Climate change mitigation in European agriculture insights from Italian data

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AWEEE – A Toxa

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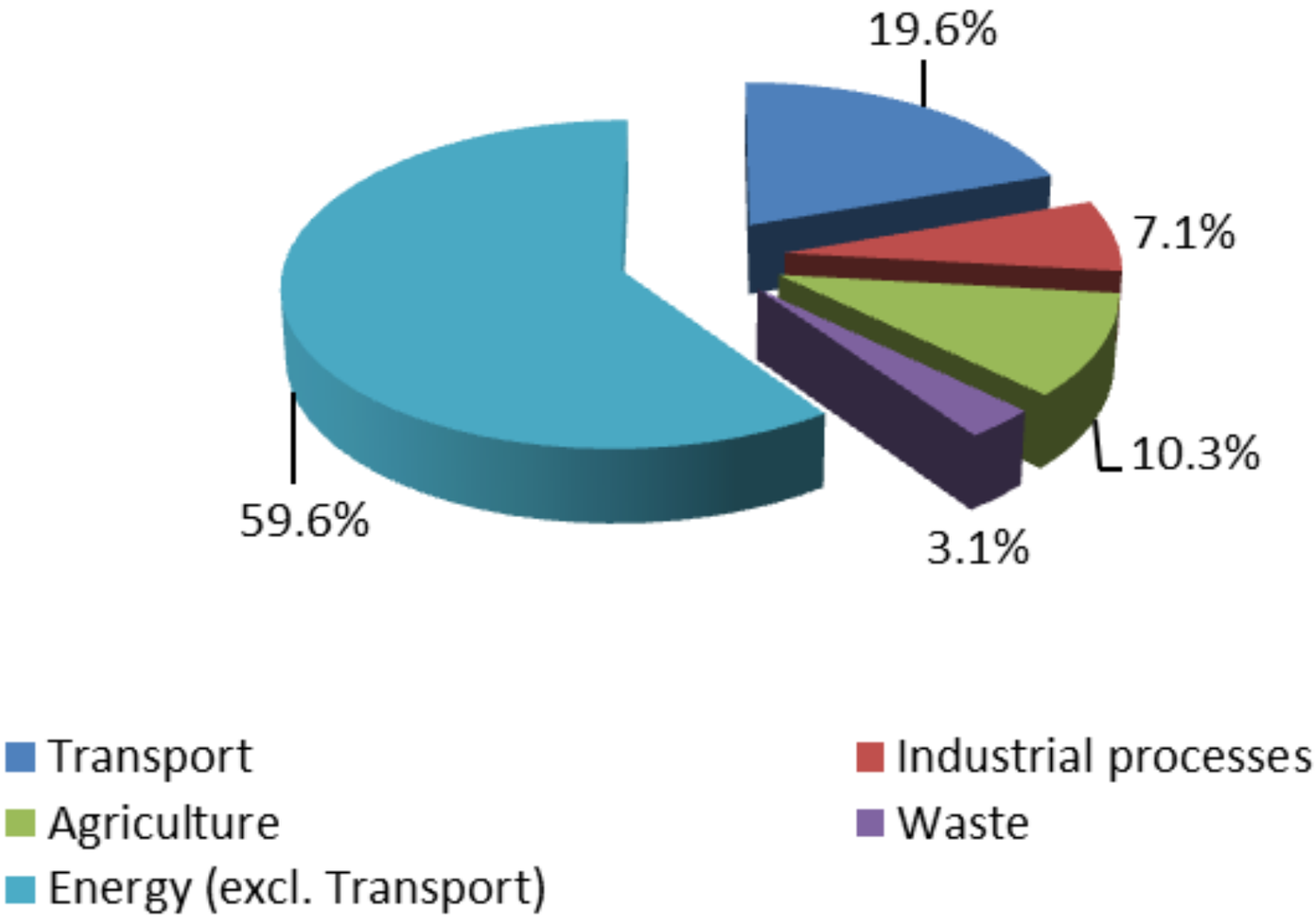
Motivation

- Mitigating climate change: priority for the EU. EU domestic emission abatement target by 2030 (40% w.r.t. 1990)
- EU ETS: reducing greenhouse gas emissions
- Agriculture is a NON-ETS sector
- Research in this area is still scarce
- Effort Sharing (Non ETS)

Agriculture & GHG Emissions in EU

GHG emissions in the EU-28: 471 MM tons of CO_2 equivalents in 2012.

