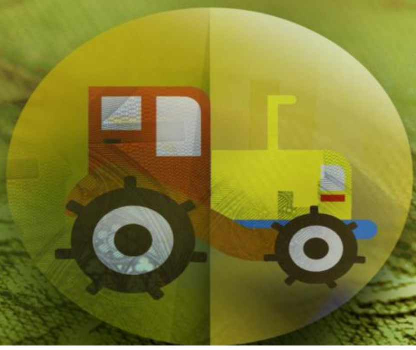
CAP SPECIFIC OBJECTIVES

...explained

– Brief No 4



AGRICULTURE AND CLIMATE MITIGATION

This is part of a series of Briefs summarising the facts and addressing the policy relevance around the nine proposed specific objectives of the future CAP.

KEY MESSAGES

- ✓ *EU agriculture, including land use and land use change (LULUC) of grassland and cropland, represented 12 % of all EU greenhouse gas (GHG) emissions in 2016.*
- ✓ *EU agriculture is more vulnerable than most other sectors of the economy to climate change. The severity of the impact depends not only on the climate related effect itself but also on the exposure and vulnerability of human and natural systems.*
- ✓ *Potential contributions from changes in farm practices to mitigate GHG include the use of mitigation technologies, carbon sink through better soil management, biomass production, reduction in fossil fuel intensity of farm production, and reduction in agricultural production losses and waste.*
- ✓ *EU agriculture has a key role to play in helping to reach the commitments of the Paris' agreement and EU strategies on sustainability and bioeconomy by stepping up its ambition in terms of GHG emissions in view of the potential risks and the stagnation of agricultural emissions since 2010, while ensuring at the same time EU's food security.*
- ✓ *Take advantage of the synergies with soil management practices for sequestering and storing carbon and watch out for carbon leakage*

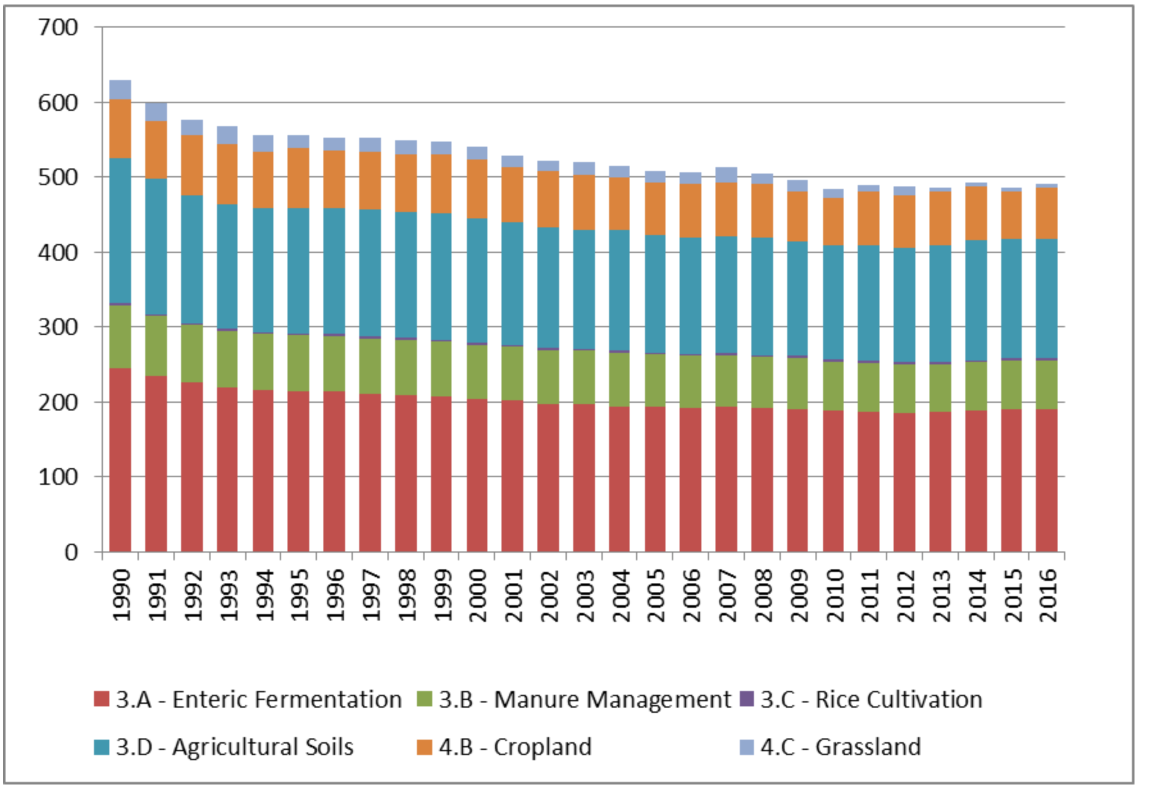
This brief is drafted by Benjamin Van Doorslaer, with contributions from Nicola Di Virgilio (DG AGRI), Arwyn Jones, Adrian Leip, Emanuele Lugato and Franz Weiss (JRC).

