Climate change: a challenge for agriculture

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INRA, Paris

ClimWine Conference,
Bordeaux, April 10, 2016

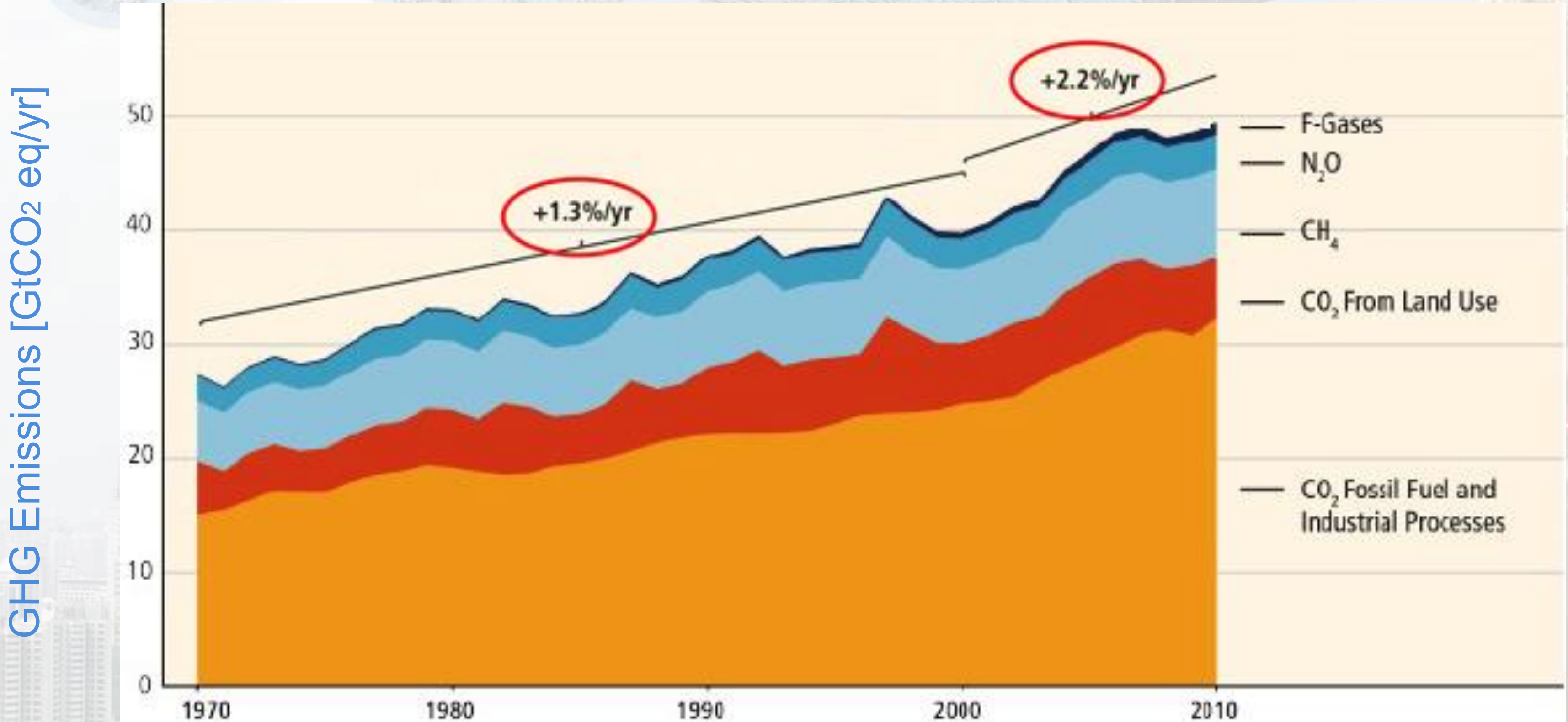
Two Goals of Our Time

1. **Achieving Food Security**
   – 800 million chronically undernourished
   – Food production to increase 50-70% by 2050
   – Adaptation to climate change is critical

2. **Avoiding Dangerous Climate Change**
   - The ' 2°C railguard ' requires major emission cuts
   - Agriculture and land use contribute to 24% of GHG emissions...

     ...and need to be part of the solution

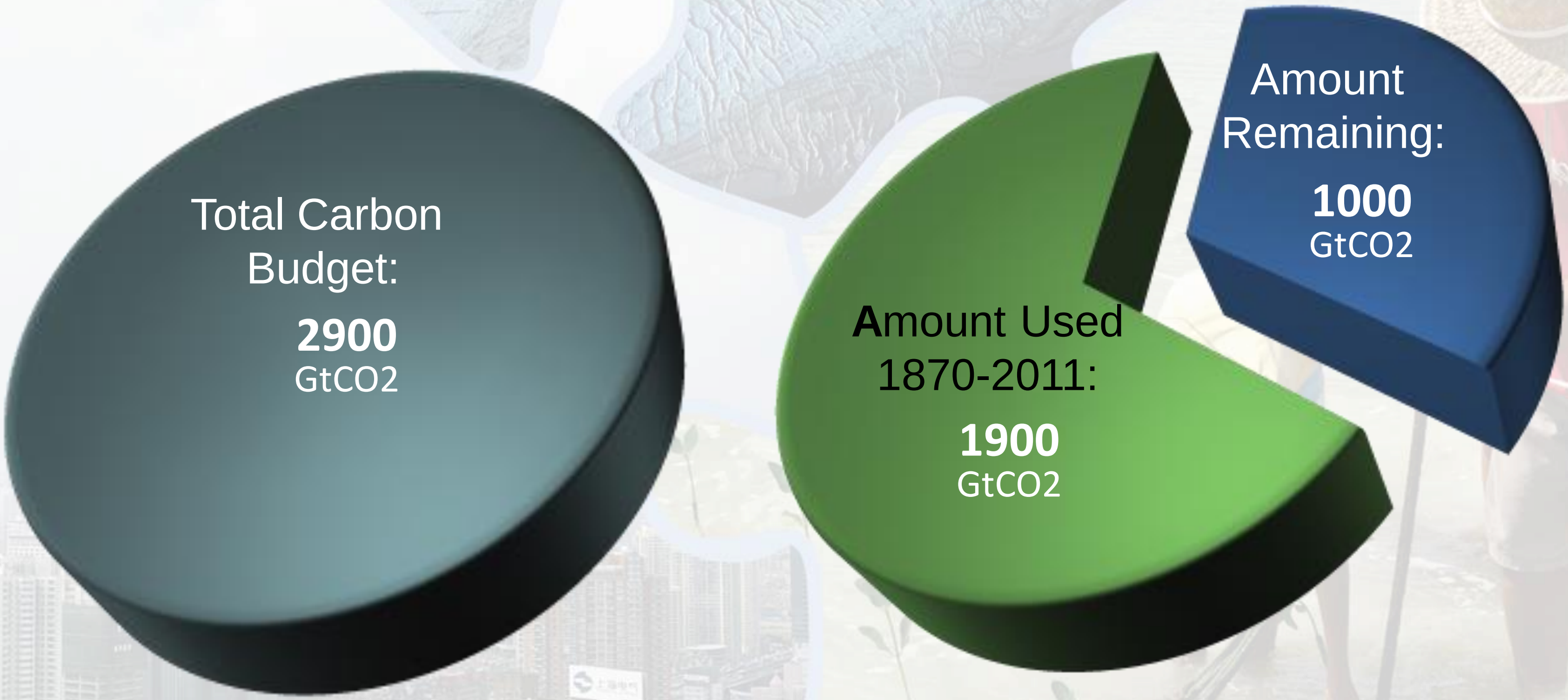
GHG emissions growth between 2000 and 2010 has been larger than in the previous three decades



