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POLICY DEPARTMENT
STRUCTURAL AND COHESION POLICIES **B**

Agriculture and Rural Development

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**RESEARCH FOR AGRI COMMITTEE -
THE CONSEQUENCES OF CLIMATE
CHANGE FOR EU AGRICULTURE.
FOLLOW-UP TO THE COP21 - UN
PARIS CLIMATE CHANGE
CONFERENCE**

STUDY



DIRECTORATE-GENERAL FOR INTERNAL POLICIES
POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES

AGRICULTURE AND RURAL DEVELOPMENT

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THE COP21 - UN PARIS CLIMATE CHANGE
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STUDY

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Abstract

This report reviews and discusses the implications for the agriculture sector of the COP21 UN Paris climate change conference and the recent EU climate policy proposals for 2030. It looks specifically at the role that the Common Agricultural Policy (CAP) plays in supporting climate action within the agriculture sector and considers how the CAP might evolve post 2020 to support the agricultural sector in reducing GHG emissions and adapting to climate change.

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LIST OF ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
CAP	Common Agricultural Policy
COP	Committee of the Parties
CM	Cropland management
CSF	Catchment Sensitive Farming
EAFRD	European Agricultural Fund for Rural Development
ECCP	European Climate Change Programme
EED	Energy Efficiency Directive
EFA	Ecological Focus Area
EIP	European Innovation Partnership
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ETS	Emissions Trading System
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FAS	Farm Advisory System
GAEC	Good Agricultural and Environmental Condition
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GM	Grazing land management
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
MFF	Multi-Annual Financial Framework
MMR	Monitoring Measures Regulation
PaM	Policies and Measures
RDP	Rural Development Programme
SBSTA	Scientific and Technological Advice
SMR	Statutory Management Requirement
UNFCCC	United Nations Framework Convention on Climate Change

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EXECUTIVE SUMMARY

Aim of the report

The aim of this report is to examine the significance of the commitments made to reduce global greenhouse gas emissions under the 2015 Paris Agreement for the agricultural sector. It has two main objectives:

1. To set out the global context for EU climate action and how this has developed over time, with a specific emphasis on the way in which the EU agriculture sector has been treated and affected by climate policy up until COP21; and
2. To analyse and discuss the implications of COP21 and developments in EU climate policy for the agriculture sector, considering the role that the CAP can play in supporting climate action within the agriculture sector and providing thoughts on the future role of the CAP in this regard.

For the purpose of this study, emissions relating to the 'agriculture sector' are taken to encompass both CO₂ and non-CO₂ emissions, as distinct from the more limited category of agriculture emissions used within the current Effort Sharing Decision (i.e. only non-CO₂). The analysis is focussed on the agriculture sector and therefore does not cover forestry sector emissions directly; although any indirect impact on the agricultural sector of mitigation policy in forestry is covered.

Background and context

The Earth's climate has always undergone periodic changes that have affected the conditions available to life on the planet. Yet recent anthropogenic emissions of greenhouse gases (GHGs) are the highest in history and atmospheric concentrations of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are unprecedented in at least the last 800,000 years. Europe wide GHG emission levels have, however, decreased since 1990, although there has been a slowing in the rate of reduction in the last decade and there have even been some increases in emission levels from agriculture in recent years.

Agriculture is one of the main sectors contributing to global GHG emissions, and is the fifth largest contributor to GHG emissions in the EU (11.3%; 514.1MtCO₂e)¹, after the energy, transport, industry, residential and commercial sectors. Agricultural GHG emissions arise largely from non-CO₂ GHGs (nitrous oxide (N₂O) and methane (CH₄)), with only minor contributions from CO₂. It contributes 10% of the total EU non-CO₂ emissions with a high degree of variation between Member States. Agriculture can aid in the mitigation of climate through reducing GHG emissions from sectoral activities (e.g. increased efficiency), increasing removals through the absorption of carbon in soils and biomass (sequestration), and increasing the contribution the sector makes towards renewable energy production (e.g. biomass production or space for infrastructure).

With the reduction of GHG emissions in other sectors, the relative share and importance of delivering emission reductions in the agriculture sector will increase. Efforts to reduce agriculture GHG emissions will need to increase if the sector is to play a significant role in the EU's emission reduction targets to 2030.

¹ This figure relates solely to non CO₂ emissions and excludes CO₂ emissions and removals accounted for through the LULUCF Decision.

EU climate action and the role of the agricultural sector

The current operational framework tackling climate action at the EU level is the 2020 Climate and Energy Framework which addresses sectoral action to deliver on the EU's Kyoto Protocol commitments. Agricultural mitigation efforts for non-CO₂ GHGs are covered under the EU's Effort Sharing Decision (ESD) addressing sectors not covered by the EU Emissions Trading System (EU-ETS). The ESD includes specific binding targets on Member States to 2020 with flexibility on the potential contribution of agriculture as opposed to other ESD sectors (e.g. transport).

Agricultural CO₂ emissions are largely addressed under the Land Use, Land Use Change and Forestry (LULUCF) Decision, relating to cropland and grazing land management, along with forestry. The LULUCF Decision does not currently count towards the EU's 2020 climate mitigation targets under the Climate and Energy framework, and therefore does not include specific targets for emission reductions in the same way as the ESD. LULUCF sectors do however count towards the EU's quantified emission limitation under the Kyoto Protocol, therefore still necessitating accounting and reporting from these sectors. For agriculture, the interplay between the ESD (net emissions) and LULUCF (net removals) sectors is important in establishing climate action in the sector.

The Paris Agreement established new ambition to climate mitigation efforts globally. In the EU this is enshrined in the EU's 2030 climate and energy framework and associated targets (to reduce emissions by 40%) and coherent with the EU's 2050 low carbon transition towards 80% emission reductions. New regulation is proposed under the 2030 framework that will supersede the ESD and LULUCF. The Commission proposal for an Effort Sharing Regulation (ESR) will, if adopted in its current form, establish new, more stringent targets on emission reductions in the non-ETS sectors (including agriculture) and the proposal for LULUCF Regulation will, if adopted, include a no-debit rule, meaning the sector cannot emit more GHG emissions than it sequesters in a given year.

There is a high degree of proposed flexibility on how to meet the new ESR and LULUCF targets, with potential to allow offsetting of ESR emissions (e.g. from agriculture) by using removals in the LULUCF sector as well as in the sectors covered by the ETS.

At the Member State level, action on climate is closely related to the share of agriculture in total GHG emissions. The share of agriculture emissions is used to set targets for the ESD and both targets and level of flexibility available to Member States in the proposed ESR. This is based on the often-unchallenged premise that it is less efficient (i.e. more costly) to deliver mitigation effort in the agriculture as opposed to other sectors. Member State action on climate reinforces this assumption, with concerns expressed over the impact of mitigation on food production and profitability of the agriculture sector as a whole. With livestock production contributing a significant proportion of the sectors emissions this raises additional questions on the demand side (about consumption patterns) and influence of behaviour outside of the sector on mitigation efforts.

Despite the clear need for action on climate in the agriculture sector, there is relatively little ambition evident as yet in Member States, particularly on mitigation. Action on climate adaptation is more prominent at the Member State level. Adaptation will be a critical priority as agriculture is the economic sector most uniquely susceptible to changes in climate patterns with the impacts highly place- and crop- specific. The main climate related pressures on agriculture are water availability, overall temperature variations, presence and persistence of pests and diseases, as well as fire risks. In the EU, climate related impacts on agriculture have largely been negative, with positive impacts limited to temperature increases in northern latitudes.

Climate Change mitigation and adaptation in the CAP

The CAP has considerable potential to help support climate mitigation and adaptation by influencing how individual farmers choose to manage their land, crops and livestock and how they use inputs, including energy, fertilisers and water.

Climate objectives have become gradually more prominent within the CAP over time. Climate change was highlighted as one of the priorities for agricultural and forest related land management payments under rural development policy for the first time in 2007. Under the CAP Health Check in 2008/9 the importance of addressing climate actions was reinforced as a result of commitments made under the Kyoto Protocol. The Health Check resulted in additional funding being made available to rural development policy (as a result of increased rates of transfers – or modulation – from direct payments) and Member States were permitted to allocate this to five priorities, one of which was climate. From 2014 onwards, climate action has become much more embedded in the priorities of the CAP as a whole. For this first time it features as a cross-cutting priorities, as one of the three overarching objectives for the CAP (covering both Pillar 1 and Pillar 2) – the sustainable management of natural resources and climate action - and is a key priority for action within rural development policy under Pillar 2.

The main CAP instruments and measures that have the potential to deliver climate mitigation and adaptation benefits are: requirements set under cross-compliance standards of Good Agricultural and Environmental Condition (GAEC); the Farm Advisory System (FAS); Pillar 1 green direct payments; and Pillar 2 rural development measures (for land management, investments and advice and capacity building). The types of climate actions that they promote can be grouped into: those involving land use and management; those which require investments; and those which involve capacity building.

Because Member States have a lot of flexibility about how to implement the CAP, achieving climate benefits on the ground depends on the choices made by Member States in programming the CAP for 2014-20, and on the choices made by farmers within the options available to them. There are some CAP measures which all Member States or regions must implement e.g. under Pillar 1 the designation Environmentally Sensitive Permanent Grassland in Natura 2000 areas and maintaining the ratio of permanent grassland within the total agricultural area (greening measures) and under Pillar 2, offering agri-environment-climate measures available throughout the country. Other CAP measures must be implemented, but within a framework or list provided in the legislation, leaving Member States free to define the farm-level requirements e.g. cross-compliance GAEC standards, the Ecological Focus Area greening measure under Pillar 1 and the compulsory elements of the FAS. For most other measures Member States can both choose whether or not to implement them (e.g. all other RDP measures, optional additional FAS and advice, European Innovation Partnerships (EIP)) and also choose what priority they give to specific climate mitigation actions within each measure, in terms of farm level requirements, targeting and expenditure allocated.

Implementation of these CAP instruments and measures for climate is very variable between Member States and regions and in many countries a rather minimalist approach appears to have been taken. In terms of the cross-compliance GAEC standards, those relating to soil are most relevant for climate. Of particular note is the decline over time of Member States defining additional requirements to maintain soil organic matter beyond the minimum requirement to ban stubble burning. This means that uptake of actions previously required under cross-compliance, such as crop rotations, stubble management, use of crop rotations, will now be voluntary for farmers to adopt under other parts of the CAP rather than compulsory for receipt of farm payments. A number of the Pillar 1 greening measures can also have climate benefits, most notably the EFA and permanent grassland measures. Although the stated aim of EFAs is to safeguard and improve biodiversity on farms, many EFAs also have potential climate benefits.

Permanent field margins, buffer strips, landscape features and trees help to protect carbon stores and sequestration potential of the soil beneath them. Individual trees, agroforestry and woodlands can store carbon and also provide shade for crops and livestock during hot weather. Climate benefits of EFAs on which agricultural production is allowed will mainly be in reducing the risk of losing soil (and organic matter) through erosion, although N-fixing crops have potential to reduce NO₂ emissions from soils (through reduced demand for nitrate fertilisers). However, for nitrogen fixing crops, catch crops/green cover and short rotation coppice, Member States can choose whether fertilisers and pesticides are permitted and when the crops must be in the ground, and these decisions will affect the extent to which the climate mitigation potential is realised in practice. In relation to permanent grassland, the most climate beneficial measure is the requirement of Member States to designate environmentally sensitive permanent grassland (ESPG) in areas covered by the Birds and Habitats Directives, which need strict protection in order to meet the objectives of those Directives, including peat and wetlands. At farm level the 'greening' requirement is to not convert or plough the ESPG, thus protecting soil carbon stocks. Member States also have the option to delineate further ESPG area elsewhere, offering the opportunity also to protect significant soil carbon stocks outside Natura 2000 areas. There are potential adaptation benefits too, through protecting the natural rainwater storage capacity of wetlands.

In relation to Pillar 2 of the CAP, climate features strongly as a priority. The European Agricultural Fund for Rural Development (EAFRD) defines six EU level priorities of which every RDP must address at least four, as well as the cross-cutting objectives of innovation, environment and climate mitigation and adaptation. Priority 5 is the one that is explicitly focused on climate, promoting resource efficiency and the shift towards a low carbon and climate resilient economy. This includes 5 sub-priorities or 'focus areas':

- 5A increasing efficiency in water use in agriculture;
- 5B increasing efficiency in energy use in agriculture and food processing;
- 5C facilitating the supply and use of renewable sources of energy;
- 5D reducing GHG and ammonia emissions from agriculture; and
- 5E fostering carbon conservation and sequestration in agriculture and forestry.

The RDP measures judged to have the greatest potential for climate mitigation and adaptation are:

- agri-environment-climate land management payments (M10);
- organic farming conversion and maintenance payments (M11);
- payments for the establishment and maintenance of agro-forestry systems and for afforestation and creation of woodland (M8); and
- conservation of genetic resources in agriculture (M10).
- investments in physical assets – including non-productive payments to support the agri-environment-climate measure (M4).
- the cooperation measure – which offers a wide range of potential support for example: developing and piloting new agricultural practices, processes and technologies; and for planning and facilitating landscape scale implementation (M16);
- the basic services measure can provide support for Natura 2000 management plans
- training, demonstration activities, information provision and advice (M1 and M2); and
- EIP operational groups and pilot projects joint action between farmers and researchers for mitigating or adapting to climate change (M16).

Although these measures offer the most potential for Member States to tailor actions for climate to address local and regional priorities in their Rural Development Programmes (RDP), to date budgetary allocations to climate priorities are much lower than for other priorities, targets

against climate related indicators have not been set in all regions and where they have are very low in many cases. For example, only 8% of the total public expenditure allocated to RDPs has been allocated to Priority 5 (although this does not account for budget allocated to other priorities that has been identified as having climate as a secondary objective). In relation to the target values set for the CAP indicators, only 1.8% of agricultural land is projected to be under contracts contributing to carbon sequestration and conservation by 2020 and only 7.7% of agricultural land is projected to be under management targeting the reduction of GHG or ammonia emissions. More positively just over 15% of irrigated land is anticipated to shift towards more efficient irrigation systems, although this is still a fairly low figure, given the pressures facing water availability in many parts of the EU.

Perspectives for the agricultural sector and the CAP in light of COP21

It seems clear that greater consideration will need to be given to how the agriculture sector can play an enhanced role in contributing towards climate mitigation activities in Europe and globally, since to reach the target agreed under the Paris Agreement may require net zero emissions from all sectors at some point around or after 2050, with zero net emissions being required sooner if the pace of emissions reductions from all sectors is not at a high level of ambition in the intervening years.

However, despite being a significant contributor to GHG emissions in the EU, there remains no clear decarbonisation agenda or GHG emission reduction targets for the agricultural sector at EU level. It is generally acknowledged that there is more limited potential to cut emissions in the agricultural sector compared to other sectors, given the “fundamental priority of safeguarding food security and ending hunger”, as articulated in the Paris Agreement. The challenges, both technical and political, of achieving cost effective reductions of GHG emissions in the agriculture sector have meant that little large-scale proactive action on climate mitigation in the agricultural sector has been taken to date. Those measures that have been adopted generally have reflected a mixture of different national and international policy drivers as well as commercial pressures, rather than being set in the context of quantitative targets for emissions reduction from the sector as a whole. There remains reticence by many Member States, farmer and landowner organisations for a more targeted approach to mitigation in the agriculture sector. Clear planning is therefore required to ensure that the agriculture sector maximises its efforts in reducing its overall contribution to GHG emissions and reaching net zero emissions by 2050.

However, although these production concerns are valid, even without stronger policy drivers, there is still progress that could be made both within the sector to enhance carbon sequestration, improve energy efficiency, and reduce GHG emissions relating to land management. These include increased action to improve the resource efficiency of the sector, including the use of inputs (fertilisers etc), land (e.g. the management of soils) and livestock (for example, through improved animal health leading to greater efficiency of production, and fewer GHG emissions per litre of milk or kilogram of meat). On the demand side, potential action to reduce EU demand for GHG-intensive agricultural production, through measures to address excess meat and dairy consumption in diets or measures to tackle food waste has not yet been adopted at EU level.

To enhance climate action via the CAP, changes are required on two fronts: changes can be made to the design of the CAP instruments and measures within the EU regulations; but also action has to be taken by Member States to improve the way in which the measures are implemented in their territories. Six priorities are identified for action via the CAP at the EU level:

1. to ensure the protection of remaining carbon rich soils where they occur in Europe, both through preventing the ploughing of those soils already under permanent grassland and minimising further losses of carbon from cultivated carbon rich soils;
2. to minimise losses of and increase soil organic matter on all soils;

3. more could be done to encourage the more efficient management of nutrients on agricultural land;
4. make the provision of advice on climate mitigation and adaptation compulsory under the Farm Advisory Service;
5. find ways of ensuring that the full role played by CAP measures on climate mitigation and adaptation are reflected in monitoring and reporting; and
6. ensure a more rapid change in the orientation of the CAP so that it becomes truly production neutral in nature.

To inform policy development, as a key forward looking priority for the European Commission, it would be valuable to produce a central database containing evidence on the mitigation potentials of different farming practices in different climatic zones and on different soil types. However, the lack of explicit GHG emission reduction or carbon sequestration targets for the agriculture sector at either the EU or Member State level, means that there is little incentive to focus attention in this area, particularly when formal climate targets (e.g. under the ESD) can be met without significant efforts from agriculture.

Conclusions

The report concludes that ambition appears to be lacking currently in terms of climate mitigation action within the agricultural sector, although more is being done in some countries on adaptation. As attention inevitably increases on the agricultural sector, as mitigation potential in other sectors is adopted, there is an urgent need for some long-term planning, especially as it is not clear from the evidence that the agriculture sector is on the right trajectory currently to deliver the scale of emission reductions required to achieve a net zero goal by 2050. The development of a 2050 low-carbon and resilience roadmap for European agriculture would be an important means of setting out a multi stage approach to climate action in the sector, avoiding a silo mentality by embedding public interventions through the CAP into a wider strategy to bring down emissions which involves the private sector and consumer concerns as well. Such a roadmap is required to feed into the facilitative dialogue required under the Paris Agreement in 2018, which involves parties considering their commitments in the light of the long-term goals. The EU will therefore need to think through the implications of the 2050 targets by 2018, in good time to feed into the negotiations for the next Multi-annual Financial Framework, and for agriculture to feed into the focus and subsequent negotiations on the post 2020 CAP.

Ensuring the right climate policy framework is in place to encourage longer-term action will be essential as will ensuring that a future CAP has the right incentives in place to support not just action on the ground but also capacity building and knowledge exchange. With respect to the CAP, a more strategic approach to the use of Pillar 1 and Pillar 2 instruments and measures is required in Member States to ensure a coherent approach to climate action is taken. Not all support will require public funding and private investment and greater use of financial instruments should also be considered. This agriculture specific measures will also have to be accompanied by a strong regulatory baseline and additional tools such as those to incentivise waste reduction or to influence consumption patterns and hence the demand for climate-intensive products.

Finally, the absence of clear targets for the agricultural sector is allowing Member States to put off the difficult decisions that must be made in relation to emission reductions and removals for the agricultural sector. The development of some form of targets for the sector at EU and/or Member State level therefore, could help provide an incentive for the agricultural sector to start planning now for the significant contributions that will have to be made to emissions reductions in the longer term.

1. INTRODUCTION AND SETTING THE SCENE

KEY FINDINGS

- Anthropogenic emissions of greenhouse gases (GHGs) are the highest in history and atmospheric concentrations of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are unprecedented in at least the last 800,000 years.
- In the EU, agriculture is the fifth largest contributor to GHG emissions (11.3%; 514.1MtCO₂e), after the energy, transport, industry, residential and commercial sectors with emissions primarily taking the form of nitrous oxide (N₂O) and methane (CH₄), with only minor contributions from CO₂.
- Agriculture contributes 10% of the total EU non-CO₂ emissions with a high degree of variation between Member States.
- As the share of agriculture emissions grows, as a result of greater reductions in other sectors, the sector will become increasingly important in the broader context of the EU's emission reduction goals.
- Agriculture can aid in the mitigation of climate through reducing GHG emissions from sectoral activities (e.g. increased efficiency), increasing removals through the absorption of carbon in soils and biomass, and increasing the contribution the sector makes towards renewable energy production.
- Adaptation will be a critical priority for the sector. Agriculture is the economic sector most uniquely susceptible to changes in climate patterns with the impacts highly place- and crop- specific. The main climate related pressures on agriculture are water availability, overall temperature variations, presence and persistence of pests and diseases, as well as fire risks. In the EU, climate related impacts on agriculture have largely been negative, with positive impacts limited to temperature increases in northern latitudes.
- The COP21 Paris Agreement, which entered into force on 4 November 2016, represents a landmark in the international commitments to tackle climate change, by establishing a new ambition for climate mitigation efforts globally. This highlights the importance of the agriculture sector in reaching the targets set.

This chapter sets out the focus and scope of this report, followed by a short background to EU climate action, in the context of global action to tackle climate change.

1.1. Focus and scope of the report

The focus of this report is the EU's agriculture sector, examining the significance of the commitments made to reduce global greenhouse gas emissions under the 2015 Paris Agreement for the sector.

This study has two main objectives:

1. To set out the global context for EU climate action and how this has developed over time, with a specific emphasis on the way in which the EU agriculture sector has been treated and affected by climate policy up until COP21; and
2. To analyse and discuss the implications of COP21 and developments in EU climate policy for the agriculture sector, considering the role that the CAP can play in supporting climate action within the agriculture sector and providing thoughts on the future role of the CAP in this regard.

For the purpose of this study, emissions relating to the 'agriculture sector' are taken to encompass both CO₂ and non-CO₂ emissions, as distinct from the more limited category of agriculture emissions used within the current Effort Sharing Decision (i.e. only non-CO₂). The analysis is focussed on the agriculture sector and therefore does not cover forestry sector emissions directly; although any indirect impact on the agricultural sector of mitigation policy in forestry is covered. The only forestry measures that are explicitly considered are those that are covered by the CAP and can be implemented on agricultural land.

1.2. Recognition of a changing climate

The Earth's climate has always undergone periodic changes that have in turn affected the conditions available to life on the planet. These changes in climate can occur in relatively short periods and locations, such as the Little Ice Age from the 16th up until the end of the 19th Century² (Matthes, 1939), through to longer term and more sustained periods of planetary warming and cooling. Climatic changes are generally recognised as being fluctuations over periods greater than a few decades with shorter variations, such as El Niño representing more localised or short-term phenomena.

The term climate change has evolved in its usage from the study and recognition that the Earth's climate changes over time, to climate change as an issue influenced by human activity that needs to be addressed. The term 'climatic change' is now used to represent the former and thus all forms of climatic variability on timescales longer than 10 years, irrespective of the cause³. Following the recognition that human activities have the potential to alter the climate in addition to natural phenomena, the term 'climate change' was adopted to represent an *issue* to be addressed (Hulme, 2016), as incorporated into the names of the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC). These terms are used consistently in this report.

Climate patterns and the drivers of climatic change have been studied for decades and across a diverse range of disciplines. Surface and ocean temperature, atmospheric gas concentrations, radiation, solar radiation, land use change and many other areas were explored before first conclusions about climate change and its causes emerged and sparked wider interest and call for action (Le Treut et al, 2007). Recent anthropogenic emissions of greenhouse gases (GHGs) are the highest in history and atmospheric concentrations of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are unprecedented in at least the last 800,000 years (IPCC, 2014a). The increase in GHG emissions has been greater in the period from 1970 to 2010 with larger absolute increased between 2000 and 2010, despite a growing number of mitigation policies in place (IPCC, 2014a). Recent evidence suggests a rapid rise in atmospheric concentrations of methane (Saunois et al, 2016), which is both a powerful and fast-acting greenhouse gas linked to livestock production.

1.2.1. Causes of climate change

The climate system is influenced by a wide array of factors known as forcings. Some of these are internal to the climate system and are attributed to natural causes, whereas others are external to the climate system and may be natural (e.g. fluctuations in solar radiation) or anthropogenic (e.g. increased release of GHGs to the atmosphere). These forcings influence the different elements of the Earth's climate system⁴ in different ways.

² A lack of scientific consensus on the precise period of the little ice age with some estimating it starting in the 14th Century.

³ Following the World Meteorological Organization (WMO) proposals in 1966.

⁴ The five key elements of the Earth's climate are the: atmosphere, hydrosphere, cryosphere, lithosphere and biosphere.

The anthropogenic causes of climate change are the result of increases in GHG emissions to the atmosphere from human activities, such as burning of fossil fuels, clearance of vegetation, and oxidation of soils. The increase of GHGs in the atmosphere takes two forms: the increased rate and level of emissions; and the decreased sequestration of GHGs in soils and vegetation. These changes alter the natural balance within the climate system, resulting in climate change. It is extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by anthropogenic GHG emissions and other anthropogenic factors combined (IPCC, 2014a). Not all anthropogenic influences on climate change are negative, however. Land use change, for example afforestation, can sequester carbon and prevent the release of GHGs and result in a cooling effect.

1.2.2. Summary of impacts and the importance of addressing climate change

Changes in climate have resulted in impacts on natural and human systems on all continents and across the oceans (IPCC, 2014b). The evidence to support climate change impacts is most comprehensive for natural systems, which in turn impact on human systems. Species patterns have changed with altered geographic ranges, seasonal activities, abundance and interactions. Water availability continues to vary with more extreme weather events and increased temperatures in northern regions causing melting. Floods and droughts are increasing in frequency, as is wildfire, cyclones and heat waves, and the presence and resilience of invasive species and disease, all of which have the potential to impact on natural and productive systems. The key climate change risks in Europe, identified by the IPCC fifth assessment (Kovats et al, 2014) are shown in Annex 1 (Figure 18) with a regional perspective on climate change impacts shown in Map 1. Most of the risks identified have direct implications for the agriculture and land use sectors.

Map 1: Anticipated regional impacts of climate change in Europe

Arctic

Temperature rise much larger than global average
Decrease in Arctic sea ice coverage
Decrease in Greenland ice sheet
Decrease in permafrost areas
Increasing risk of biodiversity loss
Intensified shipping and exploitation of oil and gas resources

Northern Europe

Temperature rise much larger than global average
Decrease in snow, lake and river ice cover
Increase in river flows
Northward movement of species
Increase in crop yields
Decrease in energy demand for heating
Increase in hydropower potential
Increasing damage risk from winter storms
Increase in summer tourism

Coastal zones and regional seas

Sea-level rise
Increase in sea surface temperatures
Increase in ocean acidity
Northward expansion of fish and plankton species
Changes in phytoplankton communities
Increasing risk for fish stocks

Mountain areas

Temperature rise larger than European average
Decrease in glacier extent and volume
Decrease in mountain permafrost areas
Upward shift of plant and animal species
High risk of species extinction in Alpine regions
Increasing risk of soil erosion
Decrease in ski tourism

North-western Europe

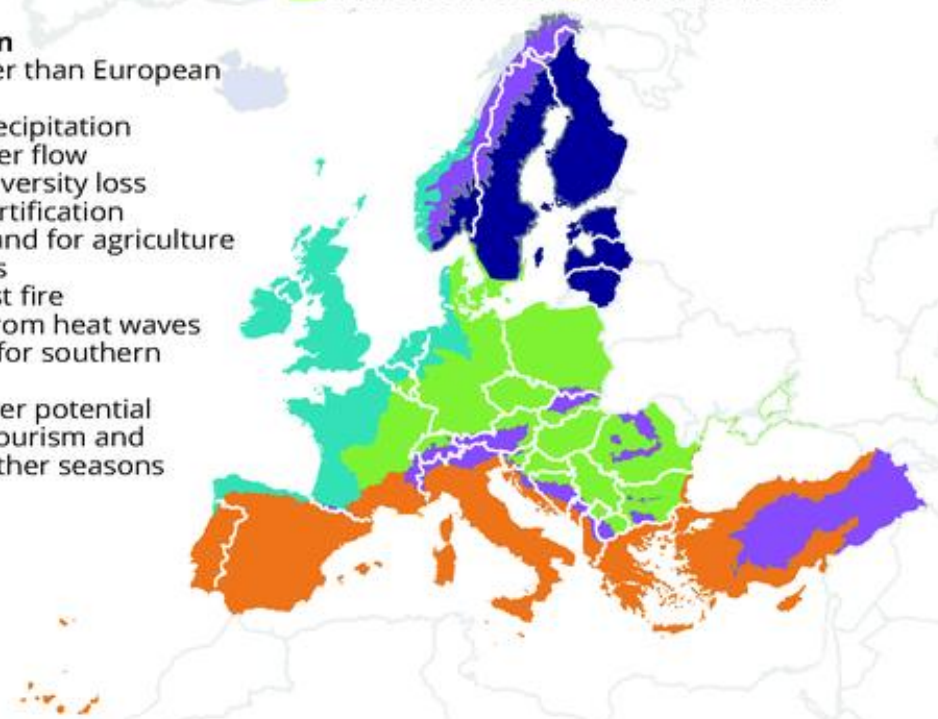
Increase in winter precipitation
Increase in river flow
Northward movement of species
Decrease in energy demand for heating
Increasing risk of river and coastal flooding

Central and eastern Europe

Increase in warm temperature extremes
Decrease in summer precipitation
Increase in water temperature
Increasing risk of forest fire
Decrease in economic value of forests

Mediterranean region

Temperature rise larger than European average
Decrease in annual precipitation
Decrease in annual river flow
Increasing risk of biodiversity loss
Increasing risk of desertification
Increasing water demand for agriculture
Decrease in crop yields
Increasing risk of forest fire
Increase in mortality from heat waves
Expansion of habitats for southern disease vectors
Decrease in hydropower potential
Decrease in summer tourism and potential increase in other seasons



Source: <http://www.eea.europa.eu/data-and-maps/figures/key-past-and-projected-impacts-and-effects-on-sectors-for-the-main-biogeographic-regions-of-europe-4>

1.3. Interactions between agriculture and climate change

EU agriculture is both affected by and has an impact on climate change (both positive and negative). The main ways in which agriculture is affected by climate change are through the increased pressures on crop and livestock production resulting from water availability, overall temperature variations, presence and persistence of pests and diseases, as well as fire risks.

In terms of agriculture's impact on climate, agricultural activities in the EU have an impact both through emitting GHGs (directly and indirectly) and through their removal from the atmosphere (carbon sequestration). The agricultural sector therefore has a potentially significant contribution to make to mitigation, both through reducing its impact as a source of GHG emissions and by increasing the role it plays in GHG removals through sequestering carbon. In addition, land-use activities can make important contributions to mitigation efforts in other sectors (e.g. renewable energy supply); and will themselves need to adapt to the impacts of climate change.

1.3.1. Effects of climate change on EU agriculture

Agriculture is the economic sector most uniquely susceptible to changes in climate patterns with the impacts highly place- and crop- specific (McArthur, 2016).

The main pressures on agriculture, as a direct result of climate change, are water availability, overall temperature variations, presence and persistence of pests and diseases, as well as fire risks. The fifth assessment of the IPCC provides a comprehensive assessment of the observed and expected impacts of climate change in Europe with specific reference made to the impacts on the agriculture and production sectors (Kovats et al, 2014)⁵.

The impacts of climate change on EU agriculture vary in the nature of their impact and the locations that will be affected. To date, climate change impacts have largely been negative for crop yields with only a few positive impacts noted in higher latitude regions (IPCC, 2014b). In future, warmer temperatures may increase productivity in northern Europe whilst at the same time extreme heat events and droughts are expected to hamper crop productivity in southern Europe⁶. Higher yearly variations in productivity are also expected as a result of varying weather patterns, pests and diseases (EEA, 2015a). The business impacts on farmers will vary and it is likely that smaller farms will remain the most vulnerable, as they often have fewer resources, more limited access to innovation, and less financial resilience (Campbell and Thornton, 2014).

⁵ It is important to note the considerable uncertainties associated with longer-term projections of climate impacts on agriculture in terms of the likely scale and duration of any impacts (Underwood et al, 2013).

⁶ However, the balance of these impacts is not well understood when compared with other negative impacts in these areas.

Table 1: Summary of projected impacts of climate change on EU agriculture by EU region

VARIABLE	CLIMATE IMPACT	SOUTH	NORTH	WEST	EAST
Temperature	Heat stress for plant production (high regional variation)	--		-	
	Increased temperatures and reduced frost period leading to increased crop range and suitability		+		
	Increase in temperature and humidity leading to livestock stress and mortality	--	-	-	-
Water availability	Reduced summer rain fall, overall decrease in water availability + droughts. Aquifer and ground water recharge rate is reduced	--	-	-	-
	Increased flood events + frequency. Crop damage and limits to soil workability. Impact exacerbated by hard flood defences in urban areas*.		-	--	--
Water quality	Salinisation and increased pest and disease problems in water courses	--	-	-	-
Pests and disease	Spread of pests and diseases from increased range varying by pathogen**. Impacts on both crops and livestock	-	--	--	-
Fire risk	Increased fire risk frequency with high inter-annual variation. Primarily on forests but risks also to cropland	---			
Wind damage	Increased risk of wind damage to crops and forests	-	-	-	-

Source: Sources and more detailed explanation of trends can be found in Annex 1.

Note: - = negative impact + = positive impact. The significance of the impact is denoted by the number of symbols. * e.g. river canalisation, flow restrictions, etc. forcing water into more rural areas and floodplains; ** Arthropod-borne diseases tend to favour warmer and drier conditions, whereas mildew and cereal stem rot may reduce as a result of increased temperatures.

1.3.2. Agriculture and the adaptation to climate change

With the potential changes to the rural environment, as a result of climate change, the agriculture sector will need to adapt and most likely change. The responses required can be highly varied (Table 1), from changing crop and animal breeds, developing access to new markets where varieties have changed, building resilience into production systems and ensuring sufficient contingency planning and insurance, forecasting systems to enable early warning of extreme and detrimental weather events, and even physical changes, such as amendments to river pathways, floodplains or vegetation structure.

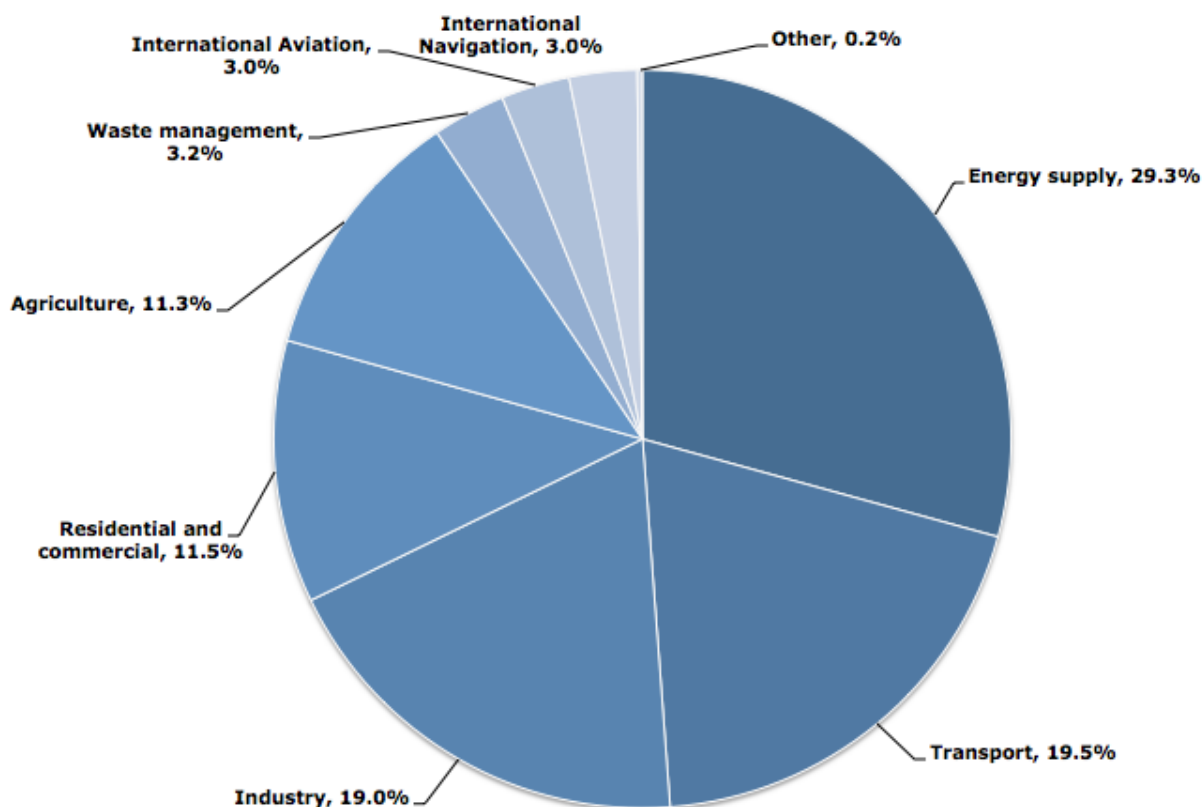
Farmers and land managers are likely to need some form of support in the development of adaptation approaches, which may include improvements in the predictability and reliability of world trading system (to reduce market volatility), financial risk management and insurance schemes, and improving the access to credit and resources for smallholders (IPCC, 2014a).

The nature of climate impacts means that local and regional adaptation responses will need to vary. Subsidiarity will be important for Member State action in this area, as will EU coherence of supporting activities in the context of the internal market.

1.3.3. EU agriculture as a contributor to climate change

In the EU, agriculture is the fifth largest contributor to GHG emissions (11.3%; 514.1MtCO_{2e}), after the energy, transport, industry, residential and commercial sectors (Figure 1).

Figure 1: EU sectoral greenhouse gas emissions by IPCC sector (2014)



Source: National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism provided by Directorate-General for Climate Action (DG-CLIMA).

Notes: Excludes LULUCF removals. Data available at: <http://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment>

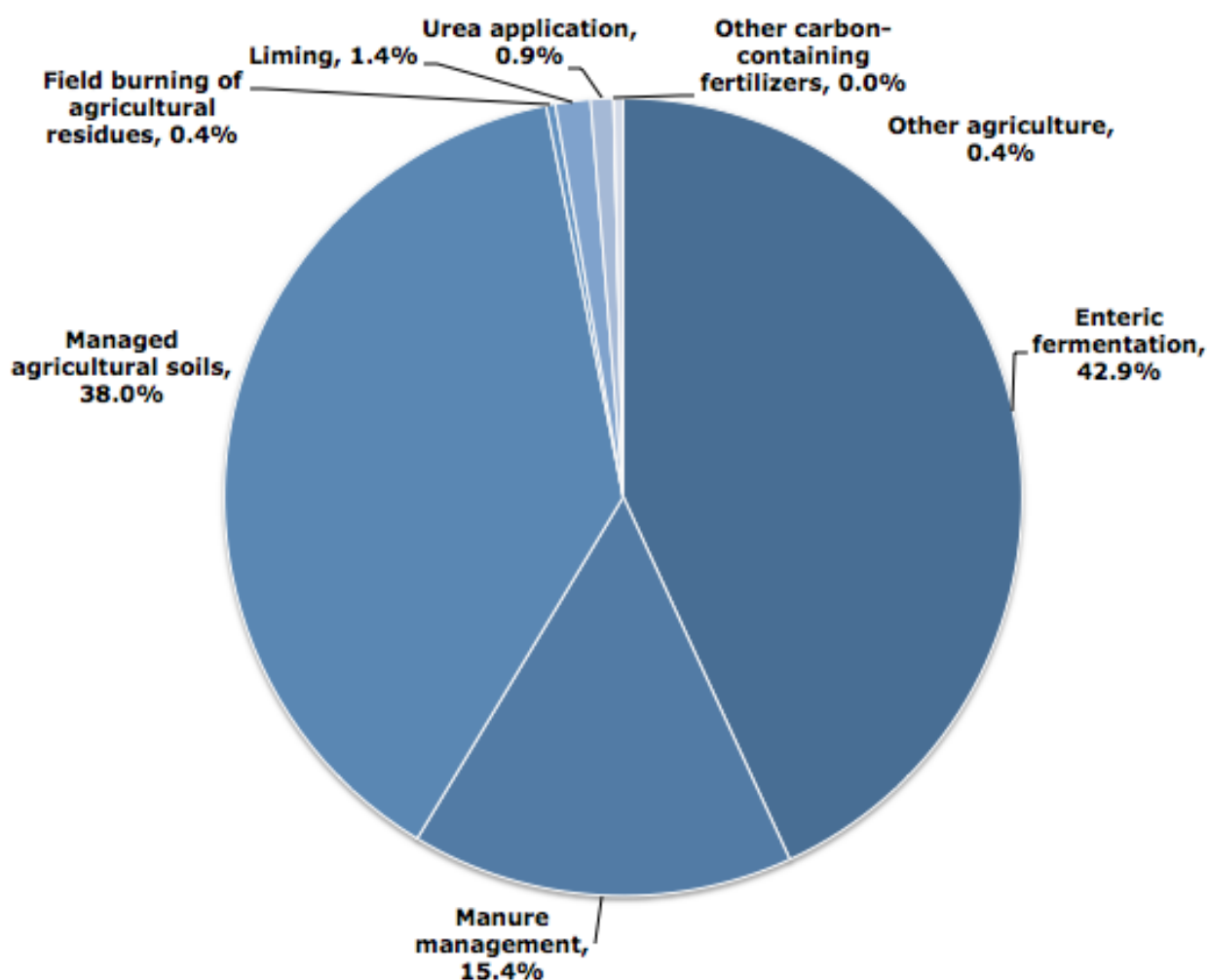
Agricultural GHG emissions arise largely from non-CO₂ GHGs (nitrous oxide (N₂O) and methane (CH₄)), with only minor contributions from CO₂⁷. The latest official figures (2014) show that agriculture contributes to approximately 10 per cent of total EU non-CO₂ greenhouse gas emissions⁸, although this average figure masks considerable differences between Member States, ranging from three per cent in Malta to 32 per cent in Ireland (2013 figures) (DG Agriculture, 2015).

