



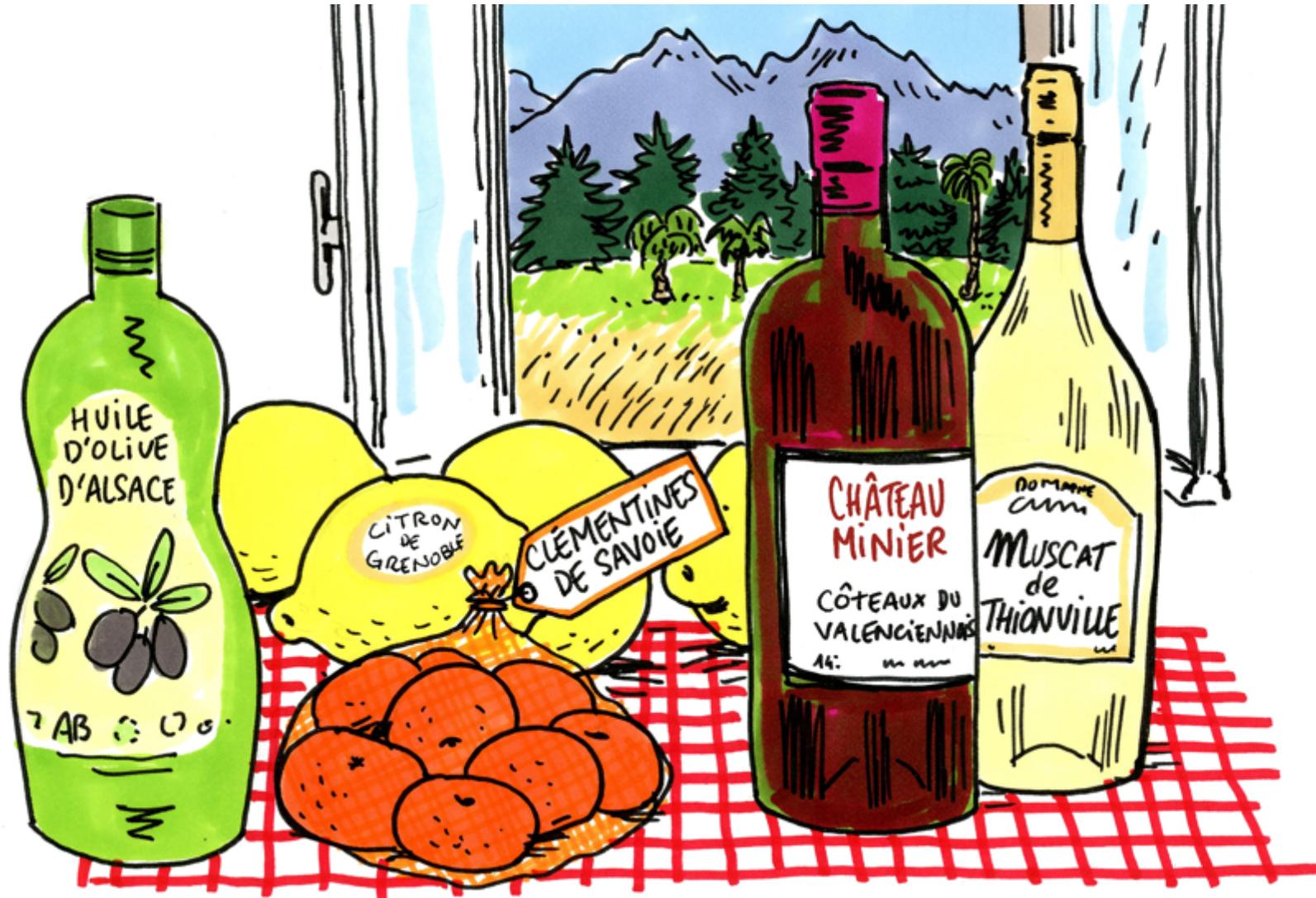
Climate change: mitigation and adaptation

INRAE

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

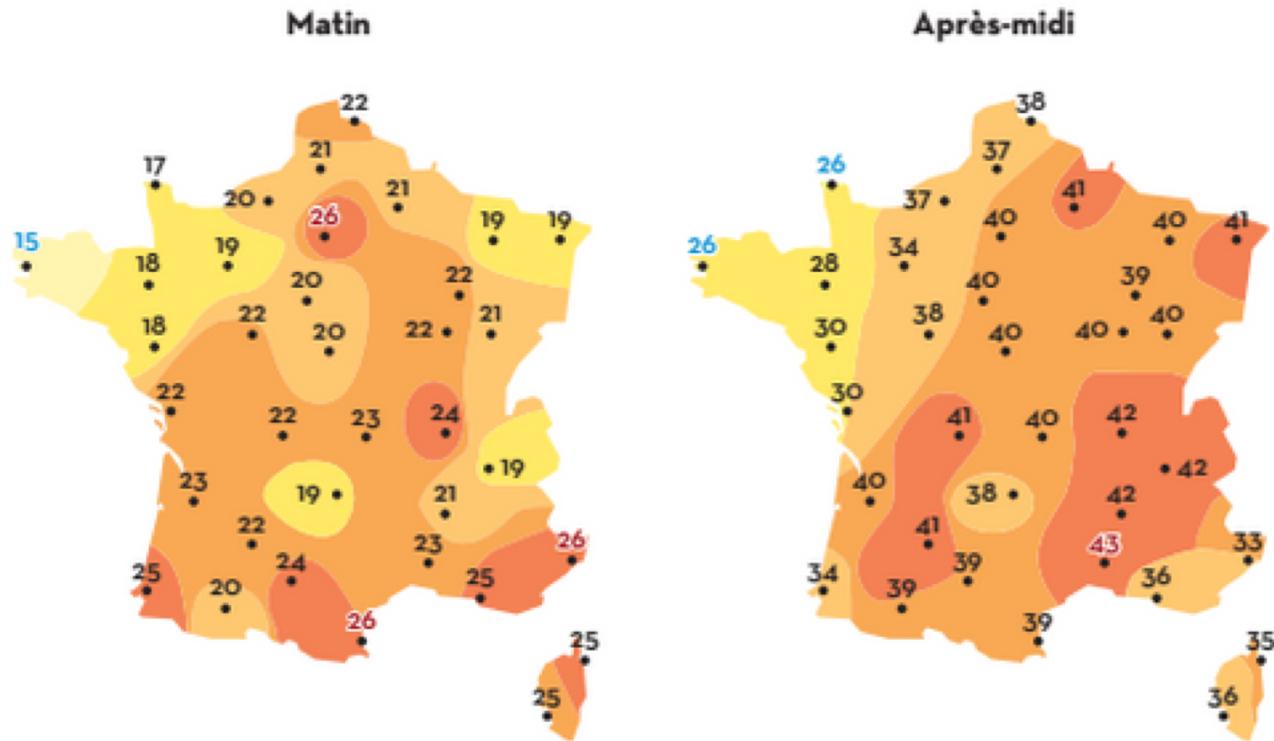
25 september 2020 / Euragri / Christian Huyghe