Total EU-28 GHG emissions - shares by sector (2012)



share of agriculture emissions in total national GHG emissions

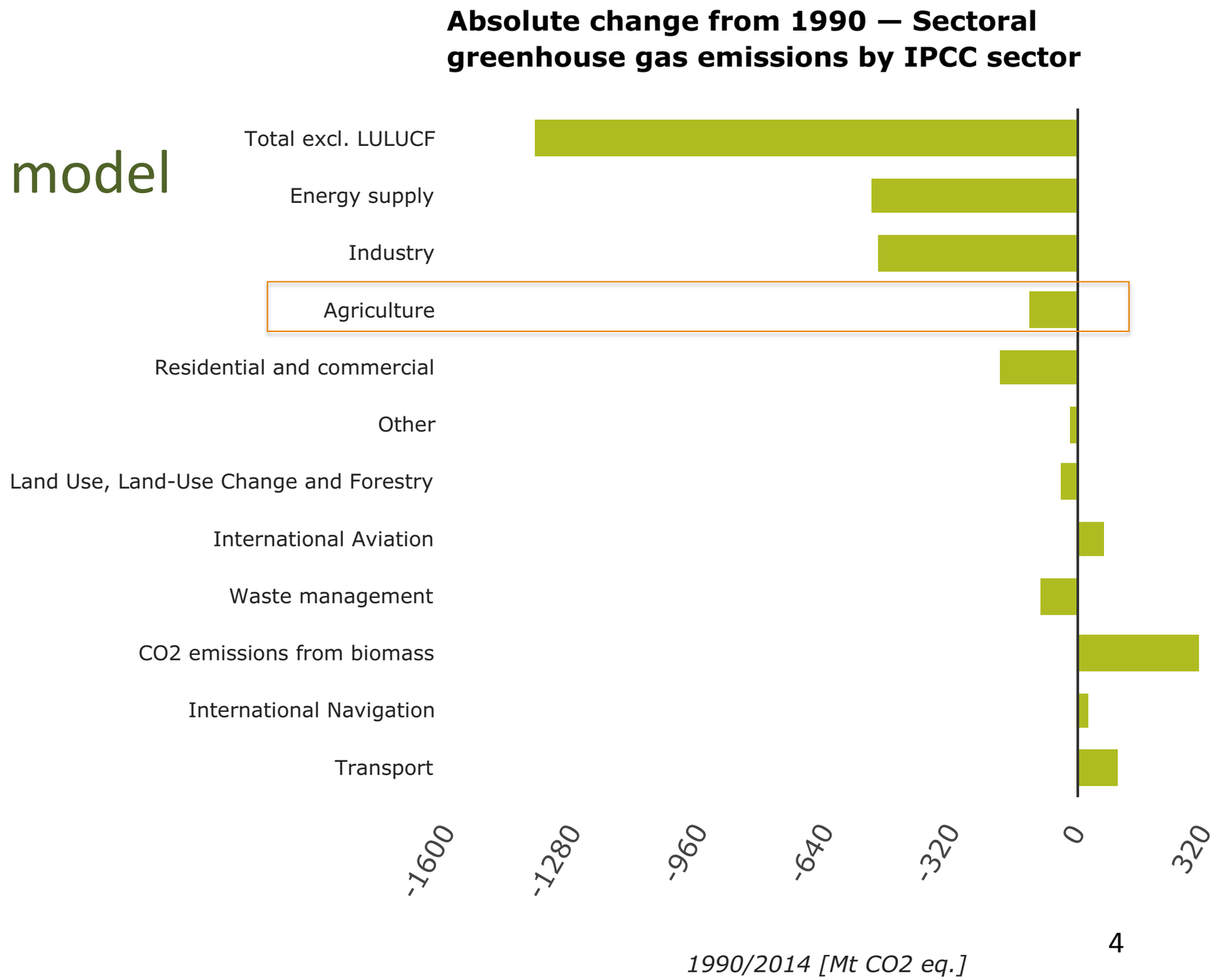
• Ireland	31%
• Lithuania	23%
• Latvia	22%
• UK	8%
• Italy	7%
• Czech Republic	6%
• Malta	2.5 %

Source: EEA (2015)

Agriculture & GHG Emissions in EU

Stable % of emission compared to other sectors: lagging behind?