1. GHG, agriculture and climate change

a. Greenhouse Gas (GHG) emissions related to "agriculture"

According to the latest inventory data published by the European Environment Agency (EEA), EU agriculture, including land use and land use change (LULUC) of grassland and cropland, represented 12 % of all GHG emissions in 2016. This share is similar to the past 10 years, but the contribution in terms of overall emissions and source of emissions differs significantly among Member States, depending on the structure of their agricultural sector. Between 1990 and 2016, emissions from EU agriculture fell by 22 %. However, the rate of decline has levelled out and emissions have stabilised since 2010 at around 490 million tonnes of CO_2-equivalent. In 2016, 39 % of emissions were related to enteric fermentation of ruminant livestock, 32 % to agricultural soils (fertiliser), 14 % to LULUC of cropland and 13 % to the management of manure.

Figure 1: Evolution of GHG emissions in EU agriculture (mio t CO_2-equivalent)

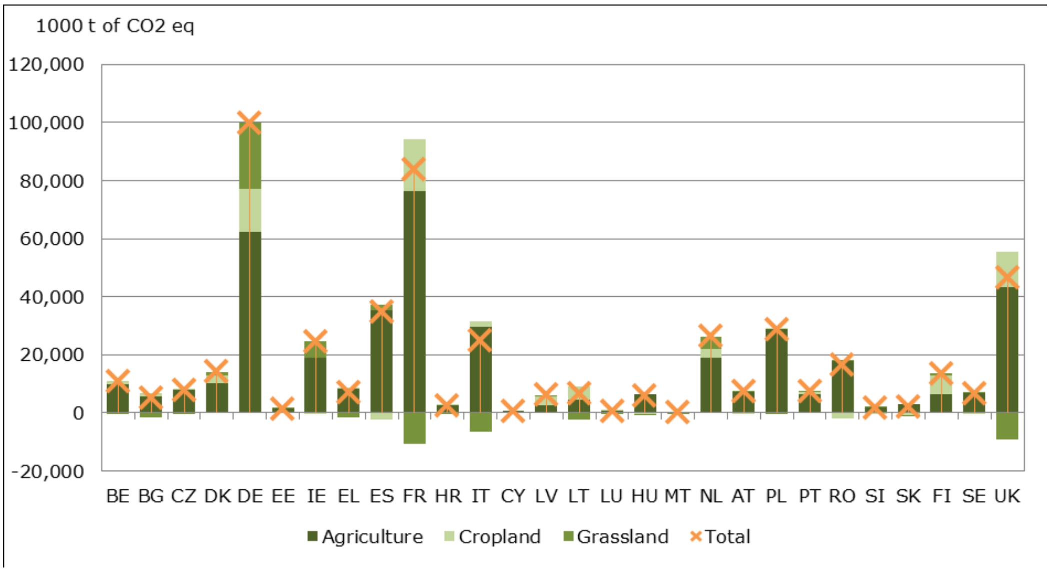


Source: EEA, 2018

Grassland is an important net carbon sink in France, Italy and the UK, but a net source of emissions in Germany, Ireland and the Netherlands (see figure 2), contrary to the common assumption that grassland always sequesters carbon. This is due to the management of (carbon-rich) grassland and the fact that the potential of grassland to capture carbon is limited over time.

Cropland on the contrary is a source of emissions in all Member States, mainly due to the management of (carbon-rich) cropland and the conversion to cropland from other land uses. In 2016, the EU emitted 70 million tonnes of CO_2-equivalent from LULUC of cropland and 6 million tonnes of grassland.

Figure 2: GHG emissions in agriculture by MS in 2016



Source: EEA, 2018

b. Impact of climate change on agriculture

Agriculture in the EU is more vulnerable than most other sectors of the economy to climate change. The severity of the impact depends not only on the climate related effect itself but also on the exposure (people and assets at risk) and vulnerability of human and natural systems (IPCC 2012). Therefore, it is important to improve the resilience of agricultural ecosystems in the EU in order to reduce the potential risk and severity of climate change impacts. The concept of sustainable agriculture should include the capacity to cope with changing climatic conditions. There is growing evidence about the positive and negative effects of climate change on food production (IPCC 2014), mainly driven by:

- changes in precipitation
- changes in temperature
- periodicity and severity of extreme events
- rise in sea level
- increase in CO_2 concentration

