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The Green Deal and the CAP: policy implications to adapt farming practices and to preserve the EU's natural resources

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The Green Deal and the CAP: policy implications to adapt farming practices and to preserve the EU's natural resources

Abstract

This document is the final report of the study developed by INRAE and AgroParisTech for the European Parliament: "The Green Deal and the CAP: policy implications to adapt farming practices and to preserve the EU's natural resources'' (IP/B/AGRI/IC/2020-036).

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AUTHOR(S)

INRAE and AgroParisTech; Hervé GUYOMARD, Jean-Christophe BUREAU, Vincent CHATELLIER, Cécile DETANG-DESSENDRE, Pierre DUPRAZ, Florence JACQUET, Xavier REBOUD, Vincent REQUILLART, Louis-Georges SOLER, Margot TYSEBAERT

Research manager: Albert MASSOT
Project and publication assistance: Catherine MORVAN
Policy Department for Structural and Cohesion Policies, European Parliament

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ABOUT THE PUBLISHER

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CONTENTS

LIST OF ABBREVIATIONS

AECM	Agri-environmental and climatic measures
AKIS	Agricultural Knowledge and Information System
AWU	Average Work Unit
CAP	Common Agricultural Policy
COP	Cereals, Oilseeds and Protein crops
DASH	Dietary Approaches to Stop Hypertension
EAFRD	European Agricultural Fund for Rural Development.
EAGF	European Agricultural Guarantee Fund
EC	European Commission
ECA	European Court of Auditors
EEA	European Environment Agency
EFA	Ecological Focus Area
EIP	European Innovation Partnership
ELO	European Landowners Organization
EMA	European Medicines Agency
EP	European Parliament
ETS	Emissions Trading Scheme
EU	European Union
FADN	Farm Accounting Data Network
FAO	Food and Agriculture Organization (of the United Nations)
F2FS	Farm to Fork Strategy
GAEC	Good Agricultural and Environmental Condition(s)
GDP	Gross Domestic Product

GHG	GreenHouse Gas
HRI	Harmonized Risk Indicator
IEEP	Institute for European Environmental Policy
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IPM	Integrated Pest Management
LU	Livestock Unit
LULUCF	Land Use, Land-Use Change and Forestry
MEP	Member of the European Parliament
MFF	Multiannual Financial Framework
MFN	Most Favoured Nation
MS	Member State
MT	Million tonnes
NDM	New Delivery Model
NGEU	Next Generation EU (recovery plan)
NGO	Non-Governmental Organization
NSP	National Strategic Plan
OECD	Organization for Economic Co-operation and Development
PCU	Population Correction Unit
PES	Payment for Environmental Services
PGP	Provider-Gets Principle
PPP	Polluter-Pays Principle
SDG	Sustainable Development Goal

SMR	Statutory Management Requirement
SWOT	Strenghts, Weaknesses, Opportunities and Threats
TFEU	Treaty on the Functioning of the European Union
UAA	Utilized Agricultural Area
VAT	Value Added Tax
WTO	World Trade Organization
WTP	Willingness To Pay

LIST OF BOXES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

KEY FINDINGS

- EU agriculture and food practices are currently not on the right track to meet the Green Deal ambition, objectives and quantitative targets related to climate, environment, nutrition and health issues in that sector.
- To reverse these unfavourable trends, there is an urgent need to significantly strengthen many technical provisions of the CAP; in particular those related to conditionality requirements and eco-scheme measures, and those to improve the CAP governance, notably by making the attainment of targets legally binding and improving their enforcement, reporting and monitoring.
- It is also crucial to complete the CAP regulations by means of a global and consistent food policy, including interventions focusing on food diets.

The European Union (EU) Green Deal, notably the Farm to Fork Strategy (F2FS), the EU biodiversity strategy for 2030, plus its climate component, could substantially affect European agriculture and food. Its objectives are materialized into quantitative targets related to climate, environment and health issues for agriculture, with substantial reductions in the use of pesticides, fertilizers and antibiotics, and large increases in agricultural land under organic farming, high-diversity landscape features and protected land areas. Objectives go far beyond the farm gate by adopting a whole food chain approach, generalizing the application of circular bio-economy principles, reducing food waste and losses, and encouraging a shift towards healthy and environmentally friendly food diets (though without setting quantitative targets).

EU agriculture is not on the right track to meet the Green Deal targets

Current trends show that reaching Green Deal agricultural targets will not be an easy task. EU agricultural greenhouse gas (GHG) emissions were reducing up until the 2010s and have slightly increased since. Significant changes in farming practices and systems are now required to achieve further substantial reductions, including a reduction in the use of nitrogen fertilization and in the number of animals farmed. Biodiversity erosion occurs due to increasingly specialised and simplified agricultural systems and rural landscapes, using larger plots of land and the widespread application of chemical inputs. Soil degradation and nutrient flows - notably nitrogen - in water and the atmosphere have reached alarming levels. With the possible exception of phosphorus and antibiotics, past trends show that it will be extremely difficult to achieve the climatic and environmental targets of the Green Deal without substantial inflexion of the Common Agricultural Policy (CAP).

In addition, a large proportion of the European population does not comply with dietary recommendations that are consistent with Green Deal nutrition and health objectives. Current trends show no change in the unrelenting increase in excess weight, obesity and related diseases. Considerably more ambitious policies are needed in this area. In addition, changes in food diets could also contribute to the reduction of GHG emissions.

A policy mix for the whole food chain is needed

To achieve the Green Deal objectives, three sets of coordinated actions must be implemented.

First, it is imperative to reduce all current inefficiencies that lead to the excessive use of water, fertilizers, pesticides and antibiotics. Innovations and incentives in that domain would benefit both the environment and farm incomes. However, reducing inefficiency alone is not enough to match the high level of ambition of the Green Deal objectives and targets.

A second set of technical and policy actions must favour the redesign of farming systems, to rely more on biological cycles and less on external chemical inputs. Such agro-ecological systems could significantly reduce the ecological footprint of agriculture. However, they could also have negative impacts on agricultural producers' incomes; the scope of which will depend on consumers' willingness to pay for higher quality products. In addition, GHG emissions would be reduced when calculated per unit of area but, in most cases, not per unit of product. The redesign of farming systems requires public support and assertive policies in order to create the right incentives for producers.

A third set of actions should target changes in dietary patterns for health, climate and environmental reasons. The higher cost of lower caloric and more balanced diets is a potential obstacle, especially for low-income households. The food and retail industries must therefore facilitate a shift towards emphasising more desirable eating patterns, by way of product reformulation, responsible marketing and advertising limitations. Public policies that increase consumers' awareness of the health, climatic and environmental impacts of food choices, as well as the modulation of consumption prices, are required in order for consumers to adopt healthier and more plant-based diets.

The CAP in this framework

Making the post-2020 CAP compatible with the Green Deal objectives requires major changes to the Commission's June 2018 proposals for this policy. While some Member States and Members of the European Parliament (MEP) wish to alleviate the climatic and environmental ambition of the future CAP, we conclude - on the contrary - that the Green Deal must make the initial proposals of the Commission considerably more stringent in these areas. Provisions that are crucial include conditionality requirements, plus targets, instruments and budgets of both the eco-schemes in Pillar 1 and climate- and environment-related interventions in Pillar 2.

General principles of public economics and fiscal federalism help to clarify the goals and roles of the various CAP tools. First, it is vital to more effectively apply the "*polluter-pays principle*", upon which conditionality relies, in order to better justify the increased implementation of the "*provider-gets principle*" that underlines both the eco-schemes and climate- and environment-related measures. Second, the Pillar 1 eco-scheme measures that are fully financed by the European budget must target global public goods; that is, climate mitigation, biodiversity preservation and restoration, as well as animal welfare. Third, the eco-schemes must be supplemented by Pillar 2 measures that are focused on local public goods; notably, water quantity and quality, soil fertility and diversified landscapes.

The current conditionality criteria should not be weakened, and exemptions must end in order to increase the environmental efficiency of the CAP and to close loopholes. Provisions of new Good and Agri-Environmental Conditions (GAEC) to replace the greening criteria of the current CAP must reflect the same level of climatic and environmental ambition at the very least and should be gradually increased over time. Both GAEC #2 on the protection of wetlands and peatlands and GAEC #9 related to high-diversity landscape features must be made more binding. New GAEC should be introduced to increase agricultural producers' awareness of the flow of the nutrients, molecules and GHG emissions they generate, and to provide a benchmark for payments under associated eco-scheme measures. Such payments would remunerate farmers for their efforts that go beyond conditionality requirements and would increase proportionally with their efforts and non-market benefits. Consistent with this, two new ring-fenced budgets would be introduced in Pillar 1, with 15% of spending reserved for climate

mitigation actions and 15% for measures targeting biodiversity. In addition, 35% of Pillar 2 expenditure should focus on environmental interventions.

We point out several unresolved issues for making CAP National Strategic Plans (NSP) more consistent with the Green Deal roadmap. The main issues concerning the Green Deal targets are: first, their legal status must be clarified; second, the ways in which they are calculated are not detailed enough and should be more precisely defined; third, the methods used to define the corresponding national targets are unknown. They also concern the CAP. The performance indicators currently proposed do not make it possible to monitor progress made towards the targets. More generally, the CAP does not allow progress to be sufficiently enforced, reported and monitored, nor does it impose an effective corrective action plan if progress does not occur.

Challenges

Sound impact assessments of any policy option are crucial in order to identify possible trade-offs between different climatic and environmental objectives. The land issue requires particular attention: the de-intensification of farming practices and systems implicitly included in the Green Deal could require more agricultural land, both in the EU and further abroad, with possible adverse ecological consequences (*"pollution leakages"*). A second possible trade-off to be addressed concerns ecological and economic impacts. We provide some orders of magnitude on overall economic consequences, but more detailed analyses are required to account for market feedback through price changes. If made binding, several Green Deal targets could significantly impact farm incomes. Consumers may also be affected by higher food prices. However, much will depend on trade policy and changes in eating patterns.

The June 2018 draft regulations for the next CAP are only marginally consistent with the climate, environment, health and nutrition ambitions of the Green Deal. This is also the case of the distinct regulation revisions being adopted by either the Council of Agricultural Ministers on 21 October 2020 or the European Parliament on 23 October 2020. Climate and biodiversity issues are insufficiently covered by either of these proposals. Indeed, nutrition issues are barely covered at all. Making EU agriculture consistent with the Green Deal ambition is possible but would require a whole food chain policy that encompasses more stringent instruments on the supply side and extensive changes in eating patterns. In other words, the climatic and environmental dimension of the CAP must be strengthened, and the CAP itself must be extended in the framework of a more focused and global food policy. Combined with efficiency gains at the farm and food chain levels, and the re-design of production systems, dietary changes at the consumer level may put the European food system on the right track to reach the Green Deal ambition.

1. INTRODUCTION[1]

The Communication on the European Green Deal, published by the European Commission (EC) on 11 December 2019, aims to make the European Union (EU) "*the world's first climate-neutral continent by 2050*" (EC, 2019a). The Green Deal goes beyond climatic issues only, by considering all environmental dimensions and proposing a new sustainable growth for the EU. To that end, the Green Deal defines a roadmap under the form of 10 key actions, detailed within different strategies. Within this framework, the "Farm to Fork Strategy" (F2FS), published by the EC in Spring 2020 (EC, 2020c), is, according to the European Parliament (EP), "*an opportunity to refresh farming policies, as well as to strengthen their contribution to achieve a fair, healthy and environmentally friendly agri-food system*" (EP, 2020a).

This new policy direction takes place in a context where a new Common Agricultural Policy (CAP) is once more on the agenda. The EC presented its legislative proposals for the future CAP on 1 June 2018. It was expected to come into force on 1 January 2021. This will not be the case, and the current CAP will be extended for at least two transitional years. Since June 2018, the initial proposals of the EC have been extensively discussed, notably within the framework of the Council and the EP. On 21 October 2020, the Council of European Agricultural Ministers adopted, by a qualified majority, the revised versions of three daft regulations for the future CAP. Two days later, on 23 October 2020, the EP did the same, but on distinct texts. These votes pave the way for trilogue negotiations to begin between the EC, the Council and the EP. The result of these negotiations is uncertain concerning, for example, the ring-fenced budget that will finally be allocated to climatic and environmental interventions within the first pillar of the CAP. However, there is no questioning the two main novelties of the initial EC proposals; that is, a new green architecture, including a new climatic and environmental tool in the first pillar (the so-called eco-schemes) and a New Delivery Model (NDM) for the CAP, through the definition of national strategic plans (NSP) giving Member States (MS) a wider measure of discretion to cope with national specificities.

The primary aim of this study is to provide an analysis of the potential consequences of the Green Deal and its associated strategies, notably the F2FS, the EU Biodiversity Strategy for 2030 and the climate texts, for European agriculture and food. In a second step, we make recommendations aimed at strengthening the role that the future CAP - and other policies - could have in efficiently and effectively contributing to the Green Deal and its strategies. Commissioned by the EP, the study was carried out by INRAE and AgroParisTech under contract N° IP/B/AGRI/IC/2020-036.

Starting from an in-depth and critical analysis of the Green Deal roadmap, we analyse to what extent the Green Deal, and its implementation in several strategies, could affect agriculture and food in the EU. We then review technical and behavioural changes in agri-food systems that would be required to achieve the Green Deal ambition, objectives and targets. This review is complemented by a parallel analysis aimed at defining how the agricultural policy, as well as other European or national policies, could contribute to the Green Deal ambition related to agriculture and food. Using that analysis, we propose policy recommendations, which lead us to highlight both the opportunities and deficiencies of the legislative proposals for the future CAP currently on the table.

Methodology

To carry out the study, different approaches have been used: specifically, an in-depth analysis of an extremely large body of documentation (official texts, academic papers, think tank reports, etc.), statistical data and simulation results, as well as expert consultations.

[1] The authors warmly thank S. Crompton Meade for her careful proofreading of the English. They also thank A. Massot Marti and F. Nègre from the European Parliament for their support and advices.

The analysis of the abundant documentation provided by the EC, for both the Green Deal and the CAP, is supplemented by means of an extensive reading of presentations given by the EC on various occasions. It is also supported by an analysis of institutional and stakeholders' reactions, statements or reports from the EP, national authorities, farmers' organizations or non-governmental organizations, etc., and a review of the growing academic literature on the future of the CAP.

Quantitative elements are provided to illustrate the potential impacts of existing and desirable policy options. Attention is focused on climatic and environmental outcomes, as well as on economic indicators.

Three expert panels were mobilized. The technical panel gathered academic experts specialising in the relevant technical and biological sciences (agronomy, livestock sciences, plant and animal genetics, plant and animal health, ecology and environment sciences, food and nutrition sciences). These experts assisted in assessing the efficiency and potential impacts of solutions (changes in practices and systems, innovations, behaviours) that could be implemented in order to achieve the Green Deal roadmap (one virtual meeting). The panel of European experts that specialised in public economics challenged our findings of the Green Deal, as well as our policy recommendations (two virtual meetings). Finally, the third panel composed of European stakeholders was also consulted twice, on the same basis as the public policy panel (two virtual meetings). ***Annex A.1.1*** provides the composition of the three panels, as well as synthetic reports of the five meetings.