Climate change
Agriculture change
Food change



Possible weather in France in 2050

Weather forecast for August 18th, 2050



RECORD NATIONAL DE CHALEUR BATTU

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

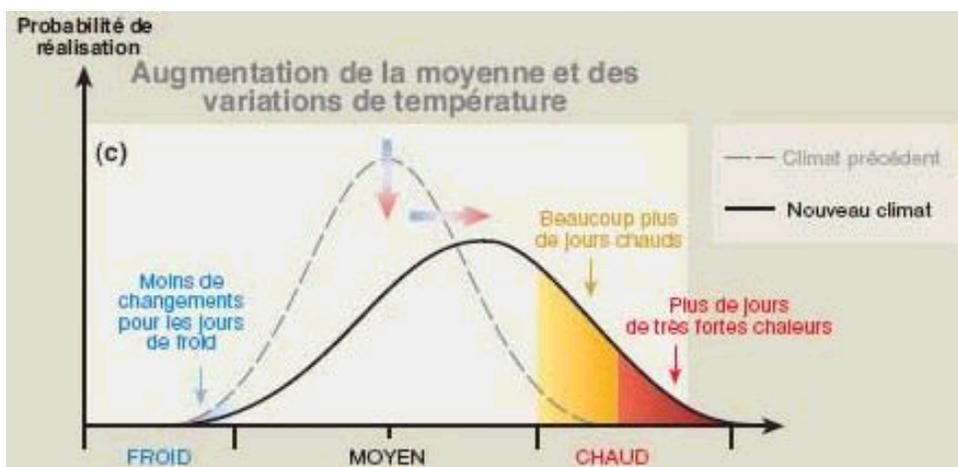
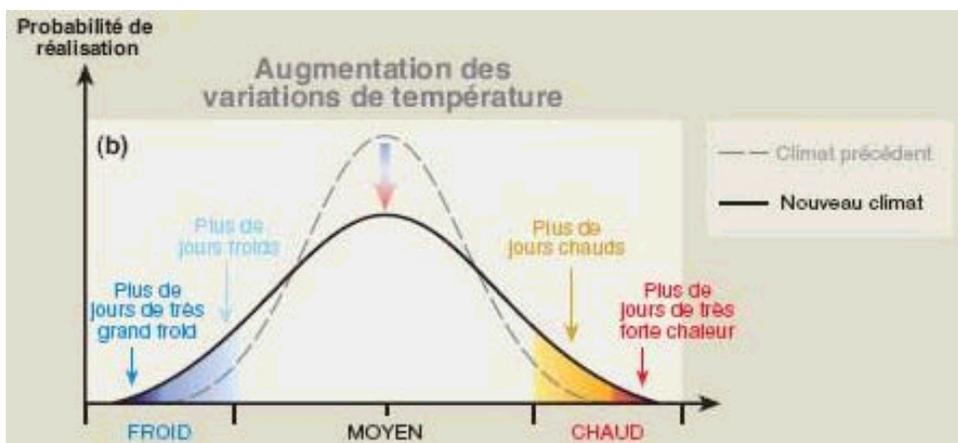
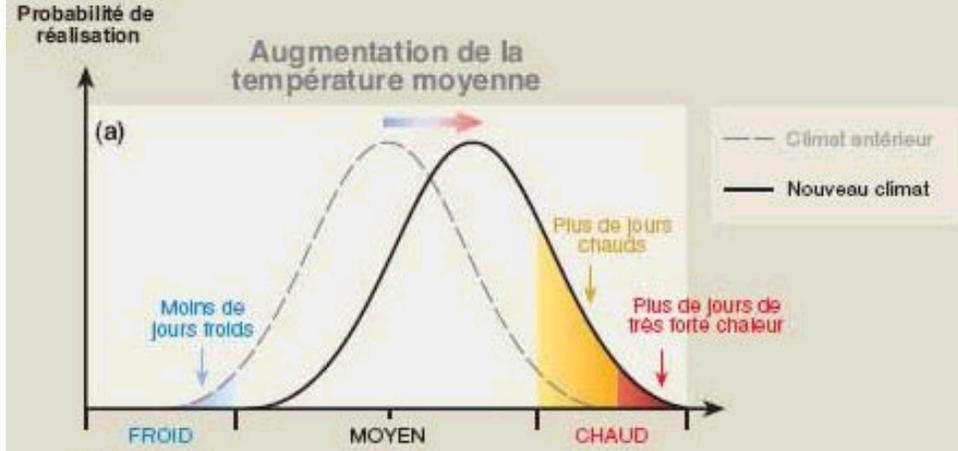
GALLARGUES-LE-MONTUEUX (30)
45,9 °C
LE 28 JUIN 2019 À 16H20