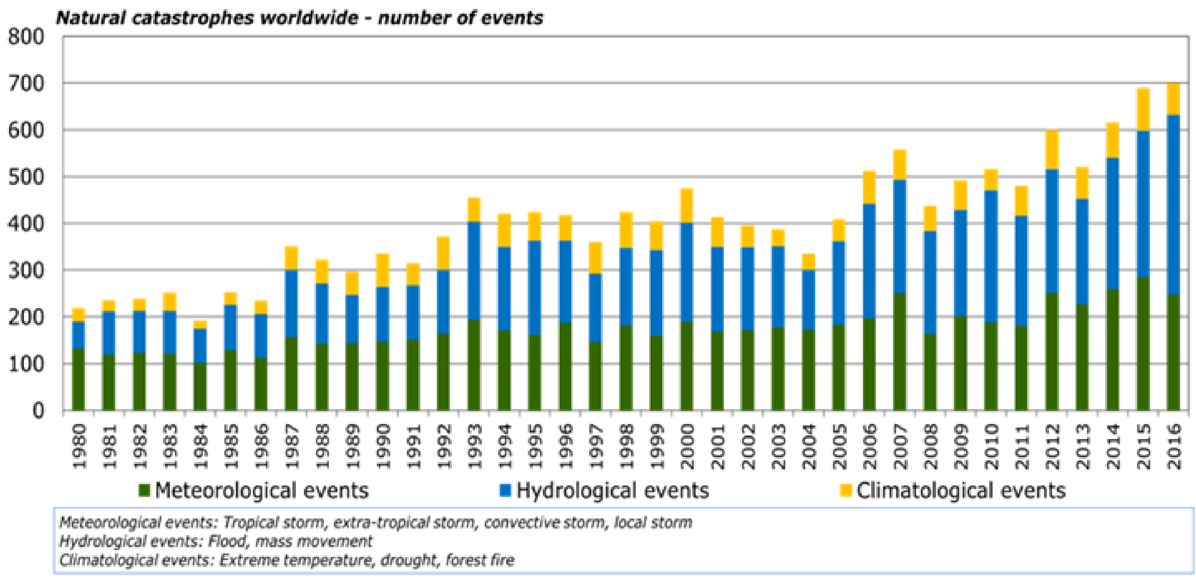
These drivers have direct and indirect effects on the level and the variability of crop yields but also on the way and the location where these crops are cultivated in the EU.

Temperature increase and the related extension of the growing season make the northward expansion of the cultivation of certain annual and permanent crops possible, thus increasing crop yield (ceteris paribus). On the other hand, it can make the cultivation of certain crops in other regions more difficult or result in a significant yield reduction due to heat stress. Also livestock production systems can suffer from heat stress and the provision of appropriate ventilation, shade and drinking water might be necessary.

Due to the increase of the CO_2 concentration in the atmosphere, so-called C-3 plants (such as wheat), will increase their potential yield as they can still improve the efficient use of CO_2. The impact on the potential yield of C-4 plants (such as maize) is less significant as their use is already maximised at current CO_2 levels.

At the same time, changes in precipitation will make irrigation or a shift in the cultivation of crops in southern Europe necessary. Changes in flowering period and harvesting dates of crops on the other hand will have a direct impact on the crop yield (Olesen et al. 2012). Cultivation practices such as timing of sowing and harvesting may change and therefore affect the use of labour force on the farm (EEA 2017). Moreover, recent research has shown that the occurrence of climate related extreme events (e.g. heat stress, drought, intense rainfall …) in the EU will likely increase progressively with a noticeable spatial gradient towards south-western regions of the EU (Forzieri et al. 2016), having a negative effect on the variability of the crop yield. The increase of extreme events is confirmed by the data from a German re-insurance company (see figure 3) and in the latest special report of the Intergovernmental Panel on Climate Change on Global Warming of 1.5°C (IPCC, 2018).

Figure 3: Number of catastrophes worldwide between 1980 and 2017



Source: Münchener Rückversicherungs-Gesellschaft Aktiengesellschaft in München

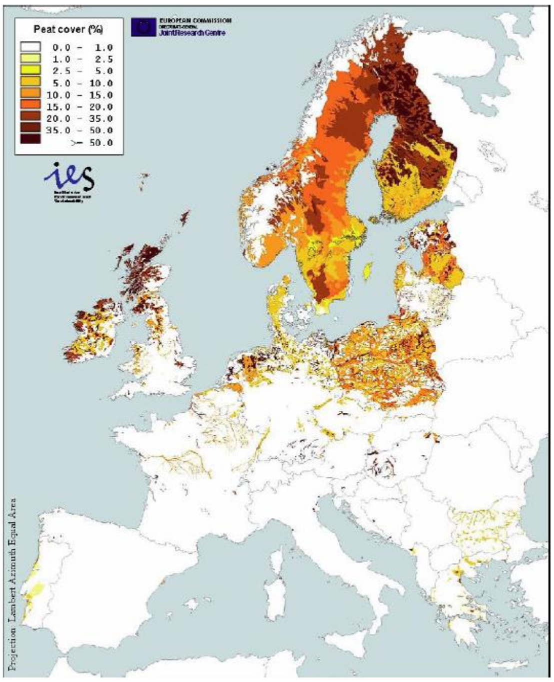
Peatland

Peatlands are a type of wetland, characterized by the accumulation of partly decayed vegetation that forms a distinctive organic-rich soil known as peat.