Policy – EU as role model



Main Sources of GHG emissions in agriculture

- **carbon dioxide (CO2):** fossil energy (fuel, electricity, gas); change of carbon stock in ag. soils and the use of fossil energy during production process of ag. inputs (mineral fertilizers, animal feed, pesticides...)

- **methane (CH4):** ruminants' enteric fermentation, anaerobic fermentation during the handling and storage of animal manure, anaerobic fermentation in flooded rice fields

- **nitrous oxide (N2O)** use of mineral and organic nitrogen fertilizers & manure management

Research Question

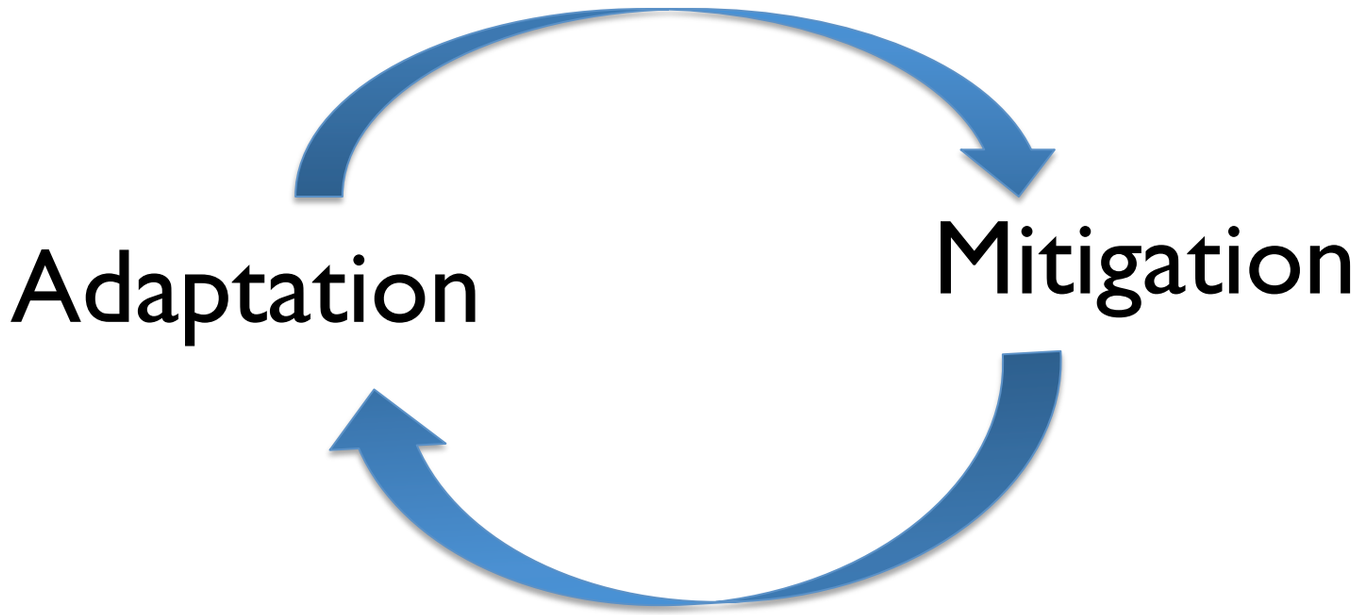
1. How EU Climate Policies and the CAP can impact farm's GHG emissions?

- **energy consumption and energy efficiency levels**
- production patterns (type of farming)

⇩

contribution of the agri-sector to overall GHG emissions in EU

2. :



Data

- Farm level data Farm Accountancy Data Network (FADN/INEA) comprehensive farm level dataset – representative sample of Italian (EU) agriculture

  ➢43,292 farms (2008-2013) – 7.215 p.y.