Report outline

Chapter 2 presents the Green Deal roadmap, the main initiatives related to agriculture and food, the budgetary issues and the stakeholders' reactions.

Chapter 3 highlights the size of the Green Deal challenges for agriculture and food in the EU. Notably, it analyses to what extent the trending prolongation of the past evolutions of key indicators (pesticides, fertilizers, antibiotics, organic farming, protected areas, habitats, species, overweight and obesity rates) would allow (or not) the corresponding Green Deal objectives to be achieved, as set out for 2030.

Chapter 4 addresses changes in agricultural and food systems that would be required to achieve the Green Deal objectives related to agriculture and food, focusing on technical solutions and behavioural changes, with special attention to synergies and trade-offs between the different objectives that must be considered together. Chapter 4 also proposes a theoretical analysis of policy tools that should be used to help achieve these objectives. For both solutions and policies, the analysis is based on a reading key that distinguishes the actions aimed at increasing efficiency (E), redesigning systems (R) and playing not only on the supply side but also on the demand side (D).

From this analysis, ***Chapter 5*** - the essence of the study - analyses how the future CAP could support the Green Deal ambition. Within the general framework of public economics and fiscal federalism, we make recommendations to strengthen the three instruments of the green architecture of the future CAP; that is, conditionality, eco-schemes in Pillar 1, and climatic and environmental schemes in Pillar 2. We also address potential trade-offs on issues related to food security in the EU, land uses and land-use changes, and economic consequences.

Chapter 6 concludes.

2. AGRICULTURE AND FOOD IN THE GREEN DEAL

KEY FINDINGS

- The Green Deal launched in December 2019 "*resets the Commission's commitment to tackling climate and environment-related challenges that is this generation's defining task*." The main ambition is that the EU becomes climate neutral by 2050. The Green Deal pursues other environmental and health objectives that are equally important for a sustainable future.
- The EC Green Deal proposal is comprehensive and ambitious. It defines a roadmap in the form of 10 key actions outlined in various strategies. Some of them, notably the EU Biodiversity Strategy for 2030, the F2FS and the various climate texts, could affect European agriculture and food in a significant way.
- Indeed, the Green Deal sets objectives, accompanied by quantitative targets for numerous items related to agriculture and food, for reductions in the use of pesticides, fertilizers and antibiotics, and for increases in agricultural land under organic farming, agricultural land under high-diversity landscape features and protected land areas.
- For agriculture and food, initiatives go beyond the farm gate - and therefore beyond the CAP - by explicitly adopting a whole food chain perspective, requiring the application of circular bio-economy principles, reducing food waste and losses along the food chain to be generalized, with a shift towards healthier and more sustainable food diets.
- The Green Deal initiatives will require European (and national) policies to be adapted, starting with the CAP, which is still under debate more than two years after the launching of the proposals for the future CAP by the EC in June 2018.
- This is in a context in which there is still uncertainty about the Multiannual Financial Framework for the period 2021-2027 and the "Next Generation European Union" Recovery Plan initiated within the framework of the Covid-19 global crisis.

This chapter presents the various Green Deal initiatives set out by the EC that are related to the European agricultural and food sectors and that may have impacts on the latter. This includes, notably, several communications on the climate, the "EU Biodiversity Strategy for 2030", the "Farm to Fork Strategy" and the "EU Bio-economy Strategy". A synthetic presentation of the Green Deal roadmap and its key actions related to agriculture and food is also provided. Links to the ongoing decisions on the EU budget and the "Next Generation European Union" Recovery Plan following the Covid-19 global crisis are described, and the positions of stakeholders regarding the EU initiative as a whole are presented.

2.1. The Green Deal in a nutshell

The European Green Deal "*resets the Commission's commitment to tackling climate and environmental-related challenges that is this generation's defining task*" (EC, 2019a). In order to "*transform the UE's economy for a sustainable future*", the EC has defined a roadmap in the form of 10 key actions. It includes a set of ambitious targets and a number of proposals that are likely to have consequences for the EU's agricultural and food sectors. Some require major changes to the proposed provisions for the post-2020 CAP.

The Commission's communication on the Green Deal draws a specific framework for the agricultural sector (EC, 2019a) detailed in the F2FS released by the EC on 20 May 2020 (EC, 2020c). However, several other components of the Green Deal may also impact the European agricultural and food sectors. This is particularly the case for the Climate Ambition Plan (EC, 2020a), the EU Biodiversity Strategy for 2030 (EC, 2020b), the Circular Economy Action Plan (EC, 2020d), the future measures aimed at supporting deforestation-free value chains, and the next Zero Pollution Action Plan for water, air and soil. All of these initiatives may require some degree of change in the agricultural sector, the food industry and other bio-based industries.

2.1.1. Climate policy in the Green Deal

By 2050, the EU aims to become climate neutral, an objective that had been endorsed by both the EP through its resolution of 14 March 2019 on climate change (EP, 2019) and the Council through its conclusions of 12 December 2019 (European Council, 2019). The Green Deal assigns ***climate neutrality for 2050*** as a goal of utmost importance through its first key action aimed at "*increasing the EU's climate ambition for 2030 and 2050*" (EC, 2019a). The climate action initiatives under the Green Deal include the European Climate Law designed "*to enshrine the 2050 climate-neutrality objective into EU law*" (EC, 2020a) and the European Climate Pact that aims "*to engage citizens and all parts of society in climate action*".[2]

The ***Climate Law proposal*** writes into law the goal for Europe's economy and society to become climate neutral by 2050 (EC, 2020a). The proposed law commits to: balance emissions and the removal of all greenhouse gases (GHG) - not only CO_2 - in line with the Paris Agreement; define a trajectory for GHG emission reductions with a detailed time frame and a succession of progress assessments; and to define an Adaptation Strategy in addition to mitigation efforts. In September 2020, EC President von der Leyen indicated that the proposed target was to achieve "at least" a 55% reduction of GHG emissions by 2030, compared to the 1990 benchmark (a figure that the EP may raise). The EC proposal for a ***Climate Target Plan***[3] encompasses a broader "European Trading Scheme" (ETS), with new sectors included.[4] It also includes a revision of the legislation on effort sharing, which establishes binding annual GHG emission targets for MS for the period 2021-2030 for sectors not included in the ETS; that is, non-ETS sectors, such as transport, buildings, agriculture and waste.

The ***European Climate Pact*** should be launched at the end of 2020. It intends to encourage a broad societal engagement, by informing stakeholders and fostering cooperation. The ***EU strategy on adaptation to climate change*** is to be defined in 2021. The main objective is to ensure that businesses, cities and citizens are able to integrate climate change into their risk management practices. The agricultural sector could potentially play a significant role in this adaptation.

On 16 September 2020, in her "State of the European Union" address (EC, 2020h), in addition to proposing a target of at least 55% for the reduction in total GHG emissions, President von der Leyen underlined that the EC would revise all of the climate and energy legislation to make it "fit for 55" during the first half of 2021. This should include emission trading, renewable energy, energy efficiency and energy taxation.

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2 *https://ec.europa.eu/clima/policies/eu-climate-action/pact_en.*

3 Released on 17 September 2020: *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0562.*

4 So far, the ETS limits emissions from power stations and industrial plants; that is, roughly 11,000 heavy energy-using installations across the EU, and airlines operating between these countries. The EC estimates that it covers around 45% of European GHG emissions.

2.1.2. The EU Biodiversity Strategy for 2030

The ***EU Biodiversity Strategy for 2030*** of "*bringing nature back into our lives*" acknowledges the extent of biodiversity loss and ecosystem collapse, and the costs of inaction. It follows harsh criticisms from the European Court of Auditors (ECA) regarding the limited results of the former actions in favour of biodiversity in the EU (ECA, 2020a, b and c). The main commitments of the EU included in this new strategy for biodiversity are to:

- Legally protect a minimum of 30% of the EU land area and 30% of the EU sea areas, and integrate ecological corridors as part of a true "Trans-European Nature Network";
- Strictly protect at least one-third of the EU's protected areas, including all remaining EU primary and old growth forests;
- Effectively manage all protected areas, by defining clear conservation objectives and measures, and monitoring them appropriately;
- Define legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment: by 2030, significant areas of degraded and rich-carbon ecosystems should be restored; habitats and species should show no deterioration in conservation trends and status; and at least 30% should reach favourable conservation status or at least show a positive trend;
- Reverse the decline in pollinators;
- Reduce the use and risk of chemical pesticides by 50% in 2030, as well as the use of more hazardous pesticides by 50% in 2030;
- Dedicate at least 10% of agricultural area to high-diversity landscape features;
- Devote at least 25% of agricultural land under organic farming management by 2030, and significantly increase the uptake of agro-ecological practices; and
- Diminish the loss of nutrients from fertilizers by 50% in 2030, resulting in the reduction of the overall use of fertilizers by at least 20%.

Other provisions focus on tree planting, contaminated soil sites, rivers, invasive species, urban infrastructures and extractive industries.[5] The Common Fisheries Policy is also mentioned, with the goal of developing more sustainable fishing techniques, rebuilding stocks and ending overfishing. It also plans to implement sustainable sea and freshwater aquaculture. The new "EU Forest Strategy", to be released at the beginning of 2021, must also be mentioned as part of the action plan for biodiversity.

2.1.3. The Farm to Fork Strategy

The ***Farm to Fork Strategy*** (F2FS) is the second strategy of particular importance for agriculture and food (EC, 2020c). It stresses that a long-term vision is required for the transition of the European agricultural and food system for it to be in line with the global objectives of the Green Deal; that is, climate neutrality, restoration of natural resources and biodiversity, food security and human health. The F2FS defines six objectives for agriculture and food, along with specific quantitative targets. Some

[5] More specifically, other provisions include: three billion new trees to be planted in the EU, in full respect of ecological principles; remediation of contaminated soil sites; at least 25,000 km of free-flowing rivers to be restored; a 50% reduction in the number of species of the Red List threatened by invasive alien species; cities with at least 20,000 inhabitants to have an ambitious Urban Greening Plan; no chemical pesticides to be used in sensitive areas such as EU urban green areas; the negative impacts on sensitive species and habitats, including on the seabed through fishing and extraction activities, to be substantially reduced to achieve good environmental status; and the by-catch of species to be eliminated or reduced to a level that allows species' recovery and conservation.

of these targets are also included in other items of the Green Deal; for example, land-use GHG emissions in the Climate Law or the reduction in the use of pesticides and nutrients and the increase in agricultural land under organic farming in the EU Biodiversity Strategy for 2030. More specifically, the F2FS aims to:

- "*Ensure sustainable food production*";
- "*Ensure food security*";
- "*Stimulate sustainable food processing, retail, hospitality and food services' practices*";
- "*Promote sustainable food consumption, and facilitate the shift towards healthy, sustainable diets*";
- "*Reduce food loss and waste*"; and
- "*Combat food fraud along the food chain*".

The transition to a more sustainable agricultural and food system must be of concern for all operators in the food value chain. Farmers are essential in the process of managing transition, and the NSP of the future CAP must reflect the ambitions of the F2FS, notably by supporting sustainable agricultural practices. Circular economic principles must be developed. Finally, sustainable food consumption is to be supported.

The F2FS highlights some tools that could favour the transition, such as research and innovation, investment and finance, the multi-level involvement of stakeholders for inclusive and transparent processes, advisory services and an efficient monitoring process.

2.1.4. Other items of the Green Deal of particular interest for agriculture and food

Several items of the Green Deal communication refer to the ***bio-economy,*** in particular through two key actions aimed at "*supplying clean, affordable and secure energy*" and "*mobilising industry for [a] clean and circular economy*" (EC, 2019a). They target agricultural biomass as a valuable source of renewable energy, as well as a carbon neutral source of inputs for biochemical and biomaterials. This involves revisions of the Renewable Economy Directive and the Energy Efficiency Directive.

One of the blocks of the Green Deal agenda for sustainable growth is the new ***Circular Economy Action Plan***, which is part of the Industrial Strategy for a Clean and Circular Economy (EC, 2020d). This action plan includes initiatives for the entire life cycle of products, promoting circular economy processes and fostering sustainable consumption. Applying circular economy principles under the Circular Economy Action Plan converges with the F2FS goal of achieving sustainable food systems (Council of the European Union, 2019). Items explicitly related to a circular economy in the food sector are essentially targeted under the fifth objective of the F2FS aimed at "*reducing food loss and waste*" (EC, 2020c). More general proposals are included in the Industrial Strategy for the reduction of waste at retail and consumer levels to be halved by 2030, plus more environmentally friendly packaging.

On the ***trade issue***, the Green Deal includes the possibility of a carbon border adjustment mechanism for selected sectors. It also proposes the development of international cooperation and actions in order to promote more sustainable production in partner countries.

On 18 December 2019, political agreement was reached between the European Council and the EP regarding the creation of a "green list", better known as ***EU Taxonomy***. The latter is an EU-wide classification system for sustainable economic activities. This agreement provides a basis from which to direct loans and capital flows towards sustainable investment and to help avoid greenwashing. It includes six environmental objectives that are closely related to the Green Deal objectives, and four requirements for economic activities to be considered as environmentally sustainable. The EC considers that "*thanks to this green list, or taxonomy, investors and industry will for the first time have a*

definition of what is "green", which will give a real boost to sustainable investments. That will be crucial for the European Green Deal to become a reality" (EC, 2019b).[6] Some of the provisions will start applying as of 31 December 2021; others a year later.

2.2. Main elements of the Green Deal related to agriculture and food

2.2.1. A review of Green Deal initiatives with potential impacts on agriculture and food

The Green Deal is clearly extremely ambitious and widely scoped. It contains provisions for a transition to more sustainable agricultural and food systems, which will concern all operators in the food value chain. Farmers will have to reduce fertilizer, pesticide and antibiotic use, for example. The food industry will have to develop circular economic principles, and more generally, a more sustainable food consumption model will need to be promoted.

Table 2.1 lists those items in the key action roadmap of the Green Deal that are most likely to impact the agriculture and food sector. It shows that the issues at stake for the sector are not limited to the F2FS. Proposals related to the EU Biodiversity Strategy for 2030 are likely to have considerable consequences for the agricultural sector. Proposals related to climate objectives could also impact farm systems, but they could likewise provide opportunities through carbon storage and energy provision. More generally, all items ticked in the left-hand column in Table 2.1 will have to be considered when designing agricultural and food policy instruments.