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

METEO FRANCE

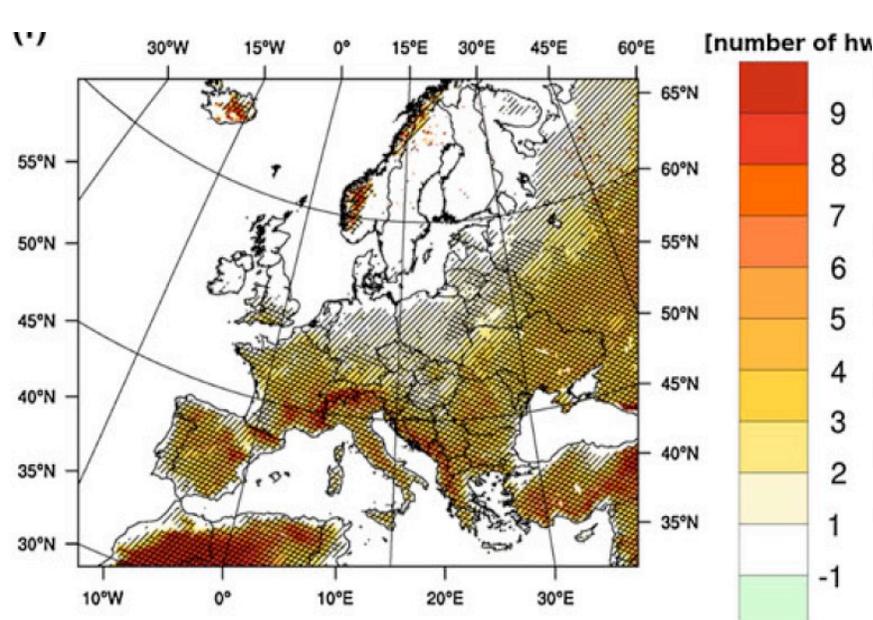
Source : Météo France/TF1 - World Meteorological Organization, 2014.

Climate in France in 2050

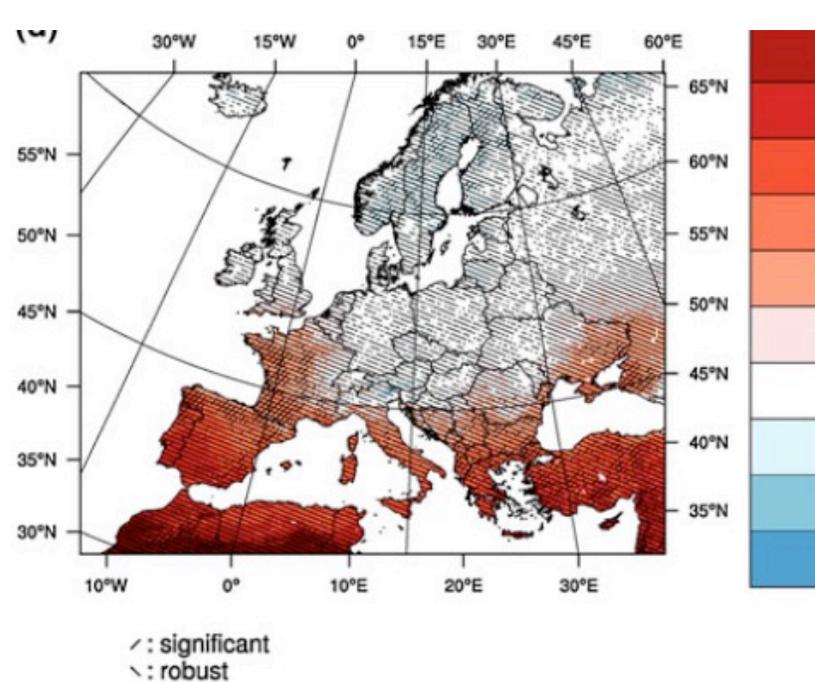


Climatic variations are likely to increase with more heat waves, more drought periods, more floodings

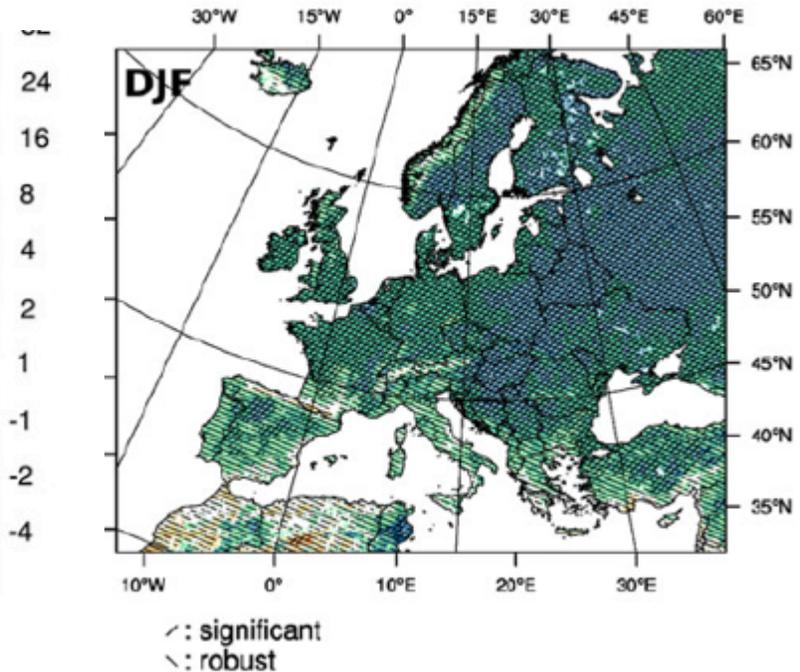
Increasing frequency of heat waves, droughts and intense rainfalls, at the end of the century, under a scenario of rapid climate change (RCP 8.5)