- Socioeconomic and geographic variables: EUROSTAT and national (e.g. ISTAT)

- Climate variables Climatic Research Unit UEA (CRU)

- Soil data HWSD v1.2 (FAO/IIASA/ISRIC/ISSCAS/JRC, 2012)

Methodology

- Panel data analysis to identify the impact of policies (RDP) on farms emissions (energy intensity)
- Region (NUTS2) FE and year FE controlling for geographic and socio economic characteristics

$$(Kw/AUL)_{it} = \alpha + \beta lag_{-1} P_{it} + \gamma X_{it} + \zeta F_{it} + \eta_t + \delta_r + u_{it}$$

"Agri-environment measures play a crucial role for meeting society's demand for environmental outcomes provided by agriculture"

- Group farms by main production type

Preliminary results

Dependent var: mechanization intensity (kwh/UAL)	Field Crops	Permanent Crops	Grazing Livestock	Mixed crop-livestock
Agri-environment payment$_{t-1}$	-.00006***	-.00021***	-.00006	-.00033***
Avg. altitude (m)	-.0032	.00157	-.0087***	-.0090***
UAL under env. constraints	-.0058*	-.0353**	-.0190**	-.0050
Family business dummy	2.7065***	4.3847***	2.8136*	5.724***
Year birth	-.0569**	-.0623***	.0392	.0190
Gender dummy	-.3752	-1.1777**	-.4878	-1.9344
Stable job dummy	-.4359	-4.1382***	-3.1895**	-4.5875
Revenue renewable energy	-2.75e-06***	-.00002	-6.48e-07	-8.87e-06*
Revenue agrotourism	-.00002*	.00002	-4.72e-06	.00008*
N	3505	8507	2604	909

Region (NUTS2) FE; Year FE; robust standard errors. *** p<0.01, ** p<0.05, * p<0.1

Next steps

- Upscale to EU arm level data
- Calculate TOTAL emission per farm
- Heterogeneity in EU
- Role European policies to influence emission

Conclusions

- Agriculture can contribute to emissions' reduction targets
- Statistically significant impact of policies on energy intensity
- Role agriculture in European emissions reductions targets

  (i) farming practices

  (ii) production patterns and related GHG emissions levels

- CC Adaptation can be a double edge swords to achieve mitigations target: RDP need to take this into account

Thank you!

Comments are welcomed!

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EXTRAS

Summary statistics

Variable |	Obs	Mean	Std. Dev.	Min	Max
kw_mach_sau	41570	15.088	59.83208	.0188679	9280.10
Kw_machineries	41570	154.034	362.3317	0	54103
AUL (Ha)	43292	27.859	56.64421	0.03	3445.08
Agri-env. payments	43292	1148.538	5395.902	0	221876
Avg. altitute (m)	43292	261.588	238.337	0	1900
AUL env. Constraints	43292	39.777	4292.114	0	800000
Family bus. dummy	43292	.844	.363	0	1
Year birth	43176	1954.646	14.018	1910	1996
Gender dummy	43176	.812	.39057	0	1
Stable job dummy	43176	.858	.349	0	1
Rev renewable en	43292	334.634	16172.76	0	2079590
Rev agro tourism	43292	1891.782	18382.6	0	1099939