More generally, this synthetic table raises ***two sets of issues***:

- First, the ambitious objectives of the Green Deal must be developed in line with what is proposed in the various communications and documents of the EC, specifically for agriculture and food. Hence, the first set of questions concerns the ***overall consistency of the various components of the Green Deal proposal.***
- Second is a set of questions as to how aspects of the Green Deal would most likely impact agriculture and food, consistent with the proposals currently under discussion for the future CAP. Hence, there is a strong ***need to tackle the Green Deal proposals in relation to proposals for the future CAP.*** There is a need to assess how NSP and the various climatic and environmental instruments of the CAP (conditionality requirements, eco-schemes in Pillar 1, climate- and environment-related interventions in Pillar 2) should be designed to reflect the Green Deal ambition related to climate and environmental objectives (EC, 2020i; Massot Marti, 2020).

Table 2.1: Items with significant potential impacts for agriculture and food in the Green Deal roadmap

Items of the key action roadmap	Potential importance for agricultural and food policy	
Climate ambition		
Proposal on a European "Climate Law" enshrining the 2050 climate neutrality objective (March 2020)	Implications for agricultural GHG emissions (notably methane and nitrous oxide).	++
Comprehensive plan to increase the EU 2030 climate target to at least 50% and towards 55% in a responsible way (Summer 2020)		++

[6] Citation of Commission's Vice-President Dombrovskis.

Stepping up EU 2030 climate ambition Investing in a climate neutral future (September 2020)	Reducing non-CO_2 emissions (mainly methane and nitrous oxide) by 35% between 2015 and 2030. Reversing and halting the downward trend of the Land Use, Land-Use Change and Forestry (LULUCF) carbon sink.	+++
Proposals for revisions of relevant legislative measures to deliver on the increased climate ambition, following the review of Emissions Trading System Directive, Effort Sharing Regulation; Land Use, Land-Use Change and Forestry Regulation; Energy Efficiency Directive; Renewable Energy Directive; CO_2 emissions performance standards for cars and vans (June 2021)	LULUCF regulation should impact land use policies, with effects on agricultural land use. Renewable Energy Directive is key to the EU production of biofuels from agricultural products.	++
Proposal for a revision of the Energy Taxation Directive (June 2021)		
Proposal for a carbon border adjustment mechanism for selected sectors (2021)	Could potentially reduce competition distortions for agriculture and food.	+
New EU Strategy on Adaptation to Climate Change (2020/2021)	Could potentially affect CAP measures aimed at favouring farmers' adaptation to climate change. Could also potentially impact food policy measures aimed at reducing the carbon footprint of food diets.	+
Clean, affordable and secure energy		
Assessment of the final National Energy and Climate Plans (June 2020)		
Strategy for Smart Sector Integration (2020)	Agriculture could play a role in reducing the carbon content of material in other activity sectors.	+
"Renovation wave" initiative for the building sector (2020)		
Evaluation and review of the Trans-European Network – Energy Regulation (2020)		
Strategy on Off-Shore Wind (2020)		
Industrial strategy for a clean and circular economy		
EU Industrial Strategy (March 2020)	Food production is quoted as a source of water stress and biodiversity loss and, as a result, potentially targeted.	+
Circular Economy Action Plan, including a sustainable products' initiative and particular focus on resource intense sectors such as textiles, construction, electronics and plastics (March 2020)	Agriculture could play a role in reducing the environmental footprint in other activity sectors. Potential regulation of "green claims" in the food sector.	+
Initiatives to stimulate lead markets for climate neutral and circular products in energy intensive industrial sectors (from 2020)	May concern agriculture through the provision of agricultural biomass.	+
Proposal to support zero carbon steel-making processes by 2030 (2020)		

Legislation on batteries in support of the Strategic Action Plan on Batteries and the circular economy (October 2020)		
Legislative proposals on waste and loss (from 2020)	Food industry among the targets aimed at reducing over packaging. Potential impacts of waste reduction measures for the whole food chain. Bioproducts as potential outlets for agricultural products.	+
Sustainable and smart mobility		
Strategy for Sustainable and Smart Mobility (2020)		
Funding call to support the deployment of public recharging and refuelling points as part of alternative fuel infrastructure (from 2020)		
Assessment of legislative options to boost the production and supply of sustainable alternative fuels for the different transport modes (from 2020)	Alternative fuels as an outlet for the agricultural sector (sugar beets, cereals, oilseeds, agroforestry, dedicated plants, etc.).	++
Revised proposal for a Directive on Combined Transport (2021)		
Review of the Alternative Fuels Infrastructure Directive and the Trans-European Network – Transport Regulation (2021)		
Initiatives to increase and better manage the capacity of railways and inland waterways (from 2021)		
Proposal for more stringent air pollutant emissions standards for combustion-engine vehicles (2021)	Bioethanol and biodiesel could play a role as additives. Could also favour the development of agricultural biogas.	+
Greening the Common Agricultural Policy / "Farm to Fork Strategy"		
Examination of the draft national strategic plans, with reference to the ambitions of the European Green Deal and the F2FS (2020-2021)	Large direct impacts on agriculture and the CAP.	+++
F2FS	Large direct impacts on agriculture and the CAP.	+++
Measures, including legislative, to significantly reduce the use and risk of chemical pesticides, as well as the use of fertilizers and antibiotics (2020-2021)	Large direct impacts on agriculture and the CAP.	+++
Preserving and protecting biodiversity		
EU Biodiversity Strategy for 2030 (May 2020)	Large direct impacts on agriculture and the CAP, notably through potential agricultural land use changes.	+++
Measures to address the main drivers of biodiversity loss (from 2021)	Large direct impacts on agriculture and the CAP.	+++
New EU Forest Strategy (2020)	Linkages to changes in land uses, agricultural practices and agricultural policy instruments.	++

Measures to support deforestation-free value chains (from 2020)	Impacts on agriculture and food through, in particular, changes of EU imports of soybean, palm oil, beef meat, etc.	+
Towards a zero-pollution ambition for a toxic free environment	Impacts on the agricultural use of pesticides, fertilizers and antibiotics.	+++
Chemicals strategy for sustainability (summer 2020)	Potential impacts on the use of chemical inputs in the food chain (fertilizers, pesticides, antibiotics).	+
Zero Pollution Action plan for water, air and soil (2021)	Large impacts on the use chemical inputs in agriculture (fertilizers, pesticides, antibiotics).	+++
Revision of measures to address pollution from large industrial installations (2021)	Potential impact on large farms and food industry plants.	+
Mainstreaming sustainability in all EU policies		
Proposal for a Just Transition Mechanism, including a Just Transition Fund, and a Sustainable Europe Investment Plan (January 2020)	Potential impacts on rural areas. Potential impacts on investments in the food chain (green investments).	+
Renewed Sustainable Finance Strategy (Autumn 2020)	Possibility to finance green investments in the agricultural and food sector.	+
Review of the Non-Financial Reporting Directive (2020)	Potential impact on the food sector.	+
Initiatives to screen and benchmark green budgeting practices of the Member States and the EU (From 2020)	Potential impacts on the agricultural and food sectors (green investments).	+
Review of the relevant State Aid guidelines, including the Environment and Energy State aid guidelines (2021)		
Align all new Commission initiatives with the objectives of the Green Deal to promote innovation (from 2020)	Potential impacts on the European Innovation Partnership "*Agricultural Productivity and Sustainability*" (EIP-AGRI) and the "*Agricultural Knowledge and Information System*" (AKIS).	+
Involvement of stakeholders to identify and remedy incoherent legislation that reduces the effectiveness in delivering the European Green Deal (from 2020)		
Integration of the Sustainable Development Goals in the European Semester (from 2020)		
The EU as a global leader		
EU to continue to lead the international climate and biodiversity negotiations, further strengthening the international policy framework (from 2019)		
Strengthen the EU's Green Deal Diplomacy in cooperation with Member States (from 2020)	Potential impacts on agriculture and food if serious action on imported deforestation is included in agreements with trade partners, and more generally, if trade agreements include strong commitments with regard to climate, environmental, health and social issues.	+
Bilateral efforts to induce partners to act and to ensure comparability of action and policies (from 2020)	Some existing international trade distortions that are related to agriculture and food could be addressed in this way.	+

Green Agenda for the Western Balkans (from 2020)		
Working together – a European Climate Pact		
Launch of the European Climate Pact (March 2020)	All sectors, including agriculture and food.	+
Proposal for an 8th Environmental Action Programme (2020)	All sectors, including agriculture and food.	+

Source: Own elaboration.
Notes: (i) The first column is derived from the annex to the EC Communication on the European Green Deal, Roadmap - Key actions (EC, 2019); the indicative timetable is the original one, which has already experienced delays because of the Covid-19 global crisis; (ii) Own elaboration for the second and third columns.

2.2.2. Climate initiatives

Currently, GHG emissions from the farm sector fall under the EU's Effort Sharing legislation, which covers the EU climate ambition in the sectors that are not included in the ETS (OJEU, 2018a). The current legislation sets GHG emission targets for each MS by 2030 that range from zero to 40% below 2005 levels. These targets, which apply to agriculture, correspond to a reduction of 30% by 2030 from 2005 at the EU level. This 30% figure corresponds to the contribution of the non-ETS sectors to the current reduction target of 40% below 1990 levels for all GHG emissions at the EU level, which the EC has proposed to raise to 55% and the EP to 60% both in September 2020.

It is worth noting that the Effort Sharing legislation does not apply to emissions and removals from land use and forestry, which are covered by the Kyoto Protocol and, from 2021, by the Land Use, Land-Use Change and Forestry (LULUCF) Regulation. As a result, GHG emissions covered by the 30% quantitative target include only those linked to agricultural inputs and outputs (manure and fertilizer-related emissions, methane emissions, etc.), and the measures concerned essentially deal with cropland management, livestock management and fertilizer use.

The Climate Law proposal (EC, 2020a) reiterates the potential role of agriculture in reducing GHG emissions and adds the need to reduce land-based emissions as planned under the 2018 LULUCF Regulation (OJEU, 2018b). The latter establishes into law the EU policy regarding the inclusion of GHG emissions and removals from LULUCF into the 2030 climate and energy framework. It is a legislative vehicle for the objective that all sectors should contribute to the EU's 2030 emission reduction target, including the land use sector. The LULUCF Regulation includes provisions for farmers to develop climate-smart agriculture practices and support agro-forestry. The Climate Law proposal can be read as a way to enshrine the "*no-debit rule*" of the LULUCF Regulation in EU law beyond 2030, *de facto* incorporating land use and forestry into the EU's emission-reduction efforts, albeit with no specific target (except the "*no debit-rule*").[7] The Climate Law proposal also states that the natural sink of forests, soils, agricultural lands and wetlands should be maintained.

On 19 September 2020, the Commission communication on "*Stepping up Europe's 2030 climate ambition*" suggests to merge agriculture and LULUCF in a single regulated sector, stating that "*such a sector would have the potential to become rapidly climate-neutral by around 2035 in a cost-effective manner, and subsequently generate more removals than greenhouse gas emissions*". This increased

[7] Within the framework of the LULUCF Regulation (OJEU, 2018b), MS have to ensure that GHG emissions from land use, land-use change or forestry are offset by at least an equivalent removal of CO_2 from the atmosphere in the period 2021 to 2030. More precisely, the Regulation sets a binding commitment for each MS to ensure that accounted emissions from land use are fully compensated for by an equivalent removal of CO_2 from the atmosphere through action in the sector ("*no debit rule*"). In brief, if a MS converts a forest to other land use, it must compensate for the resulting emissions by planting a new forest or by improving the sustainable management of existing forests, croplands, grasslands and/or wetlands.

ambition includes a new reduction target for non-CO_2 GHG (-35% between 2015 and 2030) and the need to raise the LULUCF carbon sink, which is presently declining (EC, 2020g).

On 14 0ctober 2020, the EC presented a strategy to reduce methane emissions. This strategy does not set quantitative targets, but calls for monitoring of agricultural emissions, including carbon equivalent balance calculations at the farm level. It also intends to develop research and the dissemination of best practices (EC, 2020i).

The F2FS identifies different technical solutions and practices to be implemented in agriculture in order to reach climate neutrality: precision agriculture, nitrogen management, organic farming, agroforestry, etc. Quantitative targets listed in Section 2.1 accompany some of these. Climate neutrality is also included in the third objective of the F2FS, notably through the promotion and scaling-up of sustainable production and circular business models, as well as in the fifth objective aimed at "*reducing food loss and waste*" (EC, 2020c). The role of consumers in reaching climate neutrality is highlighted through the implementation of environmental and carbon footprint labelling for food items and the role of diet changes with a reduced consumption of animal products.

Climate neutrality is also included in the third key action of the Green Deal aimed at "*mobilising the industry for [a] clean and circular economy*'' (EC, 2019a). The Green Deal key actions aimed at "*supplying clean, affordable and secure energy*" and "*mobilising industry for [a] clean and circular economy*" could have considerable consequences for the agricultural sector, as agricultural biomass can be a source of renewable energy and can provide carbon neutral feedstock for biochemical and biomaterials. Under the Green Deal, it is proposed to revise the various directives on renewable energy in order to ensure that the climate targets for 2050 are reached. The 2009 Renewable Energy Directive (OJEU, 2009a), the 2018 "*Recast*" Directive (EC, 2018c), the 2009 Fuel Quality Directive (OJEU, 2009b) and the 2012 Energy Efficiency Directive (OJEU, 2012) have played a substantial role in fostering the emergence of the European biodiesel and bio-ethanol industries. Given the significant impact of the biofuel sector for agriculture, especially for oilseed and sugar markets, the proposed revisions will be of particular importance to the agricultural sector and the bio-based industry sector.

The (upcoming) Climate Pact will encourage a commitment to concrete actions to reduce GHG emissions and adapt to the impacts of climate change. Regarding agriculture and food, some actions can be expected in terms of, for example, tree planting or nature regeneration. Given the emphasis on cooperation and innovation, it is possible that the Pact complements the existing European Innovation Partnership "*Agricultural Productivity and Sustainability*" (EIP-AGRI) and rural development measures, such as LEADER, with additional initiatives.

Coherence of the provisions and consistency with the CAP

In combination, the Climate Law, the Climate Pact, the revisions of fuel Directives and the F2FS all define how the climate ambition set out in the Green Deal will impact agriculture and food. These proposals clearly state that "*all sectors*" will have to participate in the effort towards climate neutrality. However, there is no indication in these proposals that agriculture will be subject to tradeable emissions rights and included in the ETS. ***Neither the Climate Ambition proposals, the Clean Energy proposal nor the F2FS explain how instruments within the current EU policies could be designed and implemented so that agriculture and food sectors fully fit and contribute to climate neutrality in the EU by 2050.***

Mathematically, the new Climate Target Plan, which raises the emission reduction from 40 to 55% (60% in the EP version) in 2050 compared to the 1990 benchmark, should have a direct impact on the target for agriculture set out in the Effort Sharing legislation. However, the European Environment Agency (EEA) shows that emission trends in agriculture have slightly increased over the last few years after

declining in the 1990s and 2000s (see also Section 3.1). In other words, agriculture has barely contributed to reductions in the Effort Sharing sectors. In addition, MS plan relatively low emission reductions in the future in this sector (EEA, 2020a). This means that ***significant adjustments in the CAP are likely to be needed*** to tackle this issue. Currently, there are only limited provisions (and a limited budget) in the CAP that address climate objectives, which may explain the limited contribution of agriculture to the Effort Sharing objectives. Other policies (for example, a carbon pricing-based policy) that could overcome the current obstacles for agriculture to reach its emission reduction targets may have to be mobilised in order to reinforce the CAP in incentivising cost-effective abatement.