AR5 WGIII SPM

The window for action is rapidly closing

65% of our carbon budget compatible with a 2° C goal already used



AR5 WGI SPM


WIDESPREAD
OBSERVED IMPACTS
A CHANGING WORLD
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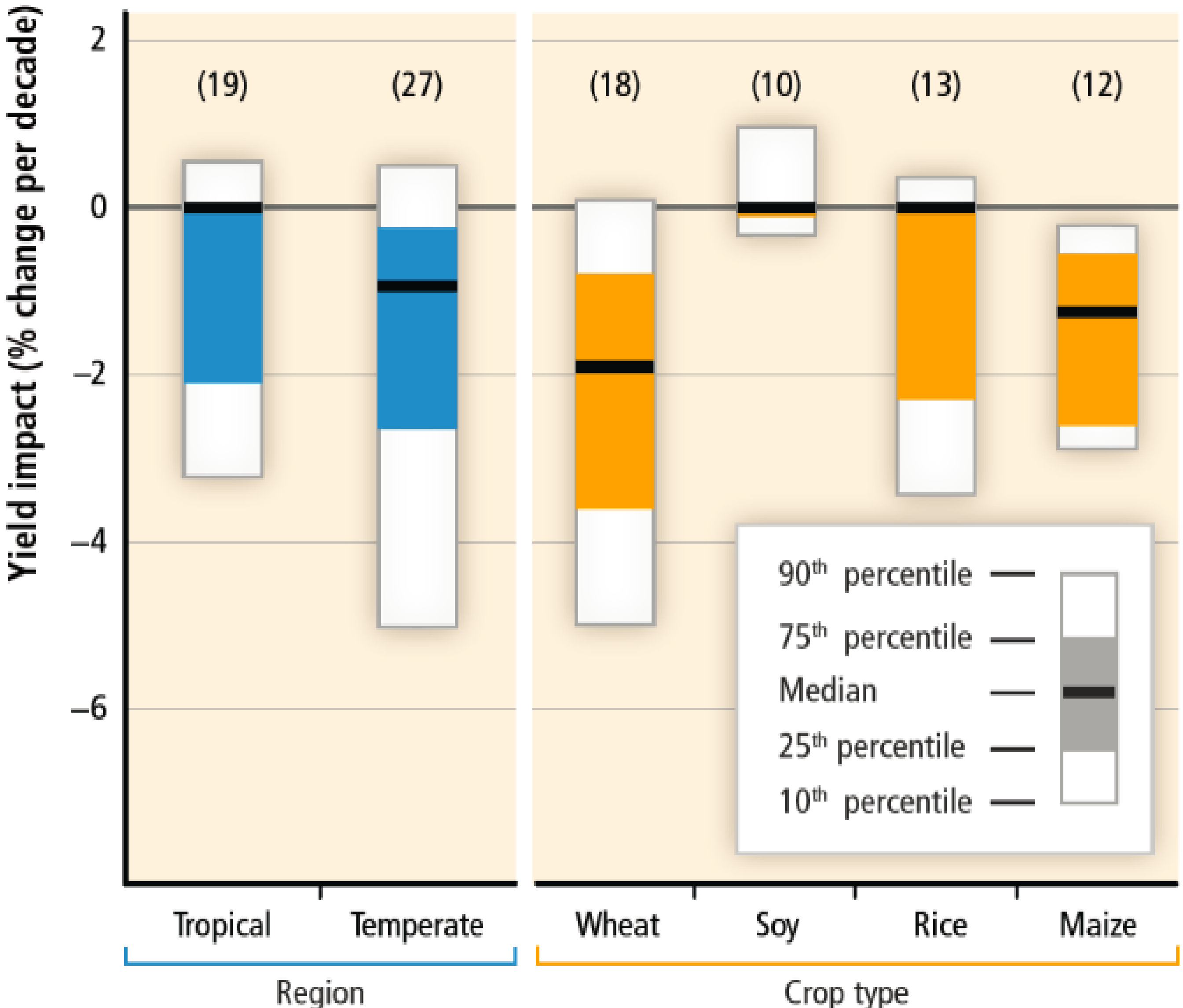
INTERGOVERNMENTAL PANEL ON climate change

Observed impacts on crop yields (% per decade)



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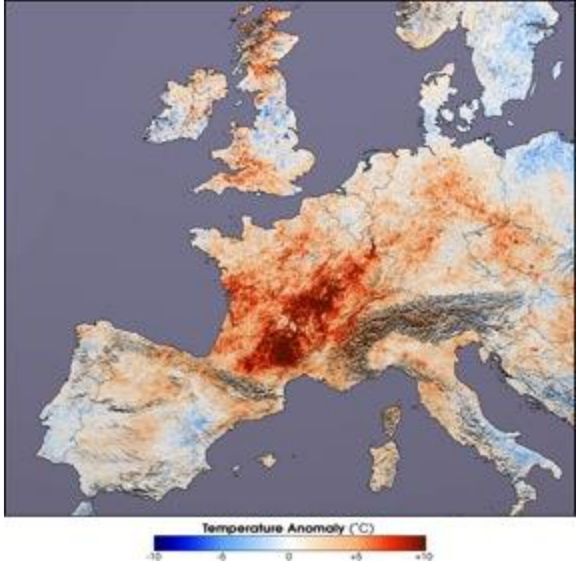
INTERGOVERNMENTAL PANEL ON climate change

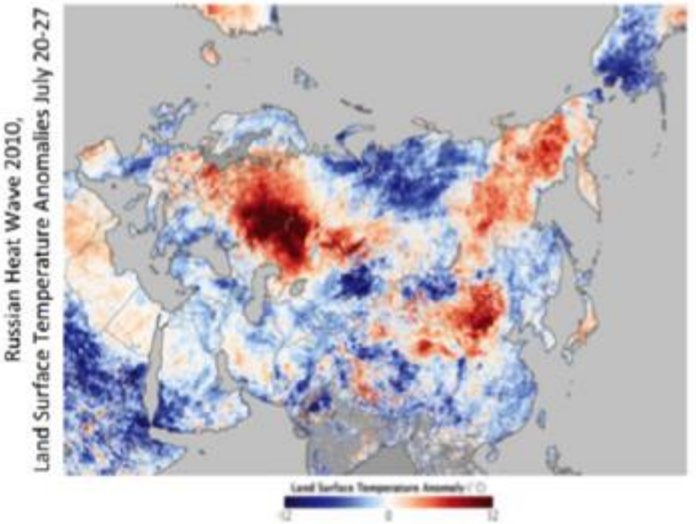
Extreme climatic events since 2000: heat and drought

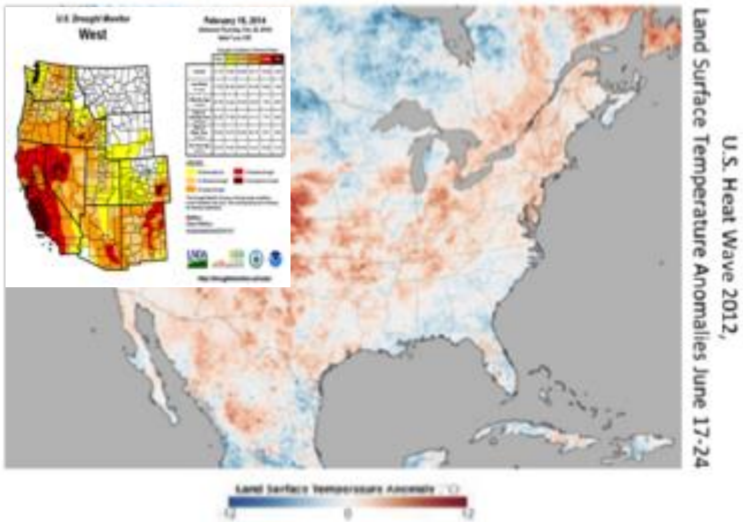
Summer 2003 Europe
(no equivalent since 1500)



Summer 2010 Russia
(no equivalent since 1500)

Summer 2012 USA





Source: NASA Earth Observatory 2012.

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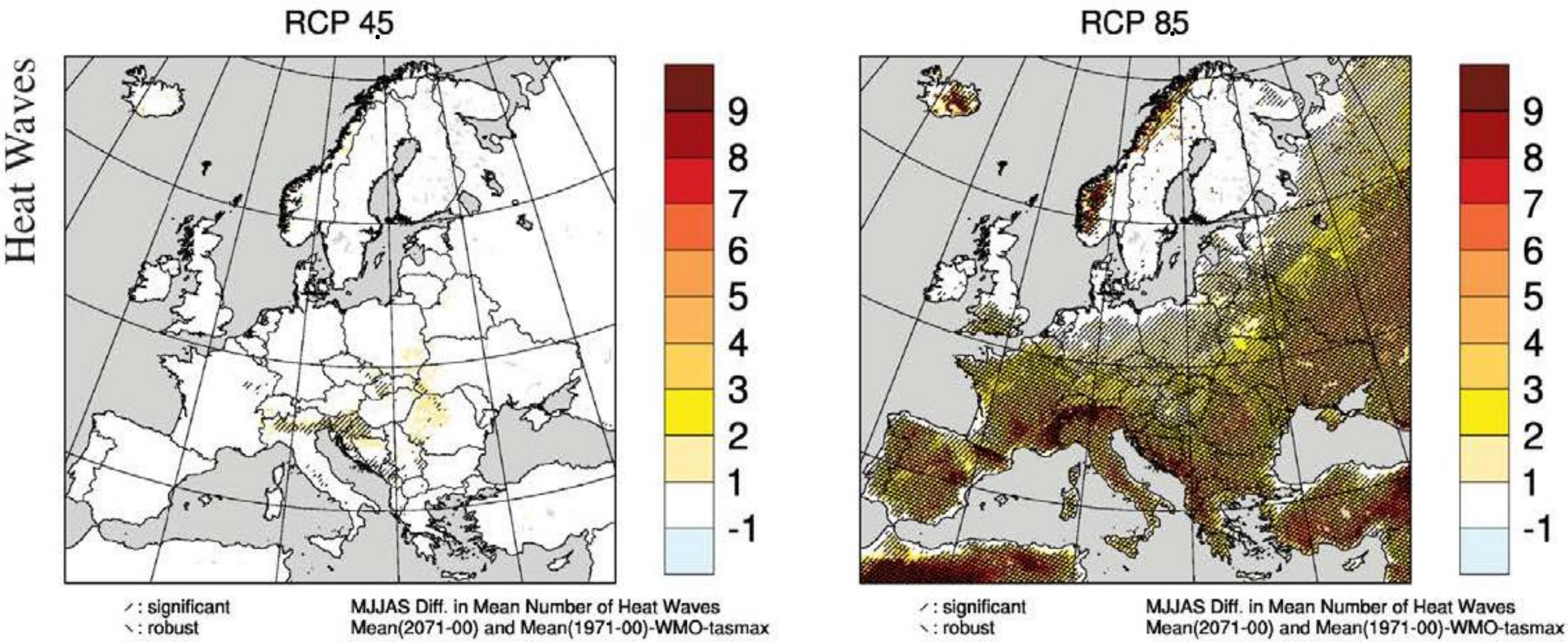
Climate impacts on world food prices