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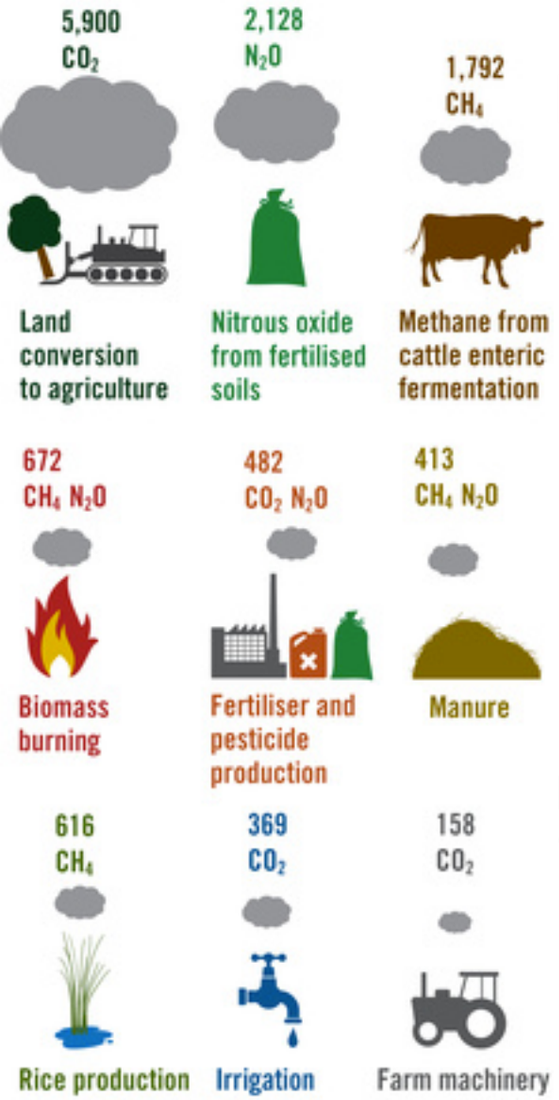
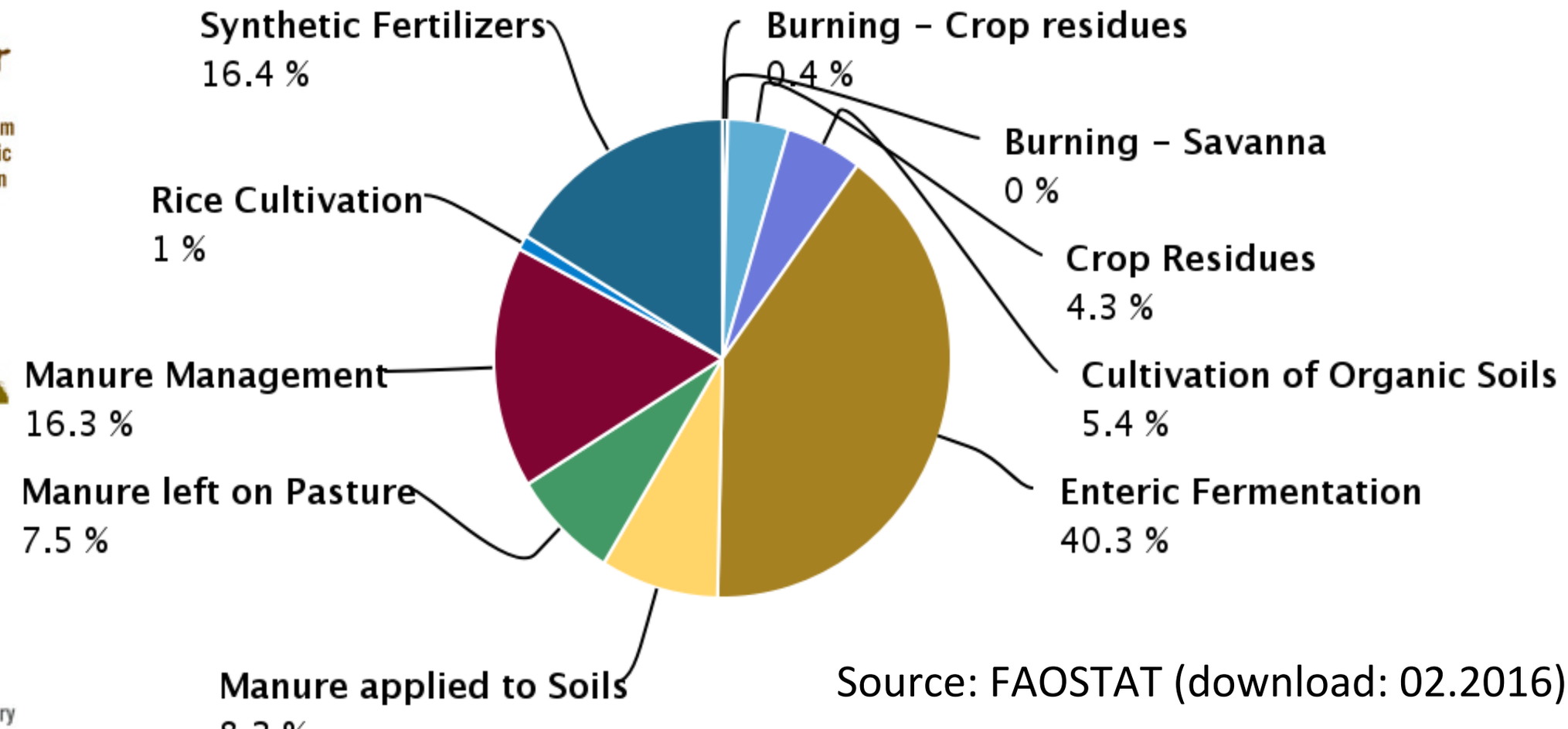