Heat waves

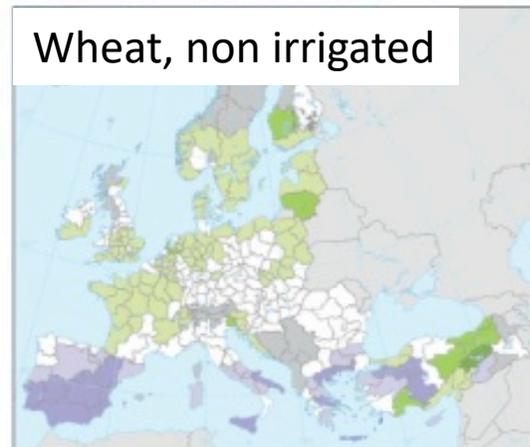
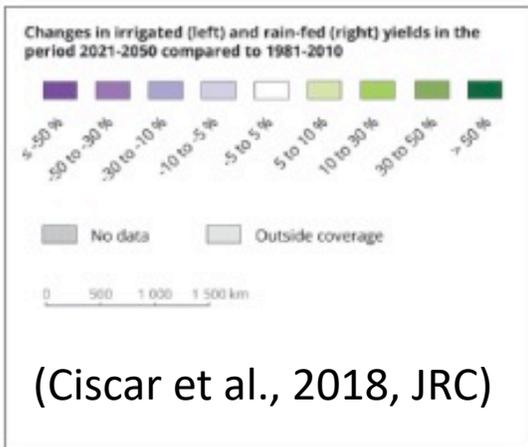
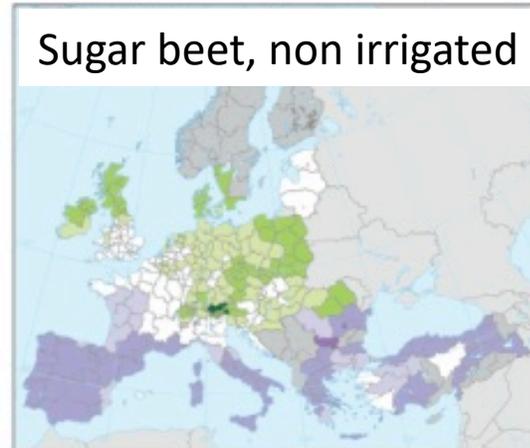
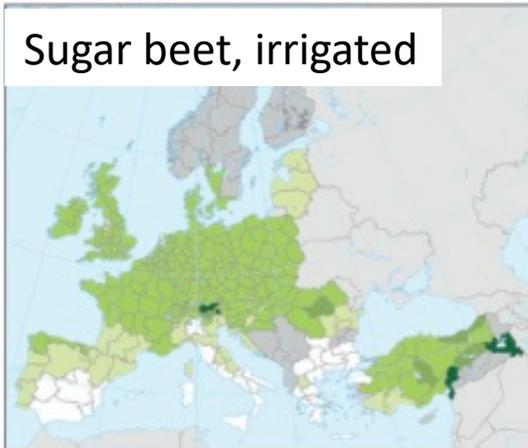
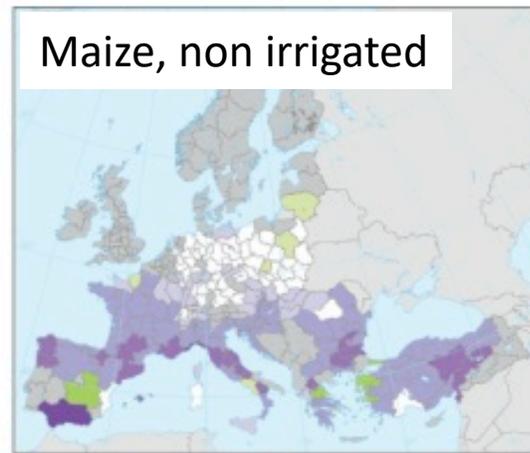
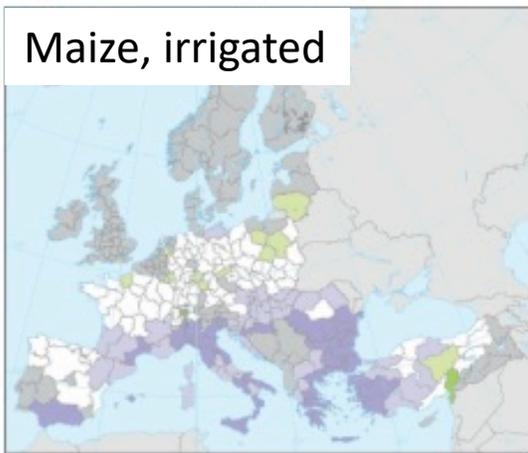


Drought



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.

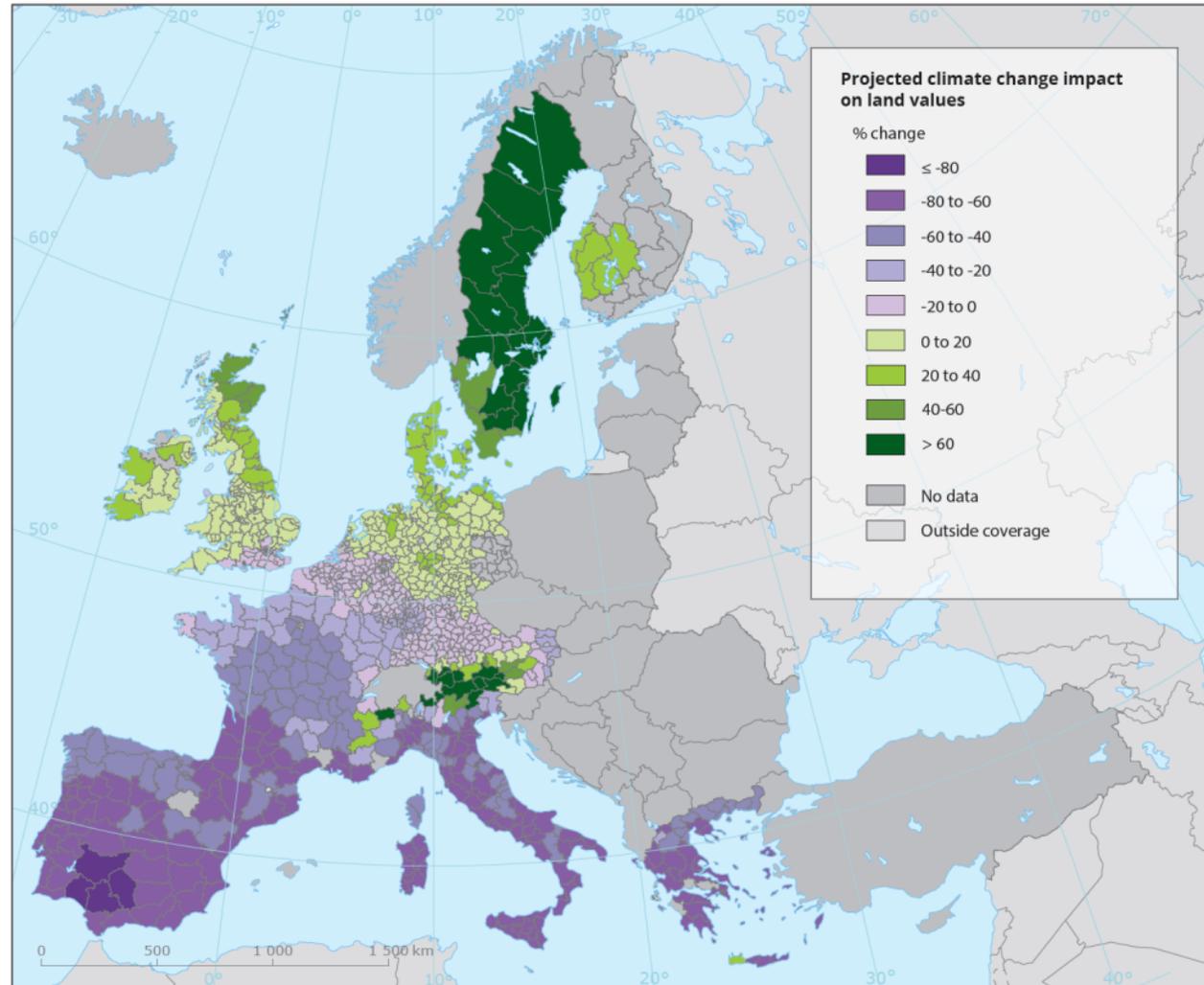
- Generalized negative effects on the Mediterranean region
- The agronomic potential of maize is strongly reduced (drought, CO₂ effect)
- Increasing wheat yield potential for bread wheat in the Atlantic regions and Northern Europe
- General increase for irrigated sugar beet