INTERGOVERNMENTAL PANEL ON climate change

Increased frequency of heat waves in Europe by the end of the century

Number of summer heat waves (>5 days) 2071-2100 compared to 1971-2000.
Heat waves are defined as periods of more than 5 consecutive days with daily maximum temperature exceeding the mean maximum temperature of the May to September season of the control period (1971-2000) by at least 5°C.

2071-2100 compared to 1971-2000.
Mean of 8 and 9 regional climate models, Eurocordex
///// Significant (P<0.05)   \\\\\ Robust (>2 models out of 3)



(Jacob et al., 2013; Eurocordex)

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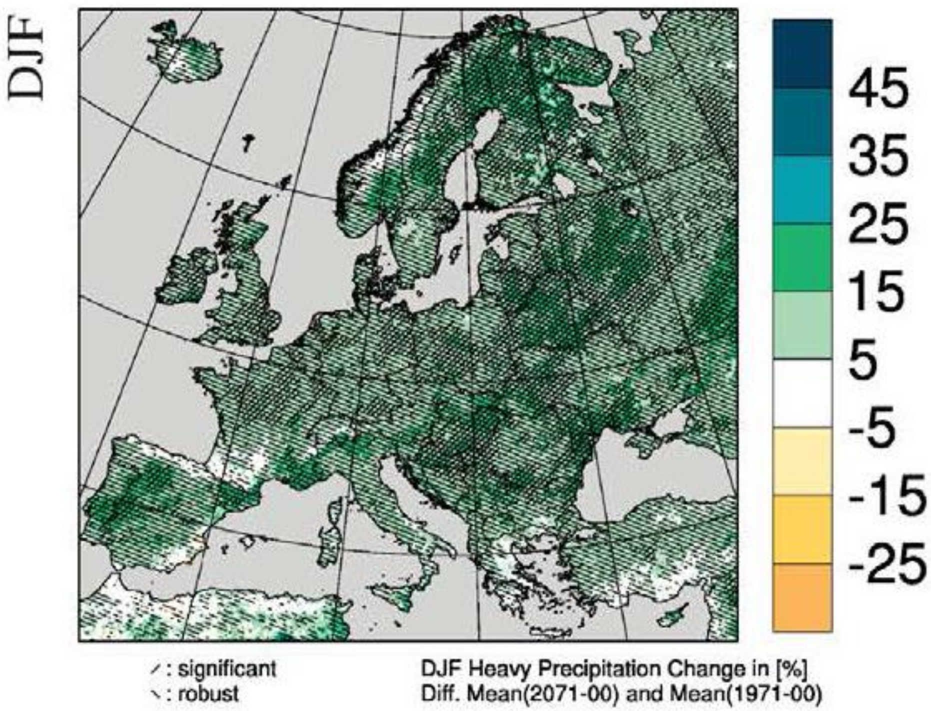
INTERGOVERNMENTAL PANEL ON climate change

Increased frequency of heavy precipitation in Europe by the end of the century

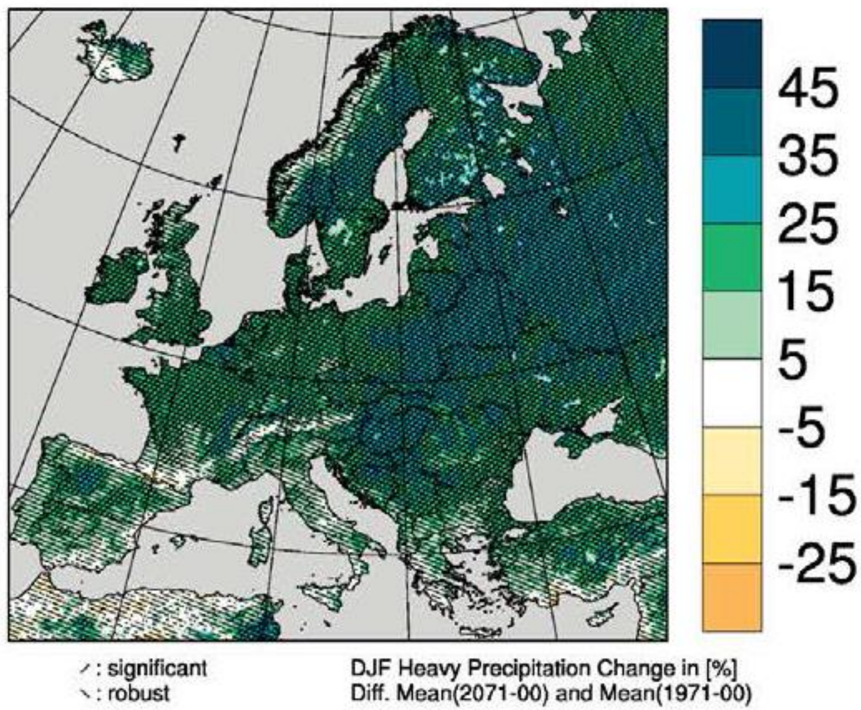
Heavy precipitation change (%) in heavy precipitation defined as the 95th percentile of daily precipitation (only days with precipitation > 1mm/day are considered)

2071-2100 compared to 1971-2000 for winter (DJF).
Mean of 8 and 9 regional climate models, Eurocordex
///// Significant (P<0.05) \\\\\ Robust (>2 models out of 3)

RCP4.5



RCP8.5



(Jacob et al., 2013; Eurocordex)