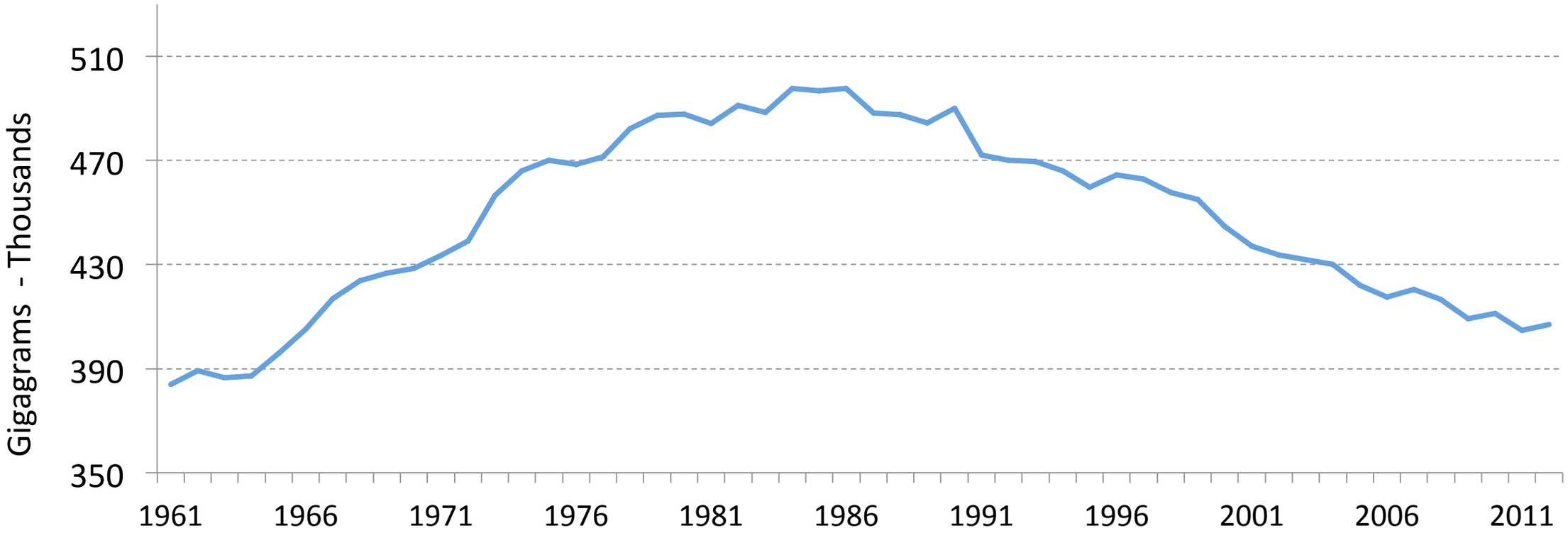
lture: GHG Emissions (direct) by Sub-Sector (average 1990-2012)



Source: FAOSTAT (download: 02.2016)

Agriculture & GHG Emissions in EU

EU Agriculture (total), Emissions (CO2 equivalent) 1961 - 2012



Source: own elaboration on data FAOSTAT, downloaded: 02.2016

Heterogeneity of Rural Development Plans

- Exclusively national (Denmark, Luxembourg, Sweden);
- Prevalently national (Austria, France, Ireland, Netherlands)
- Hybrid, but prevalently national (Finland, Greece, Portugal);
- Hybrid but prevalently regional (Belgium, United Kingdom, Spain);
- Regional (Germany, Italy)

Melozzi (2009)

2014-2020 Rural Development Programmes (RDPs)

Member States have to build their RDPs based upon at least 4 of the **6 common EU priorities**.

5: Resource efficiency and shift to low carbon and climate resilience economy in agriculture, food & forestry

As Ireland's total *GHG emissions p.c are among the highest in the EU*, and of the total GHG emissions agriculture accounts for the biggest share with 32%, *taking decisive action against climate change is an important challenge for the country*.

This priority is targeted by *improving the energy efficiency of the Irish farming sector*, with a total of €50MM investment forecast, as well as encouraging and supporting *climate-friendly agricultural practices on over 10% of the agricultural land.* Furthermore, there is a targeted intervention in order to reduce livestock emissions and emissions intensity of production.