Peatlands form a unique natural habitat and support a large range of biodiversity, playing a role in the hydrological cycle to maintain the balance of water quantity and water quality. Peatlands also act as a large carbon reservoir. They hold about 20–25 percent of global soil carbon stock but occupy only 3 percent of world's ice-free land surface (IPCC, 2014). The GHG balance of peatland depends on the net CO_2 uptake and efflux, and the efflux of CH_4 and N_2O. In general, the sequestration of carbon in peat outweighs the other fluxes.

The distribution of peatlands in the EU is quite concentrated in a few MS with relatively high surfaces, as shown in figure 4. When drained, peatlands become net sources of greenhouse gas (GHG) emissions and the accumulation of carbon is reversed and released very rapidly into the atmosphere. It is possible to combine agriculture and peatland but peatland management or restoration means often rewetting of the land, which can result in the need to change the existing agricultural management practices (FAO 2014).

Figure 4: Relative cover (%) of peat and peat-topped (0 – 30cm) soils in the SMUs of the European Soil Database



Source: European Commission, JRC, from Montanarella et al., 2006 (SMUs: Soil Mapping Units comprising one or more Soil Typological Units (STUs) e.g. histosol)

Livestock production systems in the EU are affected through the incidence of diseases and changing environmental conditions (heat, humidity), but also by the type, quality and quantity of (also imported) feed and grass. This will have an impact on the herd management as well as the feeding regime (longer or shorter grazing period, need for complementary feed and drinking water) depending on the local circumstances.

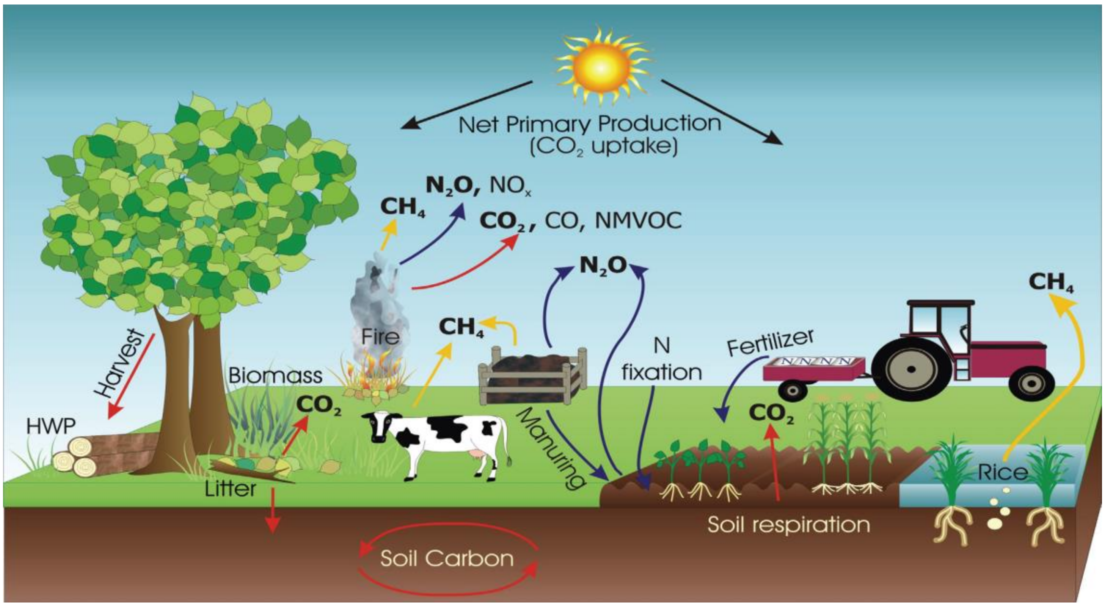
The rise of sea level will increase the risk of flooding of agricultural areas in coastal regions, and low-lying areas or areas close to water bodies. The pressure of salinisation of the soil and of irrigation water through sea water incursion into the aquifers can further decrease the agricultural potential of these areas (IPCC 2007).

2. The challenges around mitigation

Following the recent agreement of the 2030 Climate and Energy framework, Member States accepted to reduce GHG emissions in the non-Emissions Trading System (ETS) sector (including agriculture) by 30%.

Although there is no specific target for the agricultural sector, each Member State will need to define within its own National Energy and Climate Plan (NECP) how the agricultural and LULUCF sectors are going to contribute to the national targets and to align their Strategic Plans expected in the future CAP to the content of the NECP. At the same time, the need for EU food security should be ensured and made coherent with the climate objectives.