Under the hypothesis of no change in practices and varieties

Water resources and irrigation become critical

(Ciscar et al., 2018, JRC)

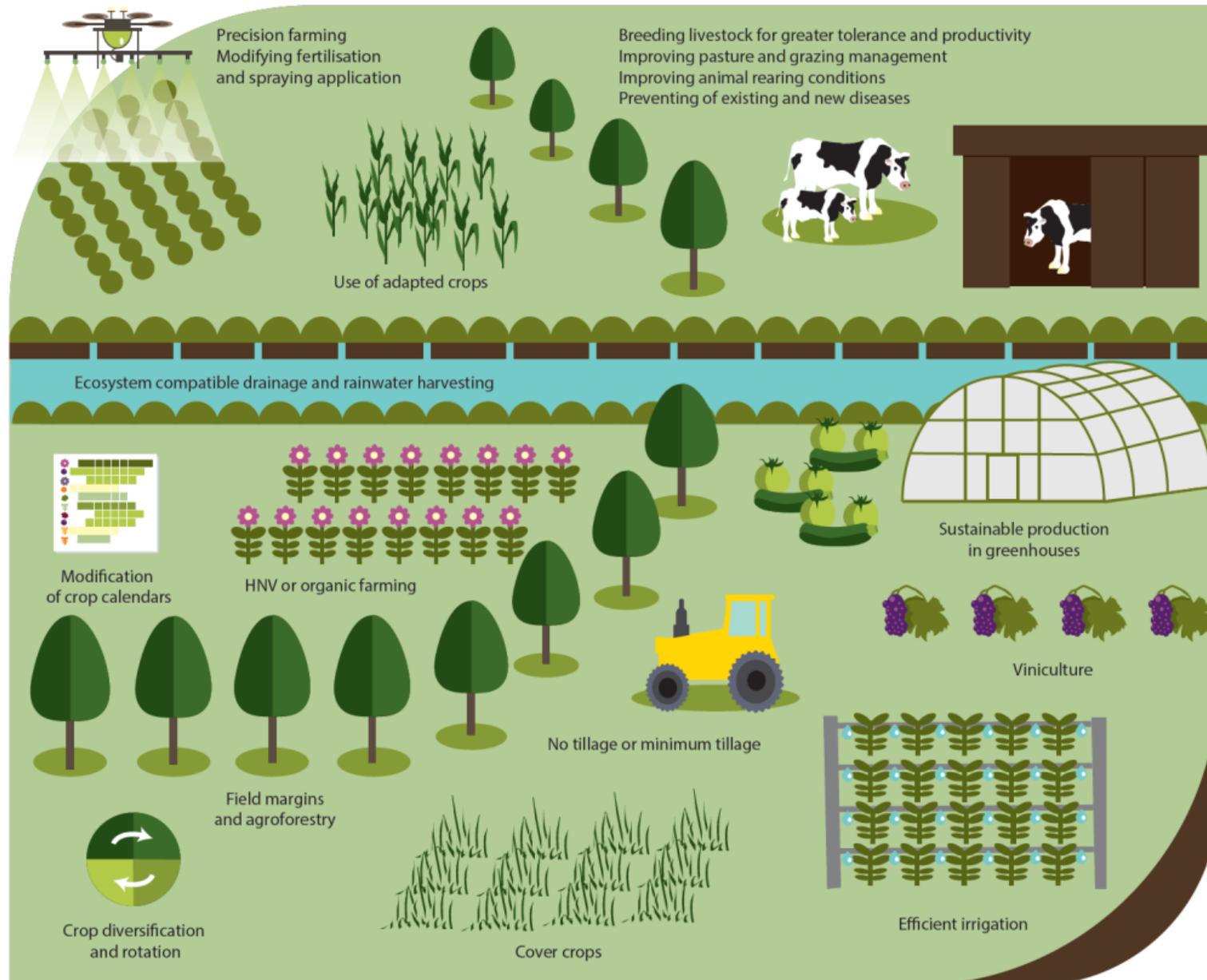
Without agriculture adaptation, what are the impacts on land prices?