Ireland

To contribute to the *reduction of greenhouse gas emissions from agriculture, the programme aims for 30% of livestock units to benefit from investments in livestock management to reduce emissions.*

Grand Duchy of Luxembourg

RDP includes a cooperation measure for joint *climate change adaptation and mitigation actions*...

Co-operation measure supports enhanced sustainability through the European Innovation Partnership and through co-operation for climate change adaptation and mitigation.

Tuscany

How GHG emissions in agriculture are calculated

- **Inventory of the agricultural sector as a whole**

- **Accounting at individual farm level:** with a balance sheet system:

emissions of GHG gases: 1. carbon dioxide (CO_2), 2. methane (CH_4), 3. nitrous oxide (N_2O)	sequestration of carbon in soils + production of renewable energy and biomaterials

- **Life cycle assessment, which calculates emissions based on agricultural products (**milk, beef, arable crops, biogas etc.)

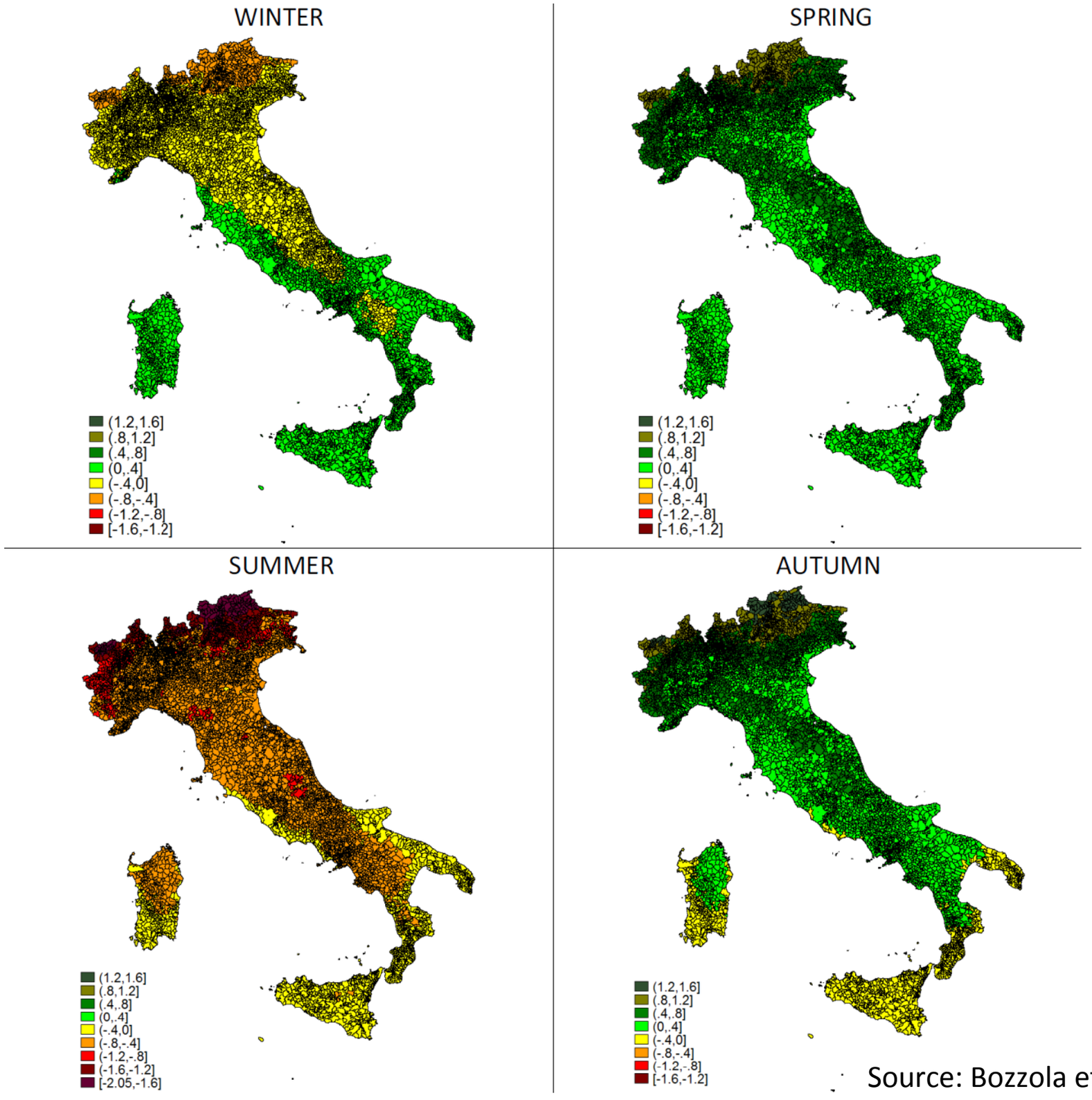
6 common EU priorities in RDP

Member States will have to build their RDPs based upon at least 4 of the **6 common EU priorities**.