The various provisions calling for the mobilization of agricultural biomass for energy and biologically sourced materials raise important questions linked to costs, sustainability criteria and possible trade-offs between food and non-food uses of agricultural biomass. Key conditions for mobilising biomass in a sustainable way, that favours sustainable food systems relying on circular economy principles, consist of significant changes in farming practices. These changes include the closing of nutrient cycles, the valuation of side products and recycling, innovations in food processing, markedly different food consumption behaviours, new relationships between primary producers, processors, consumers and even recyclers, all towards a more sober and efficient use of resources.

These key conditions will also require increased alignment between agriculture, energy, industrial and food policies, as well as with rural development measures defined as part of either the second pillar of the CAP or the European Cohesion Policy. For example, the call for agriculture to play a larger role as a renewable energy provider in the Clean Energy proposal is not necessarily in line with the ambitious targets of the EU Biodiversity Strategy for 2030, notably because it may require an extension of the agricultural area. In the same way, some of biodiversity targets, which may encourage biodiversity-friendly forms of agriculture, could be at odds with reductions in non-CO_2 GHG emissions, such as methane emissions linked to extensive grazing beef production systems.

The precise formulation of the CAP, the Bio-economy Directive and the upcoming revision of the Renewable Energy Directives will need to be carefully investigated. Under the 2018 "Recast" Directive (EC, 2018c),[8] biofuels with a high risk of indirect land use change - for example, from non-crop uses such as grassland and forest to crops with increases in net GHG emissions - do not count towards the EU's renewable energy goals for 2030. In addition, the possible use of uncertified raw materials in other sectors (detergents, cosmetics), the difficult enforcement of sustainability certification and the "*logrolling*" effect result in the limited efficiency of these provisions.

2.2.3. Biodiversity initiatives

The EU Biodiversity Strategy for 2030 acknowledges the vital role of farmers in preserving biodiversity, as well as the benefits that farmers could draw from as a result of restored biodiversity. It also emphasizes the importance of helping farmers to engage in the transition to fully sustainable practices, and the importance of the EU Biodiversity Strategy for 2030 working in tandem with both the F2FS and the future CAP, including by the promotion of eco-schemes and result-based payment schemes. It states that the EC will *"ensure that the CAP Strategic plans are assessed against robust climate and environmental criteria, and that MS set explicit national values for the relevant targets set in this strategy, as well as in the F2FS. These plans should lead to sustainable practices, such as precision agriculture, organic*

[8] The 2018 "*Recast*" Directive (EC, 2018c) sets a target of 32% of energy from renewable sources in total EU gross energy consumption for 2030 and sets limits on the use of first-generation biofuels while promoting second-generation biofuels. It includes provisions for ensuring that second-generation biofuels replace first-generation biofuels, and for raw materials to be sourced from "*sustainable*" production.

farming, agro-ecology, agro-forestry, low-intensive permanent grassland, and stricter animal welfare standards" (EC, 2020b).

The EU Biodiversity Strategy for 2030 addresses the main causes of biodiversity loss with the renewed objectives of halting this loss and restoring damaged ecosystems. The negative impacts of agricultural intensification on crop pollination, bird communities, flora and soil biodiversity are emphasised (see also EEA (2019b), Eurostat (2020h), and Section 3.2).

Among the provisions of the EU Biodiversity Strategy for 2030 that should affect the agricultural sector, the target of 30% of land protected, the target of 10% of land with high biodiversity value strictly protected and the provisions of no deterioration of all protected habitats and species are likely to require the development of ambitious and specific measures in the future CAP, with some agricultural areas subject to particular constraints. The same applies to the targets related to pesticides, fertilizers, areas under high-diversity landscapes, land under organic farming, as well as the objective of increased genetic diversity.

The farm sector could potentially find some benefits in the outlets induced by this strategy. Farmers could play a significant role in the provision of ecosystem services should they receive payment for this. Typically, provisions such as the restoration of free-flowing rivers, freshwater ecosystems, soil organic matter and carbon storage could pave the way for the EU agricultural sector to benefit from a potential flow of "*payments for ecosystem services*" (PES). The provisions on green public procurement and those included in the "*business case for biodiversity*" could foster a regulatory environment that leads to a demand for such services that farmers are in a good position to provide.

New organic legislation is also under way, in order to guarantee fair competition for farmers, while preventing fraud and maintaining consumer trust. Its entry in force has been postponed due to the Covid-19 global crisis and the request of some MS to allow for a transition period between numerous new legislations.

Coherence of the provisions and consistency with the CAP

The number and variety of species on farmland have declined at a particularly rapid rate (EEA, 2019a, b). Several recent reports from the ECA stress that intensive farming remains a principal cause of biodiversity loss, and that the greening of the 2014-2020 was not effective in reversing biodiversity decline (ECA, 2020a, b, c). This suggests that ***a major leap must be achieved in the CAP ambitions to match the biodiversity targets of the Green Deal***.

The wording of the EU Biodiversity Strategy for 2030 and the biodiversity provisions of the F2FS show a great degree of convergence and articulation; the former referring to the latter in many cases. However, the consistency of biodiversity objectives of the Green Deal with the CAP is much less compelling at this stage. The Green Deal communication, the EU Biodiversity Strategy for 2030 and the F2FS all emphasise biodiversity-related targets that could be addressed by supporting more sustainable farming practices and systems (organic farming, agroforestry, agroecology), by diversifying crop systems or by increasing genetic diversity. However, there is little indication as to how this would translate in the future CAP, notably in NSP. In brief, ***the EU Biodiversity Strategy for 2030 questions the consistency and completeness of the legislative proposals for the future CAP with the high level of ambition displayed by the EC in that domain*.**

2.2.4. Farm to Fork Strategy

The Farm to Fork Strategy (F2FS) considers issues related not only to climate, environment and environmental health, but also to the health impacts of food choices and diet (Massot Marti, 2020). As

a result, key actors that have to be considered are not only agricultural producers for the first objective of the F2FS ("*ensuring sustainable food production*''), but also food business operators and consumers for objective 3 ("*stimulating sustainable food processing […]*'' and objective 4 "*promoting sustainable food consumption […]*''). In the same way, F2FS objectives 2 ("*ensuring food security*"), 5 ("*reducing food loss and waste*'') and 6 ("*combatting food fraud along the food supply chain*") concern the entire food chain. This translates as the leading position of EC DG SANCO for a large majority of the action plan of the F2FS. To some extent, the F2FS can be viewed as an attempt to move towards a "*Common Agricultural and Food Policy*"**.**

Within the Green Deal communication, human health issues are considered essentially through the key action aimed at achieving ''*a zero pollution ambition for a toxic-free environment*'' (EC, 2019a), as well as the environmental and health impacts of agricultural practices. The F2FS expands the scope from a two-fold perspective. The first objective of the F2FS (''*ensuring sustainable food production*'') warns of the detrimental impacts to the public's health of air, water and soil pollution. In addition, "*a sustainable food system must ensure [a] sufficient and varied supply of safe, nutritious, affordable and sustainable food to people at all times, not least in times of crisis*" (EC, 2020c). This is described in four specific issues: one at the primary production stage (contaminants in agricultural products); one for food business operators (nutritional quality of processed foods); one at the consumption level (adoption of healthier diets); and one for the whole system (combatting food fraud). Numerous policy instruments may be envisaged to address these issues that are not central in the current or planned CAP, particularly concerning the promotion of processed food of higher nutritional quality and the adoption of healthier diets.

Coherence of the provisions and consistency with the CAP

The Green Deal, and, in particular, the F2FS, adopts a wider point of view than the CAP by explicitly considering the whole food chain. An important point to note is that the F2FS acknowledges that sustainability objectives imply action, not only in agriculture, but also at the food industry and food consumption stages. This is a somewhat new approach compared to the historical focus of the CAP on the farm sector. ***Because the CAP has never included - or only very poorly - "food" and "nutrition" components over the last 60 years, and because it has only marginally tackled the climate change issue, the scope of the F2FS goes considerably beyond the set of issues addressed in the current CAP reform process.*** It is worth noting that this evolution of agricultural policy towards an agricultural and food policy has been recently recommended by several think tanks and academics (see, for example, Centre for Food Policy, 2019; De Shutter et al., 2019; Recanati et al., 2019; WBAE-BMEL, 2020).

An issue of particular interest is public health. This important point of the F2FS will require significant changes in the CAP, as well as in other policies, in order to reduce the health and environmental impacts of food systems and to improve the quality of food items and diets. This issue may require complementing the EC June 2018 legislative proposals for the future CAP with policy instruments that need not only to be reinforced, but also created *ex nihilo*.

Even though the F2FS and the EU Biodiversity Strategy for 2030 are well articulated when focusing, for example, on the same reduction targets for pesticides and fertilizers, one potential issue becomes apparent. Reducing nitrogen and phosphorus leaching is not necessarily synonymous with the need to reduce the consumption of animal products for healthier diets, since animal-based fertilizers could be required to balance nutrient flows without using synthetic fertilizers.

2.2.5. Circular bio-economy

The Circular Economy Action Plan focuses on sectors other than agriculture. Nevertheless, the food sector is likely to be affected by the need to reduce packaging and improve recycling, and by the (yet to be defined) programmes for circular products in the industrial sectors. In the F2FS, the fifth objective aimed at "*reducing food loss and waste*" (EC, 2020c) should also impact both agriculture and food. In the EU, as in other developed countries, food loss and waste take place primarily at the distribution and consumption levels, notably for fresh food products. More generally, applying circular economy principles on a large scale, which is a major component of the Green Deal, will have consequences for all actors of the food chain, from producers to consumers.

2.2.6. External policy

The Green Deal claims that the EU should act as a global leader and that "*the Paris Agreement remains the indispensable framework for tackling climate change*''. From that perspective, the EU will develop "*Green Deal diplomacy focused on convincing and supporting others to take on their share of promoting more sustainable development*'' (EC, 2019). The F2FS confirms this ambition for agriculture and food by emphasising that "*[t]hrough its external policies, including international cooperation and trade policy, the EU will pursue the development of Green Alliances on sustainable food systems with all its partners in bilateral, regional and multilateral fora*" (EC, 2020c).

In a context where the World Trade Organization (WTO) negotiations of the Doha Round are currently deadlocked, the EC has changed its position by multiplying bilateral trade agreements. This is at odds with the Prodi Commission's doctrine of favouring multilateralism (1999-2004). The last generation of bilateral trade agreements includes environmental provisions, but with vague and barely enforceable provisions (Bellora et al., 2020; Ambec et al., 2020, in the specific case of the EU-Mercosur trade agreement).

The Green Deal proposal for a carbon border adjustment mechanism for specific sectors is likely to primarily target those sectors included in the ETS. However, it might be of particular interest for the agricultural and food sectors, given that EU producers have long complained about an "*unlevel playing field*" regarding environmental and safety regulations at the international level.

The coherence of the Green Deal with external trade policy requires a thorough analysis of the various EU standards in order to guarantee sustainable and safe agricultural and food imports, and to ensure an unbiased relationship between European and non-European producers. ***The proposed international action to promote more sustainable production worldwide could potentially make preferential imports subject to more stringent climatic, environmental and health conditions. These dimensions do not seem to have received enough attention in either the F2FS or the legislative proposals for the future CAP.***

2.2.7. Just transition

Favouring a "*just transition*'' is at the heart of the Green Deal. In the food sector, it is a key issue so as to guarantee: (i) decent farm incomes; (ii) a balanced distribution of value in the food chain; (iii) safe and affordable food of high nutritional quality for consumers; and (iv) a balanced development between MS and regions. The Covid-19 pandemic has moved the issue of the food security to the forefront of discussions (objective 2 of the F2FS).

The F2FS mentions cohesion issues and the reduction of imbalances between MS and regions. In relation to food consumption, it deals with health issues related to over-consumption and unhealthy diets, and discusses health inequities and the prevalence of food-related diseases that are much higher

among low-income households. In the same way, the F2FS mentions issues related to under-consumption and food insecurity; two related issues that could become more important in the aftermath of the Covid-19 global crisis. ***This raises queries around the prices of high-quality and environmentally friendly foods and of access to healthy and environmentally friendly food items and diets for low-income households; two concerns that are insufficiently included in the current CAP, as well as in EU or MS health and nutrition policies.***

2.3. Budgetary issues

The budgetary aspects of both the Green Deal initiatives and the future CAP are still evolving at the time of writing (October 2020). The complexity of the debates come from the fact that several issues interact concerning the funding of the Green Deal and the CAP.

An agreement between the European Council leaders was reached on 21 July 2020, on both the "*Next Generation EU*" recovery plan (hereafter NGEU) and the Multiannual Financial Framework (hereafter MFF). However, in spite of the formal agreement reached at that date, uncertainty and disagreements between MS surround the funding of the NGEU, in particular, on the "*own resources*" and conditionality issues. In the same way, while the EP has welcomed the NGEU to a certain extent, it is also critical on some aspects. In addition, the EP has not approved the Council version of the MFF, and discussions are currently ongoing between the Council and the EP on the latter.

The Green Deal remains, at this stage, a set of several legislations proposed by the EC. However, in the version adopted by the Council in July 2020, the NGEU recovery plan will provide most of the funding of the Green Deal.

Several budgetary issues interact in the Green Deal - CAP debate. In the dialogue with the Council, the EP wants both the NGEU and the MFF amended, which *de facto* links the two budgetary debates. In addition, the NGEU recovery plan is supposed to fund some aspects of the CAP through contributions to the European Agricultural Fund for Rural Development (EAFRD). This also contributes to link the debate on the CAP budget and the debate on the NGEU.

2.3.1. The original Green Deal budget

In the December 2019 communication on the Green Deal, the EC proposed to mobilise private and public sustainable investments in the upcoming decade (EC, 2020e). At the same date, the Sustainable Europe Investment Plan was defined as the investment pillar of the Green Deal (EC, 2020f). In total, three components were proposed for funding the Green Deal initiatives; that is, (i) the UE budget, which means than the MFF would devote a greater share of public spending to climate and environmental issues than at present; (ii) private investors; and (iii) public funding of sustainable investment that was expected to attract private funding.