**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

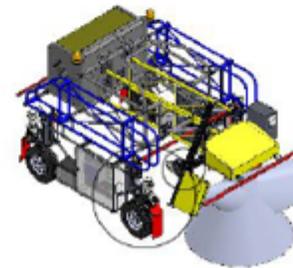
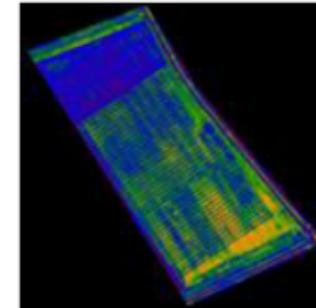
Collaborative public-private projects for varieties adapted to climate change



Infrastructures for high-throughput phenotyping



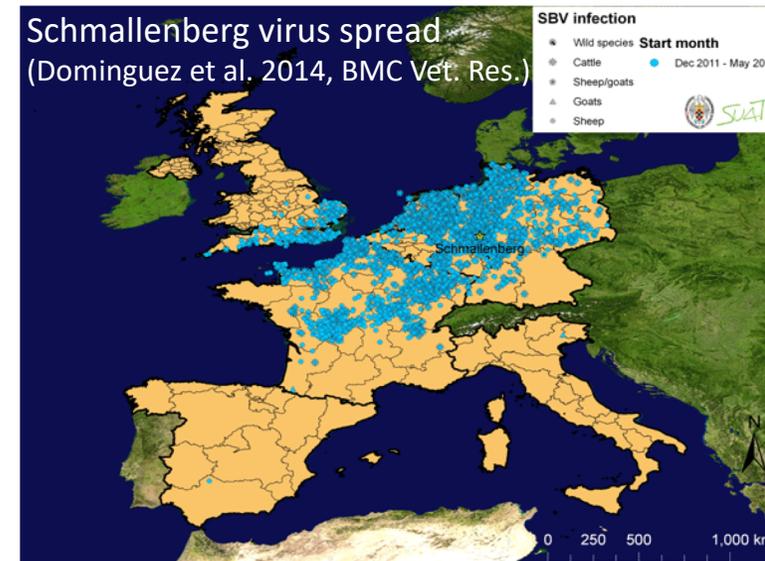
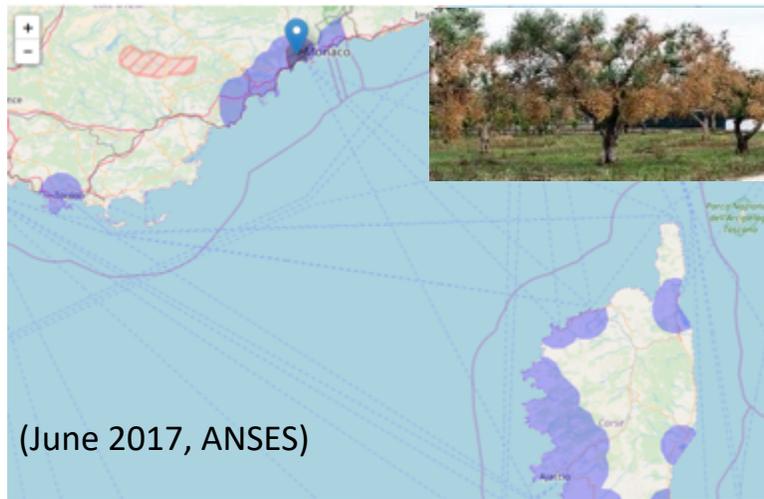
PHENOME
Réseau Français
Phénomique végétale
F P P N