ipcc INTERGOVERNMENTAL PANEL ON climate change

Increased frequency of droughts by the end of the century

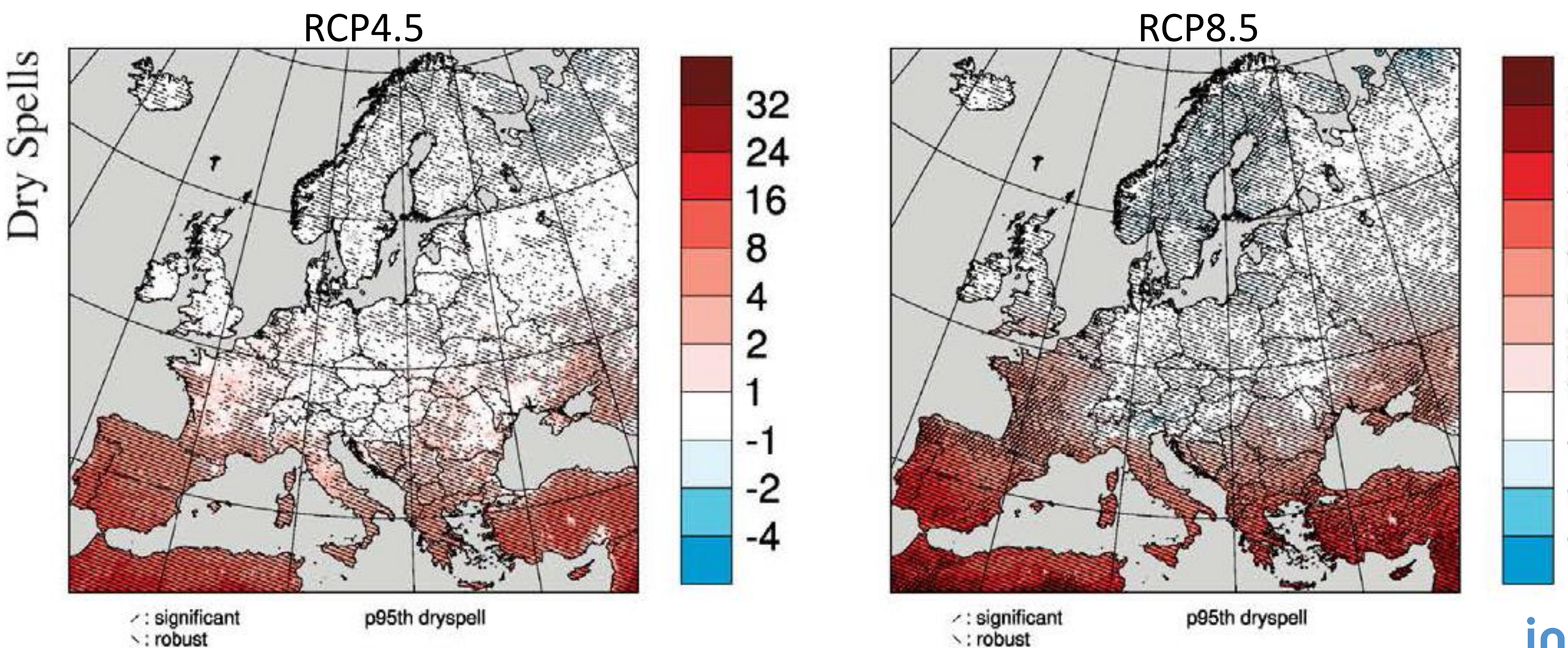
Annual duration of droughts

Projected changes in the 95th percentile of the length of dry spells for the period 2071-2100 compared to 1971-2000 (in days). Dry spells are defined as periods of at least 5 consecutive days with daily precipitation below 1mm.

2071-2100 compared to 1971-2000.

Mean of 8 and 9 regional climate models, Eurocordex

///// Significant (P<0.05) \\\\\ Robust (>2 models out of 3)



(Jacob et al., 2013; Eurocordex)

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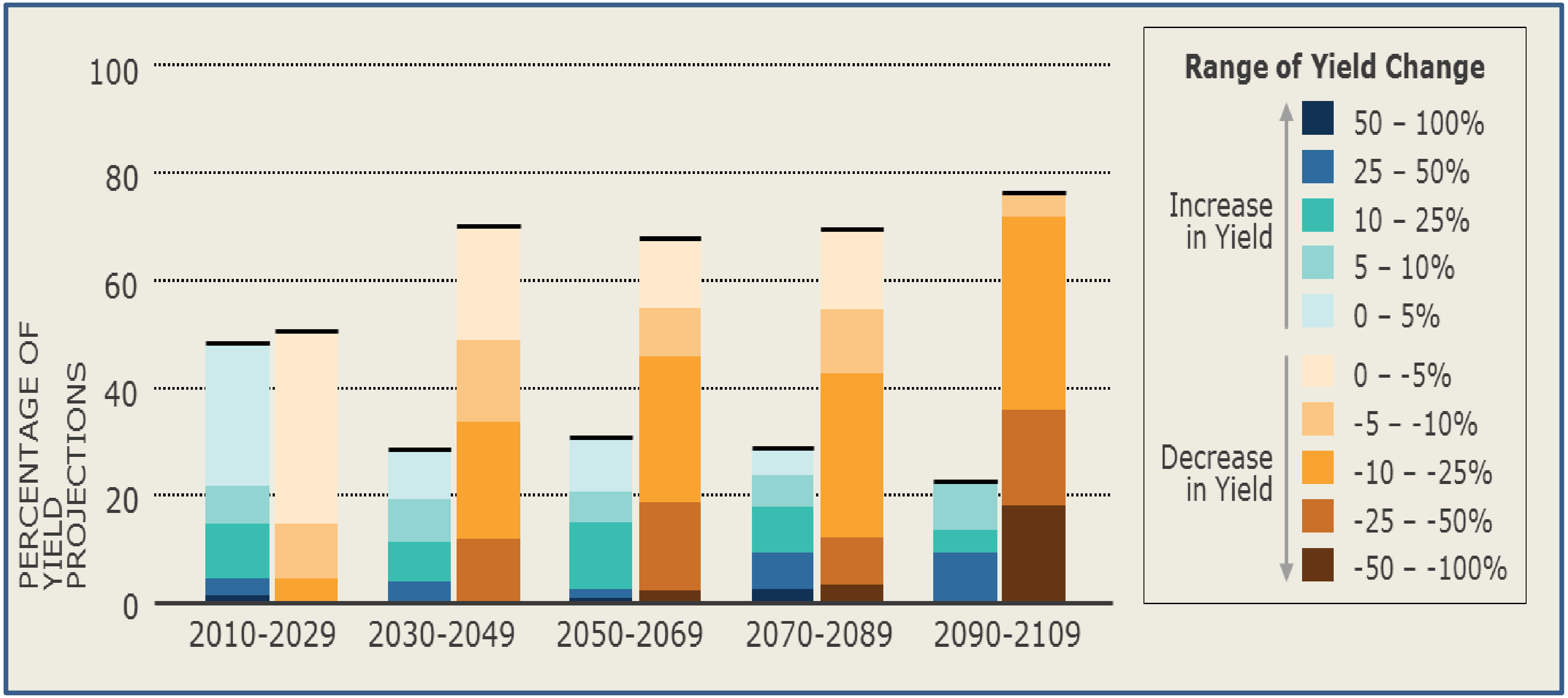
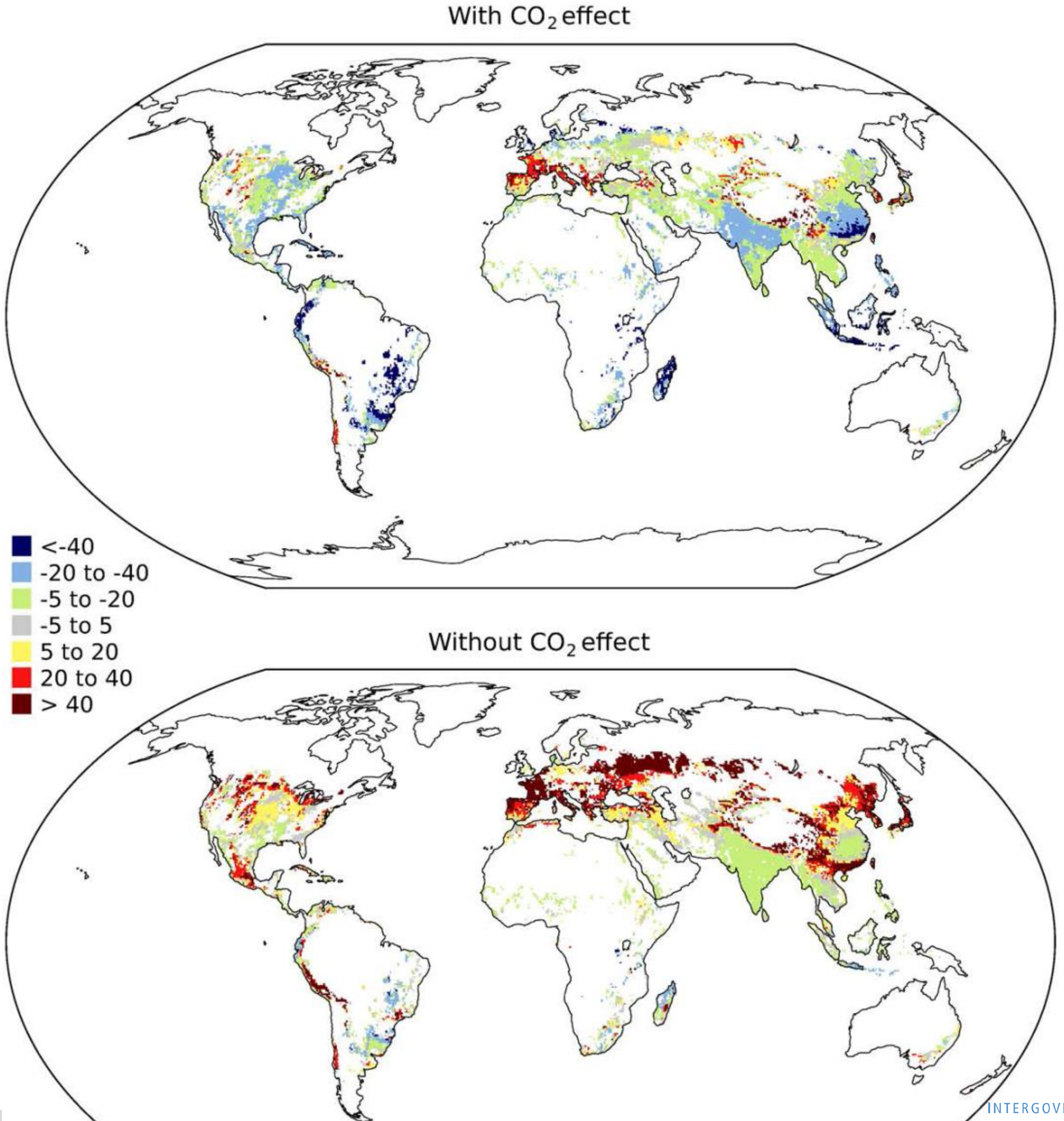
INTERGOVERNMENTAL PANEL ON climate change