When quoting an "*at least 1 trillion budget*" over the 2021-27 period "*extrapolated to 10 years*", the EC seemed to have in mind that €503 billion should come from the EU budget, with the rest of the funding coming mostly from the private sector. A strategy was thus proposed to encourage the private sector to make risky "*green*" investments through loan guarantees from the European Investment Bank. The guarantee of the "InvestEU programme" was also mobilized by national banks and financial institutions to help funding, by leveraging a planned €279 billion.[9] In addition, the Just Transition Mechanism was

[9] Created in 2018, InvestEU is the EU's proposed flagship investment programme to boost the European economy. It was designed to mobilize public and private investment using guarantees from the EU budget under the Juncker investment plan 2014-2020. It gathers several funds, including the European Fund for Strategic Investments (the heart of the Juncker Plan), and complements them by using EU budget guarantees to attract other sources of funding.

due to mobilize at least €100 billion in investments over the period 2021-2027 to support workers and citizens of the regions most impacted by the transition, for example, in areas with coal mines and steel factories. Auctioning the carbon allowances under the ETS would provide some €25 billion.[10] Over the decade, the European Investment Bank was expected to finance outside the EU mandates of around €600 billion of climate investments across MS. Investment from the private sector would also be supported by the "EU Taxonomy" (green investment classification), and the establishment of an "EU Green Bond Standard" should enable the public and private financing of sustainable investments. Finally, flexibility on State Aid rules would help support the transition to climate neutrality.

Despite a rapid launching of some of the Green Deal provisions, the Covid-19 global crisis from Spring 2020 delayed the implementation of the Green Deal and demanded a major economic recovery plan. Several MS called for a pause - or even a complete discontinuation - of the Green Deal. However, other MS urged the EC to adopt a "Green Recovery Plan", echoing the EP call to include the European Green Deal in the recovery programme from the pandemic (April 2020).

This led the EC to propose the NGEU recovery plan in May 2020, which was designed in such a way as to meet the Green Deal ambitions. A €1 trillion budget was announced, together with a €750 billion recovery package, with restrictions whereby some of the money spent would be conditional on "*green*" criteria, and that the "*do no harm*" principle would apply. This package encompasses the funding of the Green Deal initiatives.

2.3.2. The NGEU recovery plan budget

In July 2020, the Heads of States adopted both a proposal for the MFF and their version of the NGEU recovery plan in order to tackle the economic crisis caused by the Covid-19 crisis (European Council, 2020). The whole package adopted combines €1,074.3 billion for the MFF for the period 2021-2027 and €750 billion for the NGEU recovery plant. Compared to the EC initial proposal, the budget adopted by the Heads of States is lower for the Just Transition Fund, as well as some research, cooperation and health programmes. This remains an issue with the EP.

This NGEU recovery plan is designed to fund national recovery plans through subsidies (€390 billion) and loans (€360 billion). The allocation across MS is based on a formula that takes into account unemployment rates, differences in Gross Domestic Product (GDP) and their fall caused by the Covid-19 crisis. The matching of the NGEU recovery plan with the provisions of the Green Deal is made clear by a proposal of the European Council (30 July 2020) that states that 30% of the budget must be devoted to the environment in the use of European funding by MS. This is a figure that the EC is proposing to raise to 37% (EC, 2020h). The link between the NGEU recovery plan, the MFF and the CAP is also apparent in the Council's proposal that says that in the MFF, some €7.5 billion budget of the EAFRD should come from the NGEU recovery plan.

While this package is intended to fund initiatives falling under the Green Deal, it also represents a new step for the EU, given the first-time use of the EU borrowing in order to fund grants. The new instrument behind the NGEU recovery plan will involve the contracting of a mutualised debt at the EU level, provided that the EC receives approval by all MS (unanimity). The funding of the NGEU recovery plan thus relies on a loan, contracted by the EC, and on specific resources that include a tax on non-recycled plastics. The EU should start reimbursing the interest share of the loan in 2023, and the capital of the loan from 2028 until 2058.

[10] The Just Transition Mechanism proposed by the EC involved funding from MS that matched €7.5 billion from the Fund, either from their national budget or from structural funds, to attract private investments for €45 billion, and to involve a public sector loan facility with the European Investment Bank backed by the EU budget to mobilise €25-30 billion of investment.

In addition, the Heads of States asked the EC to make proposals for other sources of funding, which could involve the border carbon adjustment tax proposed by the EC in the framework on the Green Deal. New resources could also include a tax on financial transactions and numerical industries, as well as on sales of GHG emission rights for sectors that could be requested to join the ETS.

At the end of September 2020, the EP has cleared the way for the NGEU recovery plan with a plenary vote on the consultative opinion on the "*Own Resources Decision*". This vote will enable the EU to borrow €750 billion, and will allow the Council to proceed with an immediate approval of this decision and to start the ratification procedure in the various MS. However, at this stage, the EP has not approved the Council's proposal for the MFF. A rejection would delay and create difficulties in the implementation of the NGEU recovery plan.

In brief, even though the NGEU recovery plan received political agreement in the European Council and was relatively welcomed by the EP (EP, 2020b), it is still subject to a long technical and legislative process, where a great deal of uncertainty remains on the modalities and the current level of budget made available for MS. The planned agenda is that 70% of the funds will be made available to MS during Summer 2021. Between 15 October 2020 and 30 April 2021, MS will have to submit their national plans, which are subject to approval by other MS. It is significant that national recovery plans are only partially funded by the NGEU recovery plan. National budgets devoted to the 27 plans are likely to vary substantially across MS. Preliminary information shows that they exhibit heterogeneous degrees of ambition; for example, while some focus more strongly on the economic recovery side, others include a strong "*green*" component.

2.3.3. The MFF budget

The May 2018 Commission's proposal for the MFF followed intensive discussions with MS, whose positions on the EU budget differed considerably. The EP submitted its own MFF proposal in November 2018. After the rejection of a first compromise in February 2020, the European Council leaders unanimously reached an agreement on 21 July 2020 for the MFF 2021-2027 (together with an agreement on the NGEU recovery plan; see Sub-Section 2.3.2).

In the version agreed upon by the Council, the overall amount for MFF commitments is €1 074.3 billion for the seven-year period 2021-2027 (European Council, 2020). This figure, expressed in constant 2018 prices, is lower than the €1 134.6 billion proposed by the EC in May 2018 (Massot Marti and Negre, 2018).

Before a MFF Regulation can be formally adopted, the EP must provide its consent under Article 312(2) of the Treaty on the Functioning of the European Union (TFEU). Thus far, the EP has expressed its dissatisfaction with the Council's MFF proposal, and called for a budget that would allow "*[...] more European solidarity, more European action in public health, in research and digitalisation, youth, and in the historical fight against climate change*" (EP, 2020b).

The EP also calls for new own resources, arguing that the "*plastic based contribution will not do the trick alone*" for funding the EU ambitions. It has also been highly critical of the persistence (and even increase) of the national budget rebates, considered to be "*a big step back for the European project*". Moreover, the EP demands higher funding for 15 EU programmes, including the Erasmus programme, the health programme and the research budget. It insists that MS must comply with the rules of law, and requests involvement in the recovery instrument. These disagreements between the Council and the EP make the timeframe for a compromise uncertain. The lack of consensus between the Council and EP on the MFF could *de facto* delay the implementation of the NGEU recovery plan and, as a result, the Green Deal.

2.3.4. The CAP budget

The European Council agreement of 21 July 2020 details the CAP budget based on its own version of the MFF. ***CAP spending would be €343.9 billion in 2018 prices for the seven-year period 2021-2027***, with €285.6 billion for the European Agricultural Guarantee Fund (EAGF) and €77.8 billion for the EAFRD. The latter figure would be topped up with an additional €7.5 billion from the NGEU recovery plan.

Matthews (2020a) provides an extensive analysis of these figures. It is difficult to compare the budget of the future CAP to the current one, for a large number of reasons (with or without the United Kingdom, partial budget for Croatia, assumptions about the inflation over the period, etc.). Matthews's calculations, based on commitments made in the final year of the current MFF period (2020) and then multiplied by 7, suggest a reduction of 6.4 to 10%, depending on the baseline, compared to the 2014-2020 MFF in constant prices, and a slight increase in current prices. In addition, the decrease is larger for the Pillar 2 budget than for Pillar 1, even though the gap is smaller than in previous proposals.[11]

Several issues are worth highlighting in the European Council proposal:

- The flexibility between the two pillars: transfers from Pillar 1 to Pillar 2 would be up to 42%, including 25% with no restriction on intervention funded, 15% to finance only climate- and environment-related interventions, and 2% for measures in favour of young farmers. Transfers from Pillar 2 to Pillar 1 would be up to 25% and might be increased to 30% for MS whose Pillar 1 direct aid is less than 90% of the European average;
- The continuation of the external convergence: for all MS with direct payments below 90% of the EU-27 average, the gap between their current level and 90% of the EU average direct payments will be closed by 50%. In 2027, all MS shall reach at least €215 per hectare;
- The carry-over of the reserve crisis (€450 million), if unused, from one year to the next;
- The creation of a new Brexit Adjustment reserve of €5 billion in 2018 prices: this could considerably benefit the farming sector, which is likely to experience serious disruptions in the case of a "*no deal*" Brexit; and
- The reduction in co-financing rates for the EAGF: MS would be required to contribute more with their national budgets, with, in particular, a maximum EAFRD contribution rate reduced to 43% in developed regions. However, the higher EAFRD co-financing rate of 80% is maintained for climate- and environment-related interventions, which may encourage MS to give more priority to this Pillar 2 item in their NSP.

2.4. Institutions' and stakeholders' reactions

Reactions to the Green Deal ambition have been largely enthusiastic. However, some dissenting voices have been heard coming not only from different pressure groups, but also from some MS or MEP.

An apparent consensus

"*It's a bit like world peace: everyone backs the European Green Deal, in theory*" wrote the Guardian on 22 July 2020, with a touch of irony.[12]

[11] For a total CAP budget decrease in constant prices of 6.4% compared to the 2014-20 baseline, the EAGF would decline by 5.5% and the EAFRD by 9.1% (Matthews, 2020a).

[12] *https://www.theguardian.com/commentisfree/2020/jul/22/recovery-deal-eu-unifying-economic-boost-integration.*

Indeed, on 15 January 2020, the EP gave a green light to the EC proposal for the Green Deal, with a large majority (EP, 2020a). Even though it has "*watered down*" some of the budgetary ambitions (in particular, for the Just Transition Fund), the Council unanimously approved the NGEU recovery plan on 21 July 2020 (European Council, 2020). The Committee of Regions approved the Climate Law proposed by the EC in July 2020 and agrees that the Green Deal is central to the NGEU recovery plan. Regarding the Climate Pact (still to be approved), the Committee of Regions expressed its approval. However, it stressed the importance of funding rural areas as well as urban areas and asked to work closely with the European Investment Bank. On 2 June 2020, the European Economic and Social Committee also agreed on the importance of this ambitious initiative, describing the NGEU recovery plan as "*an example of the solidarity and the political will of all EU MS in times of uncertainty*".[13]

Divergence behind the consensus

However, this apparent consensus conceals a divergence both between MS and between stakeholders.

A first area of divergence relates to the core of the green ambition. In particular, Poland is the only MS that refuses to commit to being a net-zero GHG emitter in 2050, therefore disagreeing with the key objective of the Green Deal. While some MS, such as Latvia, Spain and Sweden, appear to welcome the EC proposal of a 55% reduction in overall GHG emissions by 2030, others consider it to be too ambitious and are concerned about their coal industry, which employs more than 200,000 across the EU. Several governing parties in specific MS call for a reduced ambition of the Green Deal objectives related to the "*greening*" of the MFF budget and the NGUE recovery plan. In particular, the Ministers of Agriculture of the Czech Republic, Hungary, Poland, Slovakia, Bulgaria and Romania have expressed concerns that the climatic and environmental objectives of the Green Deal could harm the economic stability of agriculture.[14]

A second area of divergence refers to the conditions for approval of the national recovery plans under the Next Generation initiative. Because the EC intends to make the funding of the national recovery plans conditional on recommendations made to each MS, some disagreements are likely to occur. While the most publicized criteria relate to environmental and numerical issues, recommendations also include reforms of the public sector, the revision of tax regimes that lead to fiscal dumping between MS, and the revision of the judicial system in line with the spirit of EU Treaties. This has resulted in the funding of the Green Deal interfering with extremely sensitive issues upon which MS have persistently disagreed over the last decades. Reforms of national administrations might result in opposition from countries such as France and Italy, while complying with a standardized EU tax rate on companies could raise opposition from countries such as Cyprus, Hungary, Ireland, Luxemburg or the Netherlands. Regarding the NGEU recovery plan proposal, in spite of the anonymous adoption by the Heads of States in July 2020, on 25 September 2020, Hungary and Poland expressed their refusal to validate the launching of the plan, as well as their disagreement with the planned mechanism to condition the corresponding financial transfers to respect of the rules of law.

Such disagreements could have major consequences. Under the NGEU recovery plan, MS will be able to exert scrutiny by holding up a vote in order to approve or reject national applications at various stages. However, no single country will have a veto right.[15] This tight scrutiny is partly aimed at ensuring

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[13] *https://www.eesc.europa.eu/en/news-media/eesc-info/072020/articles/80534.*

[14] On the occasion of the vote of the Council of Agricultural Ministers on the three CAP reform regulations of 21 October 2020 adopted by a qualified majority, Lithuania voted against and Bulgaria, Latvia and Romania abstained.

[15] MS will have to prepare their national recovery and resilience plans for 2021-2023 in accordance with the country-specific recommendations and the roadmap for the green and digital transition. The national plans will be assessed by the EC. This assessment will need to be approved by the Council by qualified majority and will be based on the fulfilment of targets and milestones. Contrary to what some MS asked, the 21 July 2020 agreement does not include a veto right for individual countries. However, if some MS consider that there are serious deviations from the fulfilment of the relevant milestones and targets, they may request the Presidency of the

that EU funds target investments and reforms in the regions and sectors that are the most affected by the Covid-19 crisis. It is also aimed at ensuring that the budget will be spent wisely by all MS, a source of worry for the most budget-conscious MS (Austria, Denmark, Sweden and the Netherlands).

Globally, the EP agrees with the NGEU recovery plan, and welcomes the modalities for the allocation of funds to MS through EU budgetary instruments. The EP also welcomes its role as co-legislator of the recovery plan. This contrasts with previous initiatives, such as the European Stability Mechanism, where its role was much less central. However, the EP has serious reservations around the budget spent on some policies under the version of the MFF proposed by the Council. The Parliament's negotiators for the MFF stressed that the NGEU recovery plan is crucial but warned that it would only give its consent to the MFF if the final agreement includes "*its main priorities and genuinely provide for Parliament's participation*". In a joint letter, the leaders of five major political groups have called for higher budgets on particular policies, full involvement of the EP in the delivery of the NGEU recovery plan, and new own resources. The EP has also requested more detail on the reimbursement of loans, and a strengthening of the provisions on the rules of law. Because of the EP disapproval of the MFF proposed by the Council, and the leverage given to the EP on the NGEU recovery plan by the right to approve the MFF, debates on the funding have enormous (potential) cascading effects, both on the Green Deal and the CAP.