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

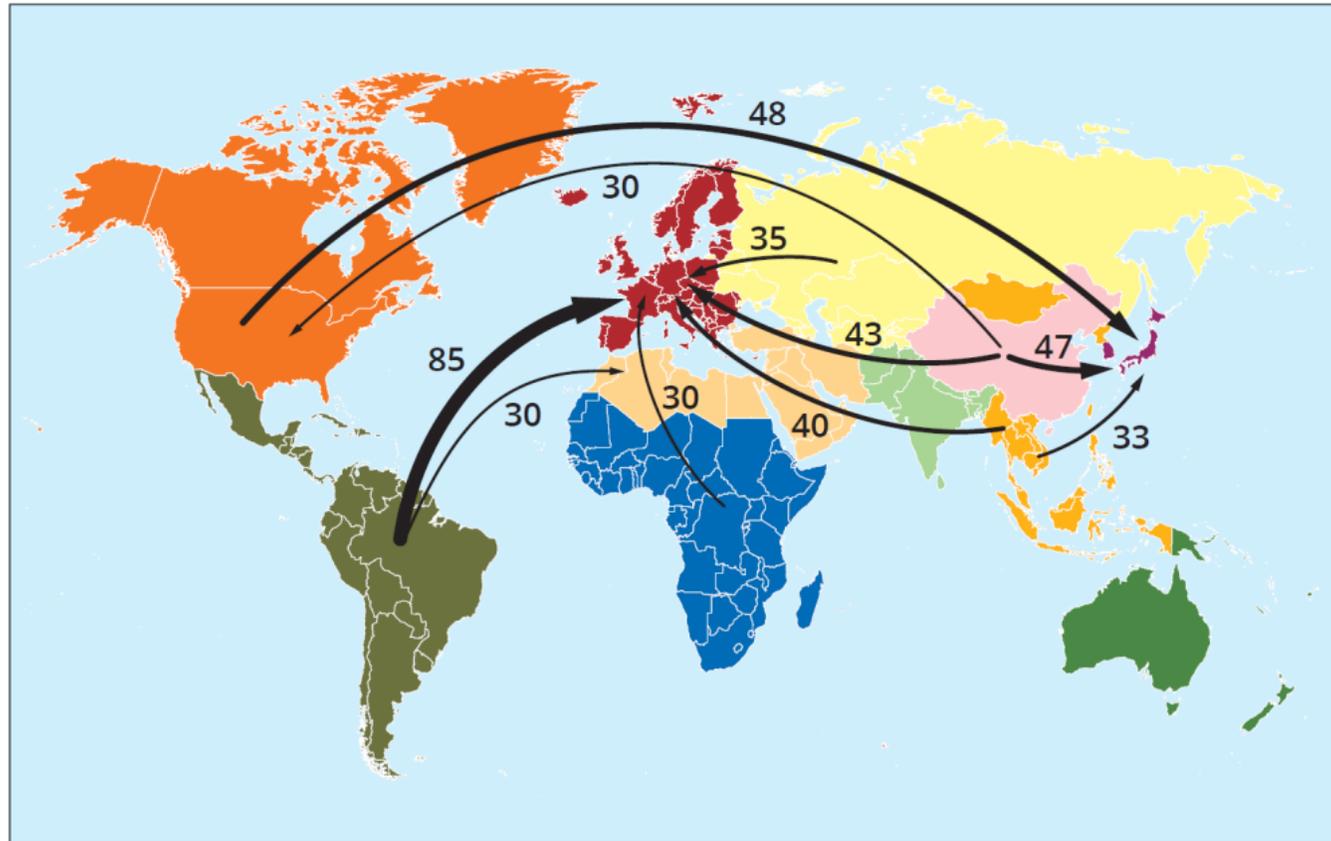
Xylella fastidiosa - Delimited zones



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)

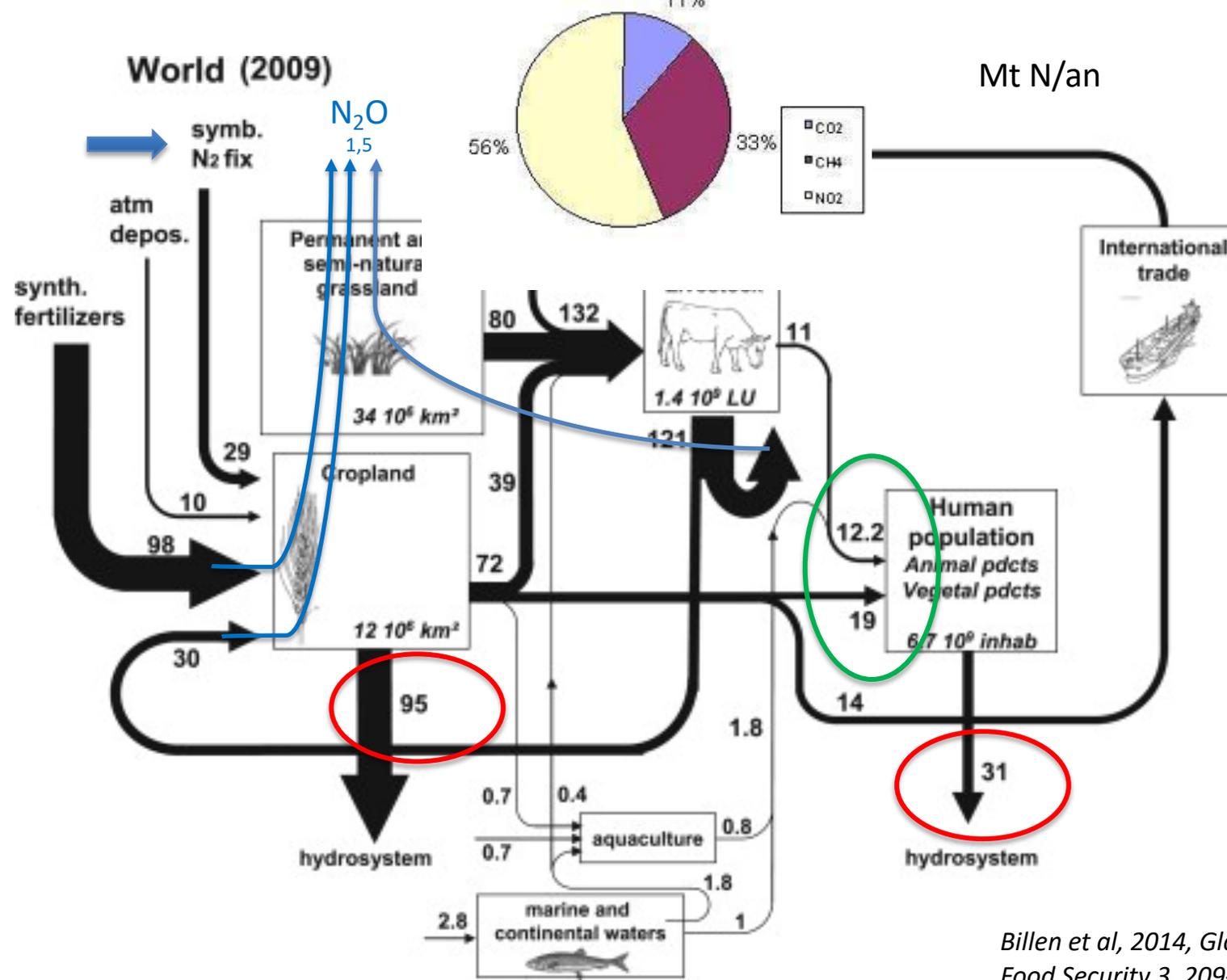


Top net trade displacements of land use

Ecological footprint (gha/year)



Source : EEA, 2019



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 CO₂ equi/year
(= 3.3/1000 for year on agricultural lands)