1. fostering knowledge transfer and innovation in agriculture, forestry and rural areas;
2. enhancing the viability/competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management;
3. promoting food chain organisation, animal welfare and risk management in agriculture;
4. restoring, preserving and enhancing ecosystems related to agriculture and forestry;
5. promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors;
6. promoting social inclusion, poverty reduction and economic development in rural areas.

Analysis of the Impact of CC on Italian Agriculture

Marginal Effects Analysis Impact in EUR/ha of 1°C by Season



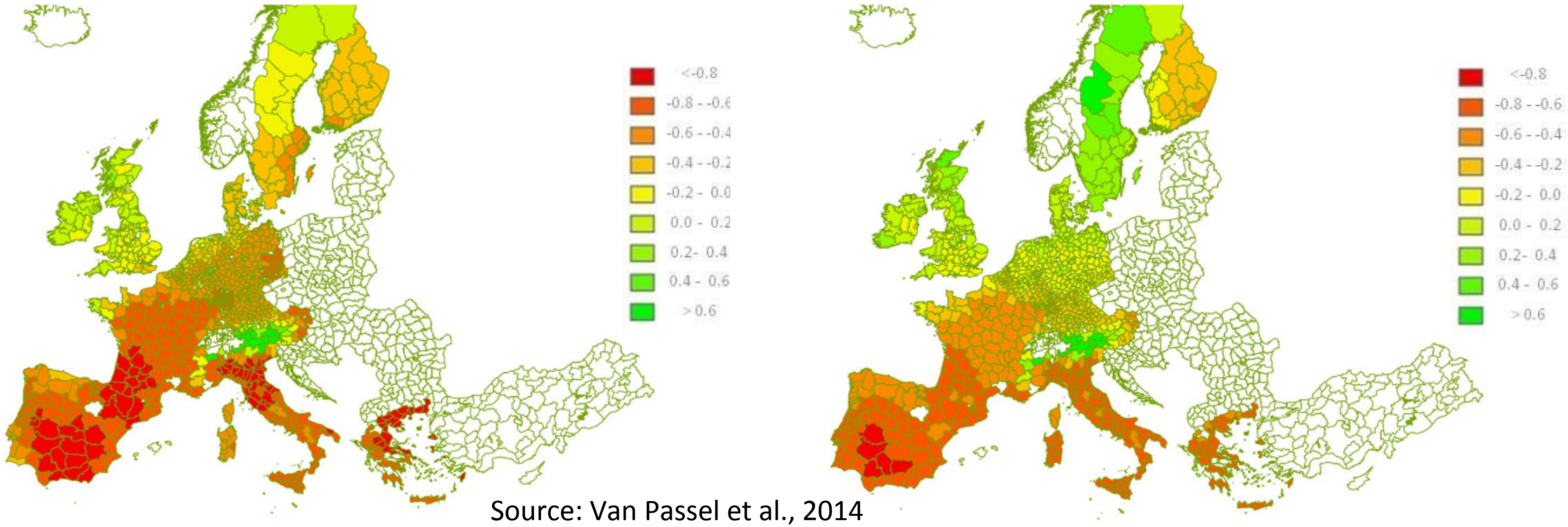
Source: Bozzola et al., 2016

Climate change impacts: heterogeneity across Europe

NORTH	SOUTH
+ CROP SPECIES + VARIETIES EXPANSION OF CULTIVATED AREAS	- CROP YIELDS + CROP YIELDS VARIABILITY - SUITABLE LAND FOR TRADITIONAL CROPS
INCREASING NEEEDS FOR PLANT PROTECTION PRODUCTS	

Source: own elaboration on selected literature

% change in farmland values predicted by different climate scenarios (CM3 and ECHO-G)



Source: Van Passel et al., 2014