Figure 5: Main flows of the carbon cycle in agriculture and forestry



Souce: IPCC, 2014

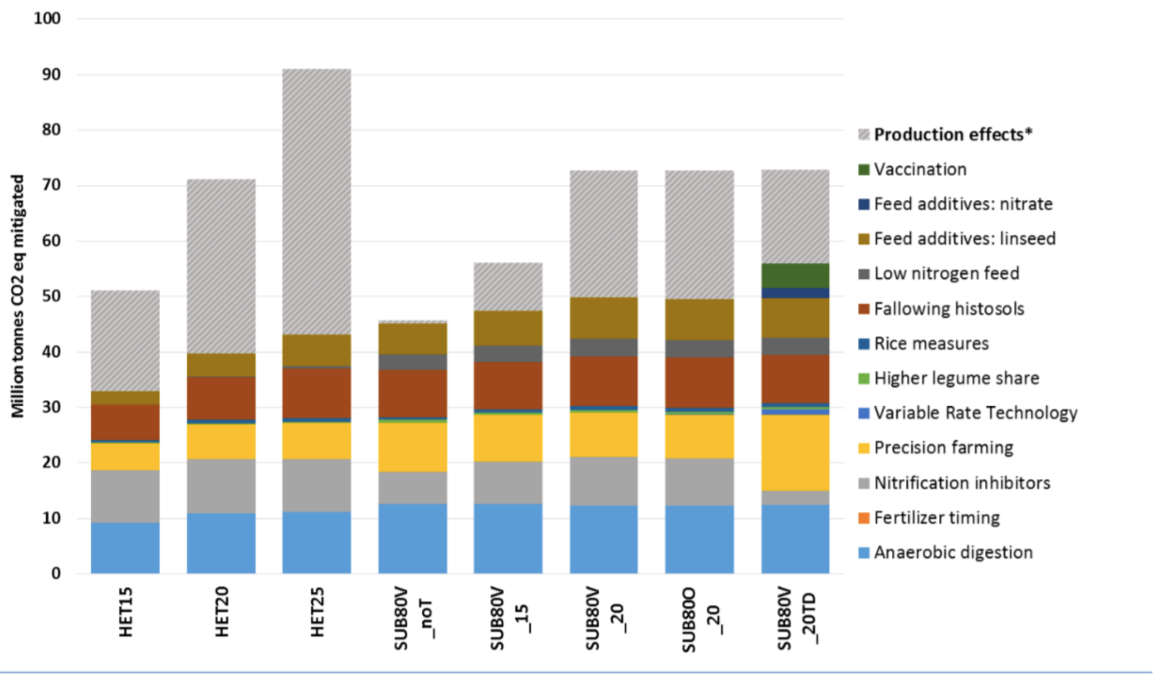
a. *Reducing GHG emissions: potential and boundaries*

Five potential contributions from the agricultural sector to mitigation of GHG emissions can be defined:

1. Reduce direct emissions through the use of mitigation technologies or appropriate farming practices (primarily reducing CH_4 and N_2O emissions from rice production, ruminants and nitrogen fertiliser application);
2. Provide a carbon sink through soil organic carbon (SOC) accumulation using appropriate agricultural soil management;
3. Sustainable production of biomass, including afforestation, for the bioeconomy, without hampering food security
4. Reduce the fossil fuel intensity of agricultural production (energy and agrochemicals)
5. Reduce agricultural production losses and waste.

The use of mitigation technologies and farming practices can help to reduce GHG emissions. In a recent study, JRC came to the conclusion that within a specific framework of assumptions and available mitigation measures, EU agriculture could reduce its non-CO_2 emissions by up to 50-55 million tonnes CO_2-equivalent per year (Ecampa, 2016), which represents 11% of its current emission levels, albeit at a relatively high average cost. According to the scenarios done with the GAINS model (EC, 2018), the mitigation potential in the agricultural sector would be around 90 million tonnes of CO_2-equivalent at a carbon price of 100 €/tonne by 2050.