Major impacts on crop yields by the end of the century



% change in net irrigation requirements of 11 major crops (1971–2000 to 2070–2099)

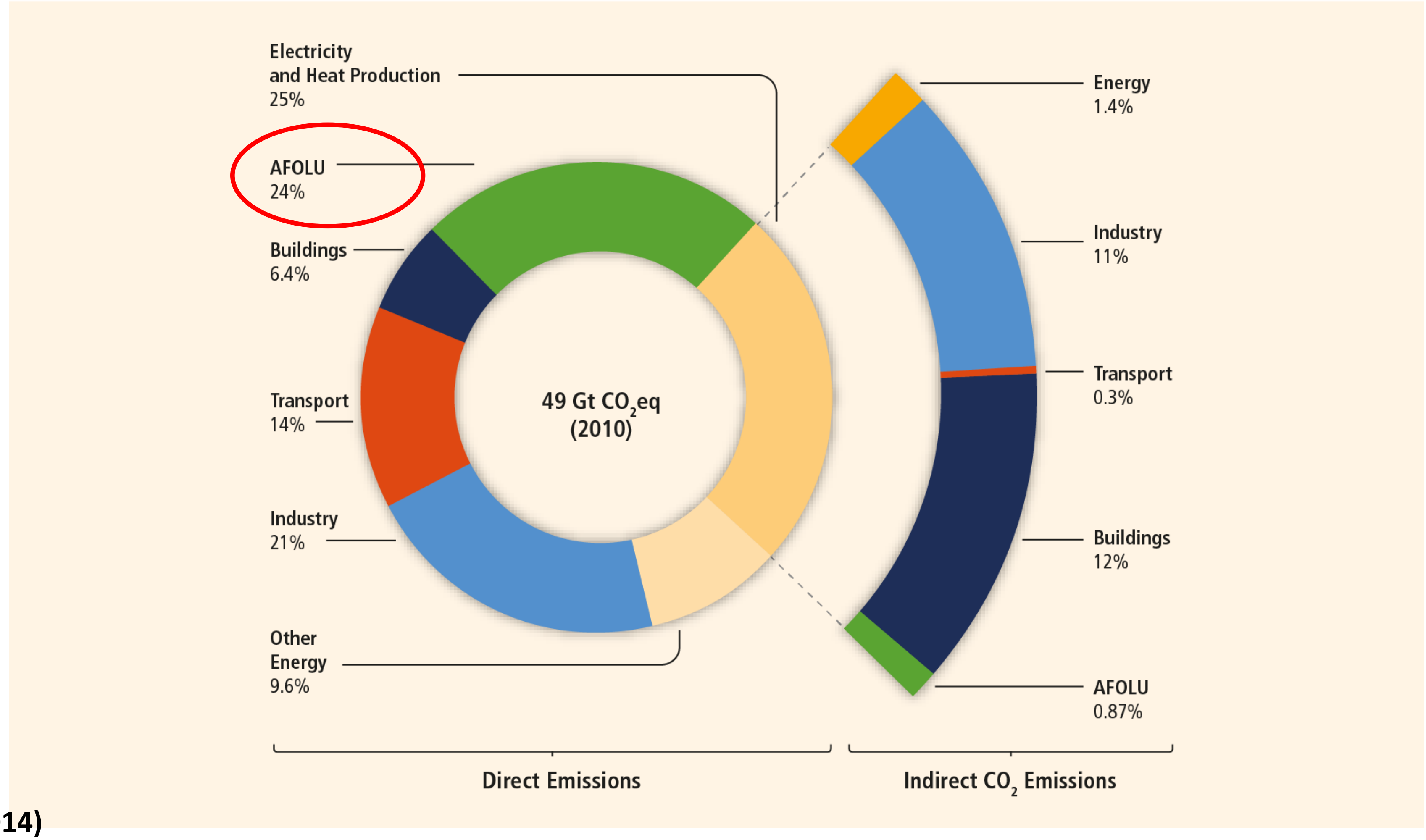
Areas currently equipped for irrigation, assuming current management practices.




Reducing GHG emissions
FROM AGRICULTURE

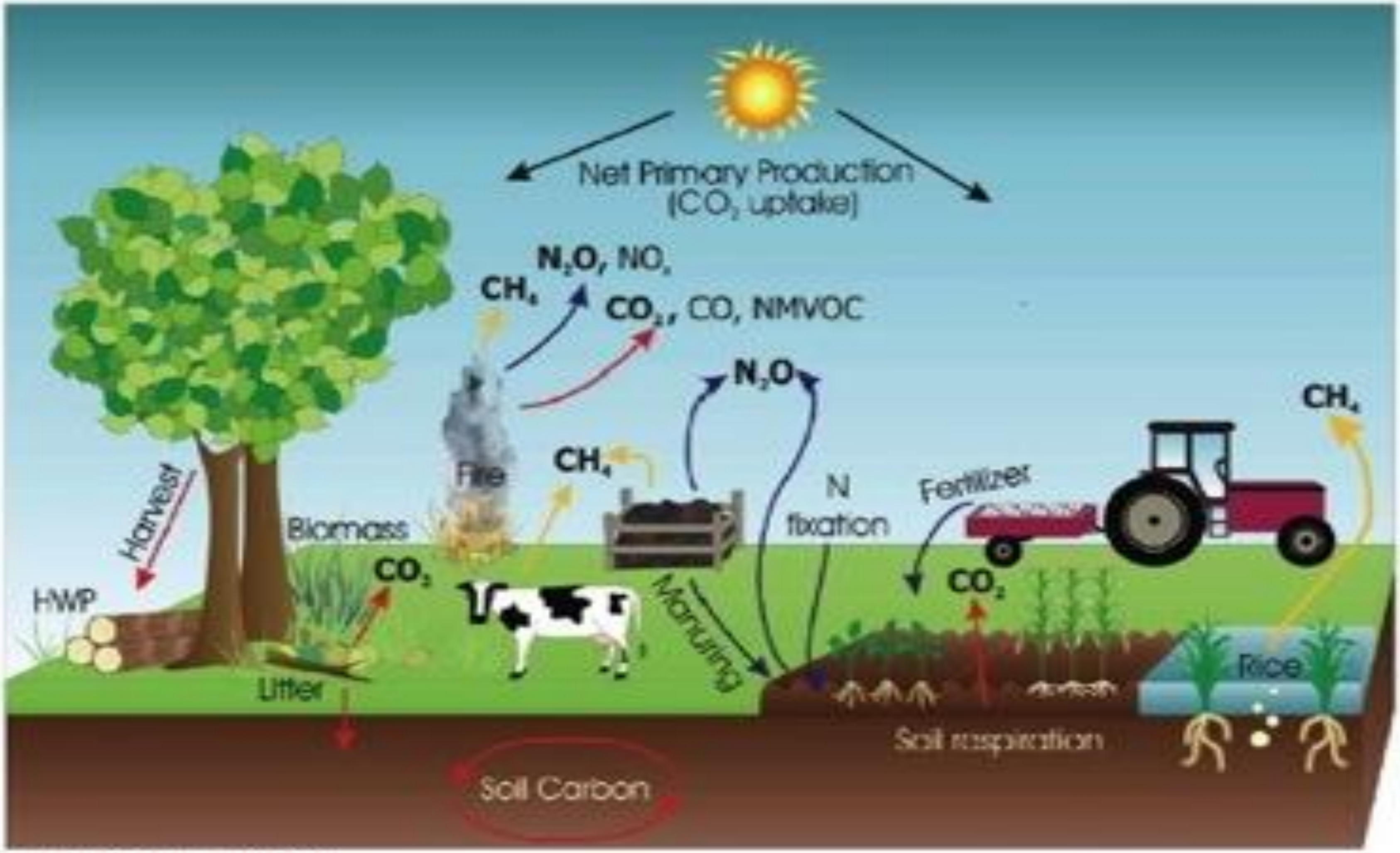
Agriculture, Forestry and Land Use change (AFOLU) in global greenhouse gas emissions

