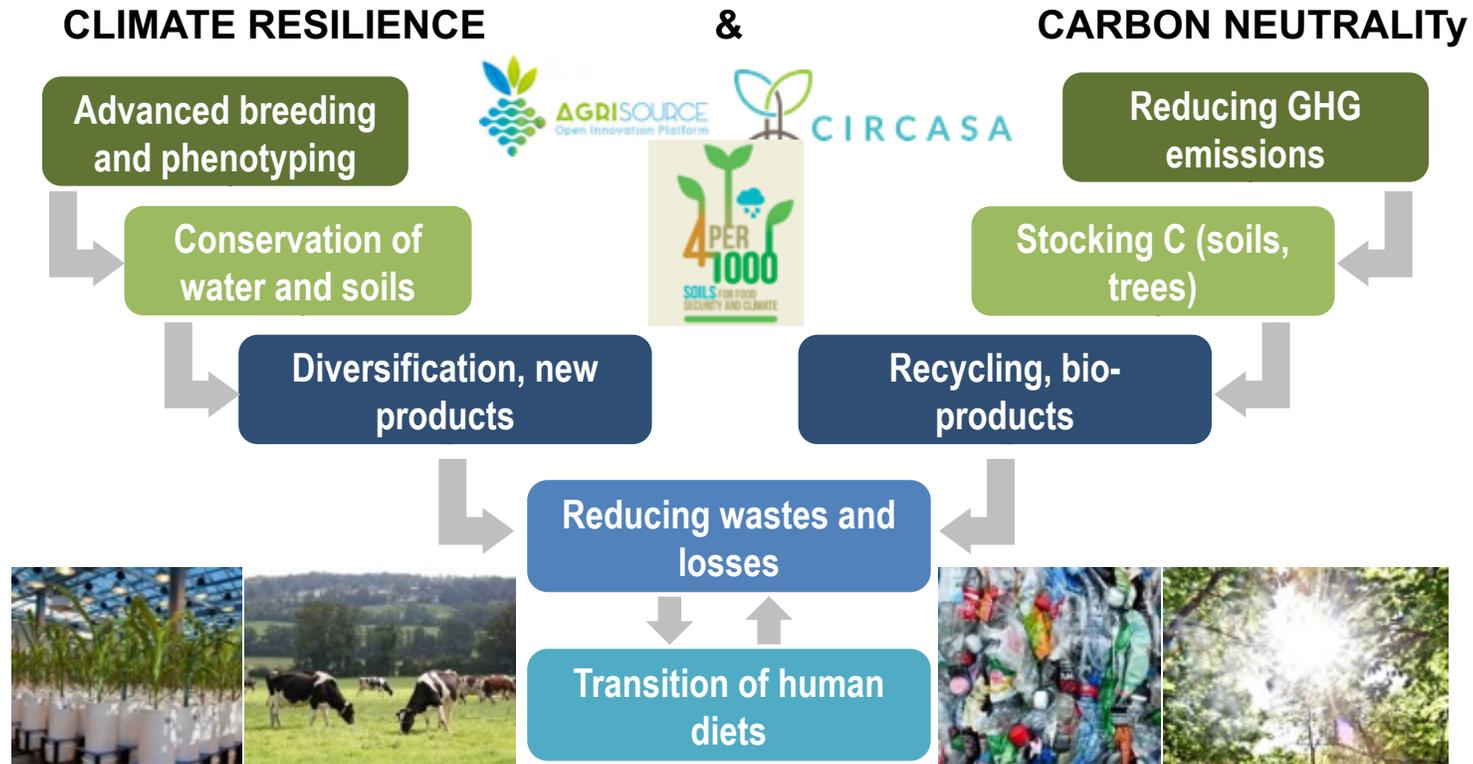


Figure 7. Stockage additionnel absolu (kgC/ha/an) sur 0-30 cm avec le scénario "Insertion et allongement des cultures intermédiaires"

# Conclusion : towards agrifood systems neutral in C equ. and resilient to climate change



Thank you for your attention!