Some disagreements between MS, and between the Council and the EP, are likely to occur on the funding of the Green Deal, in particular, for the "*own resources*". Disagreements include the tax on non-recyclable plastics, the principle of which has been agreed upon and should be implemented in 2021. They also include, at least potentially, the border adjustment carbon tax, the tax on numerical services or the tax on financial transactions, which, in principle, should be implemented by 2023. The future of such resources is highly uncertain. Talks have been held over the last decade on a border carbon tax. However, some MS, such as Germany and the Netherlands (that are subject to the pressure of export industry lobbies and fear retaliation from China and the United States), have so far avoided any implementation. It is noteworthy that implementing a border carbon tax would require MS unanimity, which is unlikely. An alternative would be for importers to face the same obligation as domestic producers under the EU ETS, in order to surrender their emission allowance (Mehling et al., 2019). Other MS, such as Sweden, are opposed to the implementation of a tax on financial transactions. They argue that they would only accept a global framework under the auspices of the Organization for Economic Co-operation and Development (OECD), which has been under negotiation for some years, and now appears highly unlikely due to the recent withdrawal of the United States from the negotiation table. Other MS are in favour of the taxation of numerical services.

Among the different stakeholders, most think tanks have welcomed both the Green Deal and the NGEU recovery plan. Some of them have warned that much will depend on the practical modalities of funding and on the national strategies, including the way in which they will be approved (Bruegel, CEPS). Some academics have expressed concerns that increases in resources to address long-term challenges come from the time-limited NGEU recovery plan rather than from the core MFF, fearing that this could be a missed opportunity to permanently reform the EU budget (European Policy Centre). They also warn that considering the €503 billion from the EU budget (a figure from the initial Green Deal proposal) as a "*green investment*" is highly ambitious and will likely be very controversial, as much of the money would need to be spent on traditional EU policies. Furthermore, Bruegel argues that the €1 trillion is

European Council to refer the matter to the next European Council. This allows a particular MS to strengthen scrutiny on how funds are spent and may delay reimbursements to another MS for up to three months (Utrilla, 2020).

only one-third of what is required if the EU follows through with the EC plan to reduce European GHG emissions by 55% in 2030.

Most environmental organizations have also welcomed the Green Deal proposal as well as the NGEU recovery plan, even though they have argued that it is not drastic enough to slow down climate change to an acceptable degree.[16] Some, such as the Club of Rome, have praised the EC proposal to align recovery spending with the Green Deal and the Sustainable Finance Taxonomy. Others have criticized the allocation of the spending towards building infrastructure. More generally, many environmental organizations are sceptical about the capacity of the Green Deal proposal to match the stated climatic and environmental ambitions. In addition, animal welfare organizations have expressed disappointment that there are no measures specifically targeting animal welfare.

Overall, the European industry has expressed support of the NGEU recovery plan, even if some sectors (for example, the nuclear industry) regret that no money will be directed to specific forms of decarbonization. The European food industry has welcomed the Green Deal as well as the NGEU recovery plan, expressing its willingness to collaborate on issues such as packaging, recycling and using bio-sourced materials.

Farmers' organizations have expressed strong reservations regarding some components of the Green Deal and its associated strategies, notably the EU Biodiversity Strategy for 2030 and the F2FS, while others organizations have been more enthusiastic. European farmers and agri-cooperatives who have regrouped under the umbrella of the COPA-COGECA organization warn that the Green Deal "*will jeopardise food security, European agricultural competitiveness and farming income*" (COPA-COGECA, 2020). Most farmers' organizations have welcomed the NGEU recovery plan as a potential source of funding for the farm sector, although they regret that "*a higher percentage was not dedicated to investments that will help farmers and their cooperatives get back on the track, deal with the on-going coronavirus pandemic and plan for additional improvements in their production in line*" (COPA-COGECA, 2020).

[16] See, for example, Greenpeace arguing, in November 2919, that the "*leaked European Green deal is not up to the task*": *https://www.greenpeace.org/eu-unit/issues/climate-energy/2496/leaked-european-green-deal-is-not-up-to-the-task-greenpeace/*. From that perspective, it is relevant to note that the Greens-European Free Alliance in the EP proposes to raise the 2030 climate target, asking for a 65% reduction in European GHG emissions at that date.

3. ASSESSING THE GREEN DEAL CHALLENGES FOR EUROPEAN AGRICULTURE AND FOOD

KEY FINDINGS

- European agricultural GHG emissions have reduced since 1990; however, emissions have slightly increased stable over the most recent years. Agriculture is identified as one of the sectors in which it will be difficult to achieve further substantial GHG emission reductions without significant changes in practices, systems, activity levels and policies. From that perspective, it is also important to consider both the carbon storage capacity in agricultural soils and the potential role of changes in food diets.
- Agricultural systems that rely intensively on chemical inputs bear responsibility for the biodiversity erosion in European agro-ecosystems. This decline can also be explained by the simplification of agricultural practices and rural landscapes, and the specialisation of farms and territories. Equally concerning are the negative impacts of most agricultural systems on the quality of air, water and soil. In that context, the Green Deal targets related to pesticides, fertilizers, antibiotics, organic farming, protected areas and high-diversity landscape features are welcomed. With the notable exceptions of phosphorus and antibiotics, past trend evolutions suggest that it will be difficult to achieve other targets without substantial changes in current practices (systems) and policies.
- The development of bio-economy, notably bio-sourced energy and materials, is an essential component of the Green Deal. From an economic point of view, agriculture and food account for the largest share of the bio-economy in the EU. Because bio-economy sectors often draw on the same resources as agriculture and food, its sustainability has been questioned. From that perspective, the Green Deal rightfully stresses the importance of a circular bio-economy, which is defined as minimizing the generation of waste and maintaining the value of products, materials and resources for as long as possible. Reducing food losses and waste, as well as packaging and increasing recycling appear to be winning strategies.
- Reducing the calorie intake of European food diets and shifting to diets with less animal products could significantly reduce GHG emissions in the entire food chain. Current trends have not shown much of an improvement in the climatic impact of food diets, and only a slight improvement of dietary quality. These trends, therefore, remain largely insufficient to avoid the increase of overweight or obesity rates for European consumers.

The objective of this chapter is to highlight the size of the Green Deal challenges for the EU farm and food sectors. This will illustrate to what extent evolutions and projections of key parameters (indicators) are aligned with the Green Deal ambition, objectives and the quantitative targets related to agriculture and food. Analysis shows that large inflexions in practices and behaviours, as well as major policy changes, are required in order to achieve the Green Deal ambition related to agriculture and food.

3.1. Agriculture and climate

Even though no specific objective has been assigned to agriculture regarding the reduction of GHG emissions, climate mitigation is at the top of the agricultural agenda. Recently, the EC has made it clear that agriculture would not be spared from GHG emission reductions and that its emissions, including

non-CO_2 gas emissions, could be integrated into a new regulated sector, together with land-use changes and forestry (EC, 2020g).

Agricultural GHG emissions

According to the EEA, the inventoried GHG emissions of EU-28 agriculture reached 436 million of carbon dioxide equivalent tonnes ($MtCO_2eq$) in 2018, representing 11% of total emissions generated in the EU (EEA, 2020b). Agricultural emissions mainly stem from three gases:

- Methane (CH_4) emissions, which account for around 55% of agricultural emissions in CO_2 equivalent, come from farm animal digestion (enteric fermentation) and manure management;
- Nitrous oxide (N_2O) emissions, which account for around 43% of agricultural emissions, come primarily from nitrogen fertilization; and
- Carbon dioxide (CO_2) emissions, which represent around 2% of agricultural emissions, come from the direct use of fossil fuel, as well as from liming and fertilization.

EU agricultural GHG emissions declined by 24% between 1990 and 2013 and increased by 4% between 2013 and 2017, with similar trends for emissions from animal production and soil fertilization. Emissions fell slightly by 1.3% between 2017 and 2018 (Matthews, 2019a). Up to 2013, improvements in apparent productivities of fertilizers and animals may have increased agricultural production while reducing agricultural GHG emissions. The most recent data suggest that it is no longer the case, and that agriculture would not contribute significantly to the objective of a significant reduction in EU agricultural GHG emissions by 2030 without substantial changes in farming practices and systems, activity levels and policies.

Figure 3.1 details the different sources of agricultural GHG emissions, their composition and evolution. Cultivated soils emit most of the N_2O, which has a global warming potential over 100 years (GWP100) and is 298 times greater than that of CO_2. The main sources of N_2O emissions are linked to organic and mineral nitrogen fertilization, as well as to the incorporation of crop residues into soils and the cultivation of hydromorphic soils rich in organic matter (found mainly in Northern European countries). Livestock is the main source of CH_4 emissions; a gas with a GWP100 28 times greater than that of CO_2. Agriculture is responsible for just under 50% of EU inventoried CH_4 emissions, mainly from ruminant dairy and beef meat cattle (more than 80% of agricultural CH_4 emissions).[17] Agricultural soils marginally contribute to EU inventoried CO_2 emissions. At this stage, it is worthwhile to note that fossil fuel consumption by agricultural equipment and buildings are inventoried in the energy sector. In the same way, fossil energy used for the synthesis of chemical fertilizers is included in the industry sector.

GHG emissions linked to land-use changes

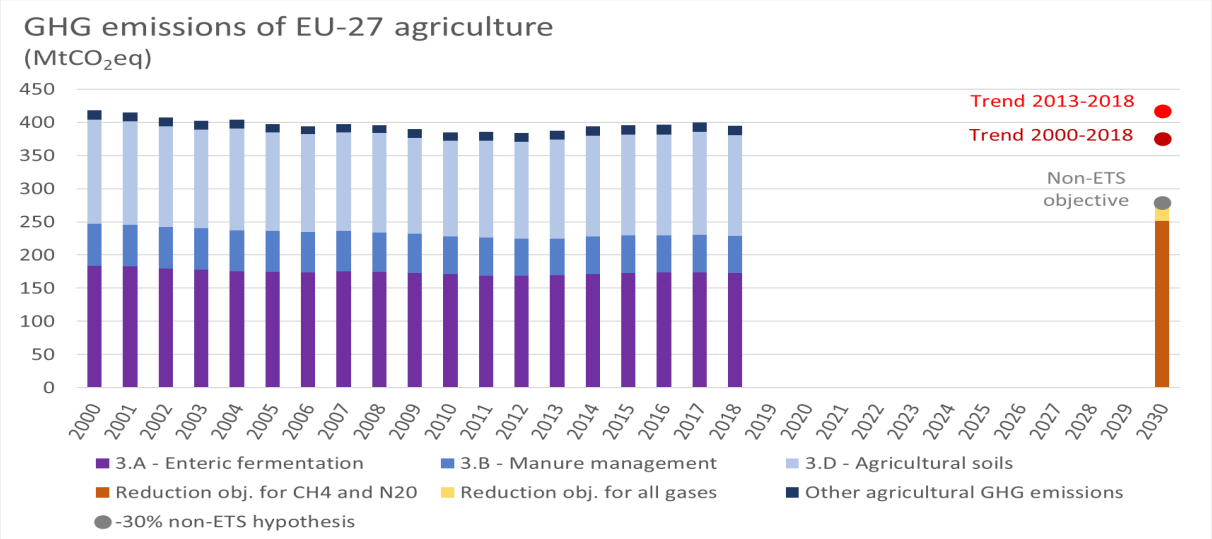
Emissions from the farm sector also arise from agricultural land-use changes. While some agricultural land conversion contributes to carbon storage, total net emissions linked to agricultural land-use changes were positive in 2017. At that time, they were equal to 30 MtCO2eq for the EU-27; that is, an amount 30% lower than in 1990. Changes include the conversions of arable land to forest or grassland, with a positive effect on soil and biomass carbon stocks, and the conversions of grassland to arable land and of agricultural land to artificial areas, this time with a negative effect on carbon stocks.

As shown in ***Figure 3.2***, the total carbon sink linked to the land use, land-use change and forestry (LULUCF) sector has been decreasing since the 2010s. Just as with agriculture, the trend suggests that there is little hope that GHG net emissions linked to LULUCF will significantly contribute to the climatic

[17] One paradox is that grass-based dairy and beef meat livestock generates more enteric methane than more intensive systems (feedlots). The latter rely in a significant way on concentrated feed that does not generate methane or generates only a little.

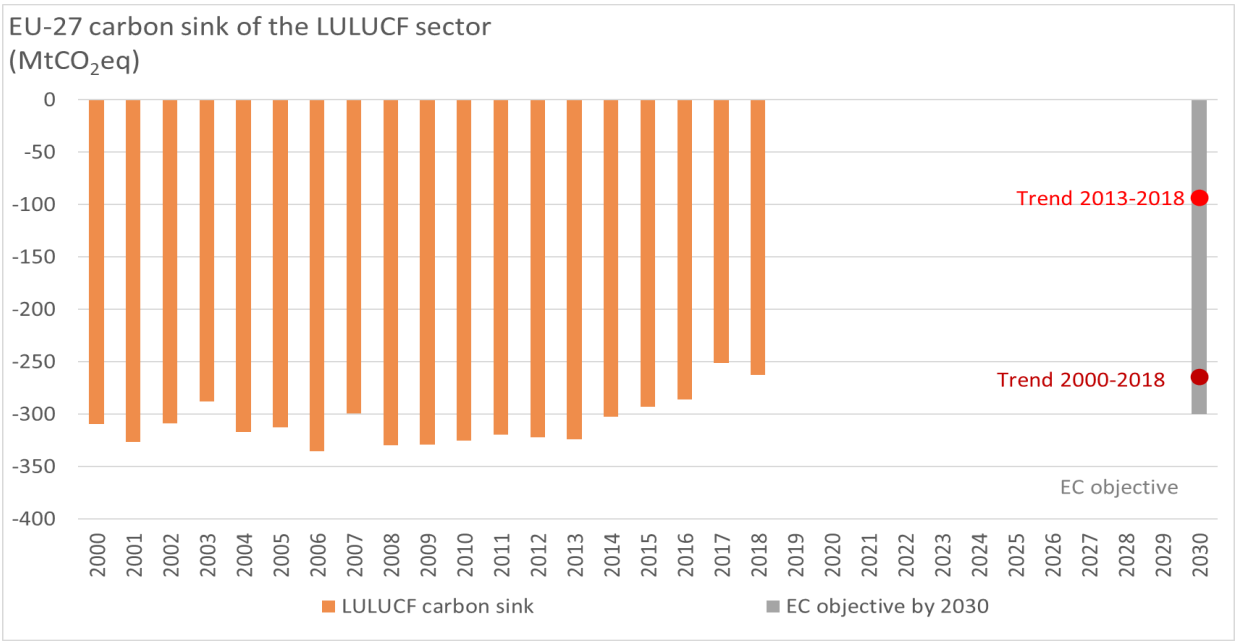
objectives of the Green Deal without important changes in land use established and supported by strong policies. Lorant and Allen (2019) reach the same conclusion.