Greenhouse Gas Emissions by Economic Sectors



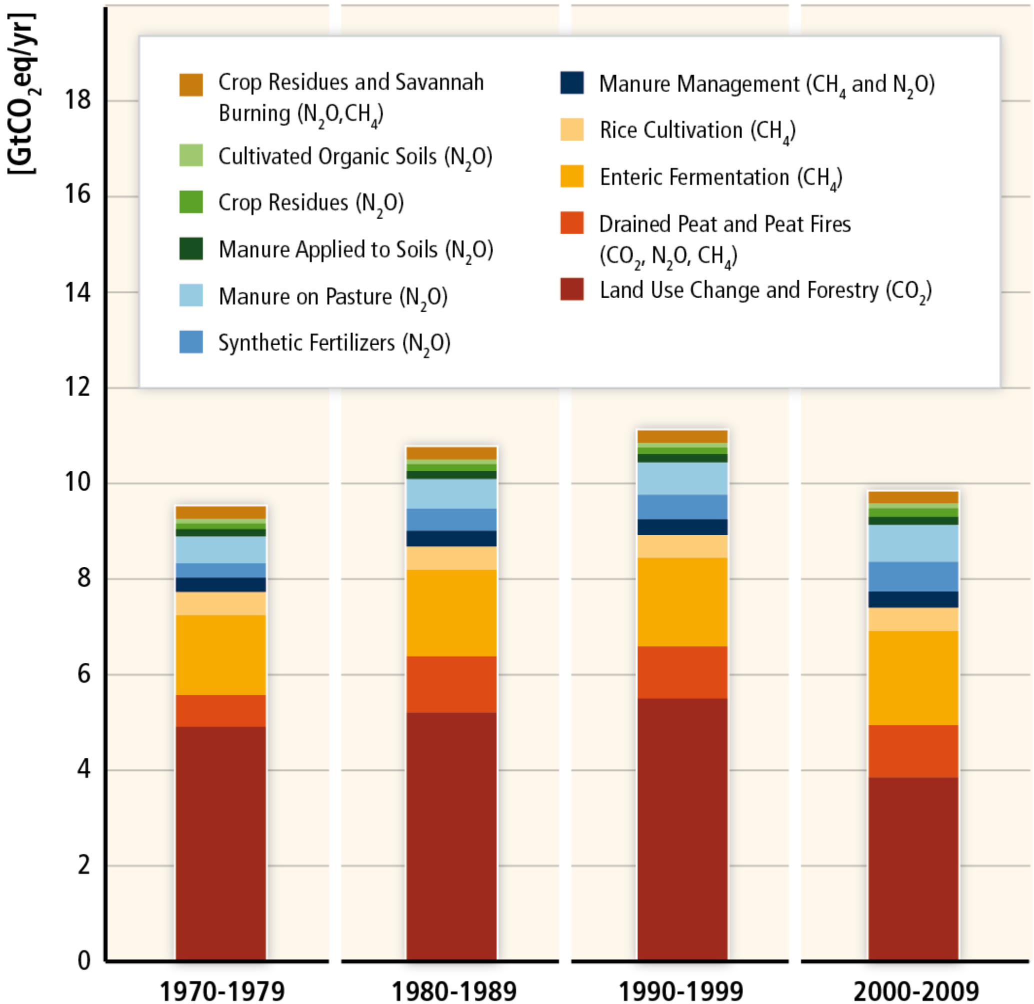
(IPCC, 2014)

Greenhouse gas in the agriculture, forestry and land use sector



Source: Paustian et al. (2006)

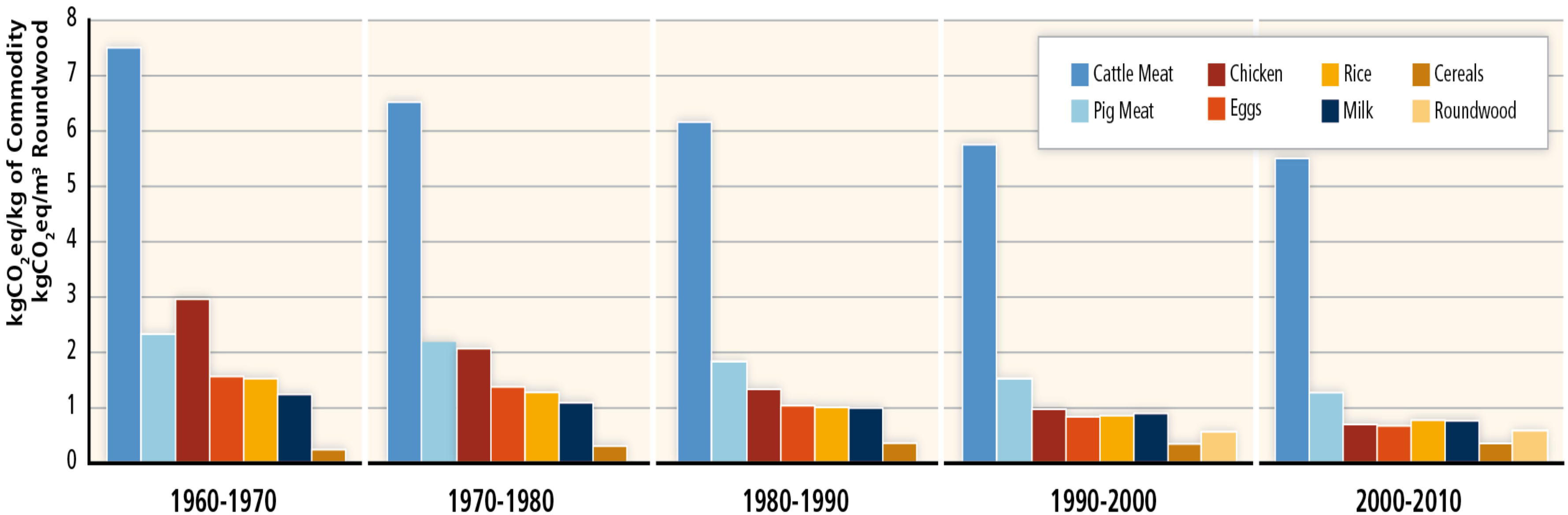
Agricultural emissions are increasing, but *net* forestry CO_2 emissions have fallen recently



- AFOLU accounts for 24% of total anthropogenic GHG emissions
- AFOLU is the only sector where net emissions fell in the most recent decade
- Whilst agricultural non-CO_2 GHG emissions increased, *net* CO_2 emissions fell, mainly due to decreasing deforestation, and increased afforestation rates

IPCC WGIII AR5

Emissions intensity of AFOLU products is falling as agriculture and forestry become more efficient



- Note that ruminant meat has a GHG intensity much higher than other agricultural products
- But also note that these are direct emissions only. If we include the emissions from the human-edible feed for mono-gastric animal products, they move closer to ruminant meat

IPCC WGIII AR5

AFOLU mitigation options:

SUPPLY SIDE

Livestock mgmt. Cropland mgmt. Int. systems Forestry

… and bioenergy

DEMAND SIDE

Dietary change
Improvement in the food chain
Use of wood products

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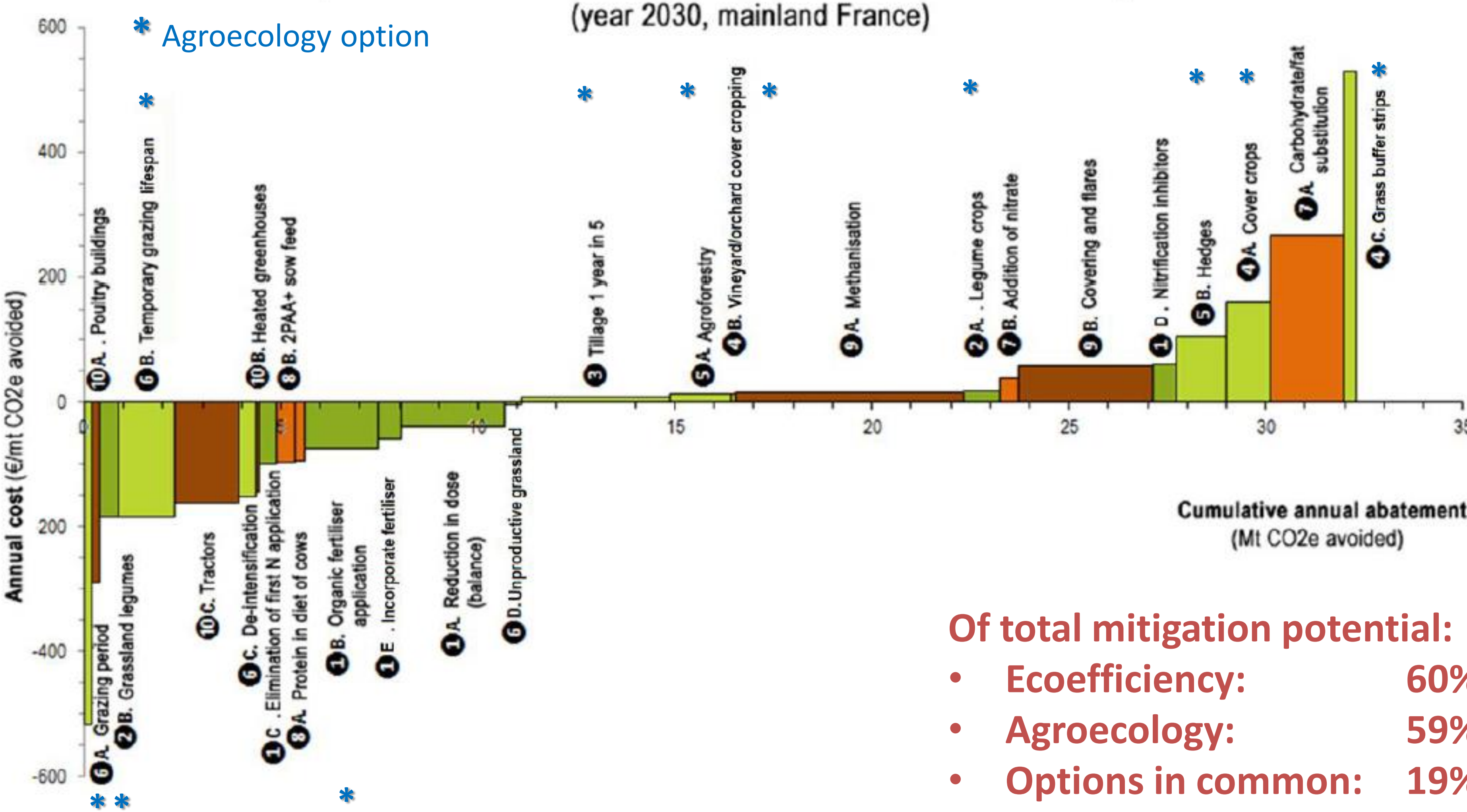
HOW CAN FRENCH AGRICULTURE CONTRIBUTE TO REDUCING GREENHOUSE GAS EMISSIONS?