⁷ Only 0.13% of total EU28+ISL emissions

⁸ Note 1: The second largest contributing sector behind energy (78 per cent). Note 2: If the footprint associated with the production of agricultural inputs (e.g. fertilisers) and certain imports were to be taken into account, this figure would be much larger.

The largest share of the EU's agricultural non-CO₂ GHG emissions comes from the more potent⁹ nitrous oxide (N₂O) and methane (CH₄). Nitrous oxide accounts for 58 per cent of non-CO₂ emissions from agriculture (largely from fertiliser application and exposed soils, as well as grazing animals), with methane accounting for the remaining 42 per cent (largely from livestock and rice cultivation). Emission contributions from agriculture arise primarily from three sources: enteric fermentation¹⁰ (42.9%; 0.186 GtCO_{2e}); management of agricultural soils (38%; 0.165 GtCO_{2e}); and manure management (15.4%; 0.067 GtCO_{2e}) (Figure 2).

Figure 2: Agriculture GHG emissions by source (2014)



Source: EEA (aei_pr_ghg)

Agricultural emissions are associated with a range of management activities (Table 2) but also with biological processes that naturally emit GHGs. Uncertainty about the magnitude of emissions is therefore more pronounced in agriculture than in industrial sectors. For the same management activity, net emissions may vary in diverse agronomic, bio-physical, environmental and climatic situations (Underwood et al, 2013).

⁹ While the global warming potential over a 100-year time span (GWP100) of carbon dioxide is 1, the GWP100 value for methane is 21 and for nitrous oxide is 310 (Based on UNFCCC figures - http://unfccc.int/ghg_data/items/3825.php).

¹⁰ The process of digestion of carbohydrates by ruminant animals, such as cattle or deer.

Table 2: Relationship of main anthropogenic causes of climate change with agriculture

ANTHROPOGENIC CAUSES OF CLIMATE CHANGE	RELATIONSHIP WITH AGRICULTURE
The combustion of fossil fuels producing carbon dioxide and nitrous oxide.	Mechanical farming practices
The reduction or removal of living biomass that absorbs CO ₂ from the atmosphere and the release of CO ₂ from this biomass. This includes forests and other natural vegetation as well as phytoplankton in the oceans.	Expansion of agriculture into semi-natural areas; removal of landscape features;
The high use of nitrogen containing fertilisers and inefficient applications, resulting in nitrous oxide emissions.	Specialisation and intensification of production. Increased application beyond carrying capacity.
The increased production of livestock resulting in the release of methane through enteric fermentation and dung.	Open grazing; increased stocking density;
The use and production of fluorinated gases. Although produced in small quantities the impact of these gases can be up to 23,000 times as detrimental as that of CO ₂ .	n/a

Source: Modified from IPCC, 2014a

In the EU, the overall level of non-CO₂ agriculture emissions has fallen¹¹ by 113 MtCO_{2e} from 1990 to 2014, a 21 per cent reduction. There has been a proportionate decline in emission levels by source mainly attributable to decrease in livestock numbers over the same period. This is allied with productivity increases as well as improvements in farm management practices and the developments in and implementation of agricultural and environmental policies. Despite these declines, the pace of reduction has slowed in the last decade, with EU-28 agriculture GHG emissions decreasing by 16% in the period 1990 to 2000 and by 8% between 2001 and 2012 (EEA, 2016a). The decrease in emissions has slowed as a result of a slowing in the reduction of livestock numbers.

The variations in emissions in different parts of the EU result from the different farming systems and management practices carried out as well as being influenced by the different biogeographic and climatic characteristics of the region concerned. Depending on the relative size and importance of the agricultural sector and emissions in other sectors, the contribution of agriculture emissions to the total national GHG emissions also varies considerably between Member States. As a proportion of national GHG emissions the contribution is highest in Ireland (32.2%; 18.7MtCO_{2e}) and lowest in Malta (3%; 0.088 MtCO_{2e}). However, in absolute terms, the greatest contribution of GHG emissions from the agriculture sector to the EU total, comes from France (18%; 79 MtCO_{2e}), Germany (15%; 66.1 MtCO_{2e}) and the United Kingdom (10%; 44.6 MtCO_{2e}). Together these three Member States account for just under 44% of total EU-28 agriculture emissions. France also accounts for the largest share of EU-28 carbon sequestration through its LULUCF sector (16.7%; 50.1 MtCO_{2e}) whereas Germany and the UK rank 8th and 11th respectively. Other factors influencing the current level of emissions include: the costs associated with implementation of mitigation activities (including technological requirements); the level of knowledge and experience in the sector of specific mitigation techniques; and the availability and effectiveness of advice.

¹¹ Excluding LULUCF emissions.

1.3.4. Agriculture and the mitigation of climate change

Agriculture is a significant GHG source in the EU, with GHG emissions arising as a result of natural processes (such as enteric fermentation) and influenced by the type and intensity of management in the sector. Alongside emissions of methane and nitrous oxide, cropland management overall is a net source of CO₂ emissions (although not in all countries) and is predicted to remain a source in the future. Grazing land management overall for the EU-28 is a net CO₂ sink (although in the past it has been a source of emissions) and is predicted to remain a sink in the future (Martineau et al, 2016). There are many ways in which agriculture, covering around 44 per cent of the EU's land area, can reduce its GHG footprint, both through reducing emissions from agricultural practices and energy use as well as through optimizing the potential to sequester carbon in soils and biomass. Opportunities to mitigate climate change through the use of agricultural land have developed in recent decades, such as new techniques to capture and store carbon in soils and the development of renewable energy infrastructure. In practice, no single mitigation option will be sufficient on its own. It is important to note, however, that the potential mitigation activities are not inexhaustible and can reach saturation, such as carbon capture in soils (McArthur, 2016).

Three strands of activities can be pursued: reducing the GHG emissions from agricultural activities; sequestering carbon in soils and biomass; or displacing GHG emissions through activities in the agriculture (and land using) sector(s) (Martineau et al, 2016; McArthur, 2016). Examples of mitigation activities can be found in Table 7 in Annex 1.

- **Addressing agriculture as a source of GHG emissions:** A host of practical steps can contribute to mitigate agriculture's GHG emissions. They include better grassland management; restoration of degraded land (through steps like re-vegetation, reduced tillage, and water conservation); and improved cropland management (through steps like improved crop rotations, increased use of cover crops, reduced burning of residue, improved fertilizer application, and better water and nutrient management for rice). Livestock-driven methane emissions represent around 10 per cent of the sector's abatement potential. They can be reduced through dietary adjustments, improved manure management to recapture nutrients and energy, and even changes in breeding practices. Reducing post-harvest food loss and post-retail food waste is also vital to decreasing the volume of food that must be produced.
- **Increasing removals through agricultural activities:** Agricultural land and the agricultural sector have significant potential not only to mitigate its own contribution to climate change, but also to provide a means of mitigating climate impacts of society in general. Through the capture and storage of carbon in soils and through the growth of biomass, there is the potential to reduce and sequester GHG emissions in the sector. This can be achieved through activities such as converting arable land to permanent grassland or selected afforestation. Using agricultural land to produce bioenergy feedstocks as well as providing space on which to site renewable energy installations, is one such approach
- **Increasing agriculture's contribution to renewable energy generation:** The other key way in which GHG emissions can be influenced in rural areas is through the reduction in the use of or displacement of fossil fuels and the production of renewable energy, whether to produce fuel for heat and power or to provide space for renewable energy infrastructure. There are many options here, for example, the use of biomass for heat, the use of agricultural crops and residues for biofuels and the introduction of solar or wind energy and hydro-power infrastructure. Concerns over the indirect land use change impacts of using agricultural crops in particular as feedstocks for biofuels, has led some to consider the increasing use of wastes and residues as a more sustainable means of

bioenergy production. However, food and feed based crops still dominate the sector. The introduction of bioenergy supply and production systems, improved manure management through capture and conversion to biogas, and the placement of wind and solar-photo voltaic (pv) infrastructure can all help to introduce low-carbon energy supply to society and, through decentralised power generation, increase resilience of current generating capacity and rural areas.

Climate mitigation activities in agriculture and on agricultural land do require balancing with other sustainability considerations, particularly when considering the scale of the mitigation potential available. For example, estimates of the potential to produce biomass for energy on agricultural land vary considerably and often exceed what is likely or even sustainable in practice (Allen et al, 2014). Forward-looking assessments of these potentials requires judgments to be made about range of interrelated factors. These include the future technical and economic situation in different contexts; the adoption and availability of new technology; improvements in yields; land that may be displaced; and supporting frameworks.

1.4. Development of EU and international policy responses

Climate change is a transboundary issue with imbalances in the contribution to and impact of climate change between countries and regions. The recognition of climate change as an issue for society stretches back decades from the first identification of links between atmospheric GHG concentrations and temperatures on the ground (e.g. Arrhenius, 1896). Yet it is only in the last 40 years that climate action has been driven through greater international cooperation and the formation of dedicated governance bodies.

The first landmark achievement in the development of climate action was the Montreal Protocol to tackle substances that deplete the ozone layer. Whilst not a specific climate treaty, this was a significant step towards the recognition of global action to reduce emissions in order to protect the atmosphere and climate. The Montreal Protocol is also one of only three multi-lateral agreements subject to universal ratification from signatory parties to the United Nations¹². In November 1988 the World Meteorological Organization (WMO) and UN Environment Programme (UNEP) established the IPCC and less than 10 years later an historic achievement was reached in the adoption of the Kyoto Protocol, the world's first GHG emissions reduction treaty (Box 1).

Box 1: Summary of historical development of international action on climate change

- **August 1987** – The Montreal Protocol on substances that deplete the ozone layer is agreed as part of the Vienna Convention.
- **November 1988** – Formation of the Intergovernmental Panel on Climate Change (IPCC).
- **August 1989** – Montreal Protocol enters into force
- **November 1990** – The First Assessment Report of Intergovernmental Panel on Climate Change was released saying "emissions resulting from human activities are substantially increasing the atmospheric concentrations of greenhouse gases" leading to calls by the IPCC and the second World Climate Conference for a global treaty.
- **December 1990** – the UN General Assembly establishes the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change.
- **June 1992** – The United Nations Framework Convention on Climate Change opens for signature at the Earth Summit in Rio, bringing the world together to curb greenhouse gas emissions and adapt to climate change.
- **March 1992** – The United Nations Framework Convention on Climate Change (UNFCCC) enters into force.
- **December 1997** – the third UNFCCC COP achieves an historical milestone with adoption of the Kyoto Protocol, the world's first GHG emissions reduction treaty.

¹² The others are the Vienna Convention, to which the Montreal Protocol belongs, and the signing of the UNFCCC in 1992.

- **January 2005** - The European Union Emissions Trading Scheme, the first and largest emissions trading scheme in the world, launches as a major pillar of EU climate policy. Installations regulated by the scheme are collectively responsible for close to half of the EU's emissions of CO₂.
- **February 2005** - Kyoto Protocol entered into force. The protocol extended the UNFCCC, with the first commitment period running from 2008 to 2012 and the second one from 2012 to 2020.
- **December 2016** - Paris Agreement is signed

Source: UNFCCC timeline - <http://unfccc.int/timeline/> and other sources

From the late 1990s onwards there has been a gradual increase in the policies and supporting actions aimed at tackling climate change leading up to the EU's 2030 Climate and Energy Framework in 2014 and the Paris Agreement in 2015. A summary of the commitments at both the international and EU level, alongside the sectors covered, can be found in Table 8 in Annex 1.

1.4.1. The Paris Agreement – a landmark in global climate action

The adoption of the 'Paris Agreement' (UNFCCC COP21, 2015) represents a landmark achievement in the international commitment to tackle climate change and will be legally binding on the 195¹³ signatory parties when ratified. The Paris Agreement entered into force on 4 November 2016, thirty days after the date on which at least 55 Parties to the Convention accounting in total for at least an estimated 55% of the total global greenhouse gas emissions deposited their instruments of ratification. The EU itself ratified the agreement in October 2016.

The ambition of the agreement is to hold *'the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, [...]'* and provide a *'bridge between today's policies and climate-neutrality before the end of the century'*¹⁴. The aims of the agreement are to be met in a bottom-up approach through intended nationally determined contributions (INDCs). These INDCs set the level of GHG emissions reductions that each country commits to deliver in order to meet the global target. Reported and reviewed every five years, each contribution and INDC should become more ambitious following the principle of progression set out in Article 3 of the Agreement. Progress on meeting targets is to be reported and tracked in a robust and transparent manner through the new 'transparency and accountability system'.

The 'legally binding' nature of the Paris Agreement means that a ratifying country becomes legally bound to observe the obligations set out in the text. However, whilst this includes the goal to ensure emissions remain below 2°C, this goal is not broken down into specific reduction obligations for a given country. INDCs are therefore indicative in this sense and unlike Kyoto, there is no mechanism to force a country to set an INDC target at a specific level or date, and no mechanism to enforce an INDC once set. This makes the agreement more dependent on the contributions and will of individual countries than previously. The EU's Climate and Energy policy framework provides added value to the Paris agreement by setting national emissions reduction targets linked to specific sectors, i.e. those under the Emissions Trading System (ETS), non-ETS sectors (including agriculture non-CO₂ GHGs), and the Land use Land Use Change and Forestry (LULUCF) sectors.

The long-term goals of the Paris Agreement suggest that an increased focus over time will be necessary on mitigation efforts in the agriculture, forestry and other land using sectors (AFOLU) globally. Agriculture as well as the Land Use Land Use Change and Forestry (LULUCF) sectors are among the most referenced sectors in the INDCs. Mitigation activities through agricultural

¹³ Whilst these are fewer than the Montreal Protocol (197) they include more parties than Kyoto (192 following the withdrawal of Canada) and includes both the USA (who did not ratify Kyoto) and China (one of the major GHG contributing countries, globally).

¹⁴ http://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm

measures are referenced in 148 countries out of 189 signatory countries' INDCs, 157 countries reference LULUCF and 168 countries reference agriculture and LULUCF together in their mitigation activities (FAO, 2016). Whilst this suggests that a significant proportion of countries have not included agriculture or LULUCF within their INDCs, those that do, account for 92 per cent of global agricultural GHG emissions. In principle, if implemented, the INDCs will stimulate climate actions through agriculture measures in most parts of the world.

The priority for action on climate within the agriculture sector is heavily linked to its share of emissions within a given country or region. As such, agriculture features as a high priority in countries where energy sector contributions are relatively small¹⁵. These are often countries with developing economies. Whilst the immediate priority for action in more developed economies (such as most EU Member States) tend to focus on the energy, industrial, transport and residential sectors, efforts are still required in the agriculture and other rural sectors and this will become more pressing over time. As efficiencies in energy generation improve, along with modal and technology change, the share of agriculture GHG emissions will see a relative increase. When considered alongside the absolute GHG emissions projected for the sector¹⁶, this suggests a need for action in both developed and developing economies alike, in order to put agriculture on a more sustainable low carbon development trajectory to meet 2050 targets, than at present.

Despite a clear need for additional mitigation action within the agriculture sector, agreeing on what action should be taken and under what framework, remains a major challenge to climate negotiations. Following COP17 in 2011, the Durban Agreement (UNFCCC, 2012) identified agriculture as priority sector for delivering against Article 4 of the UNFCCC (i.e. the commitments to mitigation anthropogenic GHG emissions and increase adaptation) and requested the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA)¹⁷ to exchange views and adopt a decision on the sectors contribution. Since Durban, agriculture has remained an item on the SBSTA's agenda with discussions focused on issues such as elements of finance, technology, knowledge sharing and capacity building in the sector. The process was set to conclude at COP22 in Marrakech, but countries were unable to reach a conclusion and the decision on agriculture was postponed to May 2017. One of the main reasons for the lack of agreement on effort in the agriculture sector comes from the difference in opinion between developed and developing countries. Countries failed to reach an agreement on how mitigation in agriculture can be addressed, together with the differentiated responsibilities of countries, and concern over the potential implications for trade in agricultural commodities. In order to reach a conclusion in May 2017, developed and developing countries will need to agree on how they refer to mitigation within the decision, while clarifying implications if any for trade and clarify their respective roles in advancing action in the sector (Meadu et al, 2016). CGIAR and CCAFS report that there is already important momentum for action on agriculture at the country level, but in the absence of a decision at the COP level, agriculture will continue to be dealt under different venues within the UNFCCC, including the Nairobi Work Programme, the Cancun Adaptation Framework (UNFCCC, 2011), finance mechanism, gender, and the technology mechanism (Meadu et al, 2016). There are concerns that this could lead to a highly fragmented approach that does not address synergies and trade-offs for food security, adaptation and mitigation within the sector.

¹⁵ As energy is often the dominant GHG emission source.

¹⁶ Based on the projections of Member States under the Monitoring Measures Regulation

¹⁷ The SBSTA is one of two permanent subsidiary bodies to the Convention established by the COP/CMP. It supports the work of the COP and the CMP through the provision of timely information and advice on scientific and technological matters as they relate to the Convention or its Kyoto Protocol. - <http://unfccc.int/bodies/body/6399.php>

2. EU CLIMATE ACTION AND THE EU AGRICULTURAL SECTOR

KEY FINDINGS

- The 2020 Climate and Energy Framework is the current policy framework to address climate action at the EU level, to deliver on the EU's Kyoto Protocol commitments. The EU is in the process of transitioning to the 2030 Climate and Energy Framework, which sets new emission reduction targets and revises the underlying policy architecture.
- Agricultural mitigation efforts for non-CO₂ GHGs are covered under the EU's Effort Sharing Decision (ESD) addressing sectors not covered by the EU Emissions Trading System (EU-ETS). The ESD includes specific binding targets on Member States to 2020 with flexibility on the contribution made by different sectors.
- CO₂ emissions from agriculture are largely dealt with under the Land Use, Land Use Change and Forestry (LULUCF) Decision. These emissions do not currently count towards the EU's 2020 climate mitigation targets but is an important sector for the EU's quantified emission limitation under the Kyoto Protocol. For agriculture, the interplay between the ESD (net emissions) and LULUCF (net removals) sectors is important in determining the climate action in the sector.
- The Paris Agreement is enshrined in the EU's 2030 climate and energy framework and associated targets (to reduce emissions by 40%) and coherent with the EU's 2050 low carbon transition towards 80% emission reductions. New legislation is proposed under the 2030 framework that will supersede the ESD and LULUCF Decisions. The proposed Effort Sharing Regulation (ESR) will, if adopted in its current form, establish new, more stringent targets on emission reductions in the non-ETS sectors (including agriculture) and the LULUCF regulation will include a no-debit rule, meaning the sector cannot emit more GHG emissions than it sequesters in a given year.
- There is a high degree of proposed flexibility on how to meet the proposed ESR and LULUCF targets, with potential to allow offsetting of ESR emissions by using removals in the LULUCF sector as well as in the sectors covered by the ETS.
- There appears to be relatively little mitigation ambition from Member States in relation to agriculture when compared to action in other sectors. This is based on the premise that it is less cost-efficient (i.e. more costly) to deliver mitigation effort in the agriculture as opposed to other sectors as well as concerns over the impact of mitigation on food production and the productivity of the agriculture sector as a whole. There is also little incentive for Member States to take action where emission reduction targets can be met without action from the agricultural sector. This situation is likely to change in the future.
- Action on climate adaptation is more prominent at the Member State level. Adaptation is often a priority as agriculture is an economic sector that is very susceptible to changes in climate patterns with the impacts highly place- and crop- specific. The main climate related pressures on agriculture are water availability, overall temperature variations, presence and persistence of pests and diseases, as well as fire risks. In the EU, climate related impacts on agriculture have largely been negative, with positive impacts limited to those associated with temperature increases in northern latitudes.

This chapter is divided into six sections. The first introduces the EU's approach to climate mitigation from a historical perspective with the following section introducing the current policy architecture. The third section introduces the Paris Agreement and the proposed changes to the EU's policy framework to 2030. The fourth section considers adaptation at the EU level and the policies that drive it. The fifth section looks at Member State action on climate change in the agriculture sector, with the sixth section looking at adaptation.

2.1. The EU's approach to climate change mitigation and adaptation – an historical perspective

In 1991, the year after the first assessment of the IPCC, the European Commission established the first Community strategy to limit CO₂ emissions and to improve energy efficiency (CEC, 1991). The components of the strategy included:

- a directive to promote electricity from renewable energy;
- voluntary commitments by carmakers to reduce CO₂ emissions by 25%; and
- proposals on the taxation of energy products.

After the adoption of the Kyoto Protocol in 1997 it became clear that the action needed at the EU and Member State level required bolstering if the EU was to meet its obligations. The EU Council of Environment Ministers acknowledged the importance of taking further steps at Community level by asking the Commission to put forward a list of priority actions and policy measures. The Commission responded in June 2000 by launching the first European Climate Change Programme (ECCP) (European Commission, 2000). The goal of the ECCP was to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol through a multi-stakeholder consultative process. Two ECCPs have been established (Box 2).

Box 2: The two European Climate Change Programmes

The first ECCP (2000-2004) examined a range of policy sectors and instruments with potential for reducing GHG emissions. Coordinated by an ECCP Steering Committee, 11 working groups¹⁸ were established and included dedicated groups on **agriculture**; sinks in **agricultural soils**; and forest-related sinks. Each working group identified options and potential for reducing emissions based on an assessment of their cost-effectiveness. The impact on other policy areas was also taken into account, including ancillary benefits, for instance in terms of energy security and air quality. The outcomes of this initiative led to the development of the EU Emissions Trading Scheme (EU ETS); the proposal for a Directive on the promotion of biofuels; and a proposal for a Directive to promote combined heat and power (CHP) biofuels.

The second ECCP (ECCP II) was launched in October 2005 with multiple goals: to facilitate the implementation of priorities established under ECCP I; and to explore and identify further cost-effective options for reducing GHG emissions in synergy with the EU's Lisbon strategy¹⁹. ECCP II broadens the objectives of the first ECCP to include climate change adaptation and improving international cooperation, technology transfer, research and education (Carlarne, 2010). New working groups* were established, covering carbon capture and geological storage, CO₂ emissions from light-duty vehicles, emissions from aviation, and adaptation to the effects of climate change. A review group was also established to assess the work done under ECCP I, focusing on transport, energy supply, energy demand, non-CO₂ gases, **agriculture**). Additional measures have therefore been investigated (e.g. in relation to flexible mechanisms, agriculture, sinks in agricultural soils, forest-related sinks). With regard to renewables, ECCP II has focused on the promotion of renewables in heating applications ("RES-H"), where biomass may play a significant role.

Notes: *The working groups included stakeholders from different backgrounds and interest groups. For example, the Agricultural soils sub-group includes representatives from the Commission (3-6), National experts (3-6), Business (3) and NGOs (3).

¹⁸ Flexible mechanisms: emissions trading; Flexible mechanisms: Joint Implementation and Clean Development Mechanism; Energy supply; Energy demand; Energy efficiency in end-use equipment and industrial processes; Transport; Industry (sub-groups were established on fluorinated gases, renewable raw materials and voluntary agreements); Research; **Agriculture; Sinks in agricultural soils; and Forest-related sinks.**

¹⁹ for increasing economic growth and job creation

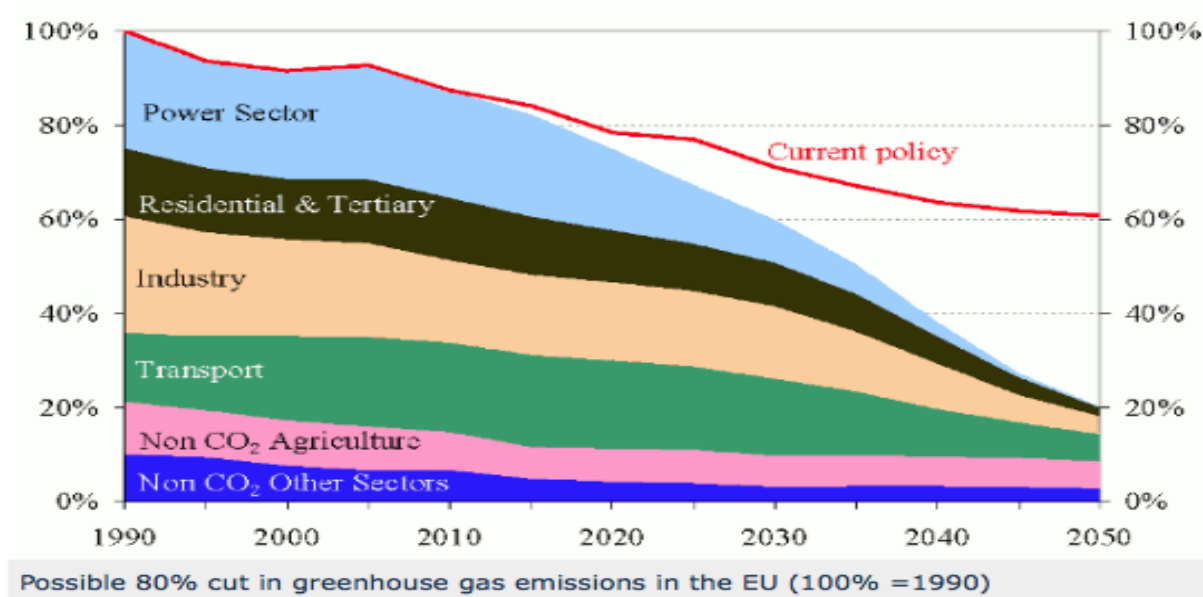
The ECCPs set the basis for Community-wide action on climate change and provided the foundations for the subsequent climate and energy frameworks. In 2007, EU leaders established the **2020 climate and energy framework** (European Commission, 2008) which introduced three key targets aligned with the Europe 2020 strategy (European Commission, 2010):

- to reduce by 20% GHG emissions (in relation to 1990 levels);
- to increase to 20% the share of renewable energy; and
- to improve energy efficiency by 20%.

These targets are to be achieved by a 21% reduction in GHG emissions in sectors covered by the EU Emissions Trading System (EU ETS)²⁰, and a 10% reduction in the non-ETS sectors²¹ (both compared to 2005 levels). The targets were complemented by a 20% target for the share of renewable energy in total final EU energy consumption under the Renewable Energy Directive (RED) (Directive 2009/28/EC) and a 20% target for energy efficiency (energy consumption compared to business-as-usual projections) under the Energy Efficiency Directive (EED) (ICEP, 2013), both to be achieved by 2020.

In order to identify what EU action would be required to contribute to limit global warming to less than 2°C above pre-industrial levels beyond the 2020 time horizon (i.e. the Kyoto Protocol target), the European Commission set out a broader **roadmap to deliver a low carbon economy by 2050** (European Commission, 2011). The roadmap, which is non-binding suggested the types of actions and targets necessary to meet the EU's 2050 climate ambitions and sits alongside the binding legislation set out in the 2020 climate and energy framework. In so doing the roadmap also laid the ground for the development of a climate and energy framework for 2030²². These included the contribution of all sectors in cutting GHG emissions to 80% below 1990 levels by 2050, with 40% and 60% milestones in 2030 and 2040 respectively. Whilst all sectors are expected to contribute to these reductions, the level of GHG emission reductions anticipated from different sectors varies considerably (Figure 3).

Figure 3: GHG emission reduction potential by 2050



Source: http://ec.europa.eu/clima/policies/strategies/2050/index_en.htm

²⁰ The ETS sector comprises energy industries, large industrial installations and aviation.

²¹ Covered by the Effort Sharing Decision (ESD) including transport, buildings, agriculture, small industry and waste.

²² Published in 2014 (European Commission, 2014).

In 2014 EU leaders adopted a renewed **climate and energy framework to 2030** (EUCO 169/14) setting out a longer term ambition to reduce GHG emissions beyond the 2020 policy window and in line with the broader 2050 low carbon roadmap. The 2030 framework affirms²³ the GHG reduction targets at the EU level to 40 per cent in relation to 1990 levels, to increase the share of renewable energy to 27 per cent and increase energy efficiency by 27 per cent. The European Council conclusions state that the 40 per cent emissions reduction target would be achieved through a contribution of emission reductions of 43 per cent in the ETS sectors (compared to 2005) and 30% in the non-ETS sectors. Agriculture's role is dealt with explicitly in the conclusions, noting that the "multiple objectives of the agriculture and land use sector, with their lower mitigation potential, should be acknowledged", and inviting the Commission to "examine the best means of encouraging the sustainable intensification of food production, while optimising the sector's contribution to greenhouse gas mitigation and sequestration, including through afforestation." The Commission was also invited to bring forward proposals for including the LULUCF sector into the target framework.

2.2. Current EU climate policy architecture and its relationship with agriculture

The Kyoto protocol and UNFCCC²⁴ require separate reporting of GHGs and sectors so that mitigation efforts and emission sources can be clearly identified. As a consequence agriculture, forestry and other land use (AFOLU) are addressed through two separate elements of the overall EU climate mitigation framework to 2020. Non-CO₂ emissions (e.g. CH₄ and N₂O) from agriculture are covered under the Effort Sharing Decision (ESD) (COM(2013)216) whereas CO₂ emissions and removals from the land using sectors are covered under the land use, land use change and forestry (LULUCF) Decision. In practice therefore different GHG impacts from the same sector are reported through separate frameworks²⁵. At present the LULUCF sector remains formally outside EU climate policies and EU emission-reduction targets. The EU's LULUCF Decision, introduced in 2013, does however require Member States to take certain actions, particularly in relation to improving monitoring and reporting for emissions and removals associated with cropland and grassland, in preparation for the sector's inclusion in the EU's emission reduction targets in the post-2020 accounting period. New proposals for the inclusion of LULUCF into the target framework for 2030 are dealt with in section 2.2.2 below.

In addition to the ESD and LULUCF Decision, the EU-Emissions Trading System (ETS) (Directive 2003/87/EC) covers emissions from other GHG generating sectors and accounts for the majority of CO₂ emissions in the EU. The EU-ETS does not cover agriculture as a sector, yet there is an indirect link through its coverage of biomass in energy generating facilities and the industrial production of ammonium nitrate used in agricultural fertilisers. A broad overview of the sectors and GHGs covered by these three different mechanisms is shown in Table 3 with a more detailed summary provided in Table 8 for current policies in Annex 2.

²³ As set out in the low carbon roadmap

²⁴ 'Reporting' denotes annual GHG emission and removal estimates included in national GHG inventories. Reporting methods are based on relevant UNFCCC/IPCC guidelines. 'Accounting' is the approach of assessing variations in GHG emissions/removals for elected or mandatory activities compared to a base year or reference level following certain accounting rules to assess the contribution towards a GHG target as required by the Kyoto Protocol. Reporting represents the basis for accounting.

²⁵ Part of the reason for this is the ability for CO₂ to be removed through absorption into biomass via photosynthesis in a way that is not possible for other gases, such as nitrous oxide or methane.

Table 3: Coverage of GHGs and sectors by the three EU climate reporting frameworks

MECHANISM	GHGS COVERED	SECTORS	RELEVANCE TO AGRICULTURE
Effort Sharing Decision (ESD)	All GHGs covered by Kyoto (CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs and SF ₆) with targets based on CO ₂ equivalence. NF ₃ not included in ESD despite introduction under Kyoto second commitment period.	<ul style="list-style-type: none"> • Energy supply (not generation) • Industrial energy use and processes • Transport energy use (excluding international maritime shipping and aviation) • Buildings (household energy use) • Services and small industrial installations • Agriculture (non-CO₂ only) • Waste 	Non-CO ₂ emissions from agriculture <i>Explicitly excludes emissions from land use, land use change and forestry (LULUCF)</i>
Land Use, Land Use Change and Forestry (LULUCF) Decision	Reporting and accounting on selected GHG emissions relevant to Kyoto reporting requirements - CO ₂ , CH ₄ , and N ₂ O.	<ul style="list-style-type: none"> • For each accounting period: emissions from afforestation, reforestation, deforestation and forest management (since 1990). Member States may also prepare and maintain accounts to reflect emissions and removals resulting from re-vegetation and wetland drainage and rewetting. Reporting only on cropland & grazing land management and preparation for accounting from 2021. • From 2021: Cropland & grazing land management accounting 	CO ₂ emissions from cropland and grazing land management.
Emissions Trading System (ETS)	<ul style="list-style-type: none"> • Carbon dioxide (CO₂) • Nitrous oxide (N₂O) • Perfluorocarbons (PFCs) 	<ul style="list-style-type: none"> • Power and heat generation • Energy-intensive industry sectors including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals • Civil aviation 	<ul style="list-style-type: none"> • N₂O emissions from the production of nitric, adipic, glyoxal and glyoxalic acids used in the manufacture of fertilisers. • Bioenergy facilities with potential to use agriculturally produced biomass. • Zero carbon rating of biomass at point of collection

Source: Own compilation

2.2.1. Effort Sharing Decision

The Effort Sharing Decision (ESD) (Decision No 406/2009/EC) came into force as part of the 2020 climate and energy package and sets national annual GHG emission allocations that are binding on Member States from 2013 – 2020. Net reduction targets are set out as binding national emission ceilings compared to 2005 levels. These range from +20% to -20%, depending on the country and aim to contribute towards an overall 10% reduction at the EU-28 level (Figure 5 – grey bars). Member States must report on their ESD sector emissions on an annual basis, including information on national policies and measures taken to promote emission reductions

and projections for future reductions. If a Member State exceeds its annual emission allocation, a deduction to its following year's allowance is made equal to its excess emissions multiplied by 1.08. It is also required to submit a corrective action plan.

The targets for each Member State to achieve a contribution to the overall EU target vary considerably and are determined on the basis of a country's relative wealth²⁶ within the EU. Some of the less wealthy Member States are allowed emission increases, compared to 2005, on the basis that their higher economic growth rates as they converge with the rest of the EU are likely to be accompanied by higher emission levels. However, the targets that have been set represent a limit in real terms compared to a business as usual growth rate. Therefore whilst emission increases are possible for ESD sectors in 13 Member States these are still seen by the Commission as 'emission ceilings' and are lower than the level of emissions that would have been realised without a ceiling in place. Member States can set more ambitious targets than those set out in the ESD²⁷.

Multiple sectors are covered by the ESD. Within these there is flexibility on how the overall emission reductions (or ceilings) are reached²⁸. Flexibility within the ESD operates in two explicit ways:

- *Geographic flexibility* allows a Member State to transfer up to 5% of its GHG emission allocations to another Member State where the transferring Member State has achieved a lower GHG emission for a given year. The receiving Member State may use this quantity to meet its obligations for the same year or any subsequent years until 2020.
- *Temporal flexibility* allows a Member State to bank or borrow annual emission allocations from one year to another within the trading period.

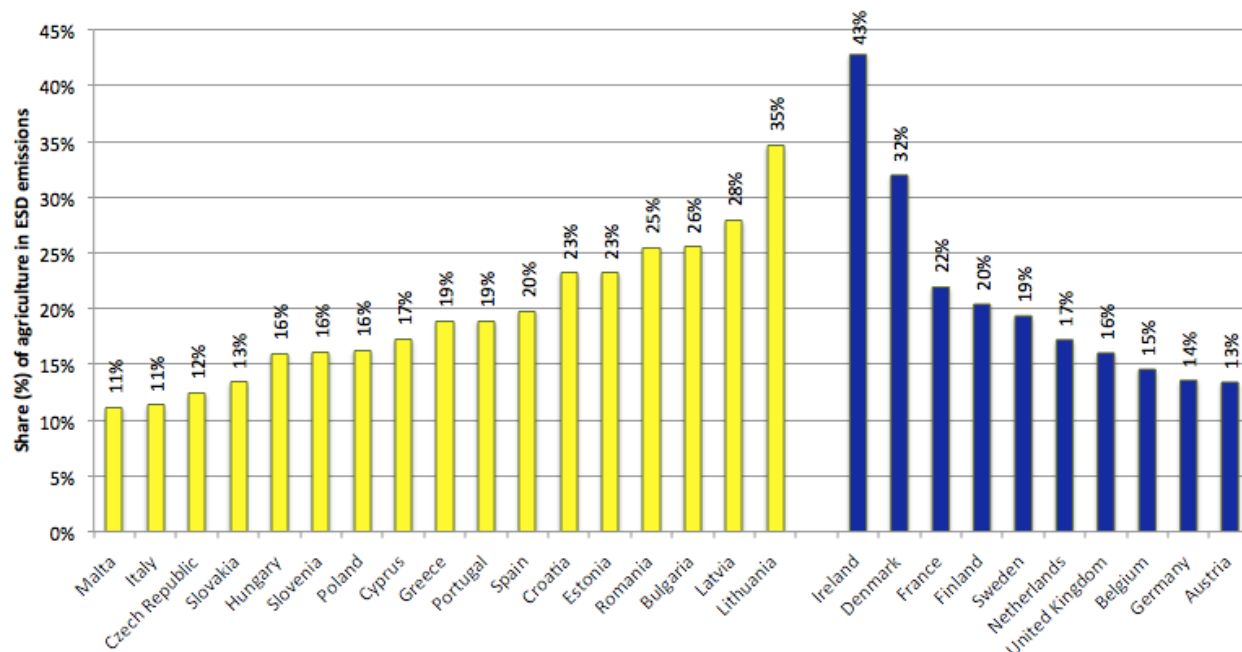
Figure 4 shows the relative share of agriculture in overall ESD emissions in each Member State. When combined with the ESD targets set out in Figure 5 it is possible to see the relative effort that a Member State may need to put in reducing emissions in the agriculture sector. For example Ireland, where 43% of its ESD emissions are attributed to agriculture, may need to deliver significant mitigation efforts in the sector, overachieve in other sectors, or make use of the existing flexibility rules or project activities, in order to meet its current ESD emission reduction target of -20%. Denmark is in a similar situation, with the same ESD target (-20%) and a share of ESD emissions from agriculture of 32%.

²⁶ Measured by Gross Domestic Product per capita.

²⁷ A number of Member States, including Denmark, Germany, Sweden and the United Kingdom, have adopted such national targets that go beyond their commitments under EU legislation.

²⁸ Sectoral flexibility recognises the different potential emission reductions within different sectors covered by the ESD.

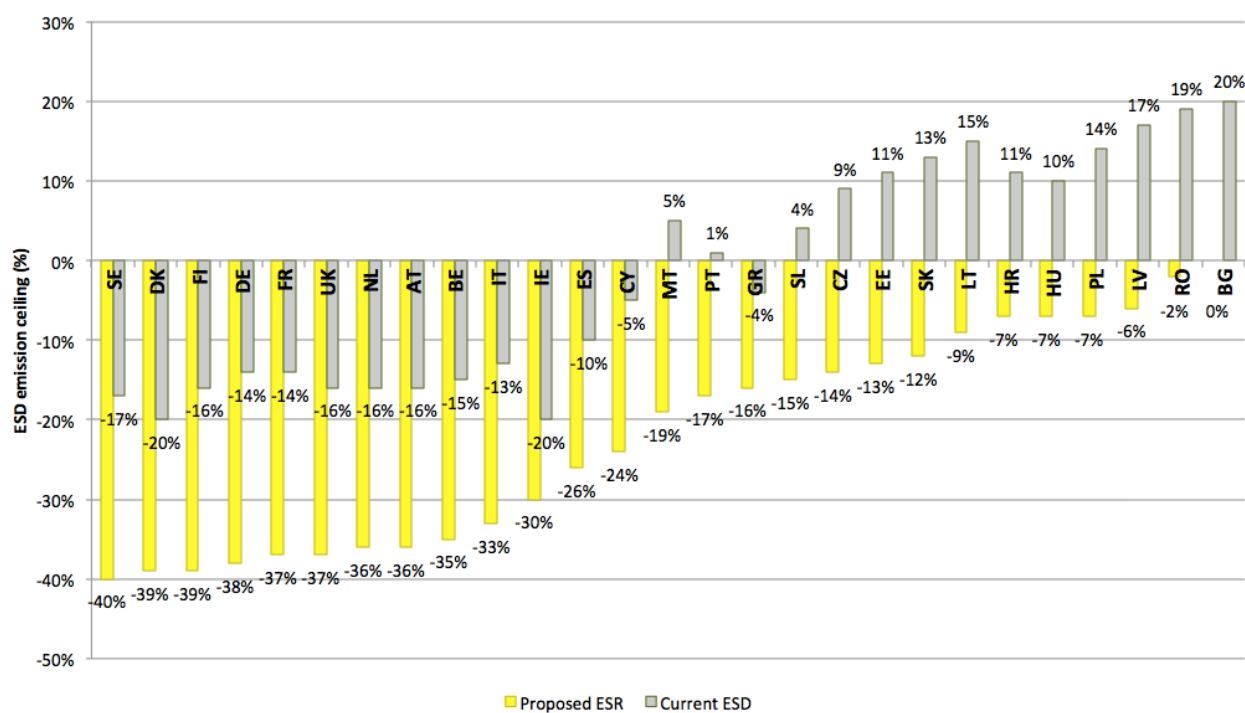
Figure 4: Share (%) of agriculture in ESD emissions in 2015



Source: IEEP, based on EEA, 2015b.

Note: Yellow bars represent Member States with GDP lower than the EU Average. Blue bars represent Member States with GDP higher than the EU average.

Figure 5: GHG reduction targets for 2020 set out in the ESD and for 2030 in the proposed ESR



Source: Based on COM(2016)482

In addition to the flexibilities offered by the ESD, Member States can make use (under Article 5 of the ESD) of credits from project activities (for example, Clean Development Mechanism²⁹ projects which generate emissions reductions in developing countries) in order to meet a limited proportion of their reduction targets. Each year a Member State can only use credits that amount up to 3% of its 2005 emission levels. Project credits include mitigation projects in countries outside of the EU, as well as Community-level projects issued pursuant to the EU-ETS.

2.2.2. Land use Land Use Change and Forestry (LULUCF)

The LULUCF Decision (Decision No 529/2013/EU), together with the Regulation on the mechanism for monitoring and reporting (MMR) of greenhouse gases (Regulation (EU) No 525/2013) were developed to help improve the quality of the data used to enable the accounting and reporting requirements under the Kyoto Protocol to be met. They also require Member States to put in place robust systems for reporting and accounting on activities that are currently not mandatory under the Kyoto Protocol (e.g. cropland and grazing land management) in preparation for the sector's inclusion in the EU's emission reduction targets in the post-2020 accounting period.

The decision provides the guidance and accounting rules necessary for Member States to complete their obligations. The LULUCF decision is not formally part of the 2020 climate and energy package as the sector does not currently count towards the EU's 20% GHG reduction target for 2020 – this only applies to those sectors covered by the ESD and ETS. This contrasts with the requirements of the Kyoto Protocol, under which some LULUCF activities³⁰ are accounted for in the EU's quantified emission limitation and reduction commitments (Nesbit et al, 2015). Under Kyoto, the EU and its Member States are required to ensure that GHG emissions from the LULUCF sector are compensated by equivalent removals in the same sectors, the so called 'no-debit rule'.

Under the UNFCCC, the emissions and removals of carbon and emissions of other GHGs in the LULUCF sector are reported for all six land categories defined by the IPCC. Land use change from one category to another is also reported. This approach is called the 'land-based' approach. In contrast, to demonstrate progress towards reaching the Kyoto targets, specific land use and land use change activities must be accounted for in line with a set of rules agreed mainly in 2011³¹. This approach is referred to as the 'activity-based' approach. The two sets of land use and land use change categories may overlap, either partially or fully (Weiss et al, 2015). Accounting is not mandatory for emissions from cropland and grazing land management activities, although countries can elect to do so. Once they have elected to do so, they must continue to account for these activities. Currently in the EU only Denmark, Spain (cropland management only), Portugal, Germany, Ireland, Italy and the United Kingdom have elected to account for these activities. The land using sectors covered by the EU LULUCF Decision are forestry (afforestation, reforestation, deforestation and forest management since 1990), wetland drainage and rewetting, re-vegetation³², and cropland and grazing land management (CM and GM

²⁹ The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO₂, which can be counted towards meeting Kyoto targets. http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php

³⁰ LULUCF activities covered by the Kyoto Protocol are listed under Articles 3.3 and 3.4. They relate to direct human-induced land-use change and forestry activities. Accounting is not mandatory for emissions from cropland and grassland management activities, although countries can elect to do so. Once they have elected to do so, they must continue to account for these activities. Currently in the EU only Denmark, Spain (cropland management only), Portugal, Germany, Ireland, Italy and the United Kingdom have elected to account for these activities. <http://unfccc.int/methods/lulucf/items/4129.php>

³² 'revegetation' means any direct human-induced activity intended to increase the carbon stock of any site that covers a minimum area of 0,05 hectares, through the proliferation of vegetation, where that activity does not constitute afforestation or reforestation.

respectively). The accounting rules treat these sectors differently. At the EU level, formal accounting for forest activities is a requirement for the entire reporting period (Article 3(1)); wetland drainage and rewetting and re-vegetation are optional for Member States for the entire period (Article 3(3); and accounting for emissions for CM and GM will be compulsory from 2021. However, under Article 3(2) of the EU LULUCF Decision Member States are required to provide estimates on their emissions and removals from CM and GM as well as the systems in place to estimate emissions and removals from CM and GM and intended improvements in these systems from 2015 onwards. This is intended to ensure that sufficiently robust systems are in place to enable the LULUCF sector to count towards EU targets from 2021 onwards.

In addition to providing the reporting and accounting rules necessary for Member States to meet their obligations, the decision sets a further requirement for Member States (Article 10) to provide information on their current and future LULUCF actions to limit or reduce emissions and maintain or increase removals resulting from the activities referred to for all land uses covered by the Decision. These 'Article 10 reports' must include a description of past trends of emissions and removals, as well as projections on emissions and removals for the accounting period. Of greater interest to mitigation interests is the required analysis on the potential to limit emissions or increase removals, the types of measures that are proposed to be used in the Member State, any supporting or proposed policies, and the timetable for adoption. The first reports were submitted in early 2015 and progress reports from all Member States are required by the end of 2016 and the end of 2020.

2.3. The Paris Agreement and action on climate change mitigation in the EU

For the EU, the Paris Agreement reinforces commitments to reduce GHG emissions³³ by at least 40 per cent by 2030 compared to 1990 levels, as set out in the EU's 2030 Climate and Energy targets (European Commission, 2014). The 40 per cent target has been adopted as the EU's INDC to the Agreement, and is consistent with the EU's ambition to reach an 80% reduction in emissions by 2050³⁴. As described below, in July 2016 the Commission tabled a proposal for a new Effort Sharing Regulation³⁵, setting out proposals for the targets for each Member State, and the new flexibilities proposed in meeting the targets, broadly in line with the European Council conclusions of 2014. These include similar rules on banking and borrowing of allowances (temporal flexibility) and on trading among Member States (geographical flexibility) as at present, but no flexibility to use non-EU project credits, and new flexibilities to use additional mitigation from the LULUCF sector. For a restricted list of Member States which are assessed as having limited cost-effective mitigation potential, for example because of a high share of the agriculture sector in their effort sharing regulation emissions, they can make a one-off transfer of effort to the Emissions Trading System. The emissions reductions targets for Member States range from a reduction of 40% from 2005 emissions levels in those with the highest GDP per head, to a 0% target for Bulgaria.

Regardless of whether a country intends to undertake mitigation activities in the LULUCF sector, the Paris Agreement requires all Parties to report information on their LULUCF emissions and removals. Unlike the Kyoto Protocol, however, it does not contain a single harmonised set of legally binding accounting rules or specify how emissions and removals from land use have to be counted towards national reduction targets beyond 2020. Parties will not be bound by one

³³ Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF₆), and Nitrogen trifluoride (NF₃).

³⁴ COM(2011)112 final: A roadmap for moving to a competitive low carbon economy in 2050.

³⁵ COM/2016/482 - Proposal for a Regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for a resilient Energy Union and to meet commitments under the Paris Agreement and amending Regulation No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and other information relevant to climate change.

stringent international set of standards. Instead, they may be allowed to choose from a "menu of options" on how to govern LULUCF (SWD(2016)249).

The Paris Agreement recognises the importance of ambition and action in all sectors but also indicates the flexibility to use both sinks and sources of emissions in each Party's mitigation efforts. For example, Article 4 of the Agreement makes a reference to the need to '*achieve a balance between anthropogenic emissions by sources and removals by sinks of GHG in the second half of this century*' and Article 5 states that '*Parties should take action to conserve and enhance, [...], sinks and reservoirs of GHG [...] including forests.*' (UNFCCC, 2015). One of the major challenges in the land using sectors is how their emissions and removals are balanced within and between the sectors and how major potential removals and sinks can (or should) be used to offset emissions in other sectors.

One specific challenge that arises from the Paris Agreement and the potentially greater focus on land-using sectors into domestic reduction targets is how to ensure a fair and equitable distribution of effort between Member States.

2.3.1. Development of the EU2030 climate and energy package

The EU is currently in the process of reviewing and updating most of its climate-related legislation to bring it into line with the 2030 targets as part of the Energy Union package (Box 3) (COM(2016)482). The proposals respond to the changes required to meet the ambitions set out in the Paris Agreement.

Box 3: Proposed revisions to EU climate-related legislation

- **July 2015:**
 - a proposal for reforming the **EU ETS**, aiming at a 43% reduction in emissions of greenhouse gases in the ETS sector, compared to 2005 levels (COM (2015) 337).
 - new legislation on energy efficiency labelling (COM/2016/860)
- **February 2016:** A proposal for a EU heating and cooling strategy (COM(2016)51);
- **July 2016:**
 - a proposal for a regulation replacing the **ESD**³⁶ to limit national emissions of greenhouse gases (GHG) for the 2021-2030 period in sectors not covered by the EU ETS (COM(2016) 482 final).
 - a proposal to integrate **LULUCF** emissions into the EU's 2030 climate and energy package (COM(2016)479).
- **November 2016:** The EU's "winter package" including amongst many proposals:
 - Proposal for revisions to the energy efficiency Directive (COM(2016)761)
 - Proposals to amend the Directive on the energy efficiency of buildings (COM(2016)765)
 - Proposal to revise the Renewable Energy Directive (**RED**) (COM(2016)767)

Source: Own compilation

Note: The negotiations on all these files can be followed on the Legislative Observatory website: <http://www.europarl.europa.eu/oeil/search/search.do?searchTab=y>

2.3.2. Agriculture in the 2030 EU climate and energy framework

Of the legislative proposals put forward under the EU's climate and energy framework, the two of most relevance for the agriculture sector are the proposed new Effort Sharing Regulation (ESR) and the proposal to formally integrate LULUCF into the 2030 climate and energy package. Importantly the proposals seek to treat the AFOLU sectors more holistically, providing increased potential for flexibilities between non-ETS sectors and between LULUCF and ESR accounts. In

³⁶ The Effort Sharing Regulation replaces the current Effort Sharing Decision.

addition to proposals that will affect the direct reporting and accounting of GHG emissions in the agriculture sector, the recent proposals for a revised renewable energy Directive will also have implications for the mitigation and adaptation efforts in the agriculture sector.

2.3.2.1. Summary of the ESR and LULUCF proposals

The Effort Sharing Regulation (ESR) proposes to continue the use of binding annual GHG emission targets for Member States, to be determined relative to GDP per capita. These targets are more demanding than the previous ESD targets (Figure 5) and are broken down to emissions limits for each year within the 10-year commitment period based on a decreasing linear trajectory. The starting point for the linear target trajectory from 2020 is set as the average emissions in 2016-2018 because this will be the latest data available in 2020. Lower income Member States that were still allowed to increase their emissions until 2020 will have a higher starting point, adding the agreed emissions increases between 2018 and 2020.

These targets would operate for the period 2021 – 2030 to meet the non-ETS sector target for the EU of reductions of 30% by 2030 compared to 2005. There has been no change to the GHGs covered by the proposed ESR³⁷ or the scope of the sectors covered.

The Commission proposal to integrate LULUCF into the 2030 climate and energy framework sets out binding commitments for each Member State and covers CO₂ from forestry and agriculture. The proposed targets are not set in a proportional sense in the same way as they are for the ESR, in part due to the significant potential for emissions removals in the LULUCF sectors. Instead the proposed requirement uses the so-called no-debit rule where, for each Member State, emissions may not exceed removals³⁸ in the land accounting categories³⁹. Two accounting periods are covered, mirroring the Paris reporting periods, 2021 to 2025 and from 2026 to 2030. Compliance checks are proposed to be undertaken at five year intervals instead of annually, in order to reduce the administrative burden for both Member States and the European Commission.

The LULUCF "no-debit" commitment is intended to incentivise Member States to take actions that increase the absorption of CO₂ in agricultural soils and forests. Although Member States undertook this commitment for forests under the Kyoto Protocol up to 2020, the proposal enshrines the commitment in EU law (for the first time) and for the period 2021-2030. There is some flexibility for Member States to balance emissions and reductions between different land categories. The proposal also sets out accounting rules so that compliance with the "no-debit" commitment is calculated consistently across all Member States. The accounting rules regulate how emissions and removals – i.e. the absorption of CO₂ by agricultural lands and forests – are to be recognised, measured and compiled in a standardised way.

2.3.2.2. Flexibilities in the ESR and LULUCF proposals

Alongside the inclusion of the LULUCF sector within the EU's GHG emission target, a further significant proposed change is the degree of flexibility proposed within the ESR and between the ESR and the LULUCF and ETS sectors. The flexibility to account for emission reductions across sectors in this way means that Member States can reduce the effort necessary to meet non-ETS sector targets by varying degrees (Figure 6). However, the flexibility is limited so that the ETS and non-ETS sectors would each need to deliver emission reductions in order to meet overall reduction targets across the economy as a whole.

³⁷ Carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrogen trifluoride (NF₃) and sulphur hexafluoride (SF₆).

³⁸ Calculated as the sum of total emissions and removals on their territory.

³⁹ Afforested land, deforested land, managed cropland, managed grassland, and managed forest land. The inclusion of wetlands remains a choice.

Flexibilities in the ESR proposal: The ESR proposal incorporates some of the existing flexibilities in the current ESD, but removes the option of using project credits from non-EU countries, and proposes two new flexibilities on the use of removals from the LULUCF sectors and the potential to cancel ETS allowances to be accounted under the proposed ESR. This second flexibility is only available for countries that either have proposed ESR targets above the EU average and their cost-effective reduction potential is limited or did not have free allocation for industrial installations in 2013.

Unlike the current ESD, the ESR proposal includes the potential to allow the offsetting of ESR emissions by removals in the LULUCF sector (Article 7). The higher a country's agricultural (non-CO₂) emissions are, the greater the potential they have in the proposal to use LULUCF removals to offset these. This arises from an assumption that there is lower mitigation potential available to the agriculture sector (SWD(2016)249). For example, Luxembourg would only be able to use from its LULUCF sector, an amount equivalent to 0.2% of its GHG emissions from non-ETS sectors in 2005, whereas Ireland would be able to use 5.6% (Annex to COM(2016)482). The flexibility applies only to net credits generated domestically by afforested land, Cropland and Grazing land management. Forest Management (FM) cannot be used for offsetting under the current proposal.

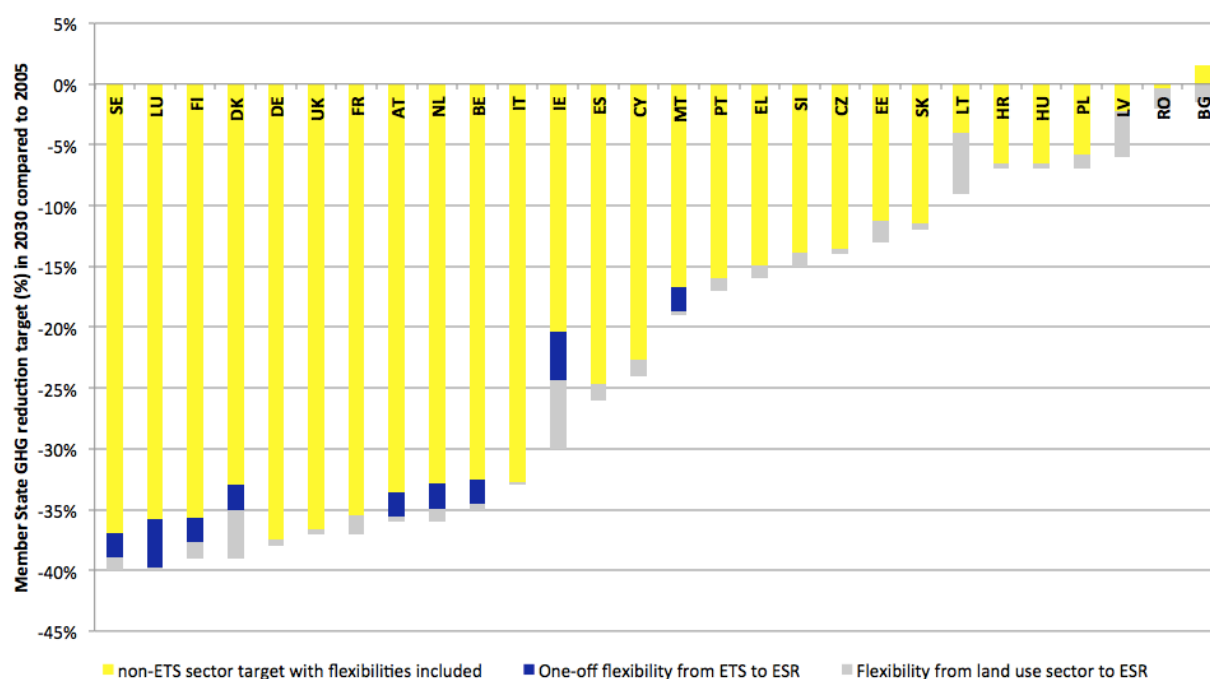
The potential to offset between the two sectors is limited and capped at 280mtCO_{2eq} for the entire commitment period (2021-2030). A Member State can use this flexibility only if it has net removals from LULUCF sector, it has not acquired additional LULUCF removals from other Member States, and that LULUCF removals are additional to the LULUCF 'no-debit' commitment set out in Article 4 of the proposed LULUCF Regulation (COM(2016)479) for the commitment period 2021-2030. Access to these removals is distributed on the basis of a Member State's share of non-CO₂ emissions in the ESD/ESR sectors. Member States with the access to largest volumes of LULUCF removals under the ESR are: France (58.2 mtCO_{2e}), Spain (29.1 mtCO_{2e}), Ireland (26.8 mtCO_{2e}), Germany (22.3mtCO_{2e} and Poland (21.7mtCO_{2e}) (details of all Member States can be found in Annex 2 – Box 13).

In addition to the flexibilities with the LULUCF sector, there are also flexibilities that would allow nine Member States with higher than average ESR reduction targets and no free allowance allocations in the previous commitment period to use part of their EU ETS allocations to meet their ESR targets. The precise amounts vary by Member State⁴⁰. The amount of EU ETS allowances that would be used to cover ESR emissions instead of being traded is limited and the Member State plans to use them must be notified to the Commission before 2020. In effect, in making use of this flexibility a Member State would choose to forego the auction revenues available from the ETS allowances in order to allow a higher level of permitted emissions to its ESR sectors.

The final set of flexibilities available to the ESR sectors is a maintenance of the banking and borrowing of annual emission allocations (AEAs) within the Member State or buying and selling of AEAs between Member States.

Flexibilities in the LULUCF proposal: Under the LULUCF proposal, Member states are allowed to use excess allocations from the ESR in order to meet the no-debit commitment where they have net emissions within the land using sectors. Like the ESR net removals can be accumulated over the commitment period. For example, if net removals of CO₂ are greater than emissions in the first compliance period (2021-2025) these can be banked and used in the next compliance period (2026-2030) to allow for inter-annual variability in land using sectors (e.g. growth and harvesting cycles).

⁴⁰ Luxembourg and Ireland get to use 4% of their 2005 emissions, whereas Austria, Belgium, Denmark, Finland, Malta, Netherlands, Sweden get to use 2% of their 2005 emissions.

Figure 6: Member State GHG reduction targets including flexibilities

Source: Based on data in Annex 2

Note(s): The combination of the yellow, blue and grey bars represents a Member State's commitment under the ESR proposal, e.g. Sweden has a proposed ESR target of -40%. Within this it has the opportunity to use a proportion of its ETS allowances (-2%) and a proportion of its LULUCF allowance (-1.1%) to meet this 40% target in the ESR sectors.

2.3.2.3. Implementation of renewable energy targets and evolution of the RED as it relates to agriculture

The current renewable energy Directive (Directive 2009/28/EC) sets a binding target of 20% final energy consumption from renewable sources by 2020 at the EU level, met by varying contributions from Member States. In addition, the Directive requires each Member State to generate at least 10% of their transport fuels from renewable sources by 2020. Member States have discretion in the way in which these targets are met. Despite a relatively balanced approach to proposed renewable energy deployment, as set out in Member State National Renewable Energy Action Plans (NREAPs), some energy modes have seen more rapid uptake than others. In 2014, renewable energy accounted for around 16% of final energy consumption in the EU-28⁴¹, with bioenergy contributing approximately 70% of this figure. In transport, renewable energy accounted for 5.9% of final energy consumption in 2014, primarily comprised from liquid biofuels (~94% based on (EEA, 2016b)). The high share of biofuels and bioenergy is largely because it can be adopted relatively easily into conventional energy infrastructure with little structural change.

The high share of biofuels in renewable transport energy is significant for the agriculture sector, as these are largely crop-based in origin. Biofuel processing facilities often require dedicated feedstock types with limited flexibility, which influences the relative demand for different agricultural commodities in a given area. These can include conventional food and feed crops, such as oilseed rape and wheat; dedicated energy crops, such as Miscanthus, giant reed or switchgrass; or the use of agricultural and food crop processing residues, such as corn cobs, straw and stover. Short rotation coppice (SRC, also grown on agricultural land) has also gained popularity as a feedstock for bioenergy facilities (co-firing or dedicated biomass) and more recently with its potential for advanced biofuel production. The production and use of these crops for developing renewable energy markets adds to the contribution of agriculture towards both

⁴¹ <http://ec.europa.eu/eurostat/documents/2995521/7155577/8-10022016-AP-EN.pdf/38bf822f-8adf-4e54-b9c6-87b342ead339>

the non-ETS sector targets (transport biofuels) and EU ETS targets (renewable electricity, heating and cooling).

Energy cropping has been supported to varying degrees at the Member State level through financial grants and energy crop schemes. Combined with incentives for the adoption of renewable energy (i.e. biofuels and bioenergy) the deployment of bioenergy and share of biomass feedstocks in agricultural production has risen since the implementation of the biofuels Directive in 2003 (Directive 2003/30/EC).

For several years prior to 2008, EU policy under the CAP required between eight and ten per cent of arable areas on certain larger arable farms to be 'set-aside'. It was, however, permissible to grow 'industrial crops', in practice mainly oilseed rape, in certain circumstances on this land. Such crops had to be dedicated for non-food use. Since 2008 and the abolition of set-aside policy, these former areas of set-aside have been absorbed back into agricultural rotations where industrial crops have been grown on land eligible also for food and feed crops.

In 2008 there was a growing awareness of the impacts on food production and natural environment of incentivised energy and biofuel crop production. In 2012 the European Commission proposed legislation to address the indirect land use change (ILUC) impacts resulting from the incentivised production of energy and biofuel crops in the EU. Where biofuels and bioenergy crops were being grown on agricultural land in the EU concerns grew over the impact this would have on the import of food and feed commodities to meet EU consumption demands. Whilst biofuel feedstocks had to adhere to sustainability criteria set out under Article 17 of the RED, food and feed commodities did not, and as result of increased demands for biofuels, expanded into environmentally sensitive areas, such as the Cerrado grasslands or tropical forests. In 2015 after a long period of negotiation, throughout which biofuel deployment slowed⁴², the ILUC Directive (Directive (EU) 2015/1513) was adopted, amending the RED⁴³ and limiting the contribution that certain biofuel feedstocks could make to national 10% transport energy targets by setting a cap of 7% on the contribution of biofuels produced from food crops. Member States are required to integrate these amendments by 2017 into national legislation and show how they will meet sub-targets for advanced biofuels.

In 2016 and in response to the Paris Agreement the commitment to renew the EU's energy and climate legislation included proposed amendments to the RED as a whole and updates to the renewable energy targets (see section 2.1). Notably these include proposals to reduce the share of food-based biofuels to 3.8% by 2030 starting in 2021 and new targets to increase the share of advanced biofuels (based on wastes and residues) to 3.6% in 2030. The proposals also include amendments to the sustainability criteria, with the inclusion of limited sustainability requirements for solid bioenergy⁴⁴, with reference to LULUCF accounting, but with little change to biofuel sustainability criteria. The contribution of agriculture to renewable energy targets, may therefore change in focus towards increased use of wastes and residues, or dedicated energy crops (which would be permitted within the 3.6% target) rather than food and feed based commodities. The proposed flexibilities allowed between the ESR and LULUCF sectors may become more or less attractive depending on how Member States respond to and use the proposed solid biomass sustainability criteria.

Decentralised energy production is also a feature of Member States renewable energy and rural development efforts. Anaerobic digestion, particularly as a means of processing and utilising

⁴² 2013 was the first year that the total volume of biofuels in final road transport energy consumption decreased from the previous year (EEA, 2016b).

⁴³ As well as the Fuel Quality Directive.

⁴⁴ A new risk-based sustainability criterion for forest biomass is introduced, as well as LULUCF requirement for ensuring proper carbon accounting of carbon impacts of forest biomass used in energy generation (COM(2016)767).

animal manures has risen in popularity along with support through Rural Development Programmes (RDPS), and has additional potential benefits for climate mitigation through its impact on lower nitrous oxide and methane emissions. The use of landscape management residues, such as hedgerow management and grass cuttings is also being used to deliver bioenergy in rural areas. Beyond bioenergy, agricultural areas in Member States also provide the space necessary for large-scale renewable energy infrastructure, such as wind turbines and solar-photo-voltaic (Solar-PV) installations. These can both aid in agriculture's contribution to mitigation efforts in other sectors, as well as helping the sector to adapt through decentralised energy production and increased energy security.

2.3.3. Other EU policies complementing climate change ambitions with relevance to agriculture

A suite of other EU policies with relevance to agriculture complement EU climate change ambitions, either through embedding actions to help reduce GHG emissions into law or by providing incentives for their uptake. These include:

- Regulations relating to the **Common Agricultural Policy**, in particular:
 - the Rural Development Regulation (Regulation (EU) No 1305/2013); and
 - the Regulation on Direct Payments (Regulation (EU) No 1307/2013) which requires those entitled to the basic payment or single area payment schemes to observe on all their eligible land agricultural practices beneficial for the climate and the environment.

The climate mitigation and adaptation potential provided by both the Rural Development Regulation and the Regulation on Direct Payments are discussed in more detail in Chapter 3.

- The **Water Framework Directive** (Directive 2000/60/EC)
- The **National Emissions Ceiling Directive** (Directive 2001/81/EC), currently under revision as part of the **Clean Air Policy Package**⁴⁵. A draft directive would affect agricultural emissions, namely of atmospheric NH₃ and PM_{2,5} emissions through national air pollution control programmes and the CAP⁴⁶;
- Actions under the new **Circular Economy package**, including the potential revisions to the EU's fertiliser regulation
- Aspects of the 'Framework Strategy for a Resilient **Energy Union** with a Forward Looking Climate Change Policy' (COM(2015)080 final)
 - Electricity grids must evolve significantly including development of high voltage long distance connections to integrate growing shares of renewables. Grid development directly contributes to the commitment under the Paris Agreement as it allows decarbonising the EU energy system in a relatively cost-efficient manner. Land use concerns may grow proportionally to the increase of the role of power grids in enabling clean energy development and energy security
 - The proposal for a new policy for sustainable bioenergy, may affect production patterns and biomass end use choices in light of climate targets.
- Other relevant policy areas include:
 - Soil;
 - Environmental Tax Reform;
 - Water – waste water treatment, organic pollutants from dispersed sources;
 - Health policy, such as reducing meat consumption;
 - Cohesion spending; and
 - Research and development

⁴⁵ Proposal to establish new national emission reduction commitments applicable from 2020 and 2030 for SO₂, NO_x, NMVOC, NH₃, fine particulate matter (PM_{2,5}) and methane (CH₄).

⁴⁶ <http://data.consilium.europa.eu/doc/document/ST-10607-2016-INIT/en/pdf>

2.4. EU's approach to climate change adaptation

The EU's intended action on climate adaptation is set out in the Climate Adaptation Strategy (COM(2013)216) with three principle objectives.

1. Promoting action by Member States by encouraging them to develop adaptation strategies relevant to their context.
2. Promoting better-informed decision-making by addressing gaps in knowledge and through the development of the Climate-ADAPT web portal – an information repository for adaptation information.
3. Promoting adaptation in key vulnerable sectors through mainstreaming of adaptation actions into sectorial policies, such as cohesion policy, fisheries and agriculture.

The adaptation strategy does not set binding targets or requirements on Member States in the same way as mitigation policy does, partly because of the less quantifiable nature of adaptation activity. Instead it focuses on providing supporting documents and guidance to aid Member States to develop their own adaptation initiatives in a coherent way and with respect to subsidiarity. Transboundary adaptation issues are, however addressed at the EU level. The strategy comprises a series of documents and supporting guidance (Box 13 Annex 2) to achieve the three objectives of the adaptation strategy, including principles and recommendations on the integration of adaptation activities into the 2014-2020 CAP (see Chapter 3). Member States are encouraged to develop adaptation strategies and report these through the MMR (see section 2.6).

Financing adaptation responses is a critical element of the EU's response. Financial support is provided with a commitment to devote at least 20 per cent of the €960 billion EU budget to climate mitigation and adaptation activities through the Multiannual Financial Framework (MFF). A dedicated LIFE environment fund (~€864 million) for mitigation and adaptation has also been created to help meet this commitment. With specific relevance to the CAP, at least 30 per cent of funding provided through Member State Rural Development Programmes must be reserved for voluntary measures beneficial for the environment and climate change (see Chapter 3). Funding for INTERREG Europe and Horizon2020 research and innovation programmes are both highlighted as key in developing EU response to the adaptation challenge in order to build knowledge and best practice. Following the Paris Agreement the European Investment Bank (EIB) has committed to increase its lending for action in developing countries to 35% of total lending by 2020 and expects to provide around EUR 100 billion for investment in climate projects around the world.

2.4.1. Knowledge development for effective adaptation

One of the key objectives of the EU's adaptation strategy is to improve the knowledge and understanding of climate impacts to enable better adaptation responses. This can include identifying the potential opportunities for the development of adaptation activities that will prove economically and environmentally beneficial under expected development trajectories.

At the EU level, the European Climate Adaptation Platform (Climate-ADAPT)⁴⁷ provides resources to support adaptation policy and decision-making. These include a toolkit for adaptation planning, a database of projects and case studies, and information on adaptation action. Adaptation options for the agriculture sector have been identified and include measures that encourage better management of soils and water resources, drought management plans, land use planning and behavioural change. Helping farmers to access risk management tools, such

⁴⁷ <http://climate-adapt.eea.europa.eu/>

as insurance schemes, is another priority. Informed decision-making is one of the priorities of the EU Adaptation Strategy to climate change. Reinforcing the knowledge base on the impacts and adaptation, including their costs and benefits for the agriculture sector, is a priority (Box 4).

Box 4: Current research initiatives under the EU Adaptation Strategy

- The Joint Research Centre (JRC) is supporting DG CLIMA and DG AGRI in modelling the economic impact of climate change on the agricultural sector, as well as the evaluation of adaptation and mitigation policies. This includes the European research projects such as the set of PESETA projects (Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis, part I and II) and AVEMAC (Assessing Agriculture Vulnerabilities for the design of Effective Measures for Adaptation to Climate Change).
- The Commission's Research and Innovation funding programmes are also improving research and knowledge for adaptation to climate change in agriculture. Key recent projects are mainly related to sustainable use of water and nutrient resources in agriculture, by improving water management and increasing water use efficiency (e. g., MOSES, BINGO, REC, etc.) and implementing of precision farming techniques (e.g., Flourish, EO-FARM, FATIMA, etc.). As for the livestock sector, the AnimalChange project is about integration of mitigation and adaptation options for sustainable livestock production under climate change. ECONADAPT project has the purpose to support adaptation planning through building the knowledge base on the economics of adaptation to climate change and concerting this into practical information for decision makers.
- The aim of the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) between 21 countries is to identify and promote measures providing the co-benefits of reducing emissions and increasing the resilience of farming, forestry and biodiversity to climate change.

Source: ClimateADAPT website

2.4.2. The Paris agreement and EU Agriculture adaptation

The Paris agreement has reinforced the necessity of adaptation efforts through climate policy beyond 2020 and establishes a global goal on adaptation of "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response" (UNFCCC, 2015). Article 7 sets out the key adaptation intentions under the Agreement. This requires Parties to the agreement to submit and update periodically an adaptation communication, which may include implementation and support needs, priorities, plans and actions. As individual Parties to the agreement, EU Member States will need to prepare these plans, alongside the EU as a Party in its own right.

Article 7(7) provides guidance on the sort of activities Parties should focus on in terms of cooperation, in light of the Cancun Adaptation Framework⁴⁸, including:

- Sharing information, good practices, experiences and lessons learned, including, as appropriate, as these relate to science, planning, policies and implementation in relation to adaptation actions;
- Strengthening institutional arrangements, including those under the Convention that serve this Agreement, to support the synthesis of relevant information and knowledge, and the provision of technical support and guidance to Parties;

⁴⁸ The Cancun Adaptation Framework (UNFCCC, 2011), whilst primarily focussed on developing countries, includes commitments for all parties to "*plan, prioritize and implement adaptation actions*" amongst other commitments.

- Strengthening scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making;
- Assisting developing country Parties in identifying effective adaptation practices, adaptation needs, priorities, support provided and received for adaptation actions and efforts, and challenges and gaps, in a manner consistent with encouraging good practices; and
- Improving the effectiveness and durability of adaptation actions.

The co-benefits of mitigation and adaptation are highlighted throughout the Paris Agreement. For example, Article 4, setting out the Nationally Determined Contributions (NDCs) requirements, makes explicit the potential co-benefits between adaptation actions and mitigation co-benefits (Article 4(7)). Article 5 of the Agreement reinforces this in the forestry sector where joint adaptation and mitigation objectives may contribute to the sustainable management of forest. The relationship between mitigation and adaptation is two-way, with the Agreement suggesting that greater mitigation efforts may reduce the need for additional adaptation efforts (Article 7(4)).

The Agreement stresses the significance of increased financial assistance for adaptation, particularly in developing countries, with the intention of reviewing adaptation arrangements under the UNFCCC in 2017. Technology development and transfer for adaptation and mitigation efforts is mentioned, again particularly with reference to transferring and sharing good practice with developing countries. With the EU's advanced agriculture sector, there is the opportunity for EU and Member States to lead the way in the development of low-carbon farming practices and technologies. Whilst not explicit in the Paris Agreement, this sharing of knowledge and best practice can be equally important within the EU. This is particularly the case between those countries or regions with experience in adaptation to climate related challenges, and those which are at an earlier stage of developing their adaptation policies. For example sharing best practice for irrigation management and water saving technology from Mediterranean areas, where droughts and water stress is a long-standing issue, to parts of North-West Europe where droughts have become more prevalent in recent years.

2.5. Member State action on climate in the agricultural sector

Within the Global and EU framework of action on climate change, EU Member States have adopted different approaches to mitigation and adaptation efforts. These reflect the structure of farming and forestry systems in Member States and the representative share of agriculture emissions as a proportion of total non-ETS emissions.

Most Member States are in the process of assessing the potential requirements and implications of the 2030 climate and energy package, and the likely requirement for revised domestic policies⁴⁹. For agriculture this has also been influenced by the recent CAP reforms and the implementation of 2014-2020 Rural Development Programmes (RDPS).

2.5.1. Requirements on Member States

At the Global and EU level there are frameworks that require reporting action on behalf of Member States under the UNFCCC rules (as signatory parties). Each year, Annex 1 parties to the UNFCCC are required to submit a national inventory report (NIR) containing detailed descriptive and numerical information; and through the common reporting format (CRF) tables containing all GHG emissions and removals, implied emission factors and activity data for the

⁴⁹ Including resulting proposals on ESR, LULUCF, RED, amongst others.

country. As an Annex 1 signatory to the UNFCCC the EU is also required to submit the same information as an aggregate view for all Member States⁵⁰ (see EEA, 2016a). The details of emissions and removals are disaggregated to the sector and sub-sector level, making it possible for Member States to identify the emission sources (Box 5) and where specific interventions may be necessary in order to mitigate emissions from agriculture⁵¹. The CRF reporting is particularly helpful as it presents together both the emissions and removals from agriculture non-CO₂ covered under the ESD (CRF category 3), and LULUCF (CRF4) allowing a common view across the land-using sectors.

Box 5: Sector specific breakdown of emissions reporting for agriculture and forestry (UNFCCC)

AGRICULTURE (CRF 3)	LULUCF (CRF4)
A. Enteric fermentation	A. Forest Land
B. Manure management	B. Cropland
C. Rice cultivation	C. Grassland
D. Agricultural soils	D. Wetlands
E. Prescribed burning of savannas	E. Settlements
F. Field burning of agricultural residues	F. Other land
G. Liming	G. Harvested wood products
H. Urea application	H. Other
I. Other carbon-containing fertilisers	
J. Other	

Source: UNFCCC CRF reporting categories

In line with the global framework (UNFCCC) and EU framework (2020 Climate and Energy) most Member States have adopted national programmes aimed at reducing GHG emissions and setting out how they will contribute to national targets (and thus EU targets). As climate change mitigation is a cross-sectorial challenge, there are usually economy wide strategies or plans, with more detailed plans for specific priority sectors Box 6.

Box 6: Examples of mitigation plans in France, Italy and Ireland

France

- Climate mitigation policy in France is set out in the **Climate Plan**⁵², i.e. the national mitigation plan, which is updated every two years. In 2015, the French Government also adopted the **National Low Carbon Strategy**⁵³, following recognition that existing policies (set out under the Climate Plan) would not be sufficient to meet future climate targets. The objective of the NLCS is to set the framework for increased future effort for GHG reduction and the types of solutions that may be required. The NLCS is complemented by **sectorial action programmes** in which more detailed and specific mitigation action is set out. Despite the NLCS envisioning action in the agriculture sector, no programme has yet been developed.

Italy

- The **National Plan for GHG emission reduction** is the key policy in Italy setting out a long-term vision for climate mitigation. Adopted in 2002 (as produced by the Ministry of the Environment), it was revised in 2013 (ICEP, 2013) and currently updated yearly (Ministry of the Environment, 2016) with the aim to set out action and policies in view of

⁵⁰ This represents a sum of the Member State reported information in their country NIR and CRF reports.

⁵¹ The reporting does not require specific action to be targeted to these particular sources.

⁵² Plan Climat. http://www.developpement-durable.gouv.fr/IMG/pdf/Fr_RMS_2013_.pdf

⁵³ *Stratégie nationale bas-carbone* (SNBC), adopted by the Decree No 2015-1491 (Décret no 2015-1491 du 18 novembre 2015 relatif aux budgets carbone nationaux et à la stratégie nationale bas-carbone).

achieving the commitments set out by the Kyoto Protocol and EU legislation in 2020. Agriculture is one of the sectors foreseen to contribute to emission reductions, alongside energy, transport and waste.

Ireland

- The **National Policy Position on climate action and low carbon development** provides a high-level policy direction for the adoption and implementation by Government of plans to enable the State to move to a low carbon economy by 2050. The statutory authority for the plans is set out in the **Climate Action and Low Carbon Development Act 2015**. Work is currently underway on developing the **National Mitigation Plan** to track the implementation of current measures and identify additional and necessary measures to meet low carbon transition agenda targets. The national mitigation plan will include sectorial mitigation measures to reduce GHG emissions to be adopted by the relevant Ministry departments responsible for key sectors. A **public consultation on a sector mitigation plan for agriculture and forestry (DAFM, 2015)** was released in January 2015, but there has been no specific **mitigation action plan released subsequently**.

Source: Own compilation

Member State National Inventory Reports (NIR) identify individual sources or sinks that are contributing significantly to their overall GHG emissions (Box 5). These are called 'Key Categories'⁵⁴. Agricultural land and management feature highly across all Member States, particularly in relation to soils and manure. For example, 26 Member States identify agricultural soils as key sources of N₂O emissions in their NIRs, manure management and enteric fermentation are identified in 20-22 Member States as a significant source of CH₄. A full summary of Key Categories and potential mitigation activities can be found in Table 11, Annex 2.

Despite the clear indication that agricultural land and management are key sources of GHG emissions for Member States (as shown in their NIRs), the level of mitigation effort to address these sources seems disproportionately lacking. The majority of Member States expect that their individual emission targets in the ESD will be met through those policy measures already in place. However, for 13 Member States⁵⁵, current projections indicate that they will not meet even their respective targets for 2020 (before considering action necessary to meet the Paris Agreement targets for 2030) without further efforts to design, adopt and implement emission-reducing policies and measures, along with consideration of the use of flexibility mechanisms⁵⁶.

Measures already in place include what is planned or required under existing policies to be implemented within a Member State and relative to the projection scenarios used to assess Member State compliance with GHG targets. For example, in the Czech Republic, cross compliance, a requirement for receiving direct payment support under the CAP, and certain measures under Rural Development Programmes are cited as 'existing measures'. The Czech Republic has also included the 'Strategy for Growth' and 'Biomass Action Plan' as policy measures to help deliver on ESD targets in the agriculture sector. These are considered as 'additional measures' and used in the 'additional measures' projection scenarios.

⁵⁴ A Key Category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term Key Category is used, it includes both source and sink categories. (IPCC)

⁵⁵ Austria, Belgium, Bulgaria, Finland, Germany, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Slovenia and Spain.

⁵⁶ Based on EEA assessments of the information taken from greenhouse gas Monitoring Mechanism Regulation (MMR) (Ministry of the Environment, 2016) Article 13-15.

Whether mitigation activities are considered existing or additional, the real test in a Member State's ability to reduce GHG emissions using the cited measures is whether they are effectively implemented. Projection scenarios and commitments to implement different measures do not always reflect reality and assume near-perfect implementation.

In addition to the national inventory reports, Member States are required to report on the Policies and Measures (PaM) through which they intend to meet emission reduction targets. These are required under both the ESD (Article 6) by reference to the Monitoring Measures Regulation (MMR) (Ministry of the Environment, 2016), and LULUCF Decision (Article 10). There are two mechanisms under which Member States are required to report.

- The LULUCF Decision: (Decision No 529/2013/EU): Member States are required (under Article 10), to report on the information on their current and future LULUCF actions to limit or reduce emission and maintain or increase removals resulting from the activities referred to in the decision. Of most relevance for agriculture, these are cropland management and grazing land management (CM and GM). Cropland and Grazing land management emissions and removals are part of the reporting requirement to 2020, with accounting becoming compulsory from 2021 (see section 2.2.2).
- The MMR (Regulation (EU) No 525/2013) requires (amongst other things) Member States to provide information on the policies and measures used to meet climate change objectives (Article 13); low-carbon development strategies (Article 4), and national adaptation strategies (Article 15); amongst other reporting requirements. These cover the ESD, EU ETS and LULUCF sectors in the EU.

The expected effort on the PaMs vary significantly between Member States. For example, under the MMR, out of the 42 PaMs mentioned in the Irish report, only 1 PaM is cited as affecting agriculture. Germany does not cite agriculture as an affected sector (0/42), France references agriculture 19/109 times, and the UK 5/58 times (Table 4).

Despite the reporting requirements for emissions and proposed actions, neither the ESD, the LULUCF Decision, nor the MMR require sector specific action to be implemented; only that actions are implemented in order to meet the respective overall national emission reduction targets (ESD). Therefore there is no specific requirement on Member State agriculture sector to implement mitigation policies in practice. It is the responsibility of Member States to determine in which sectors they will commit to climate mitigation activities, and thus the degree of effort required in the sector.

Beyond the ES and LULUCF Decisions, Member State action on climate change in the agriculture sector is currently influenced by both the indicative energy efficiency targets for primary energy consumption and final energy consumption (set out under the Energy Efficiency Directive (EED) (ICEP, 2013)); and the binding national targets to 2020 for the proportion of energy consumption from renewable sources (required under the RED (Directive 2009/28/EC)). Energy efficiency targets are relevant to the agriculture sector, particularly in the use of heavy farm machinery, as well as in the insulation and improved efficiencies in homes and buildings. For renewable energy generation, the agriculture sector can play an important role in aiding in mitigation efforts of the economy as a whole, particularly as the largest emission reductions in the EU by 2020 are projected to take place in the sectors covered by the EU ETS, rather than in the agriculture sector. Within the ETS, large reductions are expected to come from measures supporting renewable energy set out in the RED. Here Member State agriculture sectors could have a role in the production and mobilisation of biomass to produce biofuels and feed bioenergy installations, as well as providing space for renewable energy infrastructure (see section 2.3.2.3).

Table 4: Policies and Measures (PaM) reporting under the MMR for the UK (2015)

PAM NAME	DESCRIPTION	OBJECTIVE
Agriculture sector voluntary GHG action plan	Range of resource-efficient and land management measures to reduce emissions to meet UK carbon budgets	Reduction of fertilizer/manure use on cropland (Agriculture); Improved animal waste management systems (Agriculture); Improved livestock management (Agriculture); Activities improving grazing land or grassland management (Agriculture); Improved management of organic soils (Agriculture)
Nitrates Action Plan	Improved compliance with the Nitrate Directive (91/676/EEC). Designated revised "Nitrate Vulnerable Zones" (NVC); established a range of mandatory measures to reduce nitrate pollution to water in NVC. Also Code of Good Practice outside NVZs.	Reduction of fertiliser/manure use on cropland (Agriculture)
Catchment Sensitive Farming (CSF)	Delivers practical solutions and targeted support to enable farmers and land managers to take voluntary action to reduce diffuse water pollution from agriculture to protect water bodies and the environment.	Activities improving grazing land or grassland management (Agriculture); Improved management of organic soils (Agriculture)
Soils For Profit (SFP)	Provides on farm reviews and training on soils manures and nutrients.	Activities improving grazing land or grassland management (Agriculture); Improved management of organic soils (Agriculture)
Environmental Stewardship (Entry Level Schemes and Higher Level Stewardship)	Provides income foregone support under Pillar 2 of the CAP for farmers to undertake management options that benefit biodiversity, resource protection and water quality.	Activities improving grazing land or grassland management (Agriculture); Improved management of organic soils (Agriculture)

Source: UK submission to the 2015 MMR reporting requirement 30 June, 2015. Available on the EEA website.

2.5.2. Climate mitigation in Member States beyond 2020

With the signing of the Paris Agreement, Member States policy focus should increasingly turn to a consideration of what mitigation activities may be needed to meet a new set of targets to 2030 and beyond. Within the EU, new targets have been proposed which will require greater effort within the non-ETS sectors within Member States. For mitigation activities, two factors are important. The extent to which medium term action is required from the agriculture sector to meet a Member State's non-ETS target for 2030; and separately whether Member States will choose to favour mitigation effort in the agriculture sector (as opposed to delivering reductions in order ESD sectors).

There is a great deal of diversity in both the coverage and structure of agriculture and forestry systems across the EU. Added to the sensitivity of mitigation options to variations in the prevailing climate, soil structure, and hydrology, this means that the marginal GHG abatement costs can vary significantly. For example a country like Ireland will be likely to have a greater

challenge in meeting its emission reduction targets in the ESD in a cost efficient manner than a country like Austria or Slovakia. This is due to the high proportion of livestock farming in Ireland's agricultural economy and a proportionally high share of agriculture emissions relative to its total GHG emissions and those in the ESD sectors (~42%) (Figure 4). Austria and Slovakia have relatively low shares of agriculture in the ESD GHG emissions (~14%).

As set out in section 2.2, agricultural non-CO₂ emissions are included in the non-ETS sector (i.e. by the ESD and proposed ESR) and are thus included within the target to reduce emissions in 2030 by 30% compared to 2005 levels⁵⁷ and as broken down for individual Member States (see Annex 2 – Box 13). Importantly the target is not further disaggregated to the sector level, i.e. there are no specific levels of contribution set out for agriculture. This leaves the question of what level of contribution from agriculture might be necessary in order to meet the target given potential mitigation opportunities in other sectors.

The scenarios explored in the impact assessment accompanying the Commission's ESR proposal (COM(2016)482) suggest that little if any effort is required in the agriculture sector during the commitment period beyond those already expected from the policies in place. This means that the ESR targets would be met either through the increased energy efficiency improvements from a 30% energy efficiency target (under the slightly more ambitious EUCO30 scenario⁵⁸), or by meeting the 40% emissions reduction target, which itself delivers a 27% energy efficiency reduction (under the EUCO27 scenario⁵⁹).

The reasons for the anticipated lack of effort required in the agriculture sector are a function of the way in which the IA was modelled (Matthews, 2016b). Under the EUCO30 scenario, no agriculture mitigation measures were included in efforts to reduce GHG emissions as a result of concerns that efforts to reduce emissions would be a function of reduced production in the sector, rather than technology improvements (Perez Dominguez et al, 2016). In the EUCO27 scenario, a very low carbon price was used in the model (0.05€/tonne) that meant agriculture mitigation activities appeared costly (in comparison to the C price) and thus the optimisation model suggested action in other sectors would be more cost-effective. If a different series of assumptions (carbon price, mitigation actions) are used in the modelling of GHG emission reduction impacts, the resulting sectorial distribution of effort also varies. For example, the conclusions of the impact assessment for the Climate and Energy 2030 package from 2014 shows that agriculture emissions would need to reduce by around 28% if the EU was to meet its climate targets, i.e. a 30% emission reduction in the non-ETS sector (Matthews, 2016a). When determining the likely level of action necessary within the agriculture sector, or the cost and impacts of those actions, it is essential to understand fully the assumptions made in the underpinning assessments.

Understanding how Member States may react to new climate targets and the actions they will take is therefore challenging. Variations in responses are affected by the planned use of existing and proposed flexibilities between the non-ETS and ETS sectors, the cost implications of achieving mitigation activities in different contexts and the relative importance of agriculture as a share of a country's GHG emissions totals, in addition to political considerations (including the share of the agricultural workforce in the population, and its geographical concentration). Recent analysis by Mathews (2016a) highlights the relative effort that different Member States may need to undertake in their agriculture sectors in order to meet the proposed ESR targets (Box 7).

⁵⁷ As set out in the 2030 climate and energy framework.

⁵⁸ In the EUCO30 scenario, the energy efficiency target is increased to 30% to anticipate the review to be undertaken before 2020 to set the level of ambition.

⁵⁹ EUCO27 is a scenario that achieves the at least -40% GHG reduction target (with the split ETS/non-ETS reducing by -43%/-30% in 2030 compared to 2005), a 27% share of renewables and 27% energy efficiency improvements. In this scenario, the 27% energy efficiency target is met as a consequence of meeting the overall 40% reduction in GHG emissions and it is not an additional binding constraint.

Box 7: Role of agriculture in meeting Member State ESR targets

EU Member States can be split into four groups on the basis of the effort needed to meet their ESR targets and the potential need for action in the agriculture sector.

1. **Group 1: BG, HR, CZ, EE, HU, LV, LT, MT, RO, SL, SK, EL, PT & ES.** Those countries which are likely to have surplus Annual Emission Allocations (AEAs) in 2030 and expected non-ETS emissions will be below their ESR targets. These are mainly Central and East European countries but also include three Mediterranean countries.
2. **Group 2: CY, FI, PL, SE, IT & UK.** This includes those countries where the distance to target falls within a 10% range and thus will require some additional effort.

The remaining group of countries are those where the distance to target is greater than 10% and where significant additional efforts will be required over the next commitment period (AT, BE, DK, FR, DE, IE, LU, NL). From the agricultural perspective, this group can be divided into two.

3. **Group 3: LU, AT, BE & DE.** The share of non-ETS emissions coming from agriculture is relatively low in 2030, less than 20%. These countries could probably hit their non-ETS target in 2030 by taking additional measures in the building, transport and waste sectors without doing much agricultural mitigation.
4. **Group 4: DK, FR, IE & NL.** These all have 'distances to target' greater than 10% and shares of agricultural emissions greater than 20% of total non-ETS emissions in 2030. The challenges for agricultural mitigation in IE and DK are particularly marked. IE has a 'distance to target' in 2030 of 15.1% and an agricultural share in non-ETS emissions in 2030 of 49.0%. Denmark has a similar distance to target of 16.2% and an agricultural share in non-ETS emissions in 2030 of 36%. FR and NL have lower shares of agriculture in total emissions but a higher expected 'distance to target'. In these four countries, agricultural mitigation will have a play a central role if the 2030 non-ETS targets are to be met by domestic action alone.

The challenge of meeting ESR targets in individual Member States has been assessed by Mathews (2016) in terms of the 'distance to target' that Member States may face based on the following assumptions: the maximum use of flexibilities by a Member State, the projected share of agriculture in 2030 emissions, the assumption of full implementation of all existing policy measures. The author notes that these assumptions effectively represent an easiest-case scenario and any change to these assumptions would likely see greater need for mitigation in the agriculture sector.

Source: Matthews, 2016a

Note: Source data can be found in Table 10 in Annex 2. Annual Emission Allocations (AEA) are the absolute maximum amount in tonnes of GHG emissions that each Member State is allowed to emit in any year from 2013 to 2020 in the non-ETS sectors. These are set out in (Cooper, Hart and Baldock, 2009)

It is worth noting that these Impact Assessments and analysis of likely effort for Member States (Box 7) focus on the most cost efficient means of meeting the EU's climate commitments and use this economic assessment as part of the justification when setting targets. In practice, behavioural and institutional considerations are also relevant, as are any separate national commitments to emission reductions.

2.5.2.1. Different national approaches to 2030

In countries where the share of non-ETS emissions from agriculture is modest and where the distance to target is relatively small (group 2, in Box 7) it appears that existing measures within the agriculture sector, assuming they are fully implemented, are assumed to be sufficient to meet ESD targets. In Italy and Poland, for example, efforts are largely focussed on improving the efficiency of production, such as rationalising the use of mineral fertilisers and better management of animal manure (Italy), or promoting energy-efficient technologies and renewable energy in farming (Poland).

It might be supposed that in countries that have high shares of agriculture emissions and high ESR targets (i.e. group 4 in Box 7) some additional mitigation effort in the agriculture sector would be required if ESR targets are to be met through domestic action. However, a review of the assessments that underpin domestic mitigation activities and targets suggests that the level of action foreseen is extremely varied. For example, in France, the development of the national Low Carbon Strategy⁶⁰, which sets three carbon budgets for the country⁶¹, envisaged a 12% reduction in agriculture emissions by 2025 and 50% decrease by 2050 when ensuring climate action across all sectors⁶². A different picture is seen in Ireland where the National Policy Position on Climate Action and Low Carbon Development (DHPCLG, 2015) foresees action for explicit emissions reduction (by 2050) in the energy generation, built environment and transport sectors, but with a goal of climate neutrality in the agriculture and land-use sector (by 2050), which does not compromise capacity for sustainable food production (EPA, 2016).

Member State Article 10 reports, required as part of the current LULUCF Decision, reinforce the picture seen in national policy statements. In France, when modelling the potential to reduce emissions in the LULUCF sectors as part of their Article 10 report (Annex 5, section 0), we see that the scenario where the Low Carbon Strategy is fully implemented there is an anticipated reduction in emissions from cropland and grassland management by 2020 and 2035. In Ireland, the role of afforestation is more evident, through the commitment to increase forest area by 15,000ha per year. This is coherent with the aim of climate neutrality in the agriculture and land-use sectors, rather than explicit emission reductions in the agriculture sector *per se*. However, Ireland's Article 10 LULUCF report does acknowledge that the climate sequestration potential of forests is limited in its role to mitigation agriculture emissions, and foresees the longer-term mitigation benefits from fossil fuel and material substitution with harvested wood.

From the literature it appears clear that one concern Member States have about increased effort in the agriculture sector is the impact this could have on production. For example, Ireland's planned mitigation activities are determined in conjunction with its ambitious food and farming strategy FoodWise 2025 (DAFM, 2016). Projections by Ireland's Environmental Protection Agency (EPA) show that it is highly unlikely to meet its ESD annual targets in 2016/17 and is further unlikely to hit their 2020 targets (EPA, 2016). This is in part due to the increase in animal numbers as a result of FoodWise 2025⁶³ and despite Ireland being one of the most carbon efficient livestock food producers in the world (EPA, 2016).

Overall, it is clear that the mitigation efforts envisaged for the agriculture sector tend to focus on those activities that have the least impact on the productivity or growth of the sector as a whole, or those which are economically beneficial for the sector through delivering increased efficiency of production for reduced inputs (e.g. improved targeting of fertiliser application). The UK's PaMs are an indication of this (Table 4) with all but one (the Nitrates Action Plan) of the proposed PaMs being voluntary in nature and either receive income forgone payments (agri-environment-climate scheme payments), advice and support (Catchment Sensitive Farming and

⁶⁰ *Stratégie nationale bas-carbone* (SNBC), adopted by the Decree No 2015-1491 (Décret no 2015-1491 du 18 novembre 2015 relatif aux budgets carbone nationaux et à la stratégie nationale bas-carbone) in the framework of the Law No 2015-992 on the energy transition for a green growth. Loi n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte.

⁶¹ (2015-2018, 2019-2023 and 2024-2028).

⁶² In the model, the efforts would aim in particular to reduce non-CO₂ emissions (N₂O, CH₄), to maintain carbon stores in soils and in biomass and to contribute to fossil fuels substitution by producing biomass. The model is not binding, these were working assumptions to set realistic carbon budgets but it does give an indication of the priorities identified by the French government (Ministry of Environment) for the agricultural sector.

⁶³ Emissions from Agriculture in 2015 are now 5.7% below their 1990 levels but have increased for 3 out of the last 4 years, 2012, 2013 and 2015. The fluctuations in Agriculture emissions are underpinned by higher animal numbers; dairy cows population was 7.7% higher in 2015 compared with 2014 with an increase in milk production of 13.2%. This reflects national plans to expand milk production under Food Wise 2025 and following removal of milk quota in 2015 (EPA, 2016).

Soils For Profit (Table 4)), or improve resource efficiency and thus reduced operational costs (voluntary GHG plan). Relatively few countries appear to be making more fundamental changes to their agriculture sector activities, such as reducing or changing production modes.

A central challenge for the agriculture sector is then how can productivity be maintained or increased whilst concurrently reducing emissions, and what the implications are for the EU's agriculture sector and climate targets if this cannot be achieved. Synergistic activities can be beneficial here, such as those that result in both climate mitigation and aid in the adaptation of the sector to climate change. Similarly, delivery of the longer term (2050) targets in the EU roadmap and even more so in the Paris Agreement imply a focus on consumption measures, including action on diet and on food waste.

2.6. Climate change adaptation in the Member State agriculture sectors

For adaptation, Member States are required, again under the MMR (Article 15) to report on national adaptation actions⁶⁴ - *"Member States shall report to the Commission information on the national adaptation planning and strategies, outlining their implemented or planned actions to facilitate adaptation to climate change. That information shall include the main objectives and the climate change impact category addressed, such as flooding, sea level rise, extreme temperatures, droughts, and other extreme weather events."*

Where mitigation activities in the agriculture sector are relatively limited, adaptation effort shows a different picture. Member States are at various stages of preparing, developing and implementing national adaptation strategies and plans. The EU's Climate ADAPT web platform provides a summary of the status of adaptation plans across the EU based on the MMR reporting requirements and updates from EEA countries. Adaptation strategies and actions plans are present or being developed in all EU Member States with agriculture mentioned by all countries as a sector in which action is required (Table 13 – Annex 2).

The majority of action plans and strategies identify agriculture as a sector that requires support in adapting to climate change, with indicative measures to aid in this effort. For example the Cypriot climate adaptation plan includes measures to address drought and water scarcity, reduce risk of decreased crop productivity, address pests and diseases, extreme weather events and build soil fertility. Some adaptation plans see agriculture as a sector that can aid the broader country level adaptation to climate impacts. For example Estonia identifies agriculture as a key sector in bioeconomy developments and adaptation of rural businesses. Whereas some countries, like Finland see the role of agriculture (and other land-using sectors) in aiding adaptation to extreme weather events, particularly flooding, through better implementation of river basin management plans.

Forecasting and monitoring is highlighted as particularly important in a number of Member States (e.g. FR, IT, PL, IE) in order to provide early warning of climate related events (droughts or floods) so that preparatory action can be taken.

⁶⁴ Initially in 2015 and every 4 years thereafter aligned with UNFCCC reporting.

3. CLIMATE MITIGATION AND ADAPTATION IN THE CAP 2014-2020

KEY FINDINGS

- The CAP has considerable potential to advance climate mitigation and adaptation by influencing how individual farmers choose to manage their land, crops and livestock and how they use inputs, including energy, fertilisers and water.
- Climate objectives have become gradually more prominent within the CAP over time. From 2014 onwards, climate action features in one of the three overarching objectives for the CAP as a whole (both Pillar 1 and Pillar 2) and is a key priority for action within rural development policy under Pillar 2.
- Because Member States have a lot of flexibility about how to implement the CAP, achieving climate benefits on the ground depends on the choices made by Member States in programming the CAP for 2014-20, and on the choices made by farmers within the options available to them.
- The main CAP instruments and measures that have the potential to deliver climate mitigation and adaptation benefits are: requirements set under cross-compliance standards of Good Agricultural and Environmental Condition; the Farm Advisory System; Pillar 1 green direct payments; and Pillar 2 rural development measures (for land management, investments and advice and capacity building).
- Implementation of these CAP instruments and measures for climate is very variable between Member States and regions and in many countries a rather minimalist approach appears to have been taken; Rural Development Programme (RDP) budgetary allocations to climate priorities are much lower than for other priorities; targets against climate related indicators have not been set in all regions and where they have are very low in many cases.

The Common Agricultural Policy is often identified as a key instrument to provide funding and support to help enable agriculture transition to a more sustainable low-carbon future, for both adaptation and mitigation action.

The CAP is an important economic driver for farming decisions across the EU and has considerable potential to advance climate mitigation and adaptation by influencing how individual farmers choose to manage their land, crops and livestock and how they use inputs, including energy, fertilisers and water. The CAP is also the only source of EU funding to offer incentives for environmental afforestation and establishment of agroforestry systems on agricultural land. Indeed, under the current multiannual financial framework (MFF) at least 20% of the EU budget must address climate action and this includes funding through the CAP.

Member States enjoy a significant degree of subsidiarity in implementing the CAP within the framework provided by the EU Regulations. This means that the achieving climate benefits on the ground will depend on the choices made by Member States in programming the CAP for 2014-20, and on the choices made by farmers within the options available to them.

This chapter is divided into two sections. The first section assess the way in which climate concerns have been integrated into the CAP over time, set within the wider perspective of the growing EU and international climate agenda. The second section examines the way in which the CAP is currently being implemented in Member States for the 2014-2020 period. It sets out

the measures that are used to have a direct or indirect effect on climate mitigation and adaptation.

3.1. Integration of climate action into the CAP (2005 to 2020)

As explained in previous sections of this report, the emergence of climate change as an issue on which action was required and the development of policies on climate action at EU level over time have gradually shaped policies in a number of sectors. This section describes the progressive integration of climate objectives within the Common Agricultural Policy (CAP), focussing on the period since 2000.

3.1.1. 2000-2007: the early years

Prior to 2007, climate change was not a formal priority of agricultural or rural development policy in the EU. Developments outside the agricultural policy sphere progressively raised attention about the significance of climate change for the EU agricultural sector (Cooper and Arblaster, 2007), in terms of:

1. The need for agriculture to adapt to climate change; and
2. The role the agricultural sector could play in relation to mitigation by:
 - a. enhancing carbon removals from the atmosphere; and
 - b. reducing its GHG (CO₂ and non-CO₂) emissions.

Agricultural policy debates were informed by the assessments of the European Climate Change Programme (ECCP), a programme set up to implement the commitments of the Kyoto Protocol (see Section 2.1). Although the launch of the EU ETS in 2005 marked an important milestone in this period for climate action, it was not until the introduction of the Effort Sharing Decision in 2009 that the agricultural sector was included amongst those sectors from which GHG reductions could be made to meet EU targets, at least in relation to its non-CO₂ emissions (see Section 2.2).

While climate action was not a stated priority for the CAP prior to 2007, some CAP instruments and measures in those early years are likely to have had some climate mitigation effect. For example, the cross-compliance obligations introduced in the 2003 CAP reform required all farmers in receipt of direct payments and area payments under rural development policy to comply with a range of Statutory Management Requirements (SMR) and standards of Good Agricultural and Environmental Condition (GAEC) from 2005 (Council Regulation (EC) No 1782/2003). In particular, GAEC obligations required Member States to put in place standards to avoid soil erosion and maintain soil organic matter levels and soil structure, all of which had the potential to be beneficial for carbon storage and sequestration. Within cross-compliance, rules were also introduced to protect permanent pasture by limiting the proportion that could be ploughed at the national level. By constraining the conversion of permanent grassland to arable land, this measure had the potential to also reduce soil carbon losses associated with ploughing⁶⁵.

In addition, prior to 2007, rural development measures in Pillar 2 were clustered around nine themes (Council Regulation (EC) No 1257/1999), including agri-environment and forestry measures. Forestry measures were intended to promote in particular:

⁶⁵ However, it should be noted that the definition of permanent grassland permits grassland to be ploughed annually as long as the land is reseeded to grass, therefore soil carbon benefits are only secured where this practice is not carried out. In addition this measure operated at the national level, meaning that, as long as the overall area of permanent grassland did not decline below the set percentage, significant conversion of permanent grassland to arable could still take place in some areas as long as this was balanced by the creation of permanent grassland elsewhere. This possibility also reduces the soil carbon benefits of the measure.

- sustainable forest management and development of forestry,
- maintenance and improvement of forest resources; and
- extension of woodland areas.

Agri-environment measures were intended to⁶⁶:

- promote ways of using agricultural land which are compatible with the protection and improvement of the environment, the landscape and its features, natural resources, the soil and genetic diversity;
- an environmentally-favourable extensification of farming and management of low-intensity pasture systems;
- the conservation of high nature-value farmed environments which are under threat; and
- the upkeep of the landscape and historical features on agricultural land;
- the use of environmental planning in farming practice;
- the improvement of animal welfare (introduced in 2003).

Member States were obliged to implement the agri-environment measures in their countries, but had the freedom to design the measure in ways that met the environmental priorities they faced. Although climate did not feature explicitly in the objectives of the measures at this time, nonetheless the implementation choices made in Member States regarding the content of their agri-environment schemes and any afforestation of agricultural land, may have had positive effects on maintaining carbon stores in agricultural soils and landscape features and potentially enhancing sequestration through better management of agricultural land and the planting of trees. The *ex-post* evaluations of the 2000-2006 RDPs provide a few examples where agri-environment measures contributed to climate mitigation, such as in Austria and the Czech Republic (Box 8).

Box 8: Examples of RDP measures implemented in the period 2000-2006 having contributed to climate mitigation, in Austria and Czech Republic

In Austria, the agri-environment ÖPUL programme (Österreichischen Programm zur Förderung einer umweltgerechten, extensiven und den natürlichen Lebensraum schützenden Landwirtschaft) contributed to reducing GHG emissions through the promotion of organic farming and other operations aimed at reducing agricultural inputs. There were also a number of operations which included actions to improve 'carbon sinks' involving the natural removal of carbon dioxide from the atmosphere.

In the Czech Republic agri-environment sub-measures supporting the conversion from arable to grassland contributed towards the mitigation of climate change effects. In this case the mitigating effect results from a significant reduction in GHG emitting activities such as ploughing, sowing and harvesting and through significant reductions in the use of pesticides and herbicides, since the production process for these inputs has a high carbon footprint.

Source: KANTOR Management Consultants, 2012)

Over this period, increased attention was also given to the potential of energy crops to contribute to climate change mitigation. Since the 1999 CAP reform, Member States were allowed to provide

⁶⁶ (Council Regulation (EC) No 1783/2003)

support to farmers to grow industrial crops on set-aside land⁶⁷. As early as 2003, the CAP established a specific aid for energy crops “*with the objective of increasing carbon dioxide substitution*”⁶⁸. The energy crop aid was funded via Pillar 1 (EU funds). However, the actual contribution of energy crops was later proven to not have been as beneficial for CO₂ substitution as anticipated at the time ((Cooper and Arblaster, 2007))

3.1.2. 2007: climate as a formal priority for the European Agricultural Fund for Rural Development

Rural development policy for the period 2007-2013 was revised and reoriented around 4 axes, corresponding to the objectives of the new European Agricultural Fund for Rural Development (EAFRD) as set out in Council Regulation (EC) No 1698/2005⁶⁹:

- Axis 1: improving the competitiveness of the agricultural and forestry sector;
- Axis 2: improving the environment and the countryside;
- Axis 3: quality of life in rural areas and diversification of the rural economy;
- Axis 4: LEADER

These objectives were reinforced by the ‘Community Strategic Guidelines for Rural Development (programming period 2007 to 2013)’ (Council Decision 2006/144/EC). These Strategic Guidelines sought to ensure that the rural development programmes developed by each Member State were closely aligned with overarching Community priorities. The 2007-2013 priorities stressed the importance of rural development policy adhering to the Göteborg sustainability goals laid down in the EU Strategy for Sustainable Development (EUCO 10117/06) and the objectives of the Lisbon strategy for growth and jobs (COM/2005/0024 final). They also sought to ensure that rural development was consistent and coherent with other EU policies, in particular cohesion and environmental policies. A series of objectives were identified for each of the rural development ‘axes’. Under Axis 2 (improving the environment and the countryside) climate change was highlighted for the first time explicitly, stating that “*the resources devoted to axis 2 should contribute to three EU level priority areas: biodiversity and preservation of high nature value farming and forestry systems, water, and **climate change**.*”

Linking the objective of climate change to Axis 2 focussed the attention of climate actions onto the sustainable use of agricultural (and forest) land. The measures for agricultural land under Axis 2 were the following⁷⁰:

- Natural handicap payments in mountain areas and payments in other areas with handicaps;
- Natura 2000 payments and payments linked to (Directive 2000/60/EC);
- Agri-environment payments;
- Animal welfare payments;
- Non-productive investments; and
- Afforestation on agricultural land.

⁶⁷ Article 6 (3) of Council Regulation (EC) No 1251/1999 stipulates that “Member States shall be authorised to pay national aid up to 50% of the costs associated with establishing multiannual crops intended for bio-mass production on set-aside land.”

⁶⁸ Council Regulation (EC) No 1782/2003, preamble (41).

⁶⁹ The direct support fund being renamed into European Agricultural Guarantee Fund, or EAGF.

⁷⁰ A second set of measures targeted the sustainable use of forestry land.

Importantly, Member States were also required to allocate at least 25% of their total EAFRD budget to Axis 2 measures⁷¹. Overall, at EU level, the EAFRD budget had increased, from €57,689 million⁷² over the period 2000-2006 to €92,200 million for the period 2007-2013⁷³. This included the financial resources arising from the modulation mechanism, introduced in 2003, and which involved the mandatory transfer of 5% of Pillar 1 budget to Pillar 2 (from 2009 onwards, this rate was increased, see below).

3.1.3. 2009: reinforcement of the climate objective under the CAP Health Check

The 2008/09 Health Check of the CAP amended a number of CAP rules. Of relevance to climate action, the changes made to the direct support Regulation (Council Regulation (EC) No 73/2009) brought about increased rates of compulsory modulation for the rest of the budget period (i.e. to 2012⁷⁴), applicable to all payments above €5,000⁷⁵.

The additional funds raised were used to provide greater support to Member States' rural development programmes, more specifically to those areas identified as being 'new challenges', including climate change⁷⁶. A key element of the rationale for including climate change and bio-energy more explicitly than before was the need for the EU to '*adapt its policies in the light of climate change considerations*' to address commitments made under the Kyoto Protocol, whose first commitment period started in 2008 (preamble 9 of Council Regulation (EC) No 73/2009).

The budget allocated to the new challenges also included funds released through additional voluntary modulation, corresponding to Member States' voluntary transfers from Pillar 1 to Pillar 2⁷⁷, and the European Economic Recovery Package (EERP) which aimed to boost "smart" investments in response to the economic and financial crisis of 2008/09. In total, an additional budget of approximately €3 billion⁷⁸ (excluding national co-financing) was made available for Member States to spend on these issues through their Rural Development Programmes. Of this, approximately 14 per cent was allocated by 19 of the 27 Member States to measures focused on addressing climate change priorities⁷⁹, with the highest proportions allocated in Belgium, the Czech Republic, Germany, Luxemburg, Slovenia, Slovakia and the UK⁸⁰.

Two other changes to the CAP in 2009 under the Health check with implications for climate were: a) the cessation of specific support for energy crops⁸¹; and b) the abolishment of mandatory set-aside on arable land⁸². The removal of support for energy crops was justified on the following basis: '*Due to recent developments in the bio-energy sector and, in particular, to the strong demand for such products on international markets and the introduction of binding targets for the share of bio-energy in total fuel by 2020, there is no longer sufficient reason to grant specific support for energy crops*' (preamble 42). In relation to set-aside, the reasons for removing what had been a supply control mechanism were economic not climate related. However, from a climate perspective, the transition from set-aside land to more productive use of that land had

⁷¹ And at least 10% to Axis 1, at least 10% to Axis 3 and at least 5% to Axis 4.

⁷² KANTOR Management Consultants, 2012.

⁷³ COM(2015) 288 final.

⁷⁴ Modulation was levied in year n for spending in year n+1.

⁷⁵ The Regulation set an increased basic rate of modulation of 7% (previously 5%) for the year 2009, followed by an annual 1% increase up to 10% in 2012.

⁷⁶ The new challenges were climate change, bio-energy, better water management and biodiversity.

⁷⁷ Art. 136 of regulation (EC) N. 73/2009.

⁷⁸ Communication from the Commission to the European Council - A European Economic Recovery Plan http://ec.europa.eu/economy_finance/publications/publication13504_en.pdf

⁷⁹ Member States not allocating funding to climate priorities were: Cyprus, Bulgaria, Estonia, Lithuania, Latvia, Malta, Hungary, Poland.

⁸⁰ own calculations based on data within DG Agriculture's Press Release IP/10/102.

⁸¹ Article 146 of Council Regulation (EC) No 73/2009.

⁸² Article 33 (3) of Council Regulation (EC) No 73/2009.

the potential to have a negative impact on carbon sequestration, especially where set-aside had been permanent.

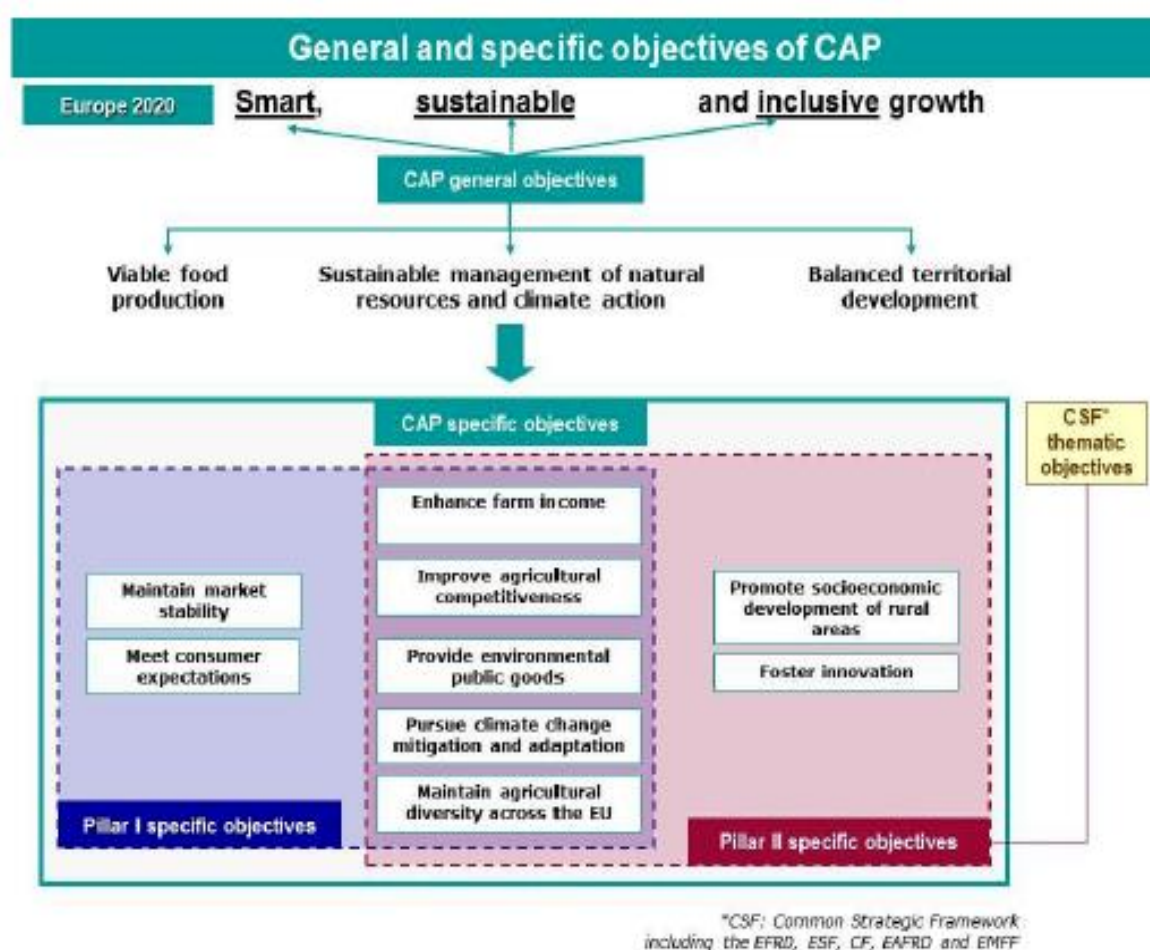
3.1.4. 2013 CAP reforms – climate as a cross-cutting objective.

The 2013 CAP reform went a step further in terms of incorporating climate priorities into the CAP, by including climate action of one of the three core objectives of the CAP. The three objectives are as follows:

1. viable food production;
2. sustainable management of natural resources and **climate action**;
3. balanced territorial development.

These three objectives cover the whole CAP, both Pillar 1 and Pillar 2, which means that for the first time in 2013 climate action became an objective for both Pillar 1 and Pillar 2. The extension of climate priorities to Pillar 1 in the CAP has been helped by the commitment under the Multiannual Financial Framework (MFF) for the period 2014-2020 to mainstream climate action into all EU expenditure, with a particular commitment to devote at least 20 % of the Union budget to support for climate change objectives⁸³.

Figure 7: General and specific objectives of the CAP



Source: Technical Handbook on the Monitoring and Evaluation Framework of the Common Agricultural Policy 2014-2020 – European Commission -Directorate-General for Agriculture and Rural Development (October 2015)

Under Pillar 1, the 2013 reform saw the introduction of the much-debated 'greening' measures. Preamble (37) of Regulation (EU) No 1307/2013 on direct payments specifies that "one of the

⁸³ Commission Communication on A Budget for Europe 2020 - Part II.

objectives of the new CAP is the enhancement of environmental performance” and that the “mandatory ‘greening’ component of direct payments [...] will support agricultural practices beneficial for the climate and the environment”. With the new greening rules, 30% of the direct payment received by a farmer have been made conditional to the fulfilment of three obligations: the crop diversification requirement, the maintenance of permanent pasture and to have at least 5% of eligible arable land under Ecological Focus Areas. The rationale behind the introduction of these green measures was to provide a substantial funding resource (30% of Pillar correspond to approximately €12 billion/year) to support basic environmental management and climate action on all agricultural land in the EU-28 (Hart, Baldock and Buckwell, 2016). The Ecological Focus Areas (EFAs) and the permanent grassland obligations, particularly the ban on ploughing of permanent grasslands designated as environmentally sensitive within Natura 2000 areas, are likely to have the highest potential for climate mitigation, as they would have the potential to enhance climate sequestration, depending on Member States choices (see Section 3.2 below).

With respect to Pillar 2, The overall ‘mission’ of the EAFRD is set out in Article 3 and states that: *‘The EAFRD shall contribute to the Europe 2020 Strategy by promoting sustainable rural development throughout the Union in a complementary manner to the other instruments of the common agricultural policy (hereinafter “CAP”), to cohesion policy and to the common fisheries policy. It shall contribute to the development of a more territorially and environmentally balanced, **climate-friendly and resilient**, competitive and innovative Union agricultural sector and rural territories.’* [Own emphasis]. The 2013 reform also introduced a new architecture for the EU’s rural development policy with the establishment of six Union Priorities and within these, 18 Focus Areas⁸⁴. Although all six priorities are required to contribute to the cross-cutting objectives of climate change mitigation and adaptation (alongside innovation and environment)⁸⁵, some have a more direct relationship with climate objectives than others. Priority 5 is concerned explicitly with “promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors”, under which lie five Focus Areas that deal respectively with increasing the efficiency in water use by agriculture (5A), increasing the efficiency in energy use in agriculture and food processing (5B), facilitating the supply and use of renewable sources of energy, by-products, wastes, residues and other non-food raw materials for the bio-economy (5C), reducing nitrous oxide and methane emissions from agriculture and fostering carbon conservation (5D) and fostering carbon sequestration in agriculture and forestry (5E). Priority 4 “restoring, preserving and enhancing ecosystems related to agriculture and forestry” can also make a contribution to climate objectives through Focus Area 4c which prioritises “preventing soil erosion and improving soil management”.

Climate change, both adaptation and mitigation are also highlighted as cross-cutting issues to be addressed through all priorities. In addition, Member States are required to and should be required to spend a minimum of 30% of their EAFRD budget on climate change mitigation and adaptation as well as environmental issues⁸⁶ (Article 59(6) of Regulation 1305/2013).

Finally, there are also a number of cross-compliance standards of Good Agricultural and Environmental Condition, which are relevant to climate. These include those relating to soil and carbon stock (three standards) as well as certain other standards related to water management (e.g. compliance with authorisation procedures for water for irrigation) and the maintenance of landscape features. Although a new GAEC standard for the protection of wetlands and carbon

⁸⁴ Article 5 of Regulation 1305/2013

⁸⁵ Article 5 of Regulation 1305/2013

⁸⁶ Through agri-environment-climate and organic farming payments and payments to areas facing natural or other specific constraints, through payments for forestry, payments for Natura 2000 areas and climate and environment-related investment support.

rich soils including a ban of first ploughing⁸⁷ was put forward as part of the Commissions original proposals in October 2011, this did not survive the negotiations.

3.2. Current CAP measures influencing climate mitigation and adaptation in agriculture

This section/chapter examines in more detail the potential role of the 2014-2020 CAP in encouraging and supporting climate mitigation and adaptation actions, focusing on the scope of the GAEC cross compliance standards, obligations under Pillar 1 greening payments requirements and for RDPs the design and programming of the most relevant measures. The section/chapter concludes by reviewing some of the implementation choices made by member states and farmers for 2014-20.

3.2.1. Overview of CAP measures with the potential to support climate action 2014-20

As highlighted in section 3.1, the 2014-2020 CAP is now more formally aligned with climate objectives than in any previous period and. There is greater potential to develop and adapt CAP measures to assist climate mitigation and adaptation efforts on a European scale, with climate objectives are now embodied in both "Pillars" of the CAP, as shown in Figure 7 above. The different CAP instruments and measures that have the potential to support climate action, under both Pillar 1 and Pillar 2 are set out in the following sections.

3.2.1.1. Cross-compliance standards for Good Agricultural and Environmental Condition (GAEC)

Farmers receiving direct payments under Pillar 1 and area-based payments under Pillar 2 must comply with cross-compliance requirements across the whole farm holding, or risk losing of part of their CAP payments.

There are two types of cross-compliance:

- Statutory Management Requirements (SMR), which are existing farm-level requirements under other EU legislation in the areas of water, biodiversity, public, animal and plant health, and animal welfare; and
- Standards for Good Agricultural and Environmental Condition (GAEC), defined by individual Member States or regions.

The SMR requirements are derived from EU legislation that also applies nationally or regionally to all farmers. SMRs include legislation with potential for indirect climate benefits⁸⁸ but are not discussed here because the farm-level obligations are the same whether or not the farmer receives CAP payments.

Member States must define their GAEC standards within a framework defined at EU level, but *'taking into account the specific characteristics of the areas concerned, including soil and climatic conditions, existing farming systems, land use, crop rotation, farming practices and farm structures'*⁸⁹.

⁸⁷ The ban on ploughing was specified as follows: 'Ploughing of wetland and carbon rich land which has been defined in 2011 at the latest as arable land in accordance with Article 2 point (a) of Regulation (EC) No 1120/2009 and which complies with the definition of arable land as laid down in Article 4 point (f) of the Regulation (EU) No DP/xxx shall not be considered as first ploughing.'

⁸⁸ For example, the Nitrates Directive (1991) which aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters, and by promoting the use of good farming practices.

⁸⁹ (Regulation (EU) No 1306/2013, on financing, monitoring and management of the CAP, Article 93 and Annex II).

The framework for GAEC standards changed from 2015, as shown in Table 5. Compared to the 2007-14 period, Member States must implement all the standards and the number of standards has been reduced to seven, with some of the previously optional standards now covered by Pillar 1 greening obligations (e.g. terraces and protection of permanent pasture). Table 5 also shows the links between the 2015 GAEC framework and climate objectives, for example the mitigation benefits of protecting carbon storage in soil organic matter and permanent vegetation and the adaptation benefits of reducing the risks of soil erosion and of unauthorised water abstraction.

Table 5 Changes in the GAEC framework between 2007-14 and 2015-20

ISSUE	2007-14 COMPULSORY STANDARDS	2007-14 OPTIONAL STANDARDS	2015-20 STANDARDS COMPULSORY REQUIREMENTS AND STANDARDS	LINK BETWEEN CLIMATE OBJECTIVES AND 2015-20 STANDARDS
WATER	Establishment of buffer strips along water courses		GAEC 1 Establishment of buffer strips along water courses ⁹⁰	<i>Protection of carbon in permanent grasslands and soils</i>
	Where use of water for irrigation is subject to authorisation, compliance with authorisation procedures		GAEC 2 Where use of water for irrigation is subject to authorisation, compliance with authorisation procedures	<i>Reduced risk of losing carbon because wetlands dry out. Reduced risk of depleting water resources</i>
			GAEC 3 Protection of ground water against pollution: prohibition of direct discharge into groundwater and measures to prevent indirect pollution of groundwater through discharge on the ground and percolation through the soil of dangerous substances, as listed in the Annex to Directive 80/68/EEC in its version in force on the last day of its validity, as far as it relates to agricultural activity	<i>Reduced risk of wetland function and loss of carbon as a result of pollution damage</i>
SOIL	Minimum soil cover	Retain terraces	GAEC 4 Minimum soil cover	<i>Protection of soil carbon and reduced risk of soil erosion</i>
	Minimum land management reflecting site-specific conditions		GAEC 5 Minimum land management reflecting site specific conditions to limit erosion	<i>Protection of soil carbon and reduced risk of soil erosion</i>

⁹⁰ The GAEC buffer strips must respect, both within and outside Nitrate Vulnerable Zones, at least the requirements relating to the conditions for land application of fertiliser near watercourses.

	Arable stubble management	Standards for crop rotations	GAEC 6 Maintenance of soil organic matter level through appropriate practices including ban on burning arable stubble, except for plant health reasons ⁹¹	<i>Reduced GHG emissions from fires</i>
		Appropriate machinery use (maintain soil structure)		
LANDSCAPE	Retention of landscape features, including, where appropriate, hedges, ponds, ditches trees in line, in group or isolated and field margins	Minimum livestock stocking rates or/and appropriate regimes	GAEC 7 Retention of landscape features, including where appropriate, hedges, ponds, ditches, trees in line, in group or isolated, field margins and terraces, and including a ban on cutting hedges and trees during the bird breeding and rearing season and, as an option, measures for avoiding invasive plant species.	<i>Protection of carbon stores and sequestration potential in woody vegetation, wetlands and soils</i>
		<i>Establishment and/or retention of habitats</i>		
	Avoiding the encroachment of unwanted vegetation on agricultural land	Prohibition of the grubbing up of olive trees		
	Protection of permanent pastures	Maintenance of olive groves and vines in good vegetative condition	[Protection of permanent pastures in 2015 and 2016, only]	<i>Protection of carbon stores and sequestration potential in permanent grasslands and soils</i>

Source: Martineau et al, 2016

3.2.1.2. Pillar 1 Green Direct Payments

Member States must use 30 per cent of their national ceilings for Pillar 1 direct payments to grant farmers an annual payment, additional to the main direct payment, for following 'agricultural practices beneficial for the climate and environment' (Regulation (EU) No 1307/2013, , Article 43). The three 'greening' obligations are: crop diversification, the maintenance of permanent grassland and Ecological Focus Areas (EFAs). Some farmers are effectively exempt from the greening requirements, including organic farmers and those with a small area of arable land or only permanent crops, as follows:

⁹¹ The requirement can be limited to a general ban on burning arable stubble, but a Member State may decide to prescribe further requirements.

Crop diversification: This requirement applies only to farms with more than 10 ha of arable land. Those with up to 30 ha of arable land have to grow at least 2 crops, and farmers with more than 30 ha of arable land have to grow at least 3 crops. In both cases the main crop cannot cover more than 75% of the land. Fallow land and grass and other herbaceous forage also count as crops.

Permanent grassland: There are two different greening requirements for permanent grassland which potentially protect permanent grassland from conversion to arable land, thus protecting soil carbon. Firstly, Member States must ensure that the ratio of permanent grassland to the UAA does not decline by more than 5%, and have the option of applying this at national, regional or sub-regional level. Secondly, Member States must designate environmentally sensitive permanent grassland (ESPG) in areas covered by the Birds and Habitats Directives, which need strict protection in order to meet the objectives of those Directives, including peat and wetlands. At farm level the 'greening' requirement is to not convert or plough the ESPG, thus protecting soil carbon stocks. Member States also have the option to delineate further ESPG area elsewhere, offering the opportunity also to protect significant soil carbon stocks outside Natura 2000 areas. There are potential adaptation benefits too, through protecting the natural rainwater storage capacity of wetlands.

Ecological Focus Areas: Both Member States and individual farmers have considerable flexibility in choosing how to implement the EFA requirement. The EU Regulation defines ten types of EFA, including both productive and non-productive land uses, as shown in Box 9. Member States must select one or more of these to compile their own national list from which farmers can choose how to meet their EFA greening requirement. Farms with more than 15 hectares of arable land must ensure that an area equivalent to 5% of their arable land is an EFA. The EFA areas do not have to be newly created, they can be existing crops or features, if the farm has sufficient to meet the requirement⁹².

Box 9: The ten types of EFA defined in the CAP Regulations, from which Member States select their national list to offer farmers

To be considered as EFA these have to be on or adjacent to the arable land, except those marked * which can be anywhere on the farm.

- **Fallow land** (no production);
- **Terraces**;
- **Landscape features**: hedges or wooded strips, isolated trees, trees in lines or groups, field margins, ponds, ditches and traditional stone walls;
- **Buffer strips**, which can be permanent grassland;
- **Agro-forestry*** areas established with RDP support (2007-13 or 2014-20);
- Strips of **farmland along forest edges** (with or without production);
- **Short rotation coppice** (no mineral fertilisers and/or plant protection products)
- **Woodland*** established on farmland, using RDP support (2007-13 or 2014-20);
- **Catch crops**, or sown **green cover**.
- **Nitrogen-fixing crops**

Source: Regulation (EU) 1307/2013

Although the stated aim of EFAs is to safeguard and improve biodiversity on farms⁹³ many EFAs also have potential climate benefits. Permanent field margins, buffer strips, landscape features and trees help to protect carbon stores and sequestration potential of the soil beneath them. Individual trees, agroforestry and woodlands can store carbon and also provide shade for crops

⁹² Some types of EFA are 'weighted' so that a hectare of EFA on the ground may count as less than a hectare for the purpose of calculating the total EFA area. For example, the weighting for nitrogen fixing crops is 0.7, so 10 ha on the ground counts as seven ha of EFA.

⁹³ EU Regulation 1307/2013, Recital (44)

and livestock during hot weather. Climate benefits of EFAs on which agricultural production is allowed will mainly be in reducing the risk of losing soil (and organic matter) through erosion, although N-fixing crops have potential to reduce NO₂ emissions from soils (through reduced demand for nitrate fertilisers). However, for nitrogen fixing crops, catch crops/green cover and short rotation coppice, Member States can choose whether fertilisers and pesticides are permitted and when the crops must be in the ground, and these decisions will affect the extent to which the climate mitigation potential is realised in practice.

3.2.1.3. Farm Advisory System

Member States are required to set up a Farm Advisory System (FAS) covering cross-compliance, Pillar 1 greening requirements, EU water and pesticide legislation, and RDP measures for farm modernisation, competitiveness building, sectoral integration, innovation, market orientation and promoting entrepreneurship.

In addition to this compulsory content Member States can choose to offer advice through the FAS on a much wider range of, including climate change mitigation and adaptation, the protection of water and risk management.

3.2.1.4. Rural Development Programmes (RDP)

In contrast to Pillar 1 of the CAP, where requirements are mostly defined at Member State level, there are 118 RDPs in total for the period 2014-2020, including regional RDPs in Belgium, France, Germany, Italy, Spain, and the UK.

The EAFRD defines six EU level priorities of which every RDP must address at least four and also the cross-cutting objectives of innovation, environment and climate mitigation and adaptation⁹⁴. As set out in Section 3.1, Priority 5, which promotes resource efficiency and the shift towards a low carbon and climate resilient economy, has five focus areas:

- 5A increasing efficiency in water use in agriculture;
- 5B increasing efficiency in energy use in agriculture and food processing;
- 5C facilitating the supply and use of renewable sources of energy;
- 5D reducing GH3 and ammonia emissions from agriculture; and
- 5E fostering carbon conservation and sequestration in agriculture and forestry.

The EAFRD Regulation offers a total of 19 measures and numerous sub-measures which Member States may choose to use to promote climate action through their RDPs. Every Member State is obliged to implement the agri-environment-climate measure (AECM) and the Leader approach but are free to choose how they design and use these and any other RDP measures to meet their priorities and needs. At least 30 per cent of the EAFRD contribution to each RDP must be reserved for measures relevant to climate change mitigation and adaptation and the environment.

The RDP measures judged to have the greatest potential for climate mitigation and adaptation are set out in Box 10 and described in more detail in Annex 6. The agri-environment-climate measure (M10) is of particular importance because it allows Member States to support implementation of appropriate soil management requirements through multi-annual contracts with individual farmers. This measure may also be used by Member States to define 'equivalent practices' to meet Pillar 1 greening requirements, instead of those set out in the Pillar 1 legislation.

⁹⁴ EU Regulation 1305/2013, Article 5

Box 10: RDP measure with the greatest potential for climate mitigation and adaptation

Measures for land management and land use

- agri-environment-climate land management contracts (M10);
- organic farming conversion and maintenance payments (M11);
- payments for the establishment and maintenance of agro-forestry systems and for afforestation and creation of woodland (M8); and
- conservation of genetic resources in agriculture (M10).

Investment measures

- investments in physical assets – including non-productive payments to support the agri-environment-climate measure (M4).

Capacity building measures

- the cooperation measure offers a wide range of potential support for example: developing and piloting new agricultural practices, processes and technologies; and for planning and facilitating landscape scale implementation (M16);
- the basic services measure can provide support for Natura 2000 management plans
- training, demonstration activities, information provision and advice (M1 and M2); and
- EIP operational groups and pilot projects joint action between farmers and researchers for mitigating or adapting to climate change (M16).

Source: own compilation from (Commission Implementing Regulation (EU) No 808/2014; Regulation (EU) No 1305/2013)

3.2.2. Mitigation and adaptation actions that can be supported via the CAP

There is a broad range of actions for all types of farming systems that contribute to climate mitigation and adaptation that can be supported under the CAP instruments, particularly RDPs, which are the most adaptable element of the CAP. Adapting to the effects of climate change will differ for farms across Europe – in the north there will be businesses benefits form a longer growing season and the opportunity to grow a wider range of crops in a warmer climate, although in some places a greater risk of flooding and storm damage. Further south water conservation and reuse will be a priority for farmers, particularly those depending on irrigated systems for example in fruit and vegetable production.

The climate actions can be grouped into those involving land use and management, those which require investments and those which involve capacity building. They are described in more detail in Table 6 in Chapter 4. Only a few of these mitigation actions are directly equivalent to a specific CAP measure, for example RDP measures for afforestation and new agroforestry, or the cross-compliance GAEC 6 standard prohibiting arable stubble burning. Others generally form part of a range of specific options that are available for funding under a particular measure.

3.2.2.1. Land use and management actions

Land management and other farming actions can help to reduce emissions of nitrous oxide from soils which is responsible for more than half the non-CO₂ emissions from agriculture and also methane from manure, although there is much less scope to address methane emissions from ruminants using the CAP. Land management activities, which provide soil cover for all or most of the time, and maintain moisture levels on peat-rich soils, are important to protect existing carbon stores in the soil from oxidation (loss as CO₂). Land use change (for example, from arable to permanent grassland, or planting woodland or agroforestry) can take this a stage further and create additional carbon sequestration potential both in the soil and above ground. Most land

management and land use change actions are best supported through targeted use of the agri-environment-climate measure, often in combination with environmental investment support (non-productive investments). In addition, there are specific measures under Pillar 2 of the CAP for establishing new agroforestry systems and woodland on farmland. Agroforestry provides two agricultural production systems on the same area of land with a tree crop above or alongside pastureland or arable crops. Depending on the type of agroforestry system, benefits can include increased overall productivity per hectare, improved carbon storage and sequestration, soil quality, water management, pest and disease control and wildlife. There are currently 10 million hectares of agroforestry in Europe in both new and traditional systems (AGFORWARD, 2015), and this area may increase as a result of RDP support for new agroforestry systems.

Many of these land management or land use changes can also have adaptation benefits – for example diversifying the farm’s cropping pattern may help to reduce the financial risks of crop failure, tree cover can improve the microclimate for both livestock and arable crops, and soils rich in organic matter can absorb more rainfall. Other management actions to make the farming system more resilient to a changing climate include adjusting the timing of farm operations, such as planting or sowing dates and treatments, and choosing crops and varieties better adapted to the expected length of the growing season and water availability, and more resistant to new conditions of temperature and humidity.

Investment in climate action

Investment support for farms and other rural SMEs can be an important first step in climate action, for example in providing the technology to generate renewable energy from farm and forest waste (e.g. anaerobic digestion of manure); and to encourage the introduction of water saving technologies such as filtration of waste water.

Some changes in land management require new field equipment, for example to encourage the use of precision farming to reduce fertiliser use, and minimum tillage to protect soil carbon.

Other investments can support infrastructure adaptation e.g. to develop climate resilient livestock housing or install rainwater storage and more efficient irrigation equipment. Investment support for off-farm developments can be important in adaptation too, for example the conservation of genetic resources in crops and livestock.

3.2.2.2. Capacity building – knowledge, skills and motivation

Some climate actions may have no net cost to the farm business and therefore make good economic sense, although making the change may require upfront investment. For example, using reduced tillage techniques, precision farming and composting crop residues or anaerobic digestion of animal waste can all be ‘win-win’ for the farm business and climate mitigation. Nevertheless, there may still be a need to persuade farmers to make these changes, and a range of capacity building measures are available under Pillar 2, for example extending the FAS to include optional advice on climate action, setting up farmer groups to build knowledge and skills in new techniques and using Operational groups under the EIP to promote exchanges between researchers developing new technologies and farmers who could put these into practice.

3.2.3. Scale and effectiveness of climate actions supported by the CAP

In considering the use of different CAP instruments to support climate actions it is important to take into account:

- the ‘reach’ of different types of CAP support;
- the scope of particular mitigation or adaptation actions in terms of the proportion of EU farmland and farmers to which it applies - for example, rewetting peatland provides very

significant reductions in carbon losses per unit area but is only likely to be implemented on comparatively small areas; and

- the unit benefit in term of mitigation potential per unit of implementation

Taking all three aspects into consideration provides some useful insights in to the overall mitigation potential of different climate action, some of which can be supported under the CAP. Examples of potentially beneficial climate actions are set out in Table 6 in chapter 4. A more detailed analysis of which climate actions could potentially be supported by the different CAP instruments can be found in Annexes 4, 5 and 6.

3.2.4. CAP implementation choices relevant for climate: 2014-20

There are some CAP measures which all Member State or regions *must implement* e.g. under Pillar 1 the designation of ESPG in Natura 2000 areas, maintaining the ratio of permanent grassland within the total agricultural area and under Pillar 2, offering agri-environment-climate measures available throughout the country. Other CAP measures *must be implemented, but within a framework or list provided in the legislation* leaving Member States free to define the farm-level requirements e.g. cross-compliance GAEC standards, EFAs under Pillar 1 and the farm advisory system (FAS).

For most other measures Member States can both *choose whether or not to implement* them (e.g. all other RDP measures, optional additional FAS and advice, European Innovation Partnerships (EIP)) and also *choose what priority they give to specific climate mitigation actions* within each measure, in terms of farm level requirements, targeting and expenditure allocated. Furthermore, most of the CAP measures concerned have multiple objectives and are not dedicated specifically to climate related goals. There are consequently valid reasons for Member States to use these measures primarily for other purposes, although this then leaves them with the necessity to use other policy instruments to meet climate objectives.

Farmers also have choices. Those receiving CAP direct payments must implement cross-compliance requirements and, for most of the larger arable farms, at least some greening requirements. However, beyond that they can choose, for example which elements to use to meet their EFA obligation and whether or not to take advantage of advisory support, agri-environment-climate schemes, investment aid and other RDP measures.

3.2.4.1. Member State implementation of relevant GAEC cross-compliance standards 2015

The GAEC soil standards apply (GAEC standards 4, 5 and 6) in practice mainly to arable land, and the landscape standard (GAEC 7) applies more widely.

Definitions of GAEC standard 4 (minimum soil cover) by different Member States or regions⁹⁵ include requirements for the season, duration and minimum proportion of soil cover, and the type of land or crops to which the requirements apply. In some Member States or regions soil cover is required only on sloping land, mostly defined simply as a gradient. Portugal uses a composite indicator of soil erosion risk, based on the morphology of the plot. Of the 32 Member States or regions considered here, seven require soil cover all year and 14 require cover during the winter (mainly by crops, grass, stubble or spontaneous vegetation). The remainder specify cover during the growing season, or at other specific periods. Not all Member States or regions appear to require complete green soil cover on all the relevant land or crops – in seven Member

⁹⁵ Most Member States define GAEC standards nationally, but in the case of Belgium and the UK GAEC standards are defined regionally, with separate standards for Flanders, Wallonia, England, Scotland, Wales and Northern Ireland. (The outermost regions are not considered here.)

States or regions the minimum percentage green soil cover ranged from 30% to 80%, but in some cases this only applies in specific circumstances.

Similarly, in defining GAEC standard 5 (minimum land management reflecting site specific conditions to limit erosion) more than half the Member States or regions use slope as the criterion to identify the land where specific land management practices are required to limit erosion. These practices include, for example, contour ploughing, ridge planting, reduced tillage, maintenance of grassland or woody vegetation, green winter cover, and restrictions on growing particular crops.

The GAEC 6 standard (maintenance of soil organic matter level through appropriate practices) is one the most important standards for both climate mitigation and adaptation. Despite this in 15 Member States the only requirement for this standard was the required ban stubble burning in 2015 compared to 6 the previous year. When examining the evolution of GAEC standards over time, there appears to have been a notable year on year decrease in the number of Member States that have defined additional requirements to maintain soil organic matter, for example restrictions on entering land when it is waterlogged or frozen, use of crop rotations, not growing successive crops with a high soil carbon demand, application and/or monitoring of organic matter, soil testing and stubble management.

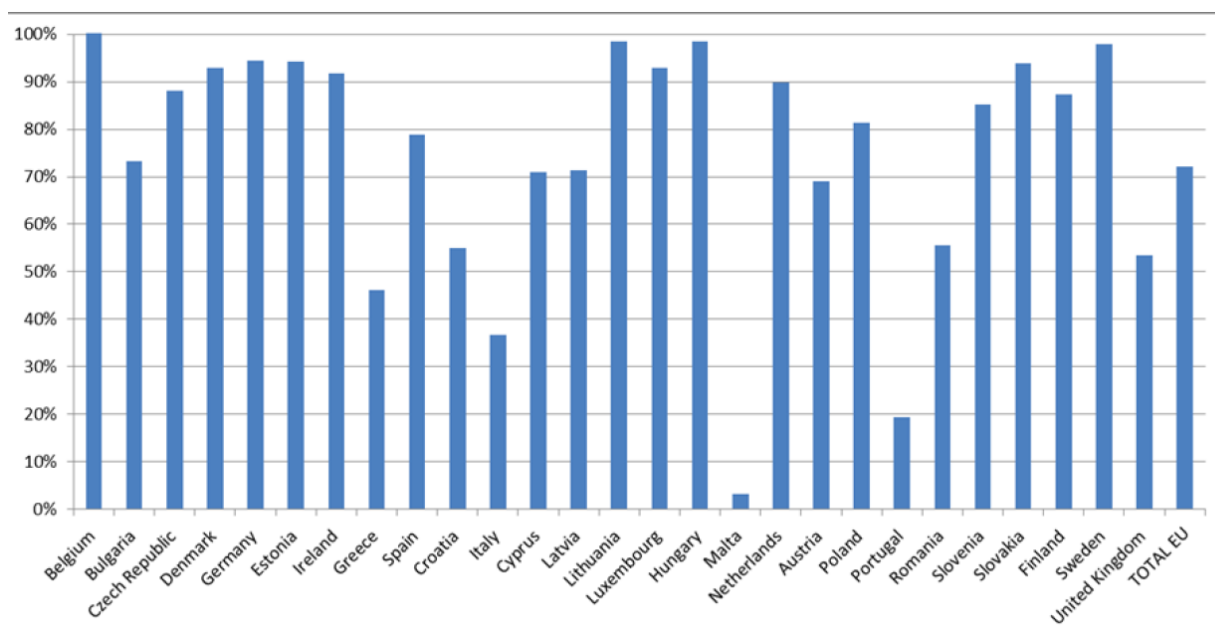
The GAEC 7 standard for landscape features does not address climate objectives directly. However it can help to protect soil carbon stores and sequestration potential in, for example, woody vegetation and wetlands. The most commonly protected features are groups of trees, ponds and hedges (in more than half of Member States), followed by trees in a line, ditches, terraces and traditional stonewalls (in more than a third). From 2015, landscape features defined and protected under this GAEC standard can also be identified by the Member State as EFA.

3.2.4.2. Member State implementation of Pillar 1 greening obligations 2015

In 2015, the first year of implementation, 72% of the total agricultural area in the EU and 36% of the beneficiaries of Pillar 1 direct payments are subject to at least one Pillar 1 greening obligation. The agricultural area that is not subject to these obligations includes organic farms, which are entitled *ipso facto* to Pillar 1 greening payments and account for 4% of the EU total agricultural area, farms that are exempt from Pillar 1 greening obligations⁹⁶, the 6% of EU farmland used to grow permanent crops (for which there are no greening obligations), and the estimated 11% of farmland in the EU that is not under the CAP direct payment system.

As might be expected there is a very wide variation between Member States in the proportion of their farmland subject to at least one Pillar 1 greening obligation. This is shown in Figure 8 and reflects differences in farming systems and structures - for example the proportion of small farms, permanent crop farms, and arable land.

⁹⁶ Including those farmers opting for the Small Farmers Scheme

Figure 8: Proportion of total agricultural area under at least one greening obligation, by Member State

Source: European Commission, 2016a based on Member States' reporting data for 2015 and Eurostat Farm Structure Survey 2013.

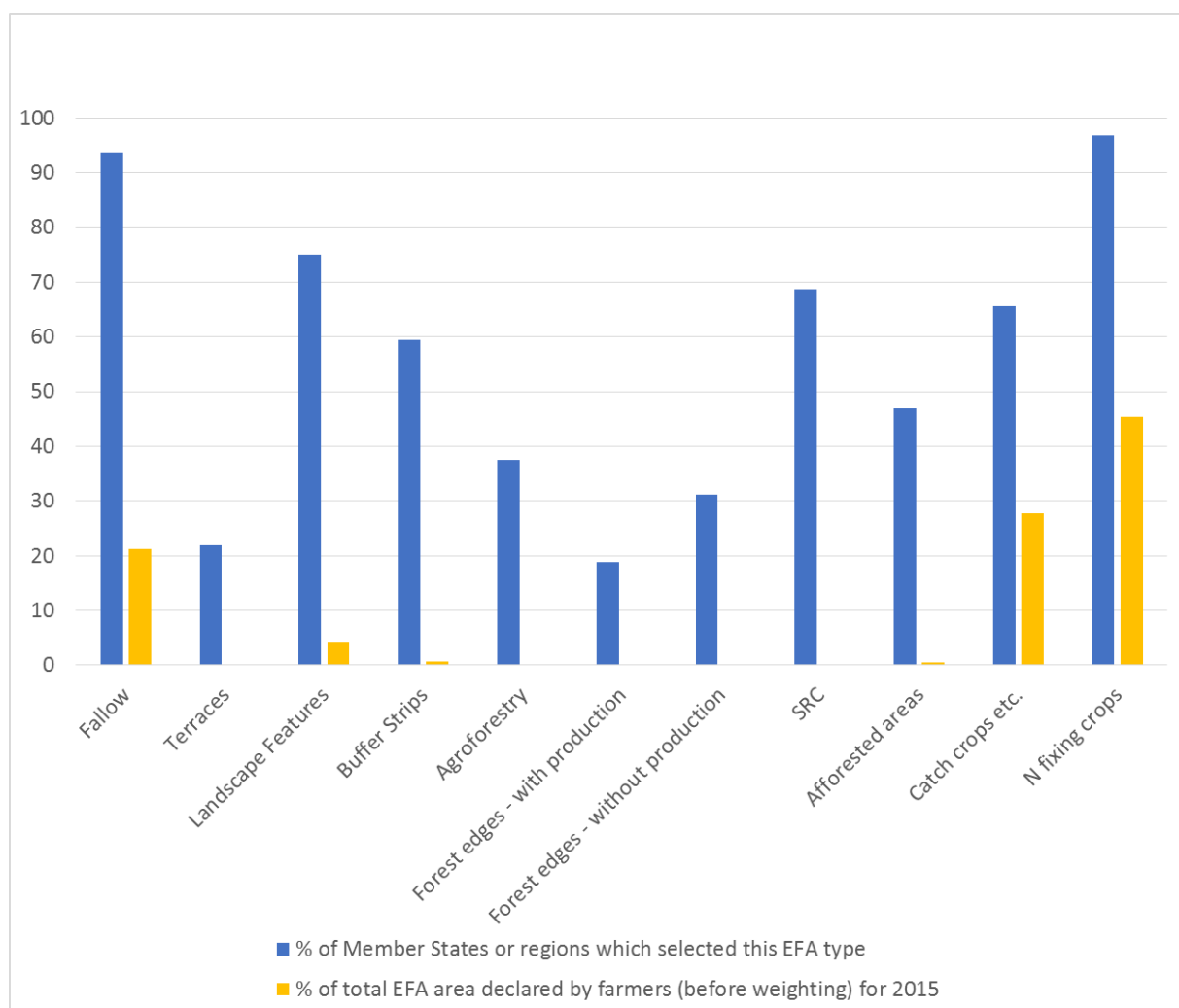
There are also wide variations in implementation of the specific obligations, as a result both of Member States' choices (especially in the case of EFAs) and of differences in farming systems and structures across the EU.

Implementation of crop diversification rules: The rules for crop diversification are set out in the EU Regulation and Member States have no choice in how to apply them. Estimates indicate that farmers who had to introduce another crop would only have to do so on a few hectares of the farm, in total on about one per cent of EU arable land. The rules merely require crop diversification, not crop rotation, which further limits any climate benefits. The Commission has concluded that, in the first year of Pillar 1 greening, the only progress towards achieving the objective of enhanced environmental benefit, and in particular the improvement of soil quality⁹⁷, has been to avoiding a further deterioration of the current situation (European Commission, 2016a).

EFA implementation choices by Member States and farmers: Member States must identify at least one type of EFA to offer farmers to meet their EFA obligation and most Member States offer farmers the choice of several types. The most frequent were nitrogen fixing crops and fallow (without production), each chosen by 31 of the 32 Member States or regions, followed by landscape features, SRC and catch crops or green cover. For landscape features they had further choices of the type of features to include and how to define them at farm level (see Annex 4 for details). Obviously farmers who have to implement the EFA requirement can choose only from the list of EFA types on offer in their region, and preliminary data now available for 2015 illustrates how they have used this flexibility. It shows the proportion of the 32 Member States or regions that chose to offer each of the 10 EFA types, and the proportion of the total EFA area declared by farmers in 2015 (before weighting) for each of the types. More than 73% of the total EFA area declared by farmers (before weighting factors are applied) is linked to agricultural production, in the form of nitrogen-fixing crops and catch crops. Fallow land without production and landscape features (including, but not necessarily limited to, those already protected under GAEC) make up most of the rest.

⁹⁷ EU Regulation 1307/2013 Recital 41.

Figure 9: Percentage of Member States choosing specific EFA types and percentage of EFA area declared by farmers in 2015 by EFA type (before weighting)



Source: own compilation based on European Commission, 2016a

Protection of permanent grassland by designation as ESPG: Leaving grassland unploughed helps maintain carbon in soils and vegetation. Of the two greening obligations on Member States to protect permanent grassland, the designation of ESPG 'no ploughing' areas will have the greatest impact on climate mitigation. This is because maintaining the ratio of permanent grassland above 95% of a reference level permits conversion of 5% of the permanent grassland and also allows farmers to plough and re-seed permanent grassland *in situ*, or to sow new permanent grassland to replace that which has been ploughed elsewhere.

The proportion of permanent grassland within Natura 2000 areas that has been designated as ESPG varies significantly between Member States, from more than 90% in ten Member States to less than 10% in five⁹⁸. In a study of ten countries' implementation of the CAP it was not apparent that climate criteria (e.g. a focus on carbon rich soils) were used to decide which Natura 2000 grasslands to designate, the main focus was on biodiversity objectives⁹⁹.

Across the EU as a whole, 75% of permanent grassland in Natura 2000 is designated as ESPG, more than 3.7 million hectares where ploughing is prohibited. However, in many Member States

⁹⁸ Bulgaria, the Czech Republic, Greece, Spain, Italy, Hungary, the Netherlands, Slovakia, Finland and Sweden have designated more than 90 % of permanent grassland in Natura 2000 as ESPG. Estonia, Ireland, Latvia, Austria and Portugal have designated less than 10 % of total permanent grassland in Natura 2000 as ESPG.

⁹⁹ Ecorys et al, forthcoming.

some of this land is on farms not within the CAP direct payments system, and preliminary analysis shows that in 2015 only 40% of the permanent grassland in Natura 2000 across the EU is ESPG was on land identified by farmers in their CAP direct payment applications. Outside Natura 2000 areas in 2015 less than 0.25 million hectares of permanent grassland has been designated as ESPG in just five Member States (for two of these in just one region)¹⁰⁰. Member States can designate additional ESPG until 2020, but at the moment it is not clear if any will choose to do so.

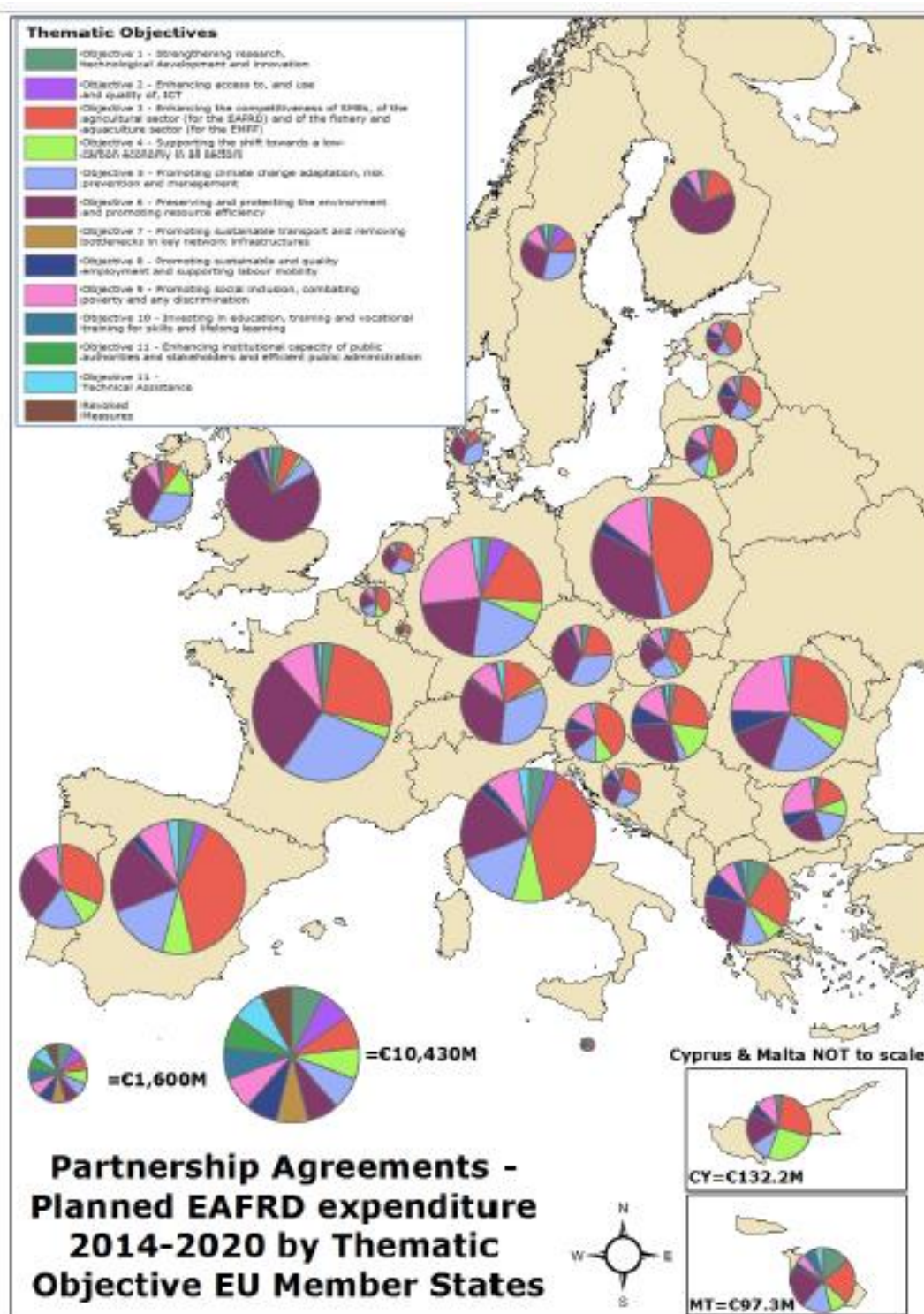
In implementing the requirement to maintain within 5% the ratio of permanent grassland within the total agricultural area, only France, Germany and the UK have chosen to apply the ration at regional rather than national level, and only Germany requires farmers to obtain prior approval for conversion of permanent grassland.

3.2.4.3. EAFRD budget allocations and target uptake indicators for RDP measures addressing climate change

The EAFRD is one of five EU Structural and Investment Funds (ESI) which support, in addition to their own specific objectives, eleven common thematic EU objectives, including '*promoting climate change adaptation, risk prevention and management*'¹⁰¹. Member State and regional managing authorities must decide how to prioritise the use of their EAFRD funding and own resources to meet many different demands and policy priorities, of which climate mitigation is only one and still an emerging priority. Figure 10 shows the proportion of total EAFRD expenditure that has been allocated to each of the 11 ESIF themes, with the green slice showing expenditure prioritising a shift towards a low carbon economy and the blue slice showing expenditure on climate adaptation. Although these figures are not specific to the agricultural sector, it does show a far greater emphasis on climate adaptation in Member States, than the low carbon economy in terms of ESIF fund allocations.

¹⁰⁰ Czech Republic, Latvia, Luxembourg, Belgium (Wallonia) and UK (Wales).

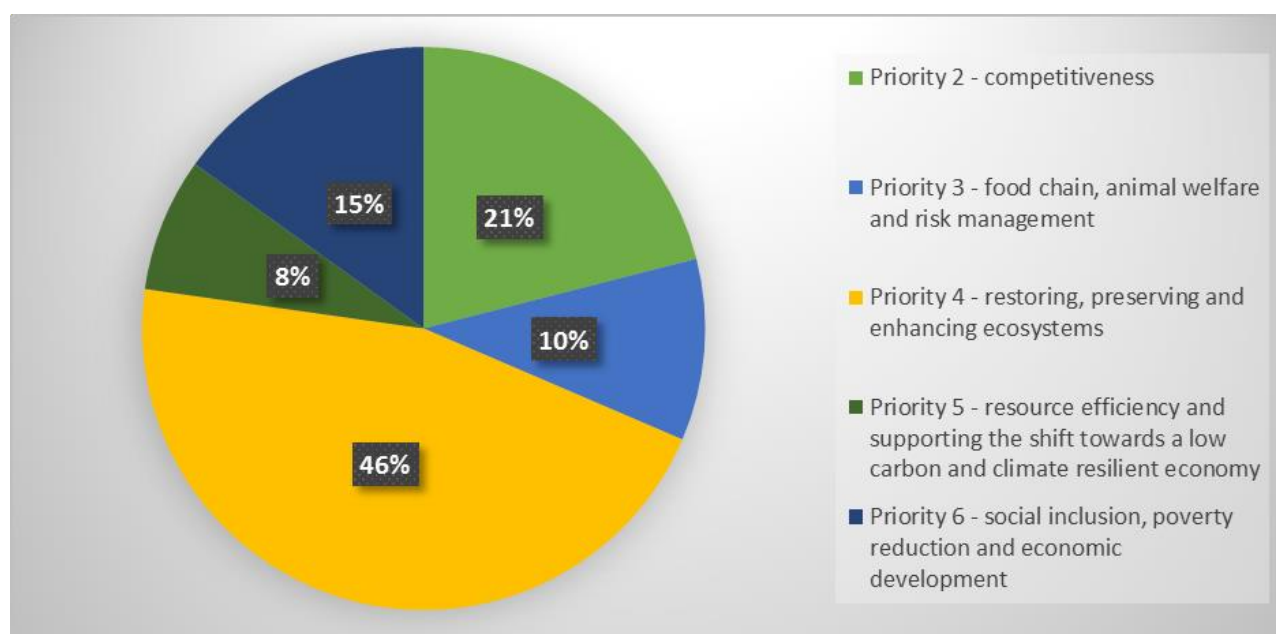
¹⁰¹ The ESI Funds comprise the European regional development fund, The European social fund, the cohesion fund, the European agricultural fund for rural development and the European Maritime and fisheries fund (EU Regulation 1303/2013).

Figure 10: Planned EAFRD expenditure according to the 11 ESIF Thematic objectives, 2014-2020

Source: Dwyer et al, 2016

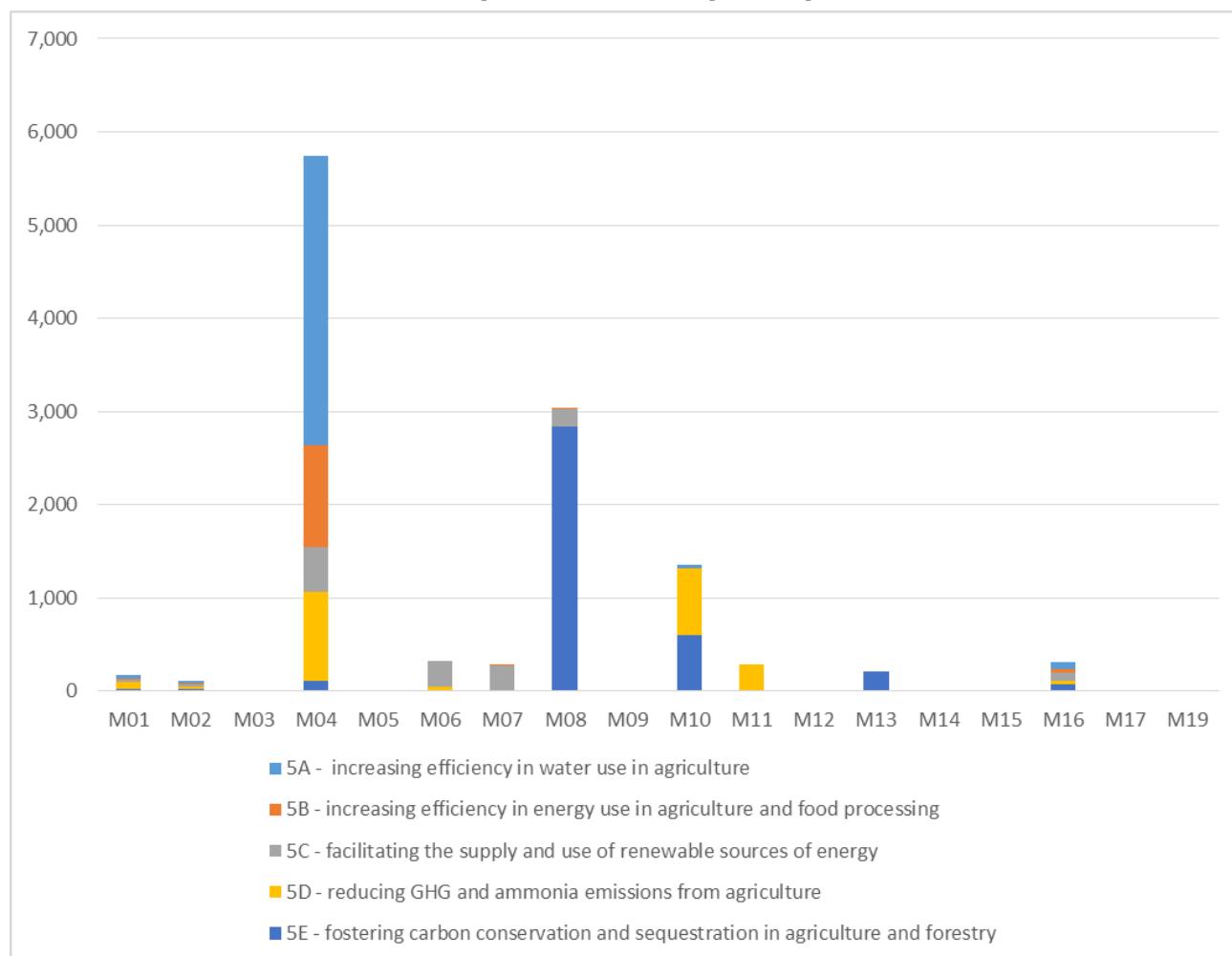
As explained above, under Pillar 2 EAFRD, these 11 thematic objectives are translated into six overarching priorities. Figure 11 shows that only 8% of the total public expenditure allocated to RDPs has been allocated to Priority 5, the priority that is explicitly linked to climate. However, some of the 46% of expenditure allocated to Priority 4 could also be climate related, given the focus on soil and water management on agricultural land. It is also possible that climate features as a secondary objective for expenditure allocated to other priorities, such as Priority 2 on competitiveness for example.

Figure 11: Overall Expenditure for RDPs by Strategic Priority, EU-28 2014-2020



Source: Own compilation based on EAFRD implementation data (ESIF data portal)

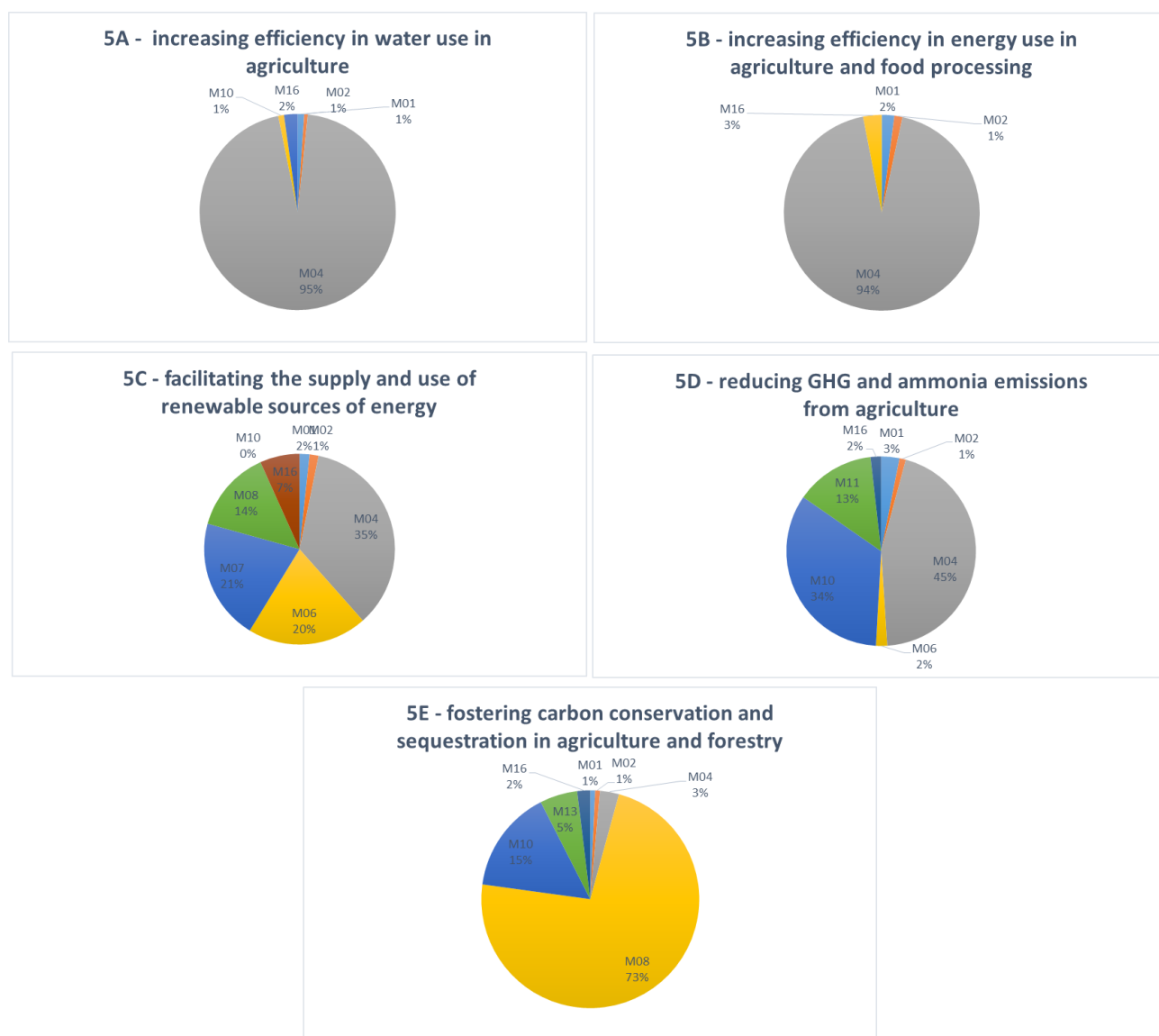
Figure 12: Proportion of total public funding (million euro) allocated to RDP measures for Priority 5 focus areas (EU-28)



Source: Own compilation based on 2014-2020 implementation data (ESIF data portal)

Figure 12 and Figure 13 show the budget allocated to different RDP measures contributing to EAFRD Priority 5 focus areas for the EU-28. This shows that it is the investments in physical assets measure (M04) that the most commonly identified measure for all focus areas, apart from 5E which focuses on carbon sequestration. For carbon sequestration it is the group of forest measures (M08) that are most commonly identified for use, this could be for planting woodland on farmland, creating new agro-forestry systems, but could also apply to afforestation off agricultural land. Other measures have a far lower budget allocated to them, although the agri-environment-climate scheme is used in some countries to help encourage management that promotes carbon sequestration and reduces GHG emissions.

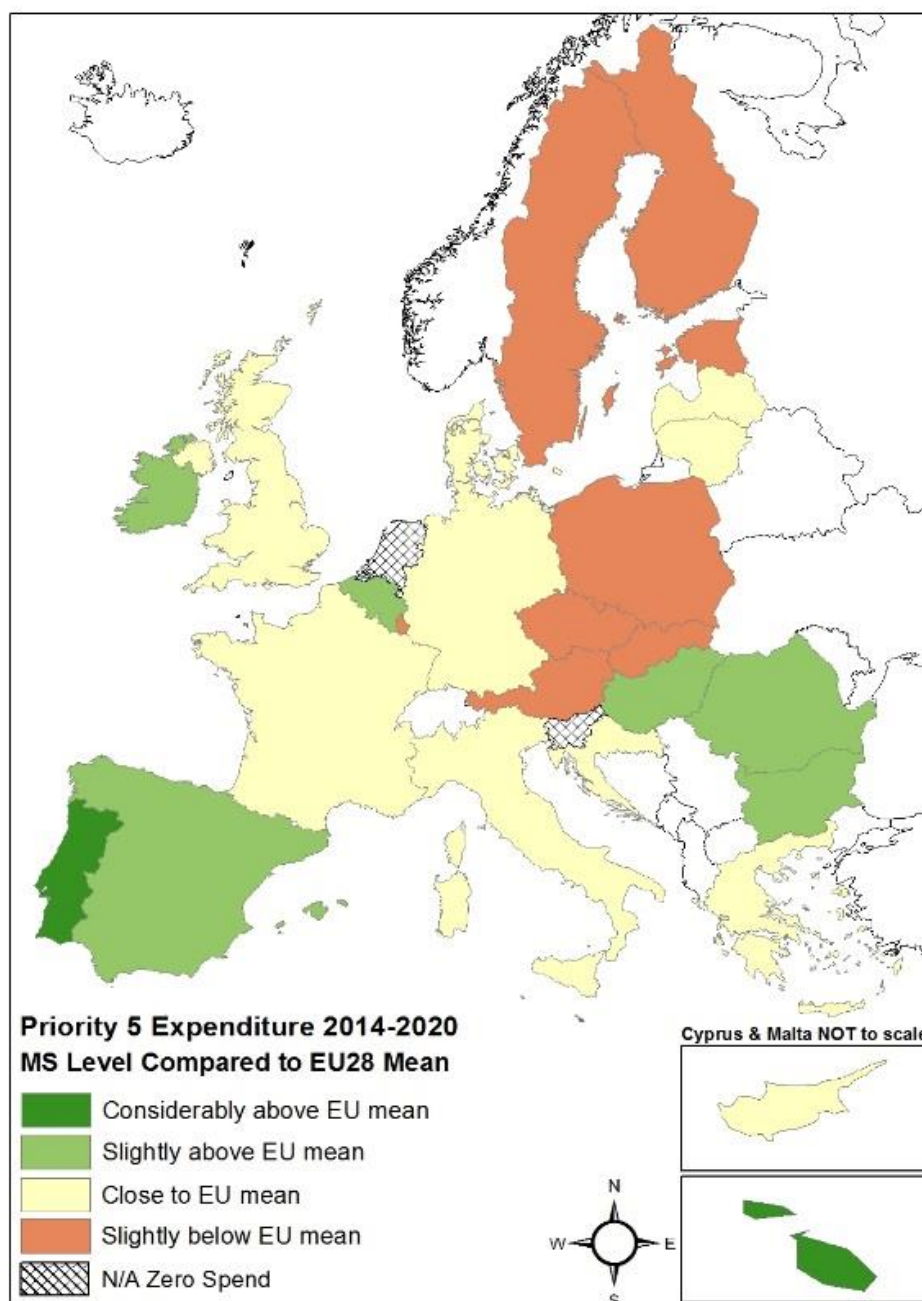
Figure 13: Breakdown of budget allocation for each focus area under Priority 5 by RDP measure



Source: Own compilation based on 2014-2020 implementation data (ESIF data portal)

The map shown in Figure 14 gives a sense of the extent to which climate issues have been prioritised through allocated expenditure in different countries in the EU-28. It focuses on the allocated funding to Priority 5 by Member States and shows that countries in the eastern part of the EU (Hungary, Romania, Bulgaria), as well as Spain, Portugal and Ireland have allocated more than the average amount of their RDP budget to Priority 5, whereas Scandinavian countries as well as Poland, Austria, Slovakia and the Czech Republic have allocated less than the average.

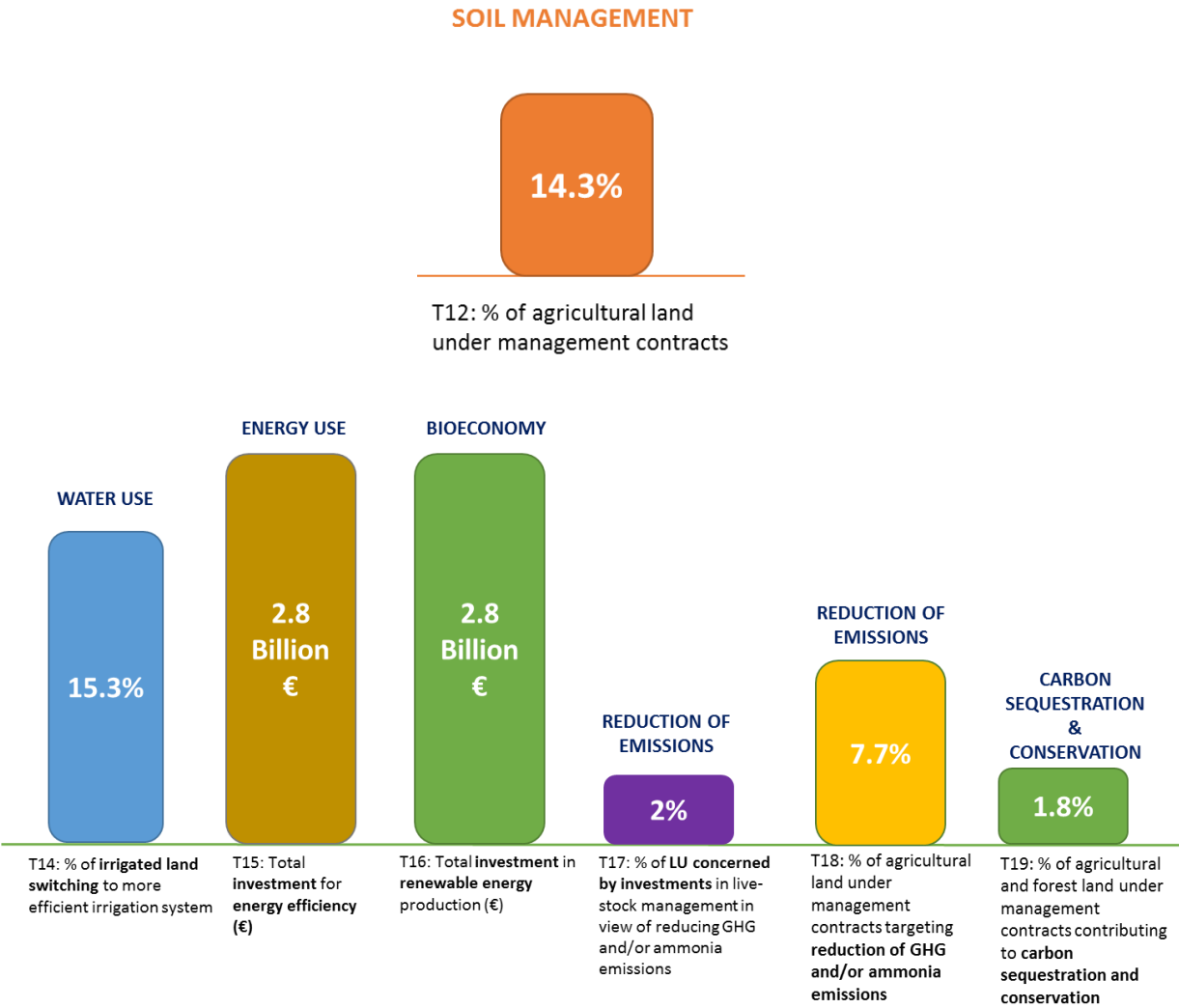
Figure 14: Member State expenditure on Priority 5 compared to the EU mean



Source: Dwyer et al, 2016

Some additional information on the scale of proposed support can be gleaned from the values attributed to the target indicators by EU-28 Member States for the focus areas under Priority 5 as well as under priority 4c for soil management. Figure 15 provides the average of all targets for the EU-28. The average target values appear rather low, for example with only 1.8% of agricultural land projected to be under contracts contributing to carbon sequestration and conservation by 2020 and only 7.7% of agricultural land projected to be under management targeting the reduction of GHG or ammonia emissions. More positively just over 15% of irrigated land is anticipated to shift towards more efficient irrigation systems, although this is still a fairly low figure, given the pressures facing water availability in many parts of the EU. Even the figures attributed to projected investments in energy efficiency and renewable energy are small when it is considered that this funding is over a seven year period and for 28 Member States.

Figure 15: Overview of targets for the output indicators related to priority 4c (soil management) and all Priority 5 focus areas for the EU-28

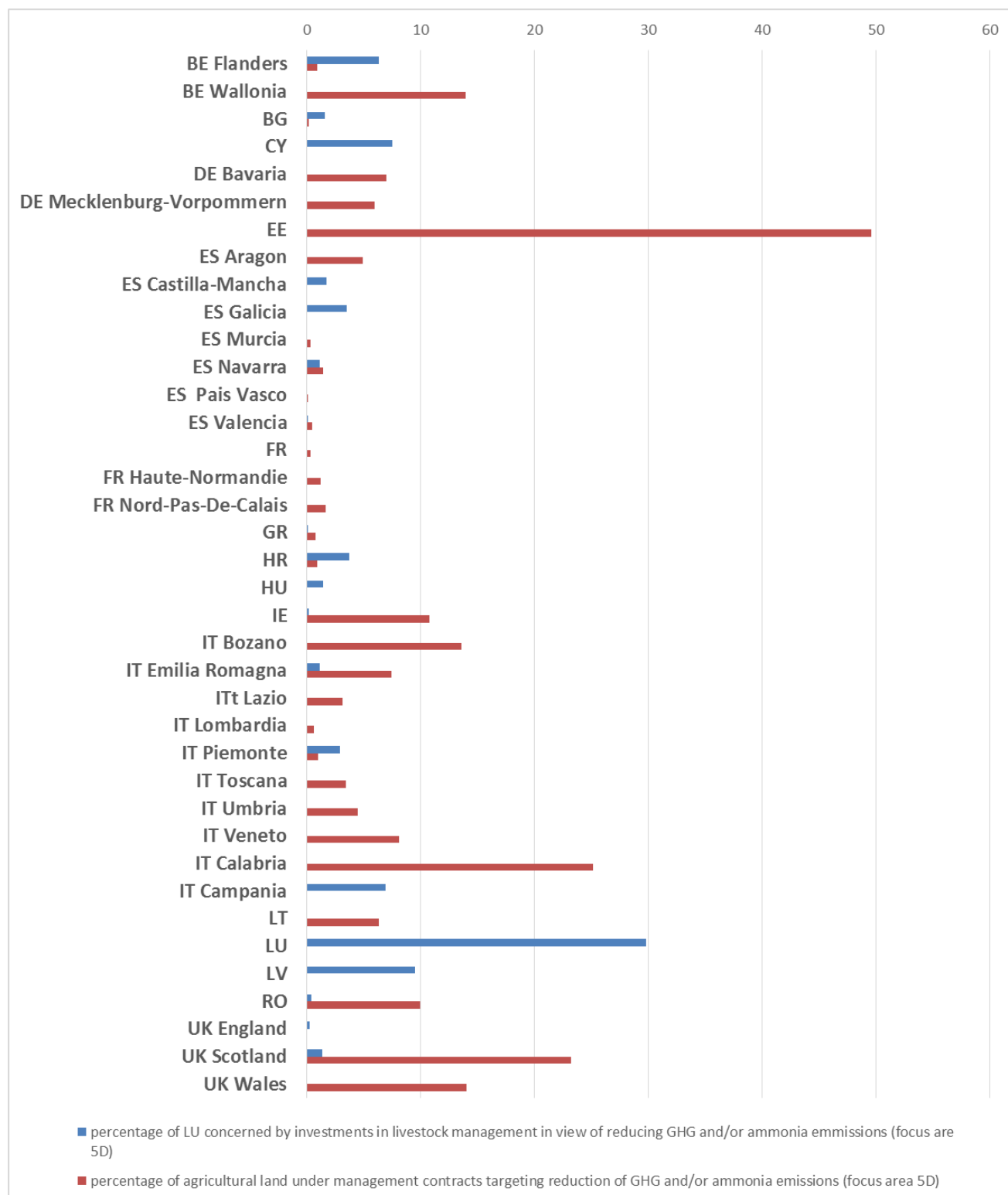


Source: ENRD Contact Point, based on DG AGRI SFC data (March 2016)

The breakdown of the targets identified for two of these indicators by Member State are provided in the figures below for focus area 5D (proportion of agricultural land under management contracts targeting a reduction of GHG and/or ammonia emissions – indicator T18) and focus area 5E (proportion of agricultural and forest land under management contracts contributing to carbon sequestration and conservation – indicator T19). This shows the large variation in the targets proposed between RDP regions. It also shows that only about one-third of regions identify any targets for reducing GHG and ammonia emissions whereas over half identify a target for carbon sequestration, even if these targets are fairly low¹⁰².

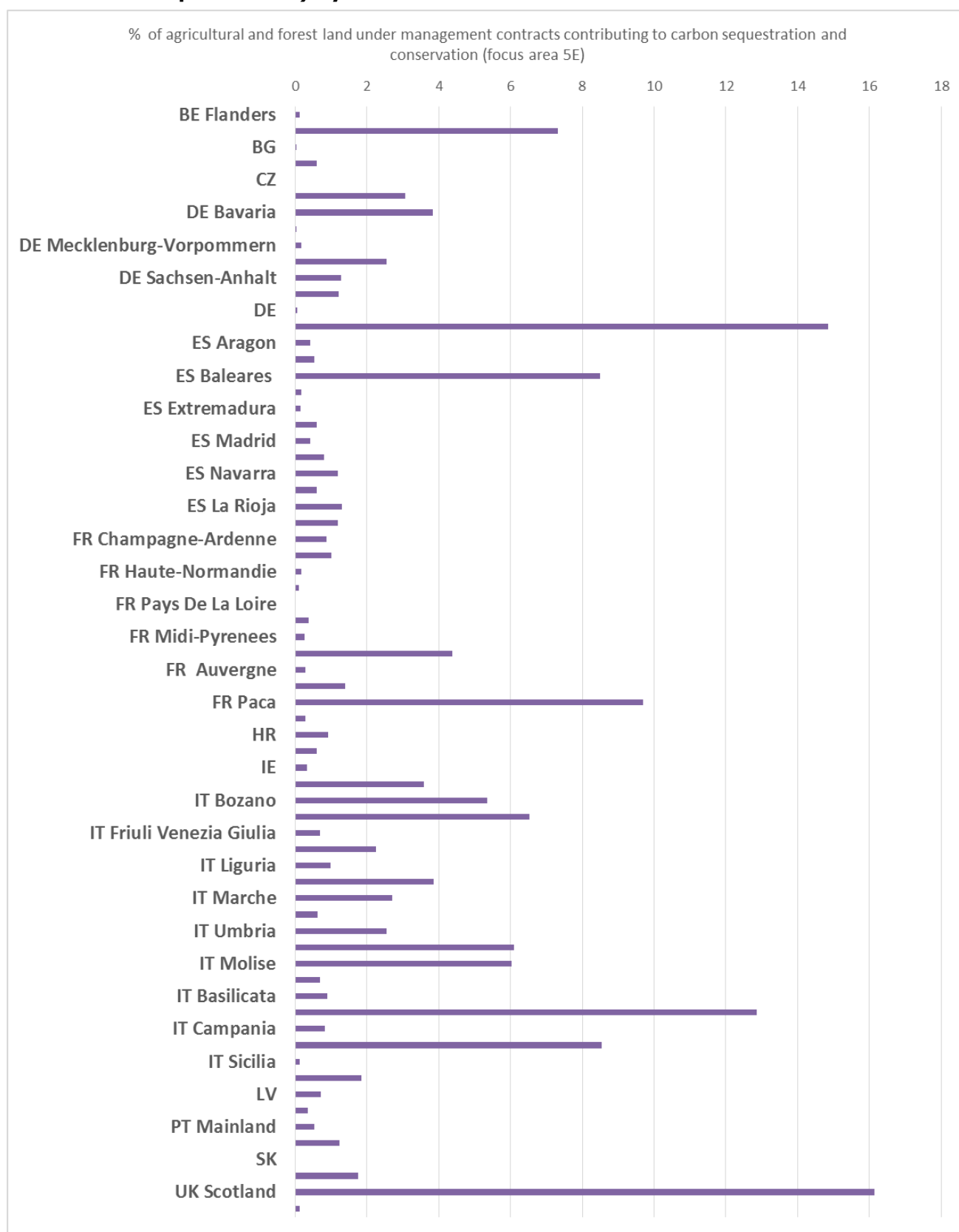
¹⁰² To note that this target indicator also include forest land.

Figure 16: Target indicators for EAFRD focus area 5D (GHG and ammonia emissions) by Member State



Source: Own compilation based on 2014-2020 implementation data (ESIF data portal)

Notes: Excludes outermost regions and RDPs which have not used this indicator

Figure 17: Target indicators for EAFRD focus area 5E (carbon conservation and sequestration) by Member State

Source: Own compilation based on 2014-2020 implementation data (ESIF data portal)

Notes: Excludes outermost regions and RDPs which have not used this indicator

A wide range of RDP measures can be used for climate action, as identified in Annex 6, but of these the agri-environment-climate measure (M10) is one of the most important

Agri-environment-climate Measure programmed for climate action in 2014-2020:

Climate is cited as a general objective for the agri-environment-climate measure in 34 RDPs but only 19 of them specify precise climate-related objectives and actions, with GHG emissions cited as a general objective for the agri-environment-climate measure by 11 and carbon sequestration by 8. Mitigation and adaptation of the agricultural sector to climate change is explicitly put forward as an objective in the Czech Republic, Germany, Denmark, Spain, Italy, and Latvia. Examples of agri-environment-climate relevant to mitigation and/or adaptation that have been programmed in the 2014-20 are shown in Box 11.

Box 11: Examples of agri-environment-climate programmes for 2014-20 that are relevant to climate objectives

In **Bulgaria**, the M10 operation supporting extensive traditional farming practices for the maintenance, restoration and management of grasslands of high nature value was considered particularly relevant as a means of maintaining carbon stores. Although this is likely to help protect carbon stores on agricultural land and will undoubtedly be important, the actual need identified in the country refers to maintaining carbon stores in forests more specifically, which is addressed via the forestry measures under M8 (see below).

In **France**, there are 70+ operations listed in the National Framework under M10, many of which have the potential to contribute to reducing GHG emissions and/or increasing carbon sequestration. In particular, the operations listed under the 'COUVER', 'HERBE', 'LINEA', 'PHYTO' categories, which respectively aim at promoting cover/catch crops, reducing environmental pressure on grassland, maintaining/restoring landscape features and reducing fertiliser and pesticide use on crops, are all expected to be relevant to the following needs: achieving better nutrient management on farmland and maintaining/enhancing carbon storage and sequestration;

Scotland and Extremadura (Spain) provide M10.1 support to compensate for livestock reductions. Fewer animals will result in lower GHG emissions other things being equal. However this action does not respond to any of the GHG emissions needs identified in Spain or Scotland – indeed this is not in fact the intended purpose of the measure, which is primarily focussed on addressing biodiversity priorities.

Scotland's peatland and wetland management and restoration options may increase short-term GHG emissions in some habitats but in the long term should lead to increases in carbon sequestration (this involves M10 operations in combination with M4.4). This responds to the Scottish need to protect soil carbon sinks (and enhance peatland quality).

In **the Netherlands**, some M10 operations, in particular the conservation of peat meadows, are very relevant for carbon storage and reducing emissions, one of the needs identified in NL. However the measure is targeted for biodiversity reasons, not climate and is not targeted to peat meadows at risk, i.e. those outside the Natura 2000 network therefore its use may not optimise the contribution that peat conservation could make to NL's carbon needs.

In **Italy** M10 support for integrated production is relevant for addressing the GHG emissions priorities in the Emilia-Romagna region which are to reduce emissions from agricultural production as well as improving the efficiency of agricultural inputs used, as it should lead to a reduction in fertiliser use and hence reduce N2O emissions.

In Poland M10 support is provided for sustainable practices, protection of soil and water, orchards, traditional fruit plantations, valuable habitats inside and outside Natura 2000. In Slovakia special attention to protection of groundwater through precise and accurate fertilization; protection against soil erosion on selected ploughed land; protection of semi-natural and natural grassland habitats and in Austria for environmental cultivation, green cover, permanent crops, mowing mountain meadows, and management of soils prone to leaching.

Source: Ecorys, Wageningen Economic Research and IEEP, Forthcoming; Martineau et al, 2016

Other RDP measures important for climate action:

For 2014-20, support for **conversion to and maintenance of organic farming systems (M11)** is separate from the agri-environment-climate measure, but is similar in structure, with five to seven year annual payments. Organic farms, account for 3% of arable land and 7% of permanent grassland in the EU, and in six Member States (the Czech Republic, Estonia, Italy, Latvia, Austria and Finland) more than 10% of the total agricultural area is under organic management.

The provision of advice, support and training for farmers is crucial for the successful implementation of climate mitigation actions. There is still a substantial unmet need for advice and support amongst farmers in the EU and in many Member States. In addition to funding the FAS, the RDP measure for **advisory services (M2)** is often used in conjunction with M10, to increase beneficiaries' knowledge and understanding about the objectives of the agri-environment-climate scheme what actions are required for successful implementation. Annex 6 provides a more detailed example of the use of M02 in the 2007-13 period.

Measures to promote **woodland planting** and the introduction of new **agro-forestry systems** on farmland using M8 (forest development and viability) has been very low to date, despite having high mitigation potential in the majority of Member States. The benefits of agroforestry systems for climate mitigation (and other environmental and production benefits) are becoming increasingly clear and interest is growing in using RDPs to support these systems¹⁰³.

EAFRD supports the establishment of the **European Innovation Partnership (EIP) for Agricultural Productivity and Sustainability** at the EU level and of EIP Operational Groups in Member States under the co-operation measure M16. This is a novel initiative and offers researchers and land managers opportunities to develop new approaches to climate mitigation and adaptation. At EU level EIP-AGRI Focus Groups have already identified ideas for applied research and for testing solutions in the field, involving farmers, advisers, the industry and other practitioners, and proposed ways to disseminate good practices. Focus Groups have already investigated the following topics relevant to climate objectives: EFAs; fertiliser efficiency; forest biomass; genetic resources; livestock emissions; nutrient recycling; organic farming; permanent grassland; precision farming; protein crops and soil organic matter¹⁰⁴. A new group will soon be working on the topic agroforestry and introducing woody vegetation into specialised crop and livestock systems.

¹⁰³ For more information on agroforestry see <https://www.agforward.eu/index.php/en/home-redirect.html>

¹⁰⁴ For more information see <https://ec.europa.eu/eip/agriculture/en/content/focus-groups>

Box 12: Examples of other RDP measures relevant to climate benefits that have been programmed in 2014-20 RDPs

M01 Knowledge transfer and information actions: in the Netherlands for training, coaching and demonstration activities to stimulate innovation in: low emission agriculture, energy efficiency and uptake of renewables; in Slovakia for knowledge and skills in: efficiency of energy utilisation in agriculture; reduction of nitrous oxide and methane emissions from soil; and carbon dioxide sequestration in agriculture and forestry.

M02 advisory services: in some Member States, the use of advisory services is compulsory for farmers entering agri-environment-climate (M10) contracts, including Luxembourg, Ireland, Slovakia, Slovenia and also some regions of Germany, Spain and the UK, and will become compulsory in France in 2016. In the German region of North Rhine-Westphalia training is mandatory for an M10 option for catch crops, and in the Madrid region of for M10 options on steppe birdlife conservation and sustainable use of grasslands in the Natura 2000 network.

M04 Investments in physical assets: in Slovakia for the construction and repair of livestock housing and breeding of livestock using new technologies for the reduction of GHG emissions; in the UK (England) for investing in improved resource efficiency or animal health and welfare; in FR-Mayotte the sub-measure for non-productive (environmental) investment (M4.4) is linked to agri-environment-climate objectives, e.g. for planting hedges of resilient forest species.

M06 Farm and business development: in Slovenia this measures supports young farmers whose business plan shows a contribution to climate mitigation e.g. introduction of technologies which reduce environmental pollution and improve animal welfare.

M07 Basic services and village renewal: the broad scope of this measure is used in France, Ireland and Spain (Cataluña) to require M10 beneficiaries to undertake a preliminary 'diagnosis' of the farm level situation to ensure that the option applied for is suitable and is correctly implemented, for example for fertiliser management. In some French regions (e.g. Midi-Pyrénées, Alsace), preparing an M10 application can entail a 'territorial' assessment of the environmental situation, which is facilitated through M07.

M12 Natura 2000 annual compensation payments: are available to farmers for permanent grassland and forest land in Slovakia and for foresters in Portugal (Madeira).

M16 co-operation: supporting joint activities to mitigate and adapt to climate change, preparation of management plans for forest maintenance, or equivalent tools in Slovakia and develop initiatives to tackle animal health and welfare issues in the UK (England).

M19 Support for LEADER local development: projects that implement community led local development strategies and have innovation, environment and climate change as a focus are supported in the Netherlands.

Source: Ecorys, Wageningen Economic Research and IEEP, Forthcoming; Martineau et al, 2016

Some examples of the use of RDP measures in the 2007-13 period are at Annex 6 and a more exhaustive list of 2007-13 RDP implementation (which includes LEADER climate projects) can be found in Frelih-Larsen et al (2014)(Annex 6).

4. PERSPECTIVES FOR THE AGRICULTURAL SECTOR AND THE CAP POST COP21

KEY FINDINGS

- It seems clear that greater consideration will need to be given to how the agriculture sector can play an enhanced role in contributing towards climate mitigation activities in Europe and globally, since to reach the target agreed under the Paris Agreement may require net zero emissions from all sectors at some point around or after 2050, with zero net emissions being required sooner if the pace of emissions reductions from all sectors is not at a high level of ambition in the intervening years.
- However, despite being a significant contributor to GHG emissions in the EU, there remains no clear decarbonisation agenda or GHG emission reduction targets for the agricultural sector at EU level.
- Despite the general acknowledgement that there is a more limited mitigation potential from the agricultural sector, given the need to reconcile food security with climate change concerns, there is still progress that could be made both within the sector to enhance carbon sequestration, improve energy efficiency, and reduce GHG emissions relating to land management.
- Potential action to reduce EU demand for GHG-intensive agricultural production, through measures to address excess meat and dairy consumption in diets or measures to tackle food waste has not yet been adopted at EU level.
- To enhance climate action via the CAP, changes are required on two fronts: changes can be made to the design of the CAP instruments and measures within the EU regulations; but also action has to be taken by Member States to improve the way in which the measures are implemented in their territories.
- To inform policy development, as a key forward looking priority for the European Commission, it would be valuable to produce a central database containing evidence on the mitigation potentials of different farming practices in different climatic zones and on different soil types.
- The lack of explicit GHG emission reduction or carbon sequestration targets for the agriculture sector at either the EU or Member State level, means that there is little incentive to focus attention in this area, particularly when formal climate targets (e.g. under the ESD) can be met without significant efforts from agriculture.

The focus of this chapter is twofold. First it considers the new obligations for the EU's agriculture sector that could/will stem from the adoption of the Paris Agreement, in terms of greenhouse gas emission reductions'. Second, it considers the way in which the CAP could develop in the future to take account of the objectives and requirements stipulated in EU climate policies, with a particular focus on mitigation, but with reference also to adaptation.

4.1. Implications for the agricultural sector resulting from COP21

The Paris Agreement entered into force on 4 November 2016 and by December 2016, it had been ratified by 116 of the 197 parties to the UN Framework Convention on Climate Change. As set out in Chapter 1, the ambition of the Paris Agreement, was to hold 'the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, [...]'. As such it provides a 'bridge

between today's policies and climate-neutrality before the end of the century'¹⁰⁵. It also highlights the critical role that agricultural land use and forests play in reaching long term climate mitigation objectives. This is because these sectors have a dual role, not only producing GHG emissions, but importantly they play a significant role in sequestering carbon from the atmosphere. The pace of emissions reduction across all sectors globally therefore has important implications for the long-term mitigation requirement from the agriculture sector; the slower the pace of emissions reductions, the greater the requirement for aggressive and ambitious carbon sequestration policies at some stage in order to stay within the 2°C or 1.5°C objectives.

In a medium term perspective, the Paris Agreement enshrines the EU's commitment to reduce emissions by at least 40% by 2030, including a 30% reduction target for the non-ETS sectors. Despite being one of the largest contributors to anthropogenic GHG emissions globally and a significant contributor to GHG emissions in the EU (10.2%) after the energy supply, energy use and transport sectors, there remains no clear decarbonisation agenda or GHG emission reduction targets for the agricultural sector at EU level. Looking ahead to 2030 and beyond, it seems clear that greater consideration will need to be given to how the agriculture sector can play an enhanced role in contributing towards climate mitigation activities in Europe and globally. This is because to reach the target agreed under the Paris Agreement may require net zero emissions from all sectors at some point around or after 2050, with zero net emissions being required sooner if the pace of emissions reductions from all sectors is not at a high level of ambition in the intervening years, leading to higher GHG concentrations and earlier impacts of climate forcing and climate feedback mechanisms (Rockström et al, 2016). As the agriculture and forest sectors are the key sectors that are in a position to remove emissions from the atmosphere through carbon sequestration, and given the level of uncertainty and technology risk associated with other removals technologies such as carbon capture and storage, far great efforts will be required of these sectors not only to offset emissions from their own activities (which themselves will have to be minimised) but also from other sectors where continued emissions are unavoidable.

This was reflected in a broad sense at the 2016 Agricultural Outlook Conference¹⁰⁶, whose theme was "Climate Change and Resource Availability: Challenges for EU Agriculture." Both Commissioner Hogan (Agriculture and Rural Development) and Commissioner Arias Cañete (Climate Action and Energy) highlighted the importance of both the adaptation of the sector to climate change as well as increasing its contribution to reducing GHG emissions. Commissioner Hogan made it clear that 'agriculture must play its full part' in addressing the climate challenge, looking to innovative and smart solutions and ways of ensuring generational renewal in the sector as important means of achieving this goal. Commissioner Arias Cañete reinforced the 'triple challenge' facing the agricultural sector of adapting to the impacts of climate change, while enhancing mitigation from agriculture and producing more food, stressing that '*while EU policies have supported a significant reduction in EU Agriculture emissions since 1990, further efforts are needed to contribute to the EUs decarbonisation efforts*'. However, how this is to be achieved in concrete terms is a challenge that is becoming increasingly urgent to address.

The key question is whether the agricultural sector is on the right trajectory to deliver the demanding scale of GHG emission reductions required. Despite the fact that non-CO₂ emissions from the agricultural sector fell by 21% between 1990 and 2014, by 2030 EU agricultural emissions are projected to decrease by only 2.3% compared to 2005¹⁰⁷. It should be noted that a large proportion of reductions since 1990 have been the result of declines in livestock numbers

¹⁰⁵ http://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm

¹⁰⁶ This took place on 6 December 2016 – for more information see: http://ec.europa.eu/agriculture/events/2016-outlook-conference_en

¹⁰⁷ Presentation by Vladimír Šucha, Director-General, Joint Research Centre, European Commission on the [Impact of climate change mitigation on EU agriculture](#)

in the EU, alongside reductions in fertiliser inputs (Baldock and Mottershead, forthcoming). 2014 data show that cropland continues to be a source of CO₂ emissions, with the main sources of non-CO₂ emissions being enteric fermentation (43%), the management of agricultural soils (38%) and manure management (15%).

It is generally acknowledged that there is more limited potential to cut emissions in the agricultural sector compared to other sectors, referring mainly to cost-effective means of achieving reductions in non-CO₂ emissions and the concern to maintain/increase food production. This is embedded in the Paris Climate Agreement which recognises in its preamble the “fundamental priority of safeguarding food security and ending hunger”. The point has also been reinforced in by the European Council, which in their October 2014 conclusions stressed the multiple objectives of agriculture and land use sector, highlighting their lower mitigation potential and the need to reconcile food security with climate change concerns and made it clear that any proposals relating to agriculture within the 2030 climate and energy package should balance “the best means of encouraging sustainable intensification of food production while optimizing the sector’s contribution to GHG mitigation and sequestration” (European Council, 2014).

The Paris Agreement references to food security were primarily a response to developing country concerns that, given the much higher share of agriculture and land use in their emissions, any commitment to climate mitigation could lead to downward pressure on food production. While the risks to food security in the EU are significantly less immediate, it is clear that climate change impacts threaten global food security, including through increased volatility of climate and production; and that if EU action on mitigation were to lead to an increase in its net demand on agricultural production systems in other economies, including developing economies, it would have the potential to worsen climate and social outcomes rather than ameliorate them. The consumption dimension is also important to highlight as a driver of agricultural production and therefore GHG emissions, particularly in relation to meat and dairy production. This is an issue that cannot only be addressed at the EU level given the global trade in these products. However, from an EU perspective little action has yet been taken. For example, the European Council has not yet addressed the potential for action to reduce EU demand for GHG-intensive agricultural production from whatever source, through measures to address excess meat and dairy consumption in diets (with attendant health impacts) or, less controversially, measures to tackle food waste.

The challenges, both technical and political, of achieving cost effective reductions of GHG emissions in the agriculture sector have meant that little large-scale proactive action on climate mitigation in the agricultural sector has been taken to date in Member States. Those measures that have been adopted generally have reflected a mixture of different national and international policy drivers as well as commercial pressures, rather than being set in the context of quantitative targets for emissions reduction from the sector as a whole. There remains reticence by many Member States, farmer and landowner organisations for a more targeted approach to mitigation in the agriculture sector. Clear planning is therefore required to ensure that the agriculture sector maximises its efforts in reducing its overall contribution to GHG emissions and reaching net zero emissions by 2050.

The Commission’s proposals for the ESR and LULUCF, with their accompanying rules on flexibilities between the sectors and the ESR proposed targets for Member States, as they stand, would do little to change the incentive to take action in the agriculture sector (see Chapter 2). This suggests that very few Member States are likely to have to require significant action in their agricultural sectors (either for non-CO₂ or CO₂ emissions) to meet their overarching targets, unless the proposals are strengthened before they are agreed. The proposed flexibilities that allow certain Member States to use part of their EU ETS allocations to meet their ESR targets,

instead of auctioning them, also appear likely to reduce the prospects of quantified approaches to mitigation in the sector¹⁰⁸. The flexibility means that countries that are concerned that their farmers would need to reduce output in order to meet ESR targets post 2020 (e.g. Ireland and Denmark) would be able to use a proportion of their ETS allocations to reduce the efforts required in the agriculture sector. In contrast, more action appears to be taking place on climate adaptation for the sector, particularly in those countries facing greater incidences of drought, flooding, storms (European Commission, 2016b).

While the proposed 2030 ESR targets for Member States appear likely to be deliverable even in the absence of an ambitious sector-wide approach in Member States to agriculture and land use, the lack of early incentives for action is likely to mean that the improvement of cost-efficiency of mitigation action, and learning and understanding how best to combine mitigation with productivity optimisation, will be delayed.

Nonetheless, even without stronger policy drivers, there is a range of actions that could be taken in the short term by the agricultural sector to reduce its emissions and enhance its role in sequestering carbon (see Table 6). These include increased action to improve the resource efficiency of the sector, including the use of inputs (fertilisers etc), land (e.g. the management of soils) and livestock (for example, through improved animal health leading to greater efficiency of production, and fewer GHG emissions per litre of milk or kilogram of meat).

In particular, the impact that soil management can have on the climate is a critical one. Not only does it play an important role in sequestering carbon in the form of organic matter, but it also releases emissions through oxidation and erosion, and through fugitive emissions of nitrous oxide. There is a need to maximise efforts to improve the management of soils to prevent unnecessary emissions and enhance removals. This is particularly the case as new studies suggest that rising temperatures could stimulate the net loss of soil carbon to the atmosphere, driving a positive land carbon–climate feedback that could accelerate climate change (Nature, 2016). Some of these actions are fairly straightforward to implement and there are still many actions that could be taken that are economically beneficial to farmers; for example, enhanced targeting of fertilisers can increase production and decrease input costs, while maximising nitrogen uptake in crops reduces the potential for N₂O emissions. However others require technological developments or require significant up front investments (e.g. new machinery; investments in new livestock housing or slurry stores etc.). What is common to all these actions is the need for adequate advice, training and knowledge exchange to facilitate their uptake, and integrate them into an acceptable business model for farm businesses.

¹⁰⁸ Luxembourg and Ireland get to use 4% of their 2005 emissions, whereas Austria, Belgium, Denmark, Finland, Malta, Netherlands, Sweden get to use 2% of their 2005 emissions.

Table 6: Climate actions and potential mitigation benefits

MITIGATION AND/OR ADAPTATION	CLIMATE ACTION	COMPARATIVE MITIGATION POTENTIAL AT EU-28 SCALE BASED ON ESTIMATED POTENTIAL UPTAKE H HIGH H(R)HIGH FOR SOME REGIONS L LOW ¹⁰⁹
Land Use and Management		
M A	Management of existing woodland, hedgerows, woody buffer strips and trees on agricultural land to optimise benefits providing shelter to livestock and crops;	H
M	conversion of arable land to grassland to sequester carbon in the soil	H
M	new agroforestry	H
M	Woodland planting	H
M	Preventing deforestation and removal of farmland trees	H
M	Leaving crop residues on the soil surface	H
M	Ceasing to burn crop residues and vegetation	H
M	Use cover/catch crops and reduce bare fallow	H
M	Biological N fixation in rotations and in grass mixes	H
M	Zero Tillage	H(R)
M	Reduced Tillage	L
M A	wetland/peatland conservation and/or restoration	L (but see text above)
M A	Use of grasslands to reduce fire risk	No information
Investments		
M	Improved on-farm energy efficiency	L
M A	Improved irrigation efficiency; on farm harvesting and storage of rainwater; using water more efficiently by reducing water losses, improving irrigation practices, and recycling or storing water.	No information
M A	Climate proofing planned investments.	No information
M A	Development of climate-adapted crops and livestock heat-tolerant livestock breeds agricultural research and to experimental production aiming at crop selection and development of varieties best suited to new conditions.	No information
M	Anaerobic digestion (to reduce GHG emissions during manure storage).	No information
M	Solar fodder dryers.	No information
M	Field machinery to reduce tillage and soil compaction and	No information

¹⁰⁹ Based on estimates in Martineau et al, 2016

Capacity building, knowledge and skills		
M	Carbon auditing tools	H
M	Livestock health planning and disease management	L
M	Use of sexed semen for breeding dairy replacements	L
M	Breeding lower methane emissions in ruminants	L
M	Feed additives for ruminant diets	L
M	Soil management planning	L
M	Improved nitrogen efficiency and precision application	L
M	Precision feeding strategies for livestock	No information
M	Plant nutrient management planning	No information
A	Adjusting the timing of farm operations	No information
A	improving ventilation and cooling systems in animal housing;	No information
A	Choosing crops and varieties better adapted to changing climate and risk of pests/diseases	No information
A	Improving pest and disease control through better monitoring, diversified crop rotations, or integrated pest management;	No information
A	Improving soil management by increasing water retention to conserve soil moisture, and landscape management, such as maintaining landscape features providing shelter to livestock;	No information

Sources: own compilation based on identification of mitigation actions in Frelih-Larsen (2014), and assessment of EU-28 mitigation potential in Martineau et al 2016

Given this potential and the corresponding new aims in the CAP, with its reinforced emphasis on climate action as a cross-cutting objective and where it is possible to support a range of actions supporting both climate mitigation and adaptation, it is perhaps surprising that relatively little action has been taken by the Member States. A recent evaluation of the way in which RDPs had been programmed for the 2014-2020 period concluded that, "Despite the political attention being paid to the need for greater climate action to be taken to meet enhanced targets to 2030 and the clear needs and priorities identified in Member States, the climate focus of CAP measures tends to be secondary to the other environmental objectives (soils and water quality mainly) or competitiveness objectives rather than identified as the primary objective for a measure. This is apparent both in the programming of funding for measures against focus areas in the RDPs as well as in the content and design of the measures" (Ecorys, Wageningen Economic Research and IEEP, Forthcoming). This is also demonstrated in Chapter 3 where it can be seen that only 8% of total RDP expenditure is explicitly attributed to climate objectives¹¹⁰, despite the requirement in the MFF for 20% of all EU spending to be allocated to climate action, and where the target values of indicators focused on climate results are extremely low for agriculture in the majority of Member States. There has been little discussion of the impact on GHG emissions of some Pillar 1 measures, such as the use of voluntary coupled payments on a significant scale to support ruminant livestock numbers (Baldock and Mottershead, Forthcoming).

¹¹⁰ As explained in Chapter 3, this does not account for budget allocations which have identified climate action as a secondary priority.

4.2. Future development of the CAP to encourage greater climate action in the agricultural sector

Discussions on how the CAP might be reformed beyond 2020 have already started and will be taken further with a public consultation planned by the European Commission for spring 2017 and a communication of the future of the CAP expected by the end of 2017¹¹¹. The timing is driven largely by the timeframe of the Multi-Annual Financial Framework (MFF) which sets the budget for the EU. The current MFF agreement runs out in December 2020 and proposals for the next period are due by the end of 2017. Since the CAP currently takes 39% of the EU budget, discussions on what level of funding is required for the agricultural sector and wider rural development and the priorities for funding are critical to feed into this debate. The MFF is not the only driver, however. Other drivers for reform include the pressure to simplify and modernise the support available and to respond to changing contexts. One such issue relates to climate action.

The urgency for the agricultural and wider land use sectors to increase efforts to address climate mitigation and adaptation has increased since the signing and ratification of the Paris Agreement, with its ambitious targets. This is reflected increasingly in political statements on the future of the CAP, acknowledging that greater action is required (see section 4.1 above). The Cork 2.0 declaration of September 2016 on the future of rural development policy, also highlights climate action as a future priority. Point 6 of the declaration focuses on climate action and states:

"Given the critical need to address the climate challenge in rural as well as urban areas, support must be targeted to the implementation of effective mitigation and adaptation strategies. There is significant scope for carbon sequestration and storage in rural areas. Action must go beyond carbon-based solutions and should promote sound nutrient and livestock management. Farmers and foresters should be encouraged to provide climate services and to engage in adaptation efforts. The potential for rural areas to produce sustainable renewable energy as well as bio-materials should be developed through appropriate investment schemes. Priority should be given to further developing the circular economy as well as the cascading use of biomaterials."

As shown in Chapter 3, for the 2014-2020 period climate action forms one of the three cross-cutting objectives of the CAP and the policy contains many policy instruments and measures to encourage climate action on agricultural land. Some of these are compulsory for Member States to implement, albeit with flexibility on how they are designed at the local level (e.g. cross-compliance GAEC standards, Pillar 1 greening measures and the Pillar 2 agri-environment-climate measure (AECM)) whereas others are optional (e.g. all other rural development measures apart from LEADER). Farmers must comply with cross-compliance and Pillar 1 greening, whereas all rural development measures (like the AECM) are voluntary.

There are two ways in which improvements to the CAP can be made to enhance climate action. Firstly, changes can be made to the design of the CAP instruments and measures within the EU regulations. Secondly, action can be taken by the Member States to improve the way in which the measures are implemented in their territories, including the content of the measures, the way they are targeted and the support provided to farmers to encourage their uptake, for example through the provision of advice, knowledge sharing and training. The latter is essential to encourage greater use of climate mitigation actions, to encourage optimal levels of uptake of the right actions in the right locations as well as demonstrating the benefits of these actions to the beneficiaries themselves. Such changes to the CAP will inevitably be carried out as part of a

¹¹¹ Speech by Commissioner Hogan at the Agricultural Outlook Conference - 6th December 2016, Brussels https://ec.europa.eu/commission/2014-2019/hogan/announcements/speech-commissioner-phil-hogan-agricultural-outlook-conference-6th-december-2016-brussels_en

multi-stage process, with some changes possible to 2020 and other more significant changes post 2020. The changes to the CAP will also have to take place in parallel with the development of actions to build new capacity, knowledge and data as well as other tools, such as ensuring a firm regulatory baseline and measures to support waste reduction, bioenergy and to influence consumption.

In terms of changing the CAP instruments and measures at the EU level, a number of suggestions can be made relevant to the discussions on the CAP post 2020.

Priority 1: To protect the existing carbon stock of carbon rich soils, it is a priority to ensure the protection of remaining carbon rich soils where they occur in Europe, both through preventing the ploughing of those soils already under permanent grassland and minimising further losses of carbon from cultivated carbon rich soils (Martineau et al, 2016). To do this under the CAP, it should be compulsory for Member States to:

- prevent ploughing on all carbon rich permanent grassland;
- put in place conservation measures for those carbon rich soils under cultivation; and
- maintain woody features (such as hedges, trees etc.).

This could be done via cross-compliance or through changes to the current Pillar 1 greening measures or a mix of both. This would not only be beneficial for climate, but could also benefit biodiversity and water quality. In addition, the greater use should be made of the agri-environment-climate measure to maintain and restore peatland and wetland areas than is currently the case.

Priority 2: Minimising losses of and increasing soil organic matter on all soils should be identified as a greater priority. The current cross-compliance GAEC standard on soil organic matter seems to have been implemented in a rather minimal way in most Member States (see Chapter 3) and this could be changed by strengthening what is required of Member States within the GAEC framework. In addition Pillar 1 greening measures and/or measures under Pillar 1, such as the AECM, should ensure actions that promote soil carbon are offered and taken up, such as encouraging the use of cover crops, putting buffer strips in place or land under fallow. For the Pillar 1 greening measures this might mean proposing a narrower but more effective range of options in any revision to the rules.

Priority 3: more could be done to encourage the more efficient management of nutrients on agricultural land. This would not only benefit climate but also be particularly beneficial to improve water and air quality, where actions go beyond what is required through regulation. Relevant for arable, permanent crop and livestock systems, requirements could be put in place to: limit the use of nitrogen and phosphorous to levels that are required by the crop in question, given the soil and climatic conditions; and to control manure management. Again, this could be done through cross-compliance or through putting requirements in place under the Pillar 1 greening measures.

Priority 4: It is currently optional for Member States to provide information via the Farm Advisory Service (FAS) on climate mitigation and adaptation issues. To ensure greater transfer of knowledge on these issues, provision of advice on this topic via the FAS could be made compulsory. This could focus on those climate mitigation actions identified as having the greatest mitigation potential in each Member State (Martineau et al, 2016). In addition, more could be done to promote the climate mitigation benefits of systems such as agro-forestry (which can also have wider environmental and production benefits). The European Commission could do more to encourage the pilot projects in Member States to demonstrate innovative ways to improve the efficient and effective use of CAP support for climate mitigation purposes. Greater EU level sharing of innovation and technological developments relating to climate mitigation on agricultural land could continue to be encouraged via the European Innovation Partnership (and

Operational Groups at the national level). And best practices of how the CAP has been used to support climate mitigation actions in different regions of the EU could be prioritised, for example via the European Network for Rural Development's Contact Point.

Priority 5: To ensure that the role policy plays in encouraging climate mitigation efforts are recognised and that climate impacts are better reported, ways need to be found within the CAP's Common Monitoring and Evaluation Framework (CMEF) to reflect the climate mitigation effects of all CAP measures even where the primary objective of the intervention may not be climate mitigation.

Priority 6: As highlighted above, much of the slowdown in the rate of GHG emission reductions from the agricultural sector is related to the size of the livestock sector and the slowing of the previous reductions in livestock numbers. There are a range of factors driving this, including the increase in demand for meat and dairy products in countries such as China. However, the CAP, particularly direct payments (the size of which are still influenced in most countries by historic payment levels linked to production) and coupled support provided to the livestock sector, continue to favour higher yield areas. From a climate perspective, there needs to be a more rapid change in the orientation of the CAP so that it becomes truly production neutral in nature.

In terms of greater action at the Member State level, as a first step, a greater emphasis could be placed on climate in the implementation decisions made by Member States, particularly in relation to their Rural Development Programmes.

A recent study concluded that for the 2014-2020 CAP *"Despite the political attention being paid to the need for greater climate action to be taken to meet enhanced targets to 2030, including within the sectors that can be supported by the CAP, the climate focus of measures tends to be secondary to the other environmental objectives (soils and water quality mainly) or competitiveness objectives rather than identified as the primary objective for a measure. This is apparent both in the programming of funding for measures against focus areas in the RDPs as well as in the content and design of the measures"* (Ecorys et al, forthcoming). This is supported by the target values set for climate indicators which are rather low (see Chapter 3) given the importance of this issue. The enhanced Annual Implementation Reports, due to be submitted in 2018 should provide greater insights into what has been achieved in practice and this point could be used as an opportunity to encourage Member States and regions to modify their RDPs to deliver greater climate ambition.

With respect to the uptake of specific current measures in the Member States, the use of those available to promote woodland planting on agricultural land and the introduction of new agroforestry systems via Pillar 2 continues to be low, despite having high mitigation potential. Perhaps if the benefits of agroforestry systems for climate mitigation (and other environmental and production benefits) were communicated more widely, then Managing Authorities could be persuaded to allocate higher levels of funding to the relevant RDP measures, which in turn could see higher uptake of these types of systems on farms. In addition, although the AECM is currently used to some extent support measures that could be beneficial for climate mitigation purposes, albeit to varying degrees in different regions, greater attention could be paid to tailoring the measure specifically for this purpose, particularly in relation to the restoration of carbon rich soils (peatlands and wetlands) as well as enhancing soil organic matter more generally. More could also be made of the investment aid measures to promote investments that encourage energy efficiency, promote renewable energy and a shift towards lower carbon production methods. The Operational Groups, introduced in Member States as part of the European Innovation Partnership for sustainable agriculture, have considerable potential to be used by Member States to promote greater links between researchers and farmers on climate

smart agriculture, with a view to encouraging more innovative approaches and uptake of climate mitigation actions.

Finally, standing back and as a key forward looking priority for the European Commission as a whole, it would be valuable to draw together into a central database the evidence on the mitigation potentials of different farming practices in different climatic zones and on different soil types. Understanding where such farming practices are likely to bring about most benefit is important in order to make judgements about how and where to target these sorts of practices to deliver climate mitigation objectives in the more efficient and effective way - for example whether they should be prioritised throughout a particular area or for the farming system as a whole, or focussed to particular areas. The availability of this sort of information could then be used as a resource by policy makers to make informed decisions about how to achieve greater emission reductions and removals in their territories. It could also be an extremely useful resource for advisers and others engaged in knowledge transfer activities with farmers, so that land managers are kept up to date with the latest science on which practices are optimal for reducing GHG emissions in their situation. Doing this at a European scale would be more cost-effective than duplicating efforts in the Member States.

However, the lack of explicit GHG emission reduction or carbon sequestration targets for the agriculture sector at either the EU or Member State level, means that there is little incentive to focus attention in this area, particularly when formal climate targets (e.g. under the ESD) can be met without significant efforts from agriculture. Attention by national authorities is focused instead on those areas where there are explicit targets to meet and where action from the agricultural sector is essential for their achievement e.g. under the Water Framework Directive or the Biodiversity and Habitats Directives. A more strategic approach to the use of the CAP would also help here, seeing the use of different Pillar 1 instruments and Pillar 2 measures as part of an overall strategy for the agricultural and land use sector. This would enable climate objectives and necessary actions to be designed and implemented in an integrated way, forming a thread that links all parts of the CAP.

5. CONCLUSIONS

This chapter pulls together the main findings from the preceding chapter and draws conclusions about the implications of the COP21 Paris Agreement and the new EU proposals for EU climate action post 2020 for GHG emission reductions from the agricultural sector and how the CAP might evolve to support a greater emphasis on climate action. The conclusions focus on opportunities mainly for climate mitigation (reducing GHG emissions, maintaining carbon stores and enhancing carbon sequestration).

The COP21 Paris Agreement, which entered into force on 4 November 2016, marks a turning point in the international commitment to tackle climate change, by establishing a new ambition for climate mitigation efforts globally:

- to achieve climate to keep increases in global average temperatures below 2°C above pre-industrial levels;
- to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels; and
- neutrality by the end of the century.

As highlighted in previous chapters, the EU's contribution to this target is encapsulated within the EU's 2030 climate and energy framework and associated targets (to reduce overall emissions by 40%) and the more ambitious vision for 2050 of a low carbon transition towards 80% emission reductions.

The agricultural sector, alongside forest land use, plays an important role in reaching these climate mitigation objectives, given its important role in sequestering carbon. However the sector is also a significant emitter of GHGs which also must be reduced, although it is acknowledged that this is more difficult in a sector which must continue to also produce food. Nonetheless, to reach the target agreed under the Paris Agreement may require net zero emissions from all sectors, including agriculture at some point around or after 2050, with zero net emissions being required sooner if the pace of emissions reductions from all sectors is not at a sufficiently high level of ambition in the intervening years.

Indeed, ambition appears to be lacking currently in terms of climate mitigation action within the agricultural sector, although more is being done in some countries on adaptation. This is evident from Member State climate policies as reported under the MMR, as well as the funding allocation and targets proposed for climate-relevant instruments and measures under the CAP. While the CAP has a number of climate-relevant measures, they are either adopted with no specific, quantified objectives for emissions reduction/sequestration (e.g. the Pillar 1 greening measures) or with very low targets not set in the context of a sector-wide contribution to climate action. In addition, discussion of the climate impact of Pillar 1 measures beyond the greening measures is limited and a more analytical approach to the support of the livestock sector, with a stronger climate focus would be timely.

Increasingly, attention will focus on the agricultural sector, as mitigation potential in other sectors is adopted, and as agriculture's percentage share of the remaining total increases. In addition, the focus that the Paris long-term targets (and the need for the EU to set out its long-term mitigation plans in 2018) will mean a focus on the need for significant volumes of land use carbon sequestration. This will require some planning, especially as it is not clear from the evidence that the agriculture sector is on the right trajectory currently to deliver the scale of emission reductions required to achieve a net zero goal by 2050.

Production concerns are valid and relevant, mainly because of the need to ensure that EU net demand for agricultural land in other economies does not increase, as well as the economic and

social impacts in rural areas. But they need also to be accompanied by action to reduce demand for GHG-intensive agricultural products (particularly meat and dairy). This can start with a focus on action to avoid wasteful consumption – either through measures on food waste, or through action on excessive consumption with negative health impacts.

The accompanying texts to the Paris agreement require a facilitative dialogue in 2018, which involves parties considering their commitments in the light of the long-term goals. The EU will therefore need to think through the implications of the 2050 targets by 2018, in good time to feed into the negotiations for the next Multi-annual Financial Framework, and for agriculture to feed into the focus and subsequent negotiations on the post 2020 CAP.

To ensure that the ambition for agricultural and other land use emissions is coherent, it would make sense to set out a low carbon and resilience roadmap for the sectors involved to 2050, setting out the actions required over the coming years. This should set out a multi stage approach to climate action in the sector, embedding public interventions through the CAP in a wider strategy to bring down emissions which involves the private sector and consumer concerns as well. This should include some actions in the short term, as earlier action can help to drive down costs, help improve understanding of the most effective means of mitigation and how they can be adopted in the most cost-effective way, while optimising production choices. Without incentives to action, this learning will be delayed and inaction now will simply postpone the date at which action will be required. The longer this is left, the shorter the timeframe will be to make the reductions required and therefore the greater the cuts will have to be. Therefore this should be a priority, even if the proposed ESR targets can be met predominantly through action in other sectors. Ensuring the right climate policy framework is in place to encourage longer-term action will be essential as well ensuring that a future CAP has the right incentives in place to support not just action on the ground but also capacity building and knowledge exchange. With respect to the CAP, a more strategic approach to the use of Pillar 1 and Pillar 2 instruments and measures is required in Member States to ensure a coherent approach to climate action is taken. Not all support will require public funding and private investment and greater use of financial instruments should also be considered. This agriculture specific measures will also have to be accompanied by a strong regulatory baseline and additional tools such as those to incentivise waste reduction or to influence consumption patterns and hence the demand for climate-intensive products.

Finally, the absence of clear targets for the agricultural sector is allowing Member States to put off the difficult decisions that must be made in relation to emission reductions and removals for the agricultural sector. The development of some form of targets for the sector at EU and/or Member State level therefore, could help provide an incentive for the agricultural sector to start planning now for the significant contributions that will have to be made to emissions reductions in the longer term.

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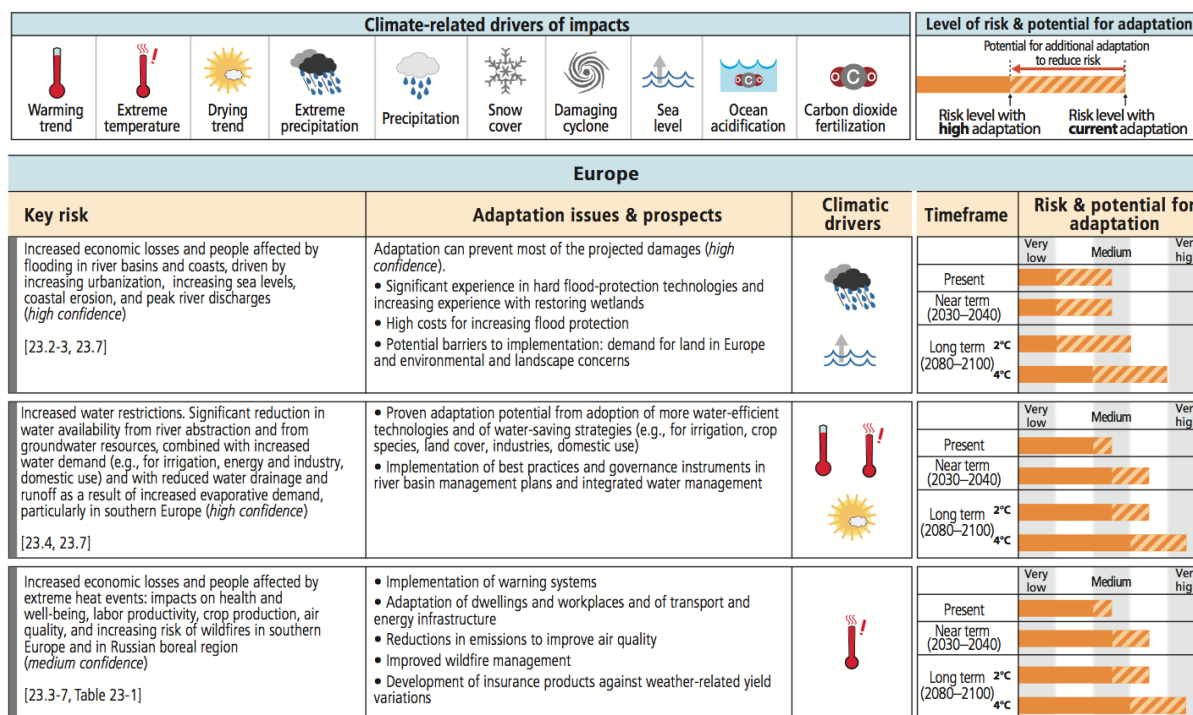
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ANNEX 1: SUPPLEMENTARY INFORMATION FOR CHAPTER 1

IPCC PROJECTED IMPACTS OF CLIMATE CHANGE ON AGRICULTURE (SUMMARY)

Figure 18 shows the IPCC's fifth assessment period key climate change risks for the European region.

Figure 18: Key climate change risks in Europe and potential for adaptation



Source: IPCC, 2014b Assessment Box SPM.2 Table 1

For agriculture, changes in temperature, water availability, pests and diseases, and fire risk will have varying impacts.

Variations in temperature, including more extreme heat waves, have already lead to changes in crop suitability in parts of Europe and is likely to continue to change (Kovats et al, 2014). General patterns suggest that Southern and Mediterranean Europe as well as some parts of Western Europe will be affected more significantly with droughts and heat stress for plant production. For example, during the 2003 and 2010 heat waves across Europe and Russia, grain-harvest losses reached 20 and 25-30% in affected regions respectively (Barriopedro et al, 2011; Ciais et al, 2005). Drought is a major contributing factor in these declines and regional variation is high in relation to the availability of rain-fed crop production potential. For example cereal production fell on average by 40% in the Iberian Peninsula during the 2004/2005 drought (EEA, 2010), country-scale rain-fed cereals yields are below agro-climatic potentials (Supit et al, 2010), and wheat yield increases have levelled off in several countries over 1961–2009 (Kovats et al, 2014; Olesen et al, 2011). By 2030 southern European regions could experience a 5-10 per cent decrease in yields compared to current levels, mainly because of changes in the growing cycle and insufficient water availability for crop growth (Bowyer and Kretschmer, 2011) as discussed below). Quantitative estimates of the distribution and magnitude of such effects vary between different yield models but concur on the overall trends (Donatelli et al, 2012; Hart et al, 2013). There is more of a mixed picture for Northern Europe with some positive yield increases, although climate variability may limit any potential gains (Peltonen-Sainio, Jauhiainen and Laurila, 2009), as may the increase in pests and diseases as a result of milder winters (Hakala, Hannukkala and Huusela-Veistola, 2008; Roos et al, 2011)

Water resource availability is a major factor influencing agricultural production. Predicted changes in weather patterns following the IPCC scenarios, shows a reduction in summer rainfall leading to impacts on overall soil moisture content, groundwater recharge and aquifer levels. These impacts are felt most strongly in already arid parts of Europe (the South and Mediterranean regions)¹¹² yet impacts are also expected across Europe, such as limited aquifer recharge potential in areas of Switzerland and the UK (England). There are indications that current water supply for agriculture may be hard to sustain in some Mediterranean countries, with a predicted increase in water scarcity problems particularly where increasing irrigation is required (EEA, 2012b, c; Iglesias et al, 2007b). The pressure to increase irrigation to combat these declines and variability is likely to be high, however, reduced recharge of aquifers and overall water availability declines will make sourcing water for irrigation more challenging. Costs for irrigation infrastructure may increase significantly¹¹³ as will impacts on natural aquatic and terrestrial ecosystems that relied previously on such water.

Water shortages are not the only source of pressure on agriculture, however. Increased flood hazards, particularly across Northern and Continental Europe could increase crop damage and make soils less workable at ploughing or harvesting times (Kovats et al, 2014). Responses to more extreme flood events has also put pressure on agricultural areas, particularly where hard defences, such as river canalisation, flow restrictions, etc. have been used to protect towns and villages, forcing water into more rural areas and floodplains, often dominated by agricultural production. The frequency of flooding events is expected to increase as the climate becomes warmer. The risk of flooding is thought to be greater in the Boreal, Atlantic central, Continental north and Alpine areas compared to other EU agro-climatic zones (EEA, 2012a). Floods are likely to particularly affect lowland agricultural areas in northern Europe where run-off rates in catchments have increased (e.g. as a result of soil sealing), upstream watercourses have been widened and deepened and active floodplains have been reduced (e.g. as a result of development) (EEA, 2012b). Wetland loss, which accelerated in the EU in the last century, adversely affects flows in river basins alongside the loss of floodplains and water meadows, thus weakening resilience to flooding. It is expected that the risk of flooding and its subsequent impact on agricultural production will increase in situations with inappropriate land management (EEA, 2012a; Underwood et al, 2013).

The impacts of flooding on crops can include increased levels of salinity in soils and water in some situations and increased pest and disease problems (Iglesias et al, 2007a). Water retention measures in catchments, such as maintaining grasslands, applying zero-tillage, creating linear features, ensuring soil cover during appropriate seasons and introducing patches of trees (Fiener, Auerswald and Van Oost, 2011; Hümann et al, 2011; Reinhardt et al, 2011) increasingly may be required to mitigate the risk of flooding in relevant river basins.

Warmer temperatures (wetter or drier) have an impact on the ability of pests and diseases to establish and spread throughout Europe. Differing conditions favour different pathogens. Arthropod-borne diseases tend to favour warmer and drier conditions, whereas mildew and cereal stem rot may reduce as a result of increased temperatures. It appears clear from the evidence, however, that pests and disease patterns will continue to change and spread as their environmental niche widens or moves as a result of climate change.

Climate change is likely to have complex impacts on soil since changes in both precipitation levels and temperatures can affect the structure of soil and its functional capacity. Soil organic carbon is expected to see variable impacts from long-term decreases in some regions, with

¹¹² Occurrences of drought and high temperatures during the first decade of the 21st century have already greatly reduced crop yields in central and southern Europe (Trnka et al, 2011).

¹¹³ Daccache and Lamaddalena (2010) suggest that irrigation system costs could increase by 20 to 27% in southern Italy.

increases in others. Negative impacts are expected to be exacerbated by erosion and faster decomposition (as a result of warming), as well as inappropriate land management activities in the short term (EEA, 2012a; Underwood et al, 2013).

Fire has always been a risk factor in Mediterranean agriculture and forestry management, yet has seen an increase in frequency since the 1970s (Pausas and Fernández-Muñoz, 2012), although a decrease in the total burnt area with high inter-annual variability (San-Miguel-Ayanz et al, 2012; Turco et al, 2013). These impacts are not only attributed to climate change and include fuel accumulation (e.g. vegetation or dead biomass) as a result of management changes. Regardless of current trends, fire risk is expected to increase over the coming decades (Kovats et al, 2014), as will wind storm damage, particularly in forests. Reduced rainfall in summer and more extreme drought events are expected to increase the frequency and extent of the conditions that allow for damaging wild fires, especially in Mediterranean countries (EEA, 2012a). Within agricultural systems, fires may affect some croplands, semi-natural grasslands, shrublands/heathlands, moorland, woody pastures (e.g. dehesas and montados) and agro-forestry. Within semi-natural habitats, fire is to some extent an integral part of certain ecosystem dynamics, prompting re-generation and controlling insect and disease damage etc. In some habitats the controlled use of fire is an important management tool for maintaining open habitats, improving forage quality and grazing conditions, and avoiding intense wild fires, particularly parts of northern Europe (Tucker, 2003). However, uncontrolled wild fires can have devastating impacts on soil and biodiversity as well as on production

The impacts of climate change on livestock production has received far less attention than that of crop production (Hjerp et al, 2012). In general, livestock production is impacted by increased temperature and humidity. Increased temperatures can result in stress and reduction in production (e.g. dairy) and stress induced mortality (Kovats et al, 2014). Livestock diseases, as with those for crops, have increased in range and frequency in recent years and have been partly attributed to climate change. Trends in diseases and pathogens are not uniform, with some expanding in their range and others in frequency.

LIST OF CLIMATE MITIGATION ACTIONS WITH EVIDENCE OF MITIGATION POTENTIAL ON AGRICULTURAL LAND IN THE EU-28

Table 7: List of climate mitigation actions with evidence of mitigation potential on agricultural land in the EU-28

LAND USE
Conversion of arable land to grassland to sequester carbon in the soil
Agroforestry
Wetland/peatland conservation/ restoration
Woodland planting
Preventing deforestation and removal of farmland trees
Management of existing woodland, hedgerows, woody buffer strips and trees on agricultural land
Crop Production Systems
Reduced tillage
Zero tillage
Leaving crop residues on the soil surface
Ceasing to burn crop residues and vegetation
Use cover/catch crops
Livestock Production Systems
Livestock disease management
Use of sexed semen for breeding dairy replacements
Breeding lower methane emissions in ruminants
Feed additives for ruminant diets
Optimised feeding strategies for livestock
Manure, Fertiliser & Soil management
Soil and nutrient management plans
Use of nitrification inhibitors
Improved nitrogen efficiency
Biological N fixation in rotations and in grass mixes
Energy
Carbon auditing tools
Improved on-farm energy efficiency

Source: Martineau et al, 2016

Table 8: Summary of current EU and international climate commitments

	INTERNATIONAL COMMITMENTS			UNILATERAL EU COMMITMENTS			
	Kyoto Protocol (KP)	UNFCCC	Kyoto Protocol	2020 Climate and Energy Package		LULUCF accounting	2030 Climate and Energy Framework Overall
Target year or period	First commitment period (2008-12)	2020	Second commitment period (2013-2020)	EU ETS	ESD	2013 – 2020 and beyond	2030
Emission reduction target	-8%	-20%	-20%	– 21% compared to 2005 for ETS emissions	Annual targets for Member States. In 2020, – 9% compared to 2005 for ESD emissions	Accounting only	At least -40%
Other targets		Conditional target of – 30% if other parties take on adequate commitments		RED: 20% share of renewable energy of gross final energy consumption; EED: increase energy efficiency by 20%		Accounting only	At least 27% share of renewable energy consumption; at least 27% increase in energy efficiency
Base year	1990 KP flexibility rules for F-gases and economies in transition	1990	1990, but subject to flexibility rules. 1995 or 2000 may be used as base year for F-gases or NF3	1990 for overall emission reduction target; 2005 targets broken down into ETS and non-ETS emissions		Not applicable	1990 for emission reduction target.
LULUCF	Included ARD* and other activities if elected	Excluded	Included ARD and FM**, other activities if elected (new accounting rules)	Excluded		Not applicable	Included. Details to be finalised prior to 2020
Aviation	Domestic aviation included. International aviation excluded	Domestic aviation included. International aviation partly included	Domestic aviation included. International aviation excluded	Domestic and international aviation (partly) included in EU ETS	Aviation generally excluded, some domestic aviation included (operators below ETS <i>de-minimis</i> thresholds)	Not applicable	Not specified yet; expectation of market mechanisms for aviation under ICAO
Use of market mechanisms	Use of KP flexible mechanisms subject to KP rules	Subject to quantitative and qualitative limits	Use of KP flexible mechanisms subject to KP rules	Subject to quantitative and qualitative limits		Not applicable	None
Carry- over of units from preceding periods	Not applicable	Not applicable	Subject to KP rules including those agreed in Doha Amendment	EU ETS allowances can be banked into subsequent ETS trading periods since the second trading period	No restriction of carry-over within the period from 2013 to 2020	Not applicable	Banking in the EU ETS is confirmed. The legislative proposal(s) for non-ETS emissions still pending
Gases covered	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆ ,	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆ ,	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆ , NF ₃	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆ (NF ₃ not included)		CO ₂ , CH ₄ , N ₂ O	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆ , NF ₃
Sectors included	Energy, IPPU, agriculture, waste, LULUCF	Energy, IPPU, agriculture, waste, aviation	Energy, IPPU, agriculture, waste, LULUCF	Power and heat generation, energy-intensive industry sectors, aviation	Transport (except aviation), buildings, non-ETS industry, agriculture (excludes forestry) and waste	Agriculture, Forestry, Wetlands	100%
Global Warming Potential (GWP) used	IPCC's Second Assessment Report (SAR)	IPCC SAR; inventory data (including historical data) based on IPCC's Fourth Assessment Report (AR4) from 2015 onwards	IPCC AR4	IPCC AR4		Not applicable	IPCC AR4
EU Member States included	15 (additional KP targets for single Member States)	EU-28	EU-28 + Iceland	EU-28 (Iceland, Liechtenstein and Norway also covered under EU ETS)		EU-28	EU-28 (Norway and Iceland intend to deliver their international commitment collectively with the EU)

Source: based on EEA, 2015b**Notes:** ARD = Afforestation, reforestation and deforestation; FM = Forest Management; IPPU = Industrial processes and product use; ICAO = International Civil Aviation Organisation. Red cells = past commitments; Green cells = current commitments; Amber cells = proposed/forthcoming commitments.

ANNEX 2: SUPPLEMENTARY INFORMATION FOR CHAPTER 2

Box 13: The EU Adaptation Strategy documentation package

Communication: "An EU Strategy on Adaptation to Climate Change, COM (2013) 216. To present the main challenges and the suggested policy orientations to address them.

Impact Assessment (vol. I and II), Commission Staff Working Documents, SWD (2013) 132 and SWD (2013) 133. To prepare evidence for political decision-makers on the advantages and disadvantages of possible policy options by assessing their potential economic, social and environmental impacts.

Green Paper on the prevention and insurance of disasters, COM (2013) 213. To evaluate and report on the potential for the European Union to support increased coverage of appropriate disaster risk insurance and financial risk transfer markets, as well as regional insurance pooling, in terms of knowledge transfer, cooperation, or seed financing.

Climate change adaptation, marine and coastal issues, Commission Staff Working Document, SWD (2013) 133. To provide further background material supportive of the Communication on adaptation challenges for marine and coastal issues. To present the outline of actions that the Commission is undertaking in the area of coastal zones, marine issues and climate change adaptation.

Guidelines on developing adaptation strategies, Commission Staff Working Document, SWD (2013) 134. To help prepare or revise climate change adaptation strategies. To provide a first answer to identified barriers to the uptake of adaptation strategies at national level. To build on and make more operational the Adaptation Support tool available on Climate-ADAPT.

Technical guidance on integrating climate change adaptation in programmes and investments of Cohesion Policy, Commission Staff Working Document, SWD(2013)135. To provide advice, methods, tips and examples to understand and integrate climate adaptation needs and priorities into Operational Programmes for the next programming period (2014-2020).

Adapting to climate change impacts on human, animal and plant health, Commission Staff Working Document, SWD(2013)136. To emphasise the social and environmental implications of climate change and climate change adaptation on health issues, as well as highlighting most recent initiatives in the area

Adapting infrastructure to climate change, Commission Staff Working Document, SWD(2013)137. To provide further background material supportive of the Communication on adaptation challenges in three key economic sectors: energy, transport and construction/buildings.

Climate change, environmental degradation and migration, Commission Staff Working Document, SWD(2013)138. To provide an overview of the research and data currently available on the inter-linkages between mitigation, environmental degradation and climate change. To review the many initiatives of relevance for the topic which are already being taken by the EU in various policy fields. To analyse on-going debates on policy responses at EU and international level.

Principles and recommendations for integrating climate change adaptation considerations under the 2014-2020 rural development programmes, Commission Staff Working Document, SWD (2013) 139. To provide advice, methods, tips and examples to understand and integrate climate adaptation needs and priorities into Member States' Rural Development Programmes (RDP) for the next programming period (2014-2020).

Guidelines for Project Managers: Making vulnerable investments climate resilient, non-paper. To provide support to developers of physical assets and infrastructure on the steps they can take to make investment projects resilient to climate variability and change.

Source: COM(2013)216

Table 9: Flexibilities to meet proposed ESR Targets from ETS and LULUCF sectors

MS	2030 TARGET COMPARED TO 2005	ONE-OFF FLEXIBILITY FROM ETS TO ESR	FLEXIBILITY FROM LAND USE SECTOR TO ESR (%)	FLEXIBILITY FROM LAND USE SECTOR TO ESR (MTCO ₂ EQ)
AT	-36%	2%	0.40%	2.5
BE	-35%	2%	0.50%	3.8
BG	0%		1.50%	4.1
CY	-24%		1.30%	0.9
CZ	-14%		0.40%	0.6
DE	-38%		0.50%	2.6
DK	-39%	2%	4.00%	14.6
EE	-13%		1.70%	0.9
EL	-16%		1.10%	4.5
ES	-26%		1.30%	58.2
FI	-39%	2%	1.30%	22.3
FR	-37%		1.50%	6.7
HR	-7%		0.50%	2.1
HU	-7%		0.50%	26.8
IE	-30%	4%	5.60%	11.5
IT	-33%		0.30%	3.1
LT	-9%		5.00%	6.5
LU	-40%	4	0.20%	0.25
LV	-6%		3.80%	0.03
MT	-19%	2%	0.30%	13.4
NL	-36%	2%	1.10%	21.7
PL	-7%		1.20%	5.2
PT	-17%		1.00%	13.2
RO	-2%		1.70%	1.2
SE	-40%	2%	1.10%	1.3
SL	-15%		1.10%	29.1
SK	-12%		0.50%	4.9
UK	-37%		0.40%	17.8

Source: http://europa.eu/rapid/press-release_MEMO-16-2499_en.htm

Table 10: The agricultural mitigation challenge in 2030 by Member State

MS	2030 TARGET COMPARED TO 2005	ONE-OFF FLEXIBILITY FROM ETS TO ESR	FLEXIBILITY FROM LAND USE SECTOR TO ESR (%)	DISTANCE TO TARGET IN 2030 ASSUMING MAX USE OF FLEXIBILITIES	PROJECTED SHARE OF AGRICULTURE IN 2030 EMISSIONS
AT	-36%	2%	0.40%	11.7%	17.0%
BE	-35%	2%	0.50%	25.4%	16.1%
BG	0%		1.50%	-22.2%	25.4%
CY	-24%		1.30%	5.8%	19.7%
CZ	-14%		0.40%	-6.6%	13.4%
DE	-38%		0.50%	17.0%	17.6%
DK	-39%	2%	4.00%	16.2%	36.0%
EE	-13%		1.70%	-4.9%	30.2%
EL	-16%		1.10%	-29.8%	21.9%
ES	-26%		1.30%	-1.5%	21.9%
FI	-39%	2%	1.30%	8.8%	24.3%
FR	-37%		1.50%	19.8%	24.9%
HR	-7%		0.50%	-15.2%	19.5%
HU	-7%		0.50%	-21.2%	19.3%
IE	-30%	4%	5.60%	15.15	49.0%
IT	-33%		0.30%	9.8%	12.3%
LT	-9%		5.00%	-9.2%	47.9%
LU	-40%	4	0.20%	54.2%	6.8%
LV	-6%		3.80%	-7.7%	28.9%
MT	-19%	2%	0.30%	-4.0%	11.3%
NL	-36%	2%	1.10%	22.6%	20.2%
PL	-7%		1.20%	6.7%	19.0%
PT	-17%		1.00%	-17.5%	23.1%
RO	-2%		1.70%	-10.5%	22.9%
SE	-40%	2%	1.10%	7.6%	23.5%
SL	-15%		1.10%	-8.5%	18.4%
SK	-12%		0.50%	-0.7%	10.9%
UK	-37%		0.40%	4.3%	17.0%

Source: First three columns from http://europa.eu/rapid/press-release_MEMO-16-2499_en.htm The last two columns are reproduced from Matthews, 2016

Notes: Distance to target and projected share of agriculture in 2030 are based on calculations by Matthews (2016) which in turn are based on the European Commission's impact assessment for the ESR proposal, Reference scenario 2016, Appendix 2 and 3.

Table 11: National inventory report key emission categories and potential mitigation actions in agriculture

KEY CATEGORY (2014)	# MS	POTENTIAL MITIGATION ACTION IDENTIFIED IN RICARDO-AEA AND IEEP (2016)	GHG IMPACT
Agricultural soils	26	Reduced tillage & No till	Soil N ₂ O
		Return crop residues	
		Cover/catch crops	
		Delay N after slurry	
		Urease and nitrification inhibitors	
		Improved nitrogen efficiency	
		N fixation	
		Maintain soil pH	
Cropland remaining Cropland	19	Maintain soil pH	CO ₂ emission
	21	Agro-forestry, SRF	CO ₂ removal
		Perennial crops in rotations	
		New farm trees and hedges	
		Reduced tillage & No till	
		Return crop residues	
		Cover/catch crops	
Enteric Fermentation	20	Breeding for low enteric CH ₄	CH ₄
	21	Feed additives	
	22	Optimising feeding strategies	
Field burning of agricultural residues	2	No burn of crop or residues	CO ₂ emission
Forestland remaining forestland	24	Grasslands forest fire break	
		Preventing deforestation	
		Management of farm trees and hedges	CO ₂ removal
Grassland remaining grassland	13	Grassland management (soil C)	CO ₂ removal
Land converted to forestland	21	Reforestation	CO ₂ emission
		Afforestation	CO ₂ removal
		New farm trees and hedges	
Land converted to grassland	19	Arable to grassland (soil C)	CO ₂ emission
Land converted to wetlands	9	Wetland / Peatland restoration	
Manure management	22	Anaerobic digestion - livestock manure	
Other Transportation	11	Farm energy efficiency	CO ₂ emission
Public Electricity and Heat Production	25	Farm energy efficiency	
Wetlands remaining wetlands	5	Wetland / Peatland conservation	

Source: Member Station NIRs as assessed by Ricardo-AEA and IEEP (2016)

FRANCE LULUCF ARTICLE 10 REPORT EXTRACT

The French Article 10 report, included as an Annex to the Low Carbon Strategy, projects the following emissions and removals from the French LULUCF sectors under the 2 scenarios described above.

Table 12: GHG emissions and removals from LULUCF in France, by type of land cover (UNFCCC format)

	FOREST LAND	CROPLAND	GRASSLAND	WETLANDS
AME scenario - all measures adopted on 1 Jan 2014				
2014	- 72,429.90	19,675.01	- 10,479.58	- 2,588.82
2020	- 82,305.14	20,238.50	- 9,979.60	- 2,588.82
2035	- 100,645.75	21,516.98	- 9,397.40	- 2,588.82
AMS2 scenario - foresees full package of measures to be adopted with the Low Carbon Strategy				
2014	- 71,518.51	18,646.50	- 10,489.77	- 2,588.82
2020	- 75,127.41	17,383.50	- 11,517.55	- 2,588.82
2035	- 66,134.90	16,981.17	- 15,383.85	- 2,588.82

[Table continues below]

	SETTLEMENTS	HWPS	TOTAL
AME scenario - all measures adopted on 1 Jan 2014			
2014	11,207.73	- 1,598.39	- 56,213.95
2020	11,967.88	- 1,809.36	- 64,476.54
2035	12,549.67	- 1,709.65	- 80,274.97
AMS2 scenario - foresees full package of measures to be adopted with the Low Carbon Strategy			
2014	11,129.54	- 1,699.40	- 56,520.46
2020	11,139.02	- 2,484.70	- 63,195.95
2035	6,919.67	- 3,431.88	- 63,638.61

Source: CITEPA

The baseline scenario (AME) reflects what would happen if no further climate action was implemented compared to the situation in 2014. It is therefore useful essentially to contextualise the AMS2. The focus here is on cropland and grassland, which are the two agricultural LULUCF sectors.

In the AMS2 scenario, both cropland and grassland are expected to contribute to climate mitigation with lower emissions and more removals, respectively. The scenario expects that, the full implementation of the Low Carbon Strategy (and its implications on agricultural policy) would enable to reduce emissions by -8.9% less from cropland and to remove 46.7% more carbon on grassland, by 2050. Under the AMS2 scenario, all emissions from agricultural soils¹¹⁴ go down from 9.9 MtCO₂ in 2013 to 3.6 MtCO₂ in 2035.

¹¹⁴ This is broader than cropland and grassland as the calculation does not match exactly

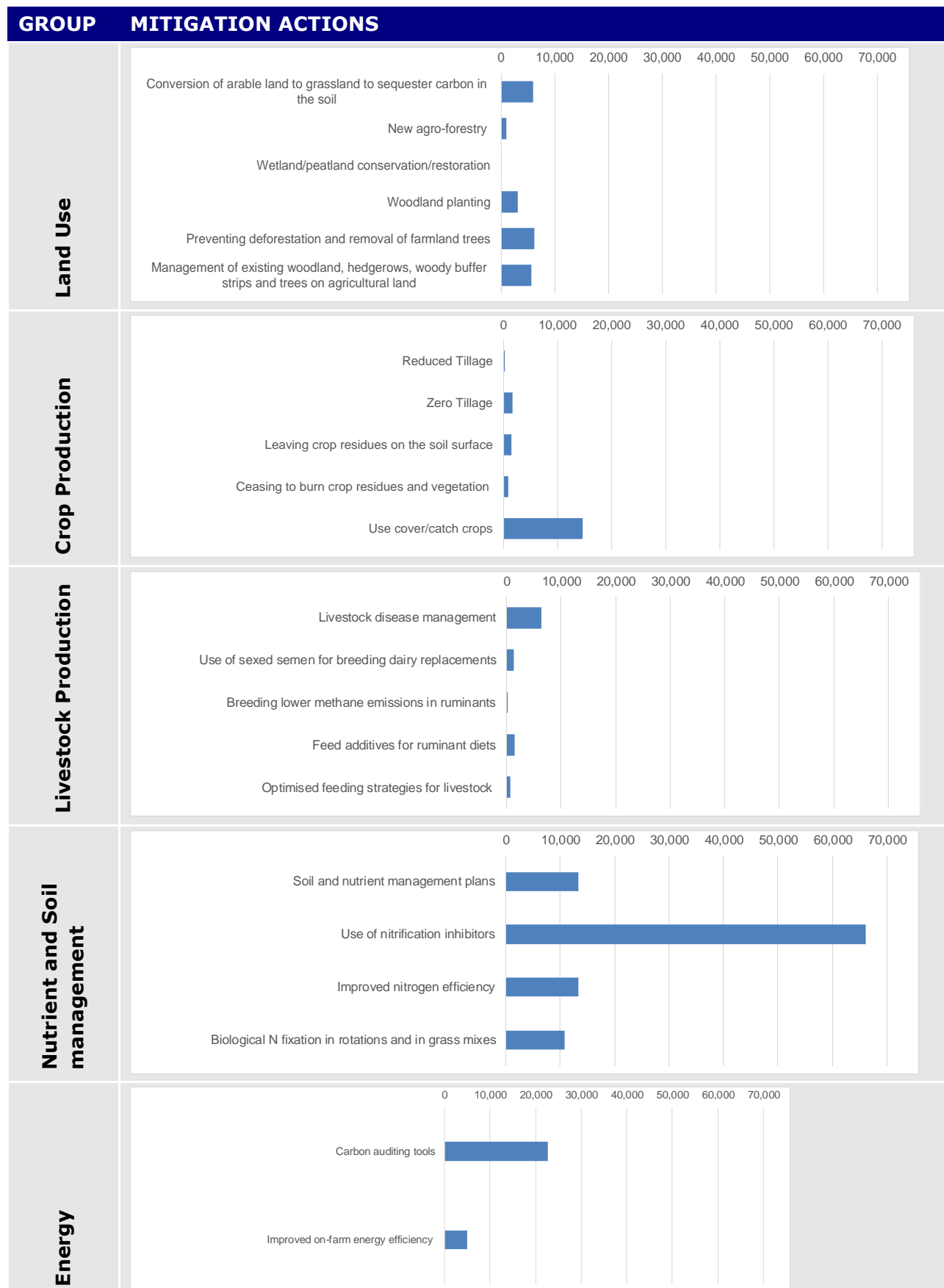
Table 13: Status of climate adaptation strategies and plans in EU Member States

MEMBER STATE	ADAPTATION STRATEGY	ADAPTATION PLAN	AGRICULTURE
AT	In Development	In Development	Yes
BE	Yes	Yes	Yes
BG	In Development	Yes	Yes
CY	In Development	In Development	Yes
CZ	Yes	In Development	Yes
DE	Yes	Yes	Yes
DK	Yes	Yes	Yes
EE	In Development	In Development	Yes (in bioeconomy)
EL	Yes	Yes	Yes
ES	Yes	Yes	Yes
FI	Yes	Yes	Yes
FR	Yes	Yes	Yes
HR	In Development	In Development	Yes
HU	Yes	In Development	Yes
IE	Yes	In Development	Yes
IT	Yes	In Development	Yes
LT	Yes	Yes	Yes
LU	Yes	n/a	Yes
LV	In Development	Yes	Yes
MT	Yes	Yes	Yes
NL	Yes	Yes	Yes
PL	Yes	No	Yes
PT	Yes	No	Yes
RO	Yes	In Development	Yes
SE	Yes	Yes	Yes
SI	In Development	Yes	Yes
SK	Yes	Planned	Yes
UK	Yes	Yes	Yes (devolved)

Source: <http://climate-adapt.eea.europa.eu/>

ANNEX 3 COMPARATIVE MITIGATION POTENTIAL OF ACTIONS IN AGRICULTURE

Mitigation potential values at EU level are shown, for management actions that involve land use change, prevention of land use change, or management of landscape features. The main mechanism of these MAs is the sequestration of carbon from atmospheric CO₂, into organic matter, or the prevention of CO₂ emission through loss of carbon in organic matter. The low value for wetland/peatland conservation/restoration relates to the comparatively small area of land that this management action is applicable to.

Figure 19: Estimated mitigation potential (kt CO₂e/y) of different land management actions for the EU-28 calculated using estimates of likely uptake

Source: Martineau et al, 2016

Table 14: Potential CAP measures available to support actions identified as having high mitigation potential (source Martineau et al 2016)

	CROSS-COMPLIANCE	PILLAR 1 GREENING MEASURES	RURAL DEVELOPMENT PROGRAMMES
Cover/catch crops	No directly relevant standards In some cases the use of cover crops under greening in areas vulnerable to soil erosion is a requirement of the soil GAEC standards (e.g. GAEC 5 - minimum land management to limit soil erosion; and GAEC 6 maintenance of soil organic matter)	Can be supported under the <ul style="list-style-type: none"> - Ecological Focus Area measure (offered to farmers in 19 MSs in 2015) - the crop diversification measure 	Can be supported under the: <ul style="list-style-type: none"> - agri-environment-climate measure or - organic farming measure
Biological N fixation in rotations and grass mixes	No relevant standards	There is potential on some arable land under the <ul style="list-style-type: none"> - Ecological Focus Area measure (through the use of N fixing crops - offered to farmers in all MSs in 2015) and - the crop diversification measure under Pillar 1 <p>Although neither measure requires these crops to be put into rotations or with grass mixes.</p>	Can be supported under the agri-environment-climate measure
The conversion of arable land to permanent grassland to sequester carbon in the soils	Encouraged to some extent through GAEC 1 to introduce buffer strips alongside water courses	Supported under the EFA measure (through the use of buffer strips, an option available to farmers in 17 MSs in 2015)	Can be incentivised under the <ul style="list-style-type: none"> - agri-environment-climate measure, - associated non-productive investments and - possibly under the measure providing compensation to farmers subject to River Basin Management Plans if conversion of arable to grassland is a requirement under the Programme of Measures.

Prevention of deforestation and removal of farmland trees	<p>Prevention of the removal of farmland trees can be supported by the requirement under</p> <ul style="list-style-type: none"> - GAEC 7 to retain landscape features in countries which choose to include copses, lines and groups of trees and individual trees within this standard. - SMR 2 (Birds Directive) and SMR 3 (Habitats Directive) standards where these prohibit the removal woodland or trees and shrubs 	<p>Supported indirectly by the EFA measure which permits certain afforested areas (available in 14 MSs) as well as woody features to meet the EFA obligation.</p>	<p>Possible to be supported indirectly through support for the management of farm woodland and individual farmland trees – e.g. via:</p> <ul style="list-style-type: none"> - forest-environment-climate measure - agri-environment-climate measure
Management of existing woodland, hedgerows, woody buffer strips and trees on agricultural land	<p>Not applicable - the GAEC standards generally require retention of these types of habitats not their ongoing management</p>	<p>It is possible to support hedgerows and trees on agricultural land as part of the EFA measure under which Member States can include a range of landscape features to count towards the EFA obligation, e.g.</p> <ul style="list-style-type: none"> - hedgerows (offered in 13 MSs in 2015); - isolated trees (offered in 13 MSs in 2015); - trees in line (offered in 16 MSs in 2015); - trees in groups (offered in 17 MSs in 2015); 	<p>A number of measures are relevant under Pillar 2 including:</p> <ul style="list-style-type: none"> - support for non-productive investments linked to the achievement of agri-environment-climate objectives (M4.4) for restoration of farmland trees and hedges; - agri-environment-climate payments, as equivalence for EFAs or separately (M10.1) for management of farmland trees and hedges; - support for prevention of damage to forests from forest fires and natural disasters and catastrophic events (M8.3) - support for restoration of damage to forests from forest fires and natural disasters and catastrophic events (M8.4) - support for investments improving the resilience and environmental value of forest ecosystems (M8.5) - compensation payment for Natura 2000 forest areas (M12.2)

			<ul style="list-style-type: none"> - payment for forest-environmental and climate commitments (M15.1) - support for the conservation and promotion of forest genetic resources (M15.2) - support for joint action undertaken with a view to mitigating or adapting to climate change and for joint approaches to environmental projects and ongoing environmental practices (M16.5) - support for drawing up of forest management plans or equivalent instruments (M16.8)
Woodland planting	Not relevant	Can be supported indirectly under EFAs, where areas of woodland created with RDP or equivalent national support, or new hedges, trees in lines or groups and isolated trees on or adjacent to arable land can count towards the EFA obligation. 14 Member States have permitted afforested areas as eligible for the EFA measure	<p>Support can be provided through</p> <ul style="list-style-type: none"> - the non-productive investments measure linked to the achievement of agri-environment-climate objectives (M4.4) for planting individual trees, groups of trees and hedges as well as through payments for afforestation and - creation of woodland on both agricultural and non-agricultural land (M8.1)
Improved on-farm energy efficiency	not relevant	no relevant measures	<p>Relevant CAP measures could include:</p> <ul style="list-style-type: none"> - vocational training and skills acquisition (M1.1) for example in techniques to improve fuel efficiency such as eco-driving and tractor maintenance - demonstration activities and information (M 1.2), for example on developing a fuel use action plan - setting up farm and forestry advisory services (M 2.2) to provide through the Member State's Farm Advisory Service

			<ul style="list-style-type: none"> - support for investments in infrastructure related to the development, modernisation or adaptation of agriculture and forestry (M4.3)
Soil and nutrient management plans	in some countries soil management plans are required as a means of identifying the actions required to comply with soil GAEC standards (e.g. GAEC 5 - minimum land management to limit soil erosion; and possibly GAEC 6 maintenance of soil organic matter)	no relevant measures	<p>The development of soil and nutrient management plans as a pre-cursor to actions on the ground can be supported via:</p> <ul style="list-style-type: none"> - demonstration activities and information actions (M 1.2); - setting up farm and forestry advisory services (M 2.2) and - the agri-environment-climate measure (M10.1)
Zero tillage, which has significant mitigation potential in a small number of the more arid Member States (Cyprus, Greece, Spain and Portugal)	Member States can specify zero tillage must be carried out in certain areas sensitive to soil erosion under GAEC 5 (minimum land management to limit soil erosion)	no relevant measures	<p>Can be supported under measures such as:</p> <ul style="list-style-type: none"> - support for investments in agricultural holdings (M4.1) and - agri-environment-climate payments (M10.1) targeted at land where there is a significant risk of soil erosion (provided the requirements of verification and payment control can be met) - advice and knowledge transfer activities using demonstration activities and information (M 1.2), for example to improve farmers' understanding of how to address potential problems, (e.g. via the use of mechanical weed control, integrated pest management or - setting up farm and forestry advisory services (M2.2). - Pilot projects could also be instigated used the cooperation measure (M16).

Source: Martineau et al, 2016

ANNEX 4: EFA IMPLEMENTATION CHOICES BY MEMBER STATES

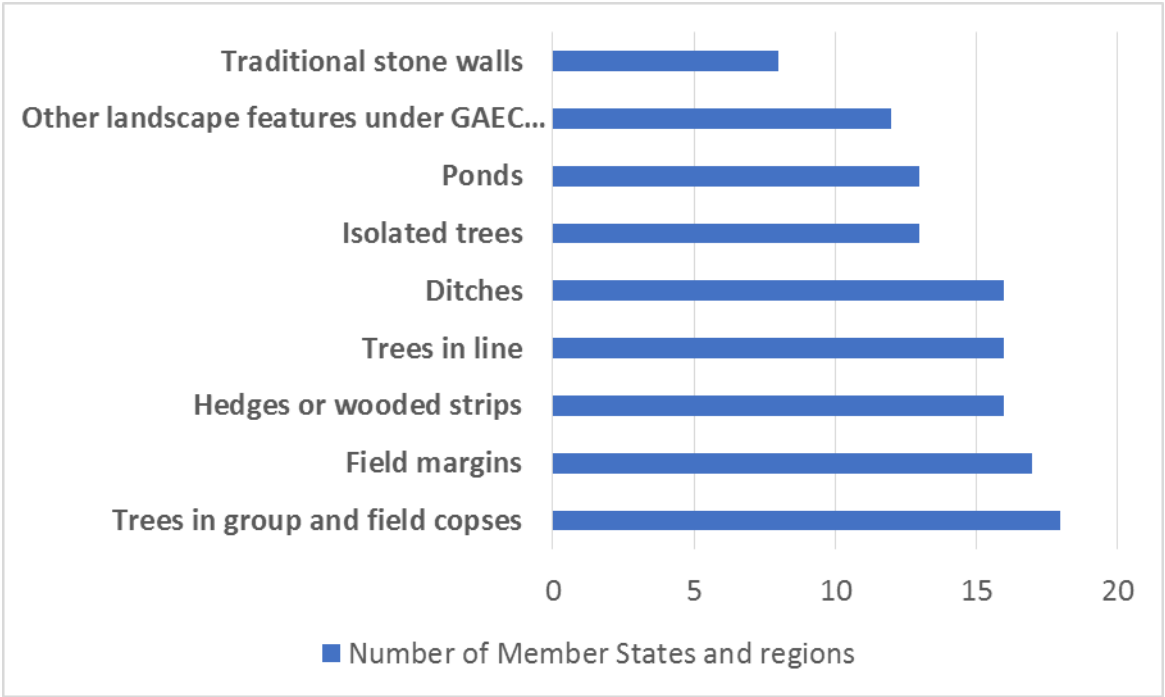
Table 15: Number and type of elements considered to be EFA, in 32 Member States or regions

MS	FALLOW	TERRACES	LANDSCAPE FEATURES	BUFFER STRIPS	AGROFORESTRY	FOREST EDGES - WITH PRODUCTION	FOREST EDGES - WITHOUT PRODUCTION	SRC	AFFORESTED AREAS	CATCH CROPS ETC.	N FIXING CROPS	TOTAL EFA TYPES BY MS (MAX =11)
AT	✓		✓					✓		✓	✓	5
BE - FI	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	10
BE - Wa	✓		✓	✓	✓		✓	✓		✓	✓	8
BG	✓	✓	✓	✓			✓	✓		✓	✓	8
HR	✓		✓	✓			✓	✓		✓	✓	7
CY	✓			✓	✓				✓		✓	5
CZ	✓	✓	✓					✓	✓	✓	✓	7
DE	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	10
DK	✓		✓	✓				✓		✓		5
EE	✓		✓					✓			✓	4
EL	✓		✓	✓							✓	4
ES	✓				✓				✓		✓	4
FI	✓		✓					✓			✓	4
FR	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	10
HU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	11
IE	✓		✓	✓				✓	✓	✓	✓	7
IT	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	10
LT	✓										✓	2
LU	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	10
LV	✓		✓	✓						✓	✓	5
MT	✓		✓								✓	3
NL			✓					✓		✓	✓	4
PL	✓		✓	✓		✓	✓	✓	✓	✓	✓	9
PT	✓		✓		✓				✓		✓	5
RO		✓	✓	✓				✓	✓	✓	✓	7
SE	✓		✓		✓			✓		✓	✓	6
SI	✓									✓	✓	3
SK	✓	✓	✓	✓				✓		✓	✓	7
UK - EN	✓		✓	✓						✓	✓	5
UK - NI	✓		✓		✓			✓	✓		✓	6
UK - SC	✓		✓	✓						✓	✓	5
UK - W	✓		✓					✓	✓		✓	5
EU 28	30	7	24	19	12	6	10	22	15	21	31	

Source: European Commission, 2016a

Figure 20 sets out the different landscape features chosen by Member States. Table 16 also identifies whether or not the landscape features that can count towards the EFA are the same as those protected under cross-compliance (e.g. GAEC7, SMR2, SMR3) or are different to those protected under cross-compliance, either different features included, or different requirements (e.g. width, height etc.) are stipulated.

Figure 20: Types of landscape features permitted within EFAs for the EU-28



Source: own compilation based on European Commission, 2016a

Table 16: Definitions of landscape features qualifying as EFA, by Member State/region

Countries	Hedges or wooded strips	Isolated trees	Trees in line	Trees in group and field copses	Field margins	Ponds	Ditches	Traditional stone walls	Other landscape features under GAEC or SMR	No of LF per MS
Belgium — Flanders	Art. 45			Art. 45	Art. 45	Art. 45	Art. 45			5
Belgium — Wallonia	GAEC 7	GAEC 7	GAEC 7	GAEC 7	GAEC 7	GAEC 7	GAEC 7			7
Bulgaria	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45 GAEC 7	Art. 45	Art. 45			7
Czech Republic		GAEC 7	GAEC 7	GAEC 7	Art. 45		GAEC 7		GAEC 7	6
Denmark						GAEC 7			GAEC 7	2
Germany	GAEC 7	GAEC 7	GAEC 7	GAEC 7	Art. 45 GAEC 7		GAEC 7	GAEC 7	GAEC 7	8
Estonia	GAEC 7		GAEC 7	GAEC 7			GAEC 7	GAEC 7		5
Ireland	GAEC 7		GAEC 7	Art. 45			GAEC 7		GAEC 7	5
Greece			Art. 45 GAEC 7	Art. 45			Art. 45			3
Spain										0
France	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45		8
Croatia	GAEC 7	GAEC 7	GAEC 7	GAEC 7		GAEC 7	GAEC 7	GAEC 7		7
Italy	GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 2 SMR 3	Art. 45	Art. 45	GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 2 SMR 3	Chosen but no description	9
Cyprus										0
Latvia				Art. 45	Art. 45	Art. 45			GAEC 7	4
Lithuania										0
Luxembourg	GAEC 7 SMR 2-3	GAEC 7 SMR 2-3	GAEC 7 SMR 2-3	GAEC 7 SMR 2-3	Art. 45	SMR 2-3				6
Hungary	Art. 45	Art. 45 GAEC 7	Art. 45	GAEC 7	Art. 45	GAEC 7	Art. 45		GAEC 7	8
Malta		Art. 45	Art. 45	Art. 45	Art. 45				GAEC 7, SMR 3	5
Netherlands					Art. 45					1
Austria						GAEC 7	GAEC 7	GAEC 7	GAEC 7	4
Poland	Art. 45	Art. 45 GAEC 7	Art. 45	Art. 45	Art. 45	Art. 45 GAEC 7	Art. 45 GAEC 7			7
Portugal									GAEC 7, SMR 2, SMR 3	1
Romania	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45	Art. 45			7
Slovenia										0
Slovakia		GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 2 SMR 3	GAEC 7 SMR 3					4
Finland									GAEC 7	1
Sweden					Art. 45					1
UK England	GAEC 7									1
UK Northern Ireland	GAEC 7						GAEC 7	GAEC 7	GAEC 7	4
UK Scotland					Art. 45					1
UK Wales	Art. 45							Art. 45		2
Member States/LF (incl. regions)	16	13	16	18	17	13	16	8	12	

Source: European Commission, 2016a**Notes:** GAEC7/SMR2/SMR3: where Member States have chosen the same features as covered by cross-compliance to count towards the EFA obligation**A45:** where Member States have used the additional options available to them under Article 45 of the delegated regulation EU 639/2014 to extend the types of landscape features eligible for EFA beyond those covered by cross-compliance.

ANNEX 5: RDP 2014-20 MEASURES RELEVANT TO ADDRESSING CLIMATE MITIGATION AND ADAPTATION IN AGRICULTURE

Box 14: RDP measures from the 2014-2020 EAFRD that can be used to support climate mitigation and adaptation actions

M1: Knowledge transfer and information actions *Optional*: can support vocational training, demonstration activities, Information provision, farm management exchanges and visits.

M2: Advisory services, farm management and farm relief services *Obligatory*: this measure funds part of the cost of the CAP Farm Advisory System (FAS) which Member States must provide, covering cross compliance; Pillar 1 greening requirements; RDP measures to improve economic performance; obligations under the WFD; requirements for integrated pest management; farm safety; advice for first-time farmers. *Optional*: can support additional advisory services helping farmers and other land managers to improve the economic and environmental performance as well as climate friendliness and resilience of their holding or enterprise; can also support training of advisors.

M4: Investments in physical assets *Optional*: can support tangible and intangible investments aimed at improved performance and sustainability of farms, processing and marketing, farm and forest infrastructure, energy and water supply/saving and non-productive environmental investments linked to agri-environment-climate objectives, Natura 2000 or other high nature value systems.

M5: restoring agricultural production potential damaged by natural disasters and introduction of appropriate prevention *Optional*: can support investments in preventive actions to reduce consequences of probable natural disasters and adverse climatic events as well as investments to restore agricultural land damaged by such disasters and events.

M6: Farm and business and development *Optional*: investment support and other payments aimed at young farmers, small farms and setting up non-agricultural businesses.

M7: Basic services and village renewal *Optional*: a wide range of support including investment in small-scale renewable energy

M8: Investment in the forest area development and improvement of the viability of forests *Optional*: support for wide range of investments for *inter alia*: afforestation and creation of woodland; establishing new agroforestry systems; prevention and restoration of damage to forests from fires, natural disasters and climate related threats; and improving the resilience, environmental value and mitigation potential of forest ecosystems. For holdings above a certain size a forest management plan is required, in line with the principles of sustainable forest management. **8.1 and 8.2: Investment in afforestation and creation of woodland (8.1) and establishing new agroforestry systems on agricultural land (8.2).**

M10.1: Agri-environment-climate this is the only measure that must be made available throughout the Member State's territory, in accordance with national, regional or local specific needs and priorities. It offers farmers and other land managers multi-annual contracts for agricultural practices that make a positive contribution to the environment and climate. The baseline above which payments are calculated includes CAP cross-compliance requirements, and there are strict rules to avoid double funding of actions that are also Pillar 1 greening options, such as EFA buffer strips.

M10.2 Conservation and sustainable use and development of genetic resources in agriculture covers both maintenance *in situ* of genetic material in natural habitats, and on farms the rearing distinctive domesticated animal breeds and cultivating locally adapted crops, and other measures including web-based inventories of genetic resources, training and advice.

M11: Organic Farming *Optional*: offers annual payments through multi-annual contracts for conversion to and/or maintenance of organic farming methods.

M12: Natura 2000 and Water Framework Directive payments *Optional*: basic compensatory payments applying to an area where there are restrictions on land management related to farm-level requirements under the WFD river basin management plans or under Natura 2000 designations on agricultural and forest areas.

M16: Cooperation *Optional*: support for a wide range of cooperative activities by different actors and sectors, new clusters and networks; supports the establishment of operational groups linked to the work of the European Innovation Partnership for agricultural productivity and sustainability (EIP-Agri).

Source: Martineau et al, 2016

ANNEX 6: EXAMPLES OF HOW RDP 2007-13 MEASURES WERE USED FOR CLIMATE MITIGATION AND ADAPTATION

Box 15: Examples of the way in which RDP measures from the 2007-13 period were used to promote climate mitigation and adaptation

Note: measure numbers changed between the two programming periods and the broadly equivalent 2014-20 measure numbers are shown for reference.

Farm Modernisation measure (similar to M4):

- In Spain, this measure has been used to support investments in manure storage and treatment facilities to reduce GHG emissions from livestock production (Balears, Galicia, Navarra and the Basque Country). In the UK, the measure has been used to support investments for manure storage (E, NI, S, W). In France, support has been offered for investments for manure treatment and processing with a view to reducing ammonia and GHG emissions, for instance coverage of pits and manure treatment equipment. Support has also been provided to support investments in precision machinery.
- In Poland, support has been provided for investments in modernisation of manure management facilities and equipment, both for solid manures and liquid slurries.

Agri-environment measure (similar to M10):

All regions in Spain used the agri-environment measure to support organic farming and the majority also provided support for integrated production, both of which were identified as being important climate measures. Other measures identified in Spanish RDPs with climate objectives were support for soil conservation techniques, extensive livestock management, maintenance of extensive dryland systems and wetland management.

In the UK, this measure has been used to support:

- Extensive livestock management and grassland management (E, S, W).
- The conversion from conventional to organic production (E, NI, S, W).
- Fertiliser management (reducing emissions from plant and soil protection practices (E, NI, W)
- Arable reversion to pasture (E, S).

In France, support has been provided for:

- organic farming (most common measure highlighted for climate);
- integrated production (limits on the use of phytosanitary products; extended crop rotations; and diversification of rotations in arable crops);
- extensive livestock grazing (extensification of pasture management, involving reduced/no fertiliser use, reduced use of phytosanitary products, actions to maintain/increase soil organic levels); and
- soil management (extensive pasture management; avoiding the use of synthetic fertilisers and chemical plant protection products).

In Poland, this measure has been used to support:

- organic farming;
- management of extensive permanent grassland;
- under-sowing of winter cover crops to limit leaching and run-off of polluting substances
- the creation of buffer zones to limit leaching and run-off of polluting substances

Non-productive investments (similar to M4.4):

- In the UK, this measure has been used to fund the restoration and reinstatement of boundary features, woodlands and wetlands (E, S, W)

Afforestation of agricultural land (similar to M8.1):

- In Spain this measure has been used to promote forests for carbon sequestration purposes (afforestation to fight soil erosion and desertification, improvement of forest roads)
- In France support for establishing forests has been highlighted as a climate measure
- In Poland support for establishing forests has also been highlighted as beneficial for climate

Measures to support training and the provision of advisory services (similar to M1 and M2):

- In Spain (Castilla La Mancha) these measures are used to increase farmer knowledge and awareness of climatic effects and to enable forest owners to access advisory services on this issue
- In the UK, the training measure has been used to increase farmer knowledge and awareness of climatic effects (E, NI, S, W)
- In France, the training measure has been used to support training for integrated production, and the reduction in the use of phytosanitary and fertilisation practices as part of integrated farm management
- In Poland, advice has been provided for environmentally-friendly production techniques in farming and forestry, which may include a climate dimension although this has been not specified

Support for young farmers (similar to M6):

- In Spain (Valencia), a top-up payment has been provided to young farmers (€2,000) if they include systems for minimising GHG emissions

Restoring forest's production potential (similar to M8.4):

- In Poland this measure has been considered to benefit climate indirectly, through support for the restoration of forests destroyed by biotic and abiotic factors and for the introduction of mechanisms to prevent forest fires.

Source: Martineau et al, 2016

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