Figure 3.1: Agricultural GHG emissions in the EU-27 in $MtCO_2eq$, evolution 2000-2018 and projections by 2030



Source: Own elaboration from data of the EEA (2019c, 2020b).
Notes: The first target in 2030 (grey point) corresponds to a 30% reduction between 2005 and 2030. It is the current legal objective for non-ETS sectors (OJEU, 2018a), however without specific objective for agriculture. The second target (orange bar) has been recently proposed by the EC for non-CO2 gases that for a large part are emitted by the farm sector (EC, 2020g). This second target is more ambitious as it implies a 35% reduction between 2015 and 2030. The two red points in 2030 correspond to linear prolongations of 2000-2018 and 2013-2018 past trends, respectively.

Figure 3.2: LULUCF net carbon sink in the EU-27 expressed in negative net GHG emissions in $MtCO_2eq$, 2000-2018 evolution and projections by 2030



Source: Own elaboration from data of the EEA (2019c, 2020b).
Notes: The target (grey bar) was proposed in September 2020 by the EC (EC, 2020g). The EC acknowledges that the LULUCF carbon sink has weakened recently and must be reinforced by 2030 to reach back -300 $MtCO_2eq$. The two red points in 2030 correspond to linear prolongations of 2000-2018 and 2013-2018 past trends, respectively.

The issue of GHG emissions linked to agricultural and food trade

One controversial issue is linked to the exclusion *versus* the inclusion of indirect GHG emissions associated with agricultural and food trade. In particular, the EU inventory approach does not take into account the GHG emissions associated with imported feedstocks. Europe imports large quantities of soya (for animal feed) and palm oil (for human consumption). These imports induce not only direct GHG emissions abroad, but also, potentially, indirect GHG emissions linked to land-use changes that can be substantial when there is also deforestation. The issue is, of course, to rigorously evaluate the whole carbon footprint of EU agriculture, and more generally, of the EU food system, from production to consumption, taking into account agricultural and food imports and exports. From this perspective, it is also important to consider any "*carbon leakage*" associated with, for example, a reduction in European livestock that could be compensated for by an extension of imports of animal products from non-EU countries. From a policy point of view, the carbon border adjustment mechanism envisaged by the EC in the framework of the Green Deal may then be justified for two reasons: first, to avoid any carbon leakage; and second, to ensure a carbon-fair level playing field between European countries and foreign competitors. This point will be discussed in detail in Chapter 5.

Understand past evolutions to assess the difficulties in reducing agricultural GHG emissions in the future.

Figure 3.1 displays the agricultural GHG emissions in 2030 according to two assumptions. The first is based on the linear prolongation of the 2000-2018 slightly-decreasing trend, while the second prolongs the 2013-2018 slightly-increasing trend. In both cases, agricultural GHG emissions would be much higher that the target defined here, either as a 30% reduction between 2005 and 2030 (the objective for non-ETS sectors; OJUE, 2018a) or as a 35% reduction between 2015 and 2030 (the objective recently proposed by the EC for non-CO2 gases; EC, 2020g). This comparison clearly shows that simply following past trends will not achieve the significant reductions in agricultural GHG emissions currently sought.

Past and future evolutions of agricultural GHG emissions essentially depend on three factors: first, the composition of output mix with more on less GHG intensive production; second, production levels for each output; and third, changes over time of GHG emissions per unit of output. The principal factor that explains the decline in agricultural GHG emissions between 1990 and the early 2010s is the sharp reduction in cattle numbers, especially in Central and Oriental European MS. Other explanatory factors include the improved conversion of feedstuffs into animal products and more efficient nitrogen fertilization techniques (Eurostat, 2013; Matthews, 2019a). During the first half of the 1990-2013 period, production prices of arable crops fell under the combined effect of the CAP reforms (lower guaranteed prices) and depressed agricultural world prices leading to reduced market incentives to use high levels of mineral fertilizers per hectare. In the 2000s, mineral fertilizer prices rose, encouraging a more parsimonious and efficient use. By capping organic fertilization possibilities, the Nitrates Directive introduced in 1991 (OJEC, 1991) also contributed to the decrease in the use of total nitrogen inputs and associated N_2O emissions throughout the 1990s. Between 2005 and 2015, increases in the ratio of cereal to fertilizer prices played in the opposite direction by encouraging the use of higher levels of mineral fertilizers per hectare. The increase in agricultural GHG emissions from the middle of the 2010s can be, at least partially, explained by the export-led growth of animal production in several MS (Dumont et al., 2019; Eurostat, 2020a).

This descriptive analysis of the explanatory factors of the past evolutions of agricultural GHG emissions suggests that it will be difficult to substantially reduce emissions unless animal production levels are markedly reduced and crop production systems use significantly less fertilizers.

3.2. Agriculture and the environment

Numerous reports and academic papers document the environmental degradation of European agro-ecosystems that can be illustrated in many ways. A large part of the decline in European birds has been attributed to decreases in the number of farmland birds (-20% within 30 years) induced by agricultural intensification (Inger et al., 2014). The biodiversity loss has also been reflected in the decline of all flying insects, including in protected areas that have experienced a loss of more than 75% over slightly more than a quarter of a century (Hallmann et al., 2017). The IUCN[18] European Red List of Bees (Nieto, 2014) reveals that over 9% of European bee species are facing extinction. Equally concerning are the negative impacts on the air, water and soil compartments. In 2019, only 40% of surface water achieved good chemical status (good or more). Pressures exerted on water resources by irrigation are highly significant in the South of the EU and, depending on the year, in a much larger number of MS throughout summer months (EEA, 2019a). Soil erosion affects about 13% of EU arable land, more importantly, in Southern MS (EEA, 2019a). In addition, European feed and food systems have negative climatic and environmental impacts outside the continent, being notably responsible for part of the global deforestation trend by means of imports of meat, soya and maize for animal feed, palm oil, cocoa, etc. According to the most recent estimates, the EU would be responsible for around 10% of global deforestation through the import of several products; mainly timber, rubber, cocoa, meat, maize, soya and palm oil (EC, 2019c).

In this rather negative context, the next sub-section analyses past evolutions and proposes trend projections for several quantitative environmental targets of the Green Deal with an interest in agriculture.

3.2.1. Pesticides

The quantitative targets set out by the Green Deal aim to reduce the overall use and risk of chemical pesticides by 50% in 2030, and the use of more hazardous pesticides by 50% by 2030. From that perspective, the F2FS underlines that "*[t]he Commission has already established a Harmonized Risk Indicator to quantify the progress in reducing the risks linked to pesticides. This demonstrates a 20% decrease in risk from pesticide use in the past five years*" (EC, 2020c).

Figure 3.3 displays the evolution of pesticide sales in the EU-27 between 2011 and 2018. Sales are globally constant. As a result, a prolongation of the 2011-2018 trend will clearly be at odds with the 50% reduction target related to the use of pesticides in the EU.[19]

EU average figures mask some important disparities among MS. While sales of pesticides have experienced significant increases between 2001 and 2018 in some MS, such as Cyprus, Austria, France and Slovakia, sales have substantially declined in other MS, such as Portugal, Denmark, Ireland, the Czech Republic and Italy (***Figure 3.4***). These contrasted evolutions between MS raise the issue of setting national targets in CAP national strategic plans (here, in the specific case of pesticides), in a context where not only national evolutions are contrasted but also where absolute levels of pesticides (per hectare of agricultural land and in total) vary considerably between the different MS. This issue of effort sharing among the different MS applies to all quantitative targets of the Green Deal that are currently only defined at the EU level. A second issue, which also applies to fertilizer and antibiotic targets, is the

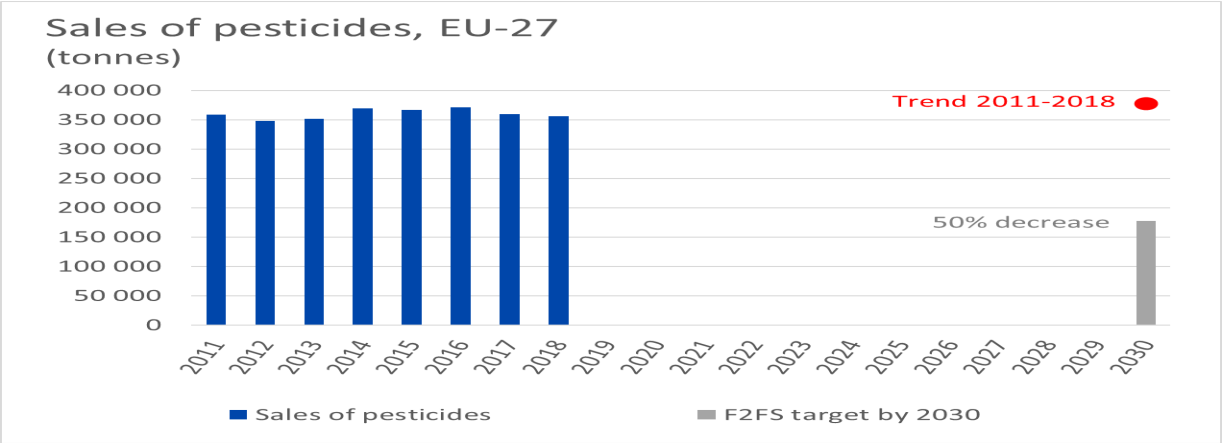
[18] IUCN for International Union for Conservation of Nature.

[19] Eurostat data used to construct Table 3.3 correspond to sales of active substances contained in plant protection products placed on EU markets. They do not exactly correspond to the use of active substances. FAO data report the quantities of pesticides (in tons of active substances) used in or sold to the agricultural sector for crops and seeds; they do exhibit a similar increasing trend than sales over the most recent years, after declining from 2000 to 2010 (Buckwell et al., 2020).

choice of the date or reference period from which reductions must be calculated. A third issue is related to the choice of indicators.

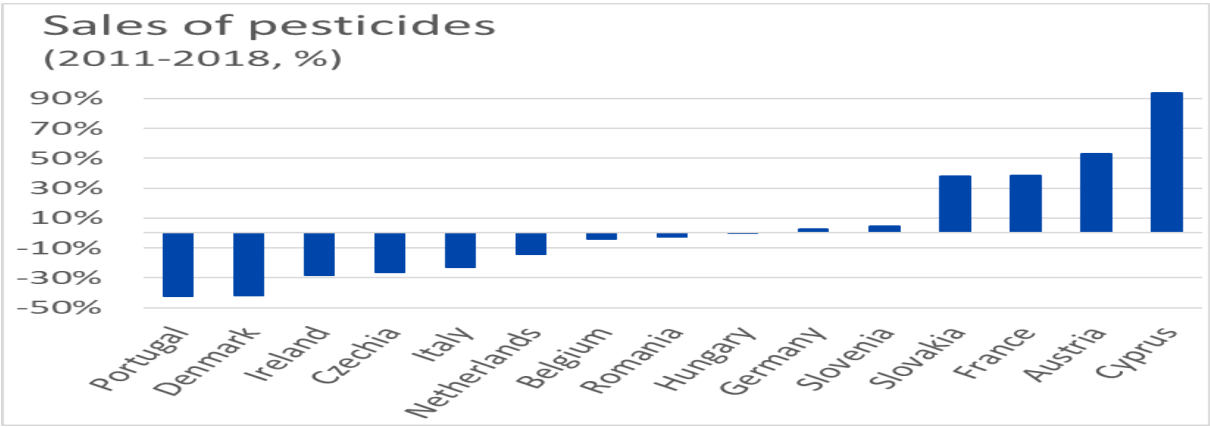
The Harmonized Risk Indicator 1 (HRI 1) is based on quantities of active substances in plant protection products on EU markets under Regulation (EC) No 1107/2009 (OJEU, 2009c). Substances are classified in four groups as categorized in Commission Directive (EU) 2019/782 (OJEU, 2019c). Each group is multiplied by a weighting factor depending on its toxicological profile. The index is calculated relative to the average for the three years 2011-2013. According to Eurostat data,[20] it appears that the 17% HRI 1 decrease in 2018 was essentially driven by the decline of substances of the fourth group, that is, non-approved active substances with a very high weight. For the three other groups, the index increased. In particular, active substances of group 3 (substances "*candidates for substitution*" corresponding to the most hazardous pesticides approved and used), increased by 9% in 2018, relative to 2011-2013.

Figure 3.3: Sales of pesticides in the EU-27 in tons, 2011-2018 evolution and projections by 2030



Source: Own elaboration from Eurostat data (Eurostat, 2020b, 2020f).
Notes: The 2030 target (grey bar) corresponds to a 50% reduction of sales from the 2018 base year. Six major groups of substances were considered: "*Fungicides and bactericides*", "*Herbicides, haulm destructors and moss killers*", "*Insecticides and acaricides*", "*Molluscicides*", "*Plant growth regulators*", and "*Other plant protection products*". The red point in 2030 corresponds to the linear prolongation of the 2011-2018 trend.

Figure 3.4: Evolution of pesticide sales in selected MS over the 2011-2018 period, in percent



Source: Own elaboration from Eurostat data (Eurostat, 2020f).
Note: Six major groups of substances were considered; that is, "*Fungicides and bactericides*", "*Herbicides, haulm destructors and moss killers*", "*Insecticides and acaricides*", "*Molluscicides*", "*Plant growth regulators*", and "*Other plant protection products*".

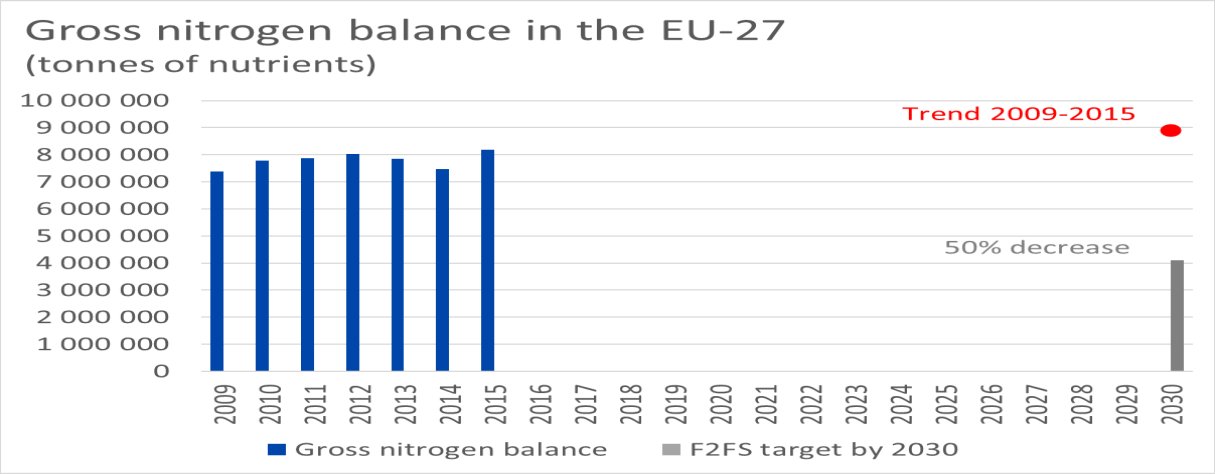
[20] *https://ec.europa.eu/eurostat/databrowser/view/AEI_HRI__custom_125817/default/table?lang=en.*

3.2.2. Fertilizers

A Green Deal target set out in both the EU Biodiversity Strategy for 2030 and the F2FS concerns the reduction of nutrient losses (nitrogen and phosphorus) by at least 50% by 2030, while ensuring that there is no deterioration in soil fertility. According to the EC, this target will reduce the use of fertilizers by at least 20% by 2030 (EC, 2020c).

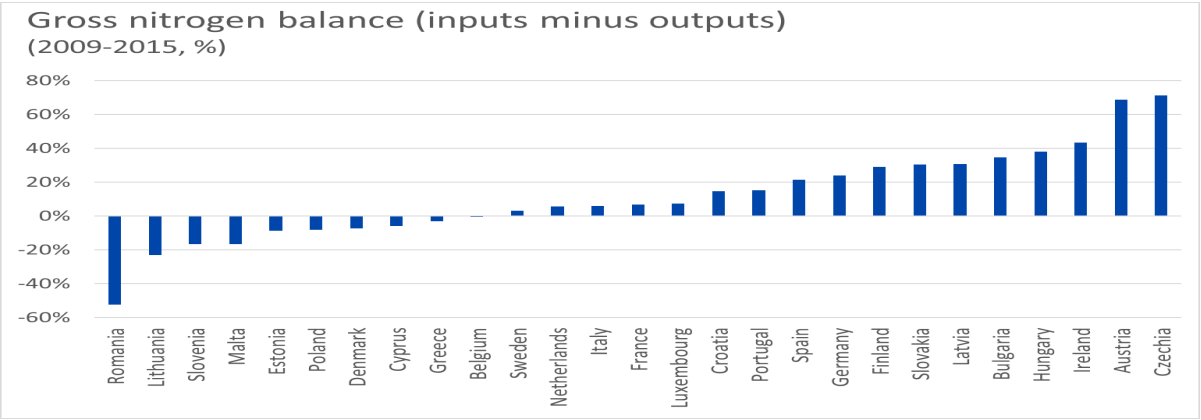
The EU-27 nitrogen balance increased 7.4 million tonnes in 2009 to 8.2 million tonnes in 2015 (***Figure 3.5***). As for pesticides, the prolongation of the 2009-2015 trend will lead to a nitrogen balance in 2030 at odds with the target of a 50% reduction in nitrogen losses at that date.[21] As for pesticides, the EU average figure masks contrasted evolutions of fertilizer uses among MS, from more than -50% in Romania to +70% in Czechia between 2009 and 2015 (***Figure 3.6***). As in 2009, the 2015 gross nitrogen balance varied very substantially from one MS to another (***Figure 3.7***).

Figure 3.5: Gross nitrogen balance in the EU-27 in tons of nutrients, 2009-2015 evolution and projections by 2030



Source: Own elaboration from EEA and Eurostat data (EEA, 2018; Eurostat, 2020d).
Note: The 2030 target (grey bar) corresponds to a 50% decrease from the 2015 base year. The red point in 2030 corresponds to the linear prolongation of the 2009-2015 trend.

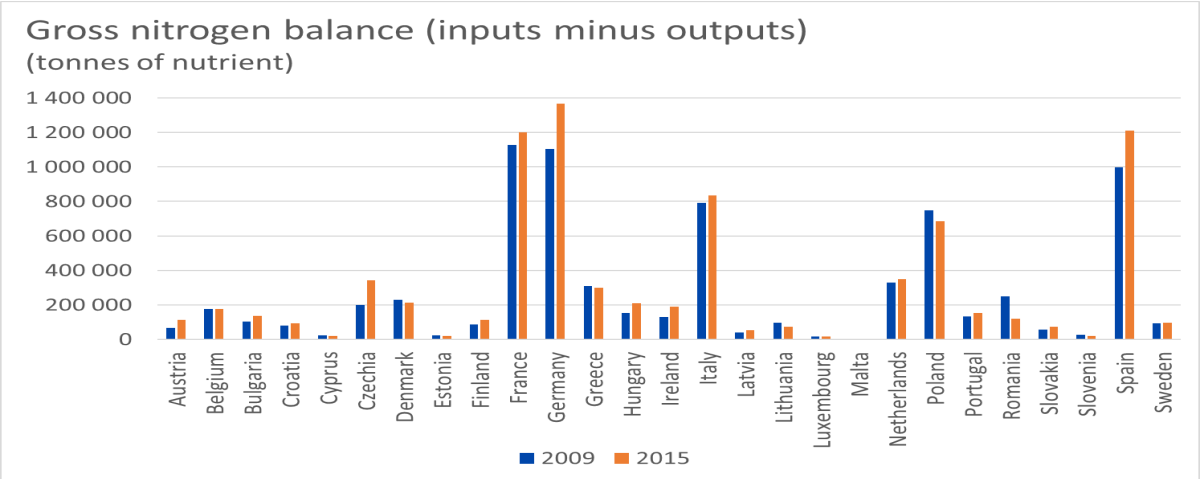
Figure 3.6: Evolution of the gross nitrogen balance in the 27 MS between 2009 and 2015, in percent



Source: Own elaboration from Eurostat data (Eurostat, 2020d).

[21] Calculations based on the EU gross nitrogen balance per hectare of utilised agricultural area exhibit a similar pattern.

Figure 3.7: Gross nitrogen balance in the 27 MS in 2009 and 2015, in tons of nutrients



Source: Own elaboration from Eurostat data (Eurostat, 2020d).

Unlike nitrogen, phosphates are non-renewable resources essentially supplied by five countries that hold 90% of the world's reserves. Their use in agriculture, and in other activities, contribute to surface and seawater pollution, with dramatic impacts in some areas (for example, hypoxia in the Baltic Sea). Moreover, phosphate resources could become limited in the future because of an increasing agricultural demand (FAO, 2015). In the EU, Eurostat data suggest that the gross phosphorus balance decreased significantly from at least the mid-2000s, from 3.9 kilogram of nutrients per hectare of utilised agricultural area in 2004-2006 to 1.2 kilogram of nutrients per hectare of utilised agricultural area (Eurostat, 2020d).[22]

3.2.3. Antimicrobials

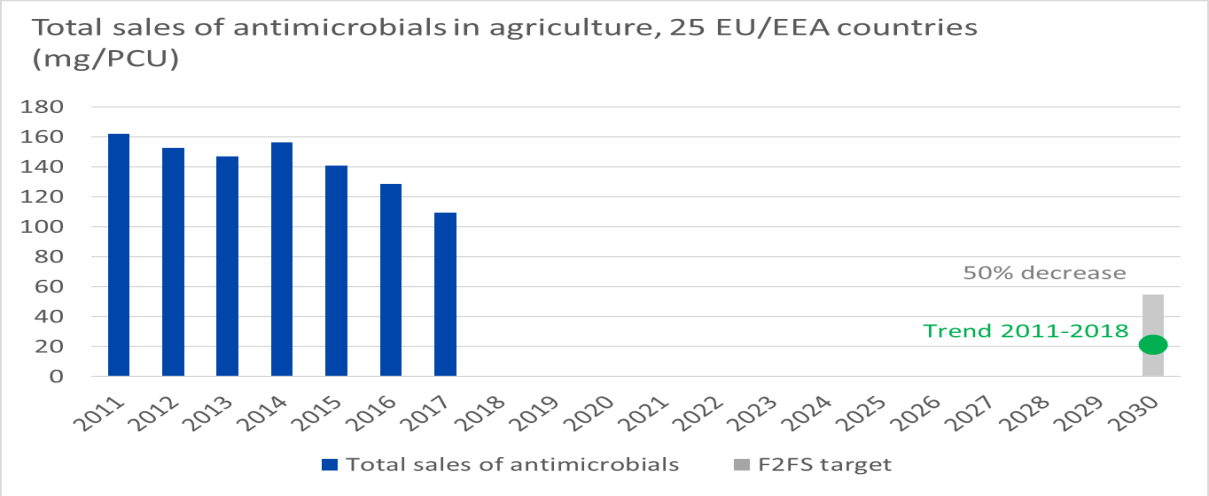
The F2FS target is to reduce overall EU sales of antimicrobials for farmed animals and in aquaculture by 50% by 2030 (EC, 2020c). It is worth noting that the Green Deal communication addresses the issue of "*antibiotics*" (EC, 2019a) while the F2FS addresses the issue of "*antimicrobials*". The former are used against bacteria while the latter cover a larger spectrum, including drugs to treat infections caused by other microbes, such as parasites, viruses and fungi.

In this domain, significant progress has been made over the two last decades. Among the 25 European countries (within the EU and outside) that have provided data, overall sales of antimicrobials have decreased by around 33% from 2011 and 2017, and the EU as a whole could be on track to reach the reduction target by 2030 (***Figure 3.8***). Important reduction margins exist in the MS where sales of antimicrobials, expressed in milligrams per population correction unit (mg/Population Correction Unit or PCU),[23] are still very important, for example, in Italy and Spain (***Figure 3.9***). Over the past years, decreases in sales can be partly explained by restrictions that the EU has imposed on the use of growth-promoting antibiotics (antibiotics provided to healthy animals at a low concentration in order to foster production). A further continuation of the decline may require cutting the use of therapeutic and prophylactic antibiotics. This, however, is likely to raise technical difficulties and induce higher costs.

[22] A phosphate is a salt of phosphoric acid. Inorganic phosphates are mined to obtain phosphorus for use in agriculture and industry.

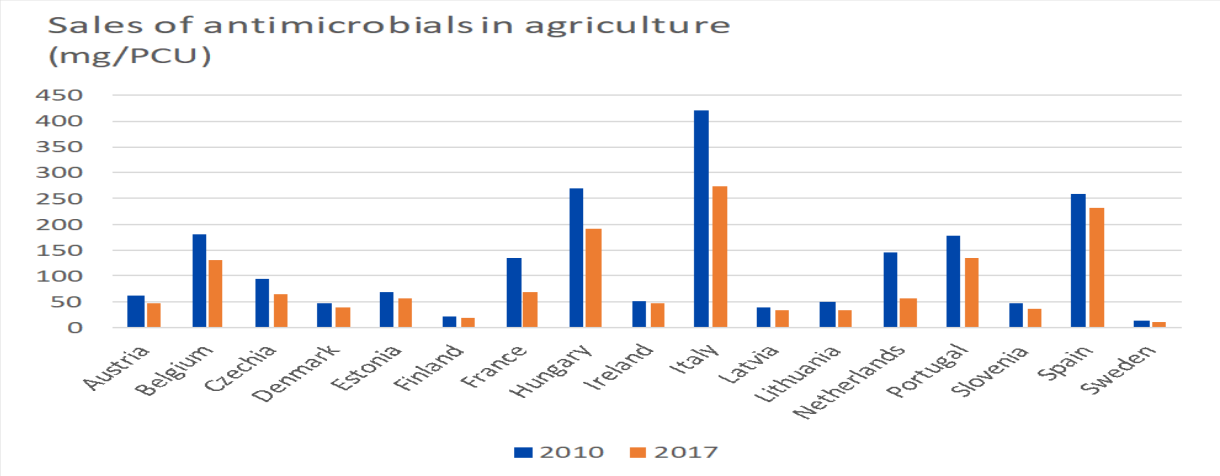
[23] This unit of measurement has been developed by the European Medicines Agency (EMA) to monitor antimicrobial use and sales across Europe. The denominator takes into account the animal population and the estimated weight of each category of animals at the time of treatment with antimicrobials.

Figure 3.8: Total sales of antimicrobials in agriculture, for 25 EU/EAA countries, in mg/PCU, 2011-2017 evolution and projection by 2030



Source: Own elaboration from data of the EMA (EMA, 2019).
Notes: The 2030 target (grey bar) corresponds to a 50% reduction from the 2017 base year. The green point in 2030 corresponds to the linear prolongation of the 2011-2018 trend. The 25 EU/EEA (EEA here for Economic European Area) are Austria, Belgium, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. Mg/PCU for milligrams per population correction unit.

Figure 3.9: Sales of antimicrobials in agriculture in various MS, in mg/PCU, in 2010 and 2017



Source: Own elaboration from data of the EMA (EMA, 2019).
Notes: Mg/PCU for milligrams per population correction unit.

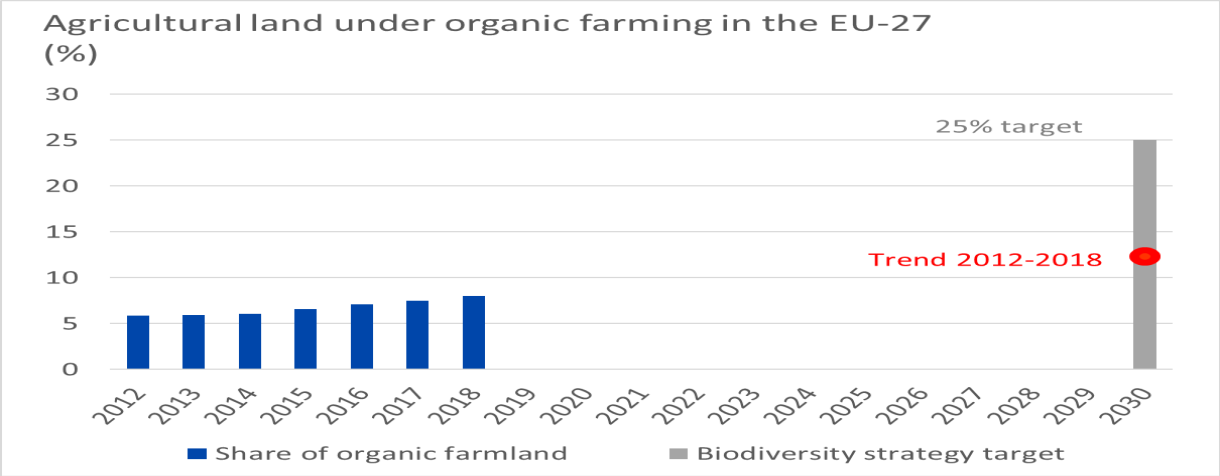
3.2.4. Organic farming

Under the provisions of the EU Biodiversity Strategy for 2030, at least 25% of the EU's agricultural land must be under organic farming by 2030, while organic aquaculture must increase significantly (EC, 2020b).

At the EU-27 level, the share of land under organic farming was equal to 8% in 2018 (***Figure 3.10***). This share has been continuously increasing over the past years. In 2012, it was equal to 5.9%. The linear prolongation of the 2012-2018 trend would allow the EU to reach a share of 12.3% by 2030; that is, a percentage that would be far below the 25% target. To reach this target, the EU should more than triple its 2018 share of agricultural land under organic farming. This ambition is perhaps not out of reach given the rapid progression of organic farming in several MS over the most recent years. In addition, it