ABATEMENT POTENTIAL AND COST OF TEN TECHNICAL MEASURES

Short summary of the study report conducted by INRA
on behalf of ADEME, MAAF and MEDDE – July 2013

Cost per metric ton of CO2e avoided for the farmer and abatement potentials
(year 2030, mainland France)



Of total mitigation potential:

- **Ecoefficiency: 60%**
- **Agroecology: 59%**
- **Options in common: 19%**

Soil organic matter: multiple benefits

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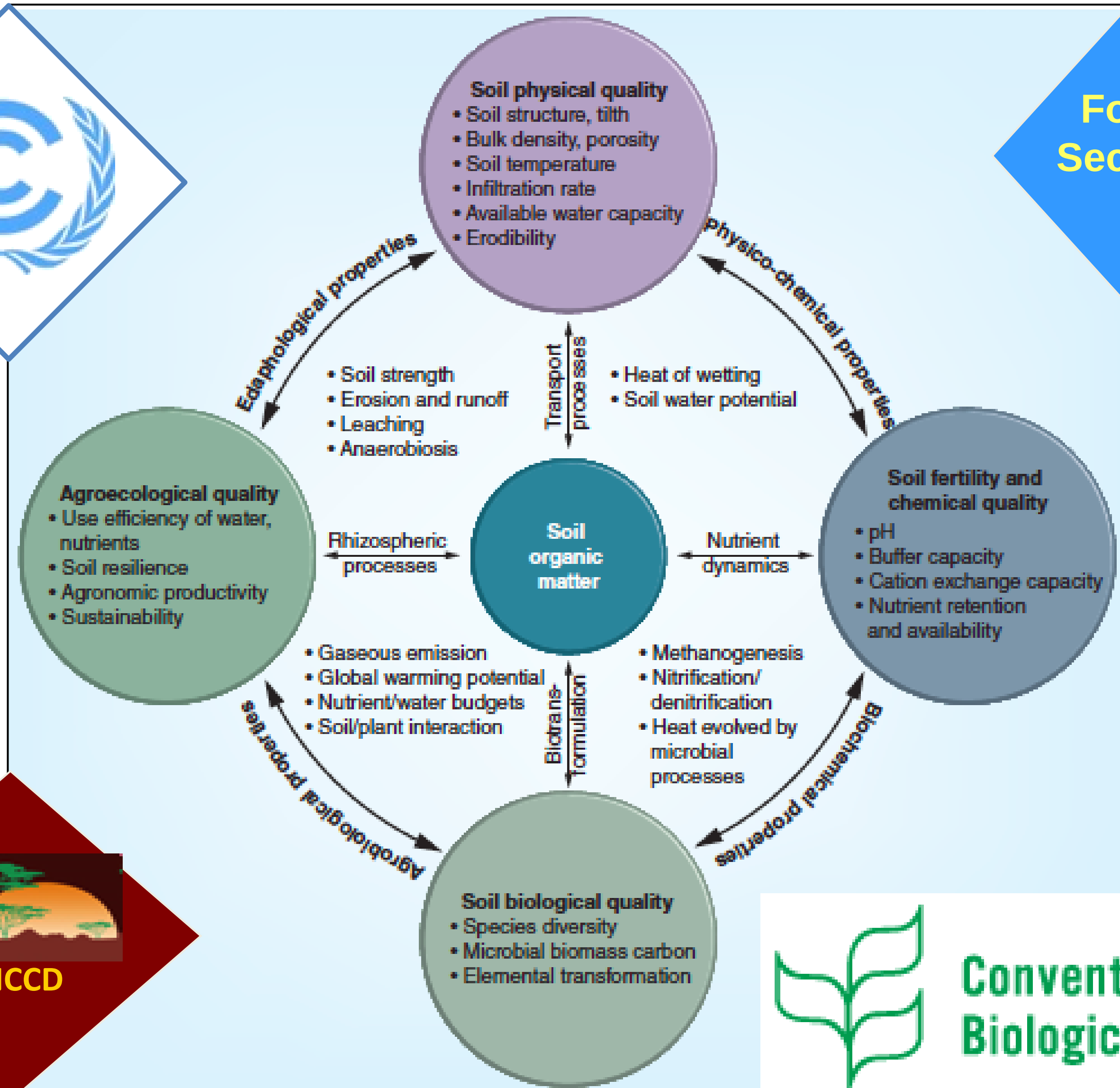
Soil Carbon

Food Security



UNCCD

Convention on Biological Diversity

a multipartner (state and non-state actors) program of actions for better management of soil carbon in order to combat poverty and food insecurity, while contributing to climate change adaptation and mitigation by:

- the implementation of agricultural practices at local level and management of environments favourable to the restoration of soils, to an increase in their organic carbon stock and to the protection of carbon-rich soils and biodiversity;
- the implementation of training and outreach programs to encourage such practices;
- the financing of projects to restore, improve and/or preserve carbon stocks in soils;
- the development and implementation of public policies and appropriate tools;
- the development of supply chains of soil-friendly agricultural products, and so on.

an international research and scientific cooperation programme – "Soil carbon and food security" focused on four complementary research themes:

- study of mechanisms and assessment of the potential for carbon storage in soils across regions and systems;
- performance evaluation of best farming practices for soil carbon and their impact on other greenhouse gases, on food security and on other regulation and production services;
- support of innovation and its promotion by appropriate policies;
- monitoring and estimating variations in soil carbon stock, especially at farmers level.

A public-oriented research institute (1/2)

Under the aegis of:

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE
DE L'ÉDUCATION NATIONALE,
DE L'ENSEIGNEMENT SUPÉRIEUR
ET DE LA RECHERCHE

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MINISTÈRE
DE L'AGRICULTURE
DE L'AGROALIMENTAIRE
ET DE LA FORÊT

MAAF

With a mission to:

- Produce and disseminate **scientific knowledge**
- Contribute to shaping **national research policy**
- Provide scientific expertise to **policy makers and private stakeholders**
- Develop **innovations**
- Furnish **educational training** by and for research
- Foster **science-in-society** debates
- Promote **ethics and integrity** in research

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A public-oriented research institute (2/2)

Our research encompasses three main areas with a 10-year strategy:

- Multi-faceted agriculture: design, evaluation, optimisation, diversification
- Climate change: impacts, mitigation and adaptation
- Energy and chemical applications of biomass and bio-derived products
- Healthy and sustainable food systems

4 priorities to address major challenges

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- Predictive biology
- Agroecology