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

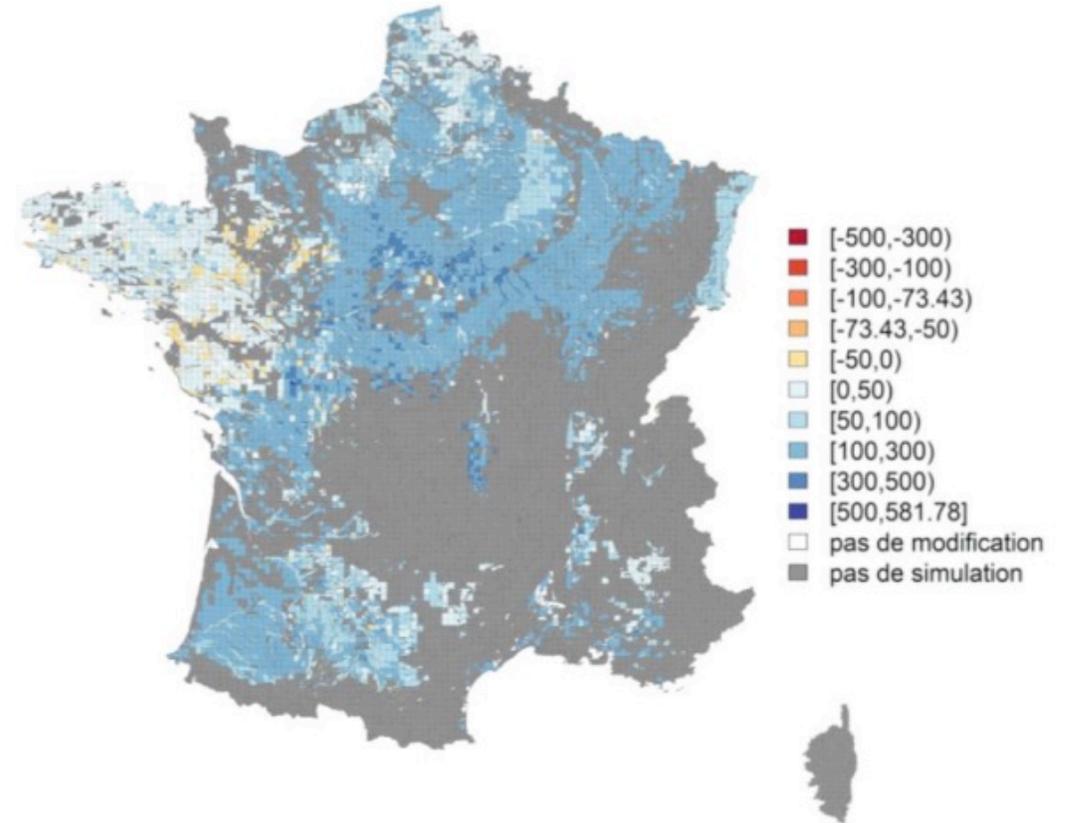
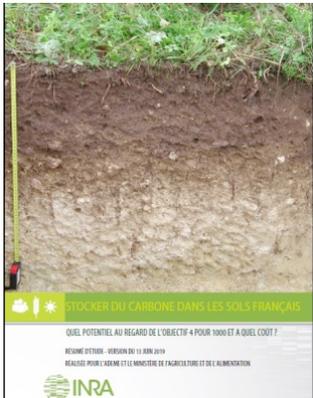
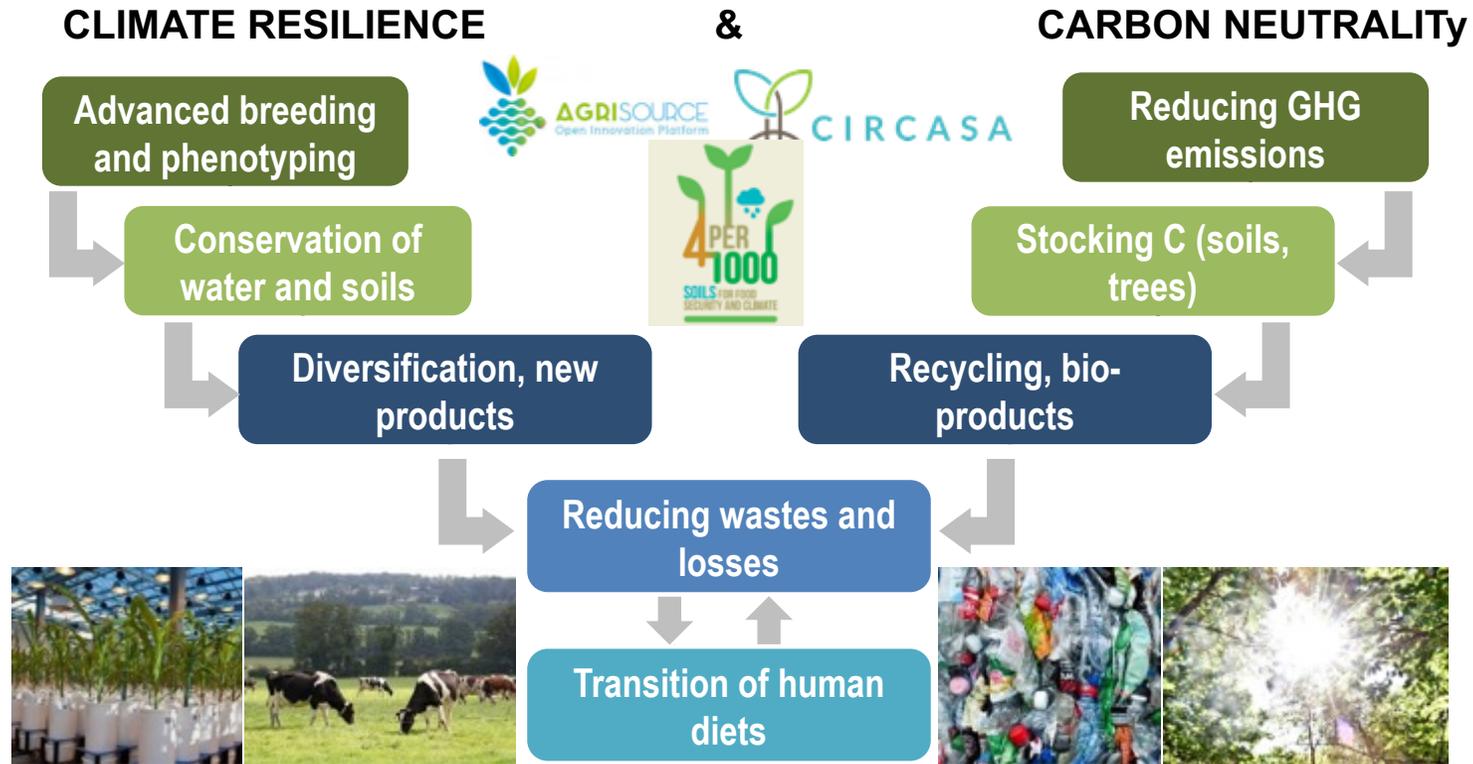


Figure 7. Stockage additionnel absolu (kgC/ha/an) sur 0-30 cm avec le scénario "Insertion et allongement des cultures intermédiaires"

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



Thank you for your attention!