Figure 6: Contribution of each technology or farming practice to total mitigation for a selection of scenarios (EU-28, 2030)

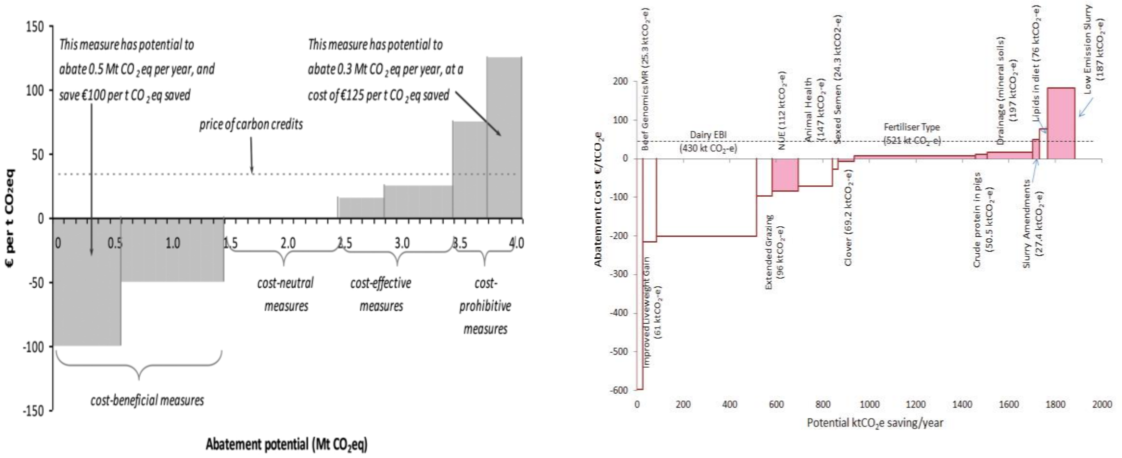


Source: Pérez Domínguez et al. (2016)

The investment or operational costs are very different between mitigation measures and depend among many factors on the characteristics of the farm production system. Many scientific studies use marginal abatement cost curves (MACCs) to represent the reduction potential of a selection of mitigation measures.

Although there are some criticisms on this representation because off limitations on 1) formulation and presentation of assumptions, 2) sectoral or spatial boundaries of the analysis, 3) representation of costs and non-financial barriers, 4) heterogeneity and uncertainty and 5) inclusion or exclusion of co-effects (Kesicki et al., 2011; Eory, 2018), a MACC remains a powerful visual tool to exchange information between scientists and policy makers. Many EU Member States have drawn up their specific MACCs for the agricultural sector or even for the whole economy, as shown in the example below.

Figure 7: Hypothetical marginal abatement cost curve (MACC) and the example of Ireland



Source: Lanigan et al., 2018

MACCs can feed the debate on which practices should be mandatory or receive an incentive, be it financial, through advice or other means. Anyway, there is scope to harvest low-hanging fruits for mitigation options having marginal abatement costs with negative or close to zero values. As can be seen on the ground, the uptake of certain options, like anaerobic digesters and precision farming, is ongoing and increasing over time. Certain mitigation options have clear co-benefits which are not always reflected in the MACC.

As an example, the reduction of fertiliser use, directly or indirectly by the implementation of variable rate technologies or nitrification inhibitors, decreases GHG emissions as well as the risk of nitrogen leaching into surface and ground water.

Although there is still a great deal of uncertainty about the mitigation potential, development of novel technologies and their actual costs and implementation in the field, a comprehensive meta-review of potential mitigation technologies was provided by RICARDO-AEA (2016).

An important conclusion was that there are a diverse range of actions that may be taken and that their impact is dependent upon regional and local conditions. For certain mitigation options better information is needed to determine the precise level of mitigation potential and the interaction with local conditions.

Agriculture and GHG reporting

In order to have a common set of principles for the reporting of GHG emissions at international level, the IPCC compiled guidelines on the national greenhouse gas inventories. The latest update was done in 2006 and a revision is expected in 2019.
Agriculture is defined as one of the sectors in this common reporting format. Within this framework, parties have the choice between three different approaches (referred to as Tiers), from simple emission factors per activity to process-based or advanced modelling. The basic formula is represented by:

$$Emission_{i,j} = A_j \ x \ EF_{i,j}$$

where:
Emission i,j = emissions of greenhouse gas i over source category j;
A_j = underlying activity data (hectares or number of animals)

The boundaries of the sector 'Agriculture' (=source category 3) according to IPCC do not always coincide with the definition used in other policy frameworks.

In the Common Monitoring and Evaluation Framework (CMEF) of the current CAP, GHG emissions from 'Agriculture' include as well land use changes attributed to cropland and grassland. On the other hand, efficiency gains in energy use by farms are, for example, accounted for in the 'Energy' sector even though they originate in the agricultural sector.

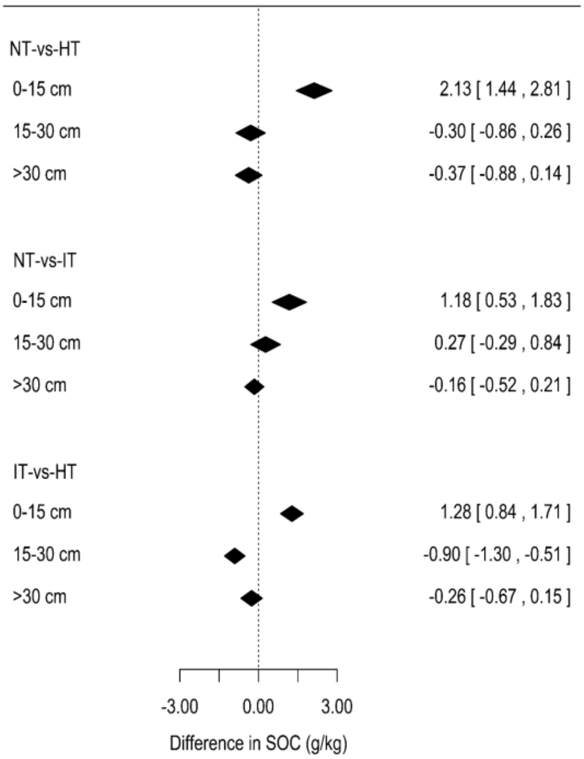
Other mitigation measures, such as low emission housing systems or feeding line seed, do not or only partly appear in any of the GHG inventories. Therefore, 'Agriculture' should be clearly defined and the monitoring or reporting of GHG emissions checked for gaps.

b. Soil organic carbon

Agricultural land in the EU contains around 51 billion tonnes of CO_2-equivalent in the topsoil as soil organic matter. This is a huge amount compared to the 4.4 billion tonnes of CO_2-equivalent emitted annually in EU Member States (2016), all sectors together. This means that releasing just a fraction of the carbon in agricultural soils to the atmosphere could easily wipe out any savings of greenhouse gas emissions made by other sectors.

The 2015 LUCAS survey shows that cropland exhibits much lower soil organic carbon concentrations compared to grasslands and natural vegetation (eg. 17.8, 40.3 and 77.5 g per kg, respectively). Around 75% of all EU croplands are below 2% of organic content. A large toolkit of best farming practices and applications is available to support the sequestration potential from the ground up (EIP, Landmark, Smartsoil, among others). For example, the adoption of cover crops can show benefits not only in terms of carbon accumulation but also by contributing to reduced soil erosion and hence related CO_2 emissions (Poeplau & Don, 2014). As shown in figure 9, tillage practices can have different impacts on the soil organic carbon content depending on the type of tillage and the soil depth.

Figure 9: Comparison of meta analyses of global data on soil tillage and SOC at different soil depths



NT: no tillage, IT: Intermediate tillage, HT: Intensive or conventional tillage

Source: Haddaway et al. (2017)

Yet, carbon sequestration shows two important limitations: carbon sequestration practices enhance carbon storage until they reach a new equilibrium in the soils after 20-100 years (saturation), while some practices are easily reversed and then lead to a loss of the sequestration benefits (non-permanence) (Smith, 2016; Frank, 2017).

Overall, it is important to maintain the carbon content in agricultural soils, as recognised already in the current Good Agricultural and Environmental Conditions (GAEC) standards of the Common Agricultural Policy (CAP). Moreover, increasing the soil organic carbon content has important positive co-benefits on the soil health (see Brief n°5) and on improving the farm's resilience to climate change (such as drought).

c. Use of biomass for *replacing fossil-based products and energy*

In 2013, 805 Mt in dry matter biomass was harvested and used in the EU for food and non-food, of which 578 Mt came from agriculture and 227 Mt from forestry (Camia et al., 2018). In addition, 119 Mt were grazed in pastures. At the same time, the bioeconomy can enhance Europe's self-reliance and the provision of jobs and business opportunities, especially in rural areas. In 2015, the bioeconomy sectors employed nearly one in ten EU workers or 18 million people, and generated EUR 2.3 trillion turnover. Biomass is increasingly viewed as the raw material for replacing fossil carbon in many applications (chemical, energy, pharmaceutical...). Therefore, agriculture and forestry have a key role to play in the new Bioeconomy Strategy for a sustainable Europe, launched in October 2018, in line with the 2030 Climate & Energy Framework. Agriculture can provide part of the renewable resources while at the same time ensuring food and nutrition security. Biomass production can be the main purpose (like for Myscanthus or forestry) or just a by-product (like crop residues or manure). Other production systems, like agro-forestry, consider biomass production as part of a broader multidimensional framework.

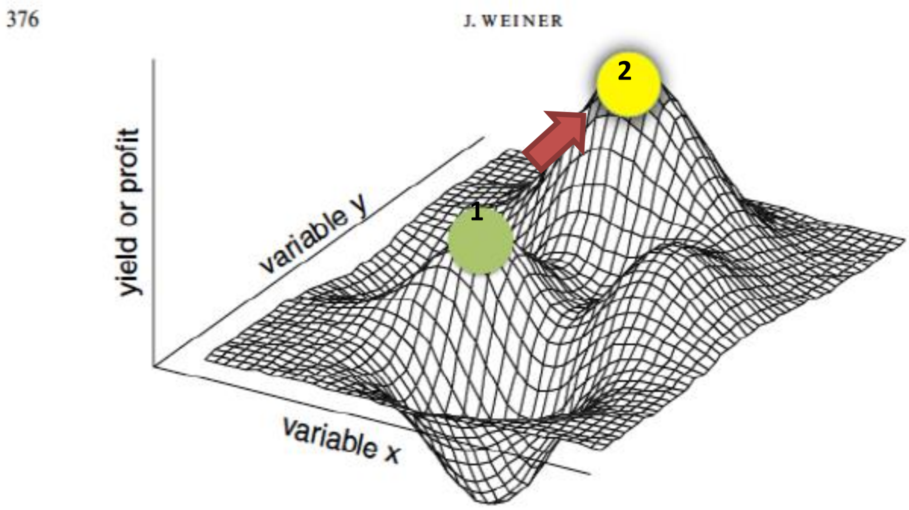
3. The challenges of implementation

a. Potential barriers to adoption of mitigation options

Adoption of GHG mitigation options is not guaranteed, even if it is profitable from an economic point of view. A wide range of literature exists on the potential "barriers" to adoption of new technologies and to changes in production systems (Wreford, 2017, Weiner 2003), ranging from bio-physical constraints to cognitive and behavioural barriers, through social and institutional factors. As EU agriculture is very divers, a first important step is to know the actual conditions on the ground and to adjust the climate measures to the local needs. Simple awareness raising might already help farmers to understand or to get a better knowledge of the issues at stake. Behavioural experiments might also help to get an inside in the farmer's logic and adjust the implementation rules if necessary.

Knowledge transfer and investments in proper advice are considered of utmost importance. The European Innovation Partnership for Agriculture (EIP-AGRI) is an example of a network that brings together actors with different types of knowledge (practical, scientific, technical, organisational, etc.), fostering sustainable agriculture and forestry.

Figure 10: Graphical representation of "barriers" to adoption or change



Source: Weiner J.,2003

b. Carbon leakage

Carbon leakage refers to the change of GHG emissions at global level that may occur if production activities shift to other countries with higher emissions per unit of production. The result is that the level of GHG emissions in the domestic country is reducing but the change at global level can be positive or negative depending on the efficiency of the production activity in terms of GHG. The IPCC uses a ratio to define carbon leakage as: "The increase in CO_2 emissions outside the countries taking domestic mitigation action divided by the reduction in the emissions of these countries."

The results of the ECAMPA study confirmed that there is a risk of carbon leakage when the GHG emission reduction in the EU comes from a reduction in EU agricultural production.

If the production efficiency of a particular commodity in the EU is higher in terms of GHG and there is no change in domestic consumption, GHG emissions at global level can increase because EU production is simply replaced by imports of less efficient production outside the EU.

This effect is not only applicable to the agricultural sector but to all sectors of the economy. Therefore, careful design of the exact implementation of the policy is needed.

c. Carbon efficiency and environment

Global demand for agricultural commodities (food, feed, biomass) will continue to increase over the next decades (OECD, 2018). Therefore, global agricultural production will need to increase, while at the same time keeping emissions under control. As agricultural production is a biological process, a full elimination of CO_2-emissions is not possible with the current and neither with foreseen technology and management practices. One of the EU strategies is the improvement of the carbon efficiency of its production systems. For example, the use of fossil energy and fossil carbon based products could be reduced significantly and the carbon footprint diminished as a result. Also from the output side, productivity increases per animal or per unit of land in a sustainable way could be envisaged. Since productivity increases might lead to an intensification of agriculture, the potential negative environmental impact and trade-offs should be carefully considered.

Fertiliser use

Greenhouse gas emissions from fertiliser use are one of the main sources of non-CO_2 emissions in agriculture and should therefore be one of the priorities in GHG reduction. Some examples of management practices (non-exhaustive) to reduce the emissions from nitrogen fertiliser use are listed below.

Thanks to ***precision farming****, the application of fertiliser can be adjusted in such a way as to match the need of the crops almost perfectly in space and in time. Quantity and quality of the fertiliser can be aligned to the phenology of the plant, input and output flows of minerals, and administered at the right moment, spot and depth. In that way, the amount of fertiliser can be reduced while at the same time, avoiding leaching and runoff of non-absorbed minerals.*

Nitrogen fixing plants *included in the crop rotation or production system (grass mixes) are a biological replacement of nitrogen fertiliser by using atmospheric nitrogen (N_2) as a source and making it available to the plant. Environmental co-benefits include reduced nitrate leaching, increased food sources for pollinators, greater structural diversity of farmland and improved soil fertility (RICARDO-AEA, 2016)*

For more information

https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/future-cap_en#objectives

https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/env_background_final_en.pdf

https://ec.europa.eu/agriculture/statistics/factsheets_en

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