2 emerging interdisciplines

Food security by 2050 in a rapidly changing global context

1 major goal

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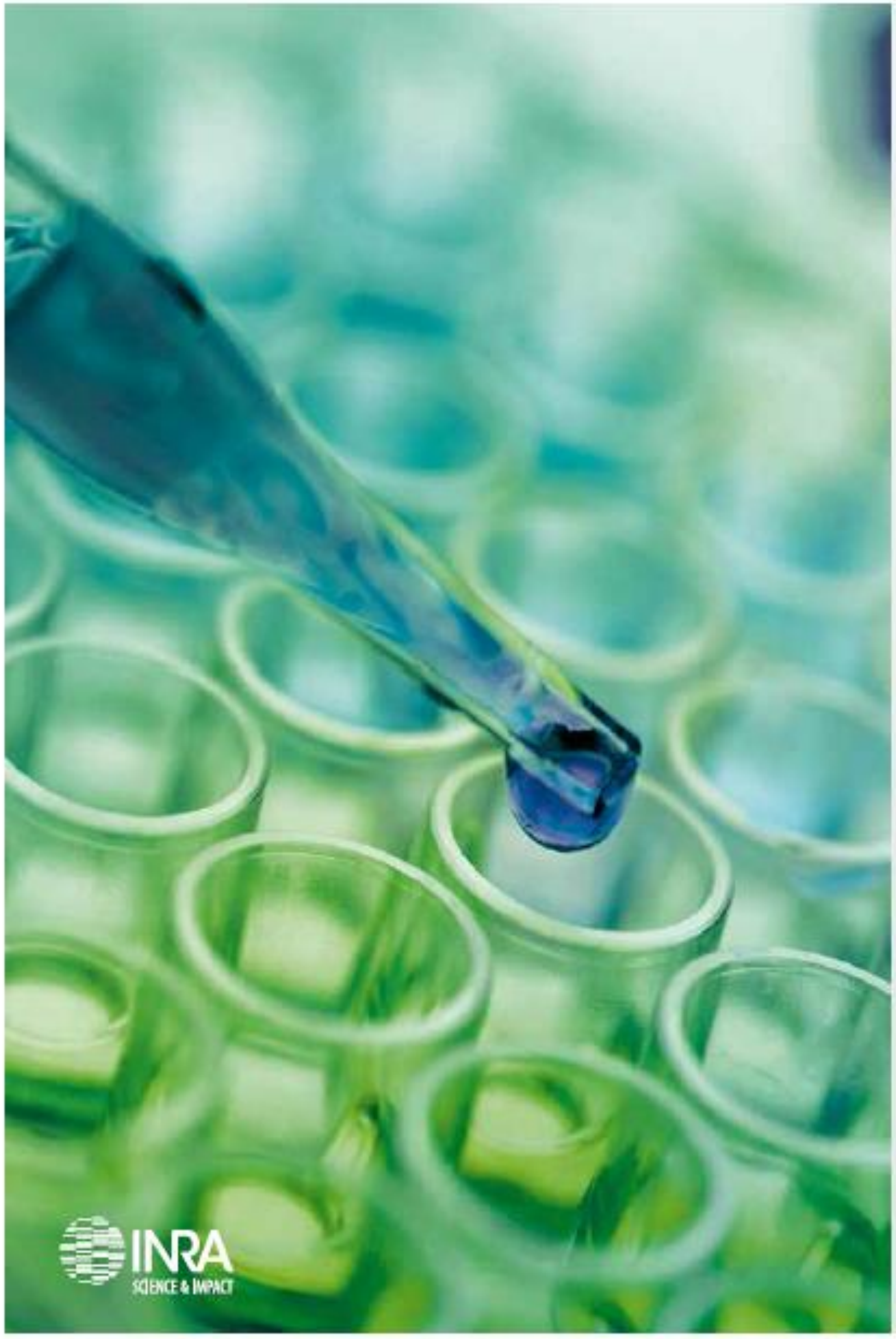

Metaprogrammes
Addressing major challenges

Metaprogrammes have been implemented to develop cross-disciplinary approaches

- Tackle socio-economic and scientific challenges through research
- Strengthen the impact of and ensure greater congruity in our research
- Promote and facilitate national and international partnerships

Metaprogrammes
Transcending disciplinary boundaries

8 metaprogrammes

ACCAF
Adaptation of agriculture and forests to climate change

GISA
Integrated management of animal health

GloFoods
Transitions to global food security (with CIRAD)

SelGen
Genomic selection

EcoServ
Agriculture and forest ecosystem services

DIDIT
Diet impacts and determinants: interactions and transitions

MEM
Meta-omics of microbial ecosystems

SMaCH
Sustainable management of crop health

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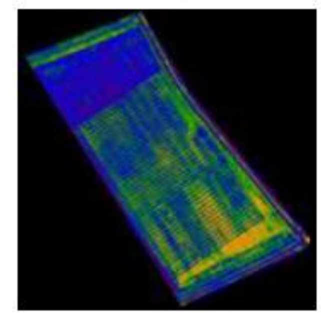
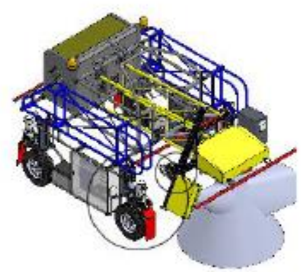
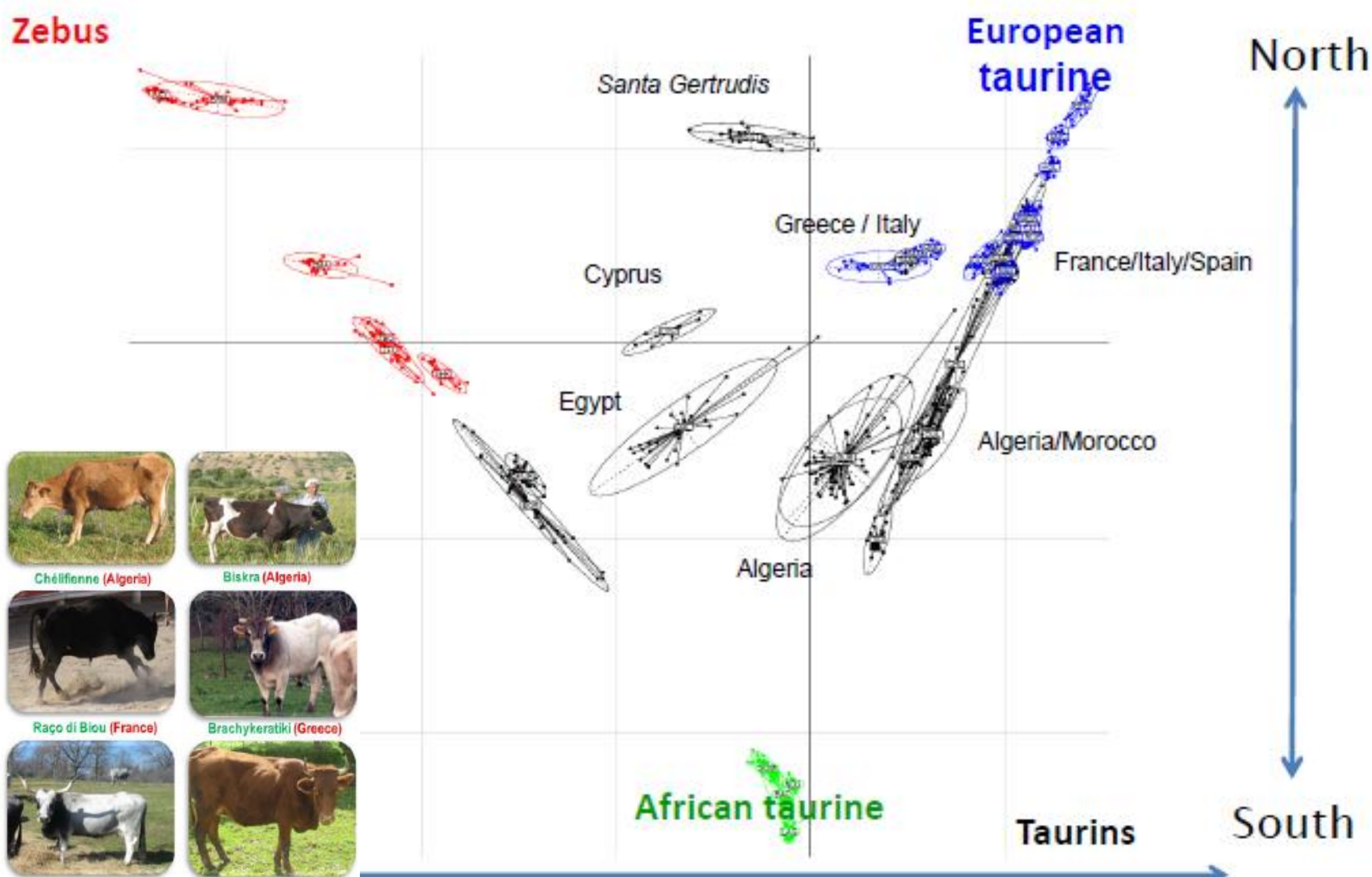
Plant breeding for heat and drought tolerance

Crop programs in France:
from genomics to phenotyping





Exploring the genetic diversity of Mediterranean cattle breeds



(Laloe et al., Galimed project)

Thank you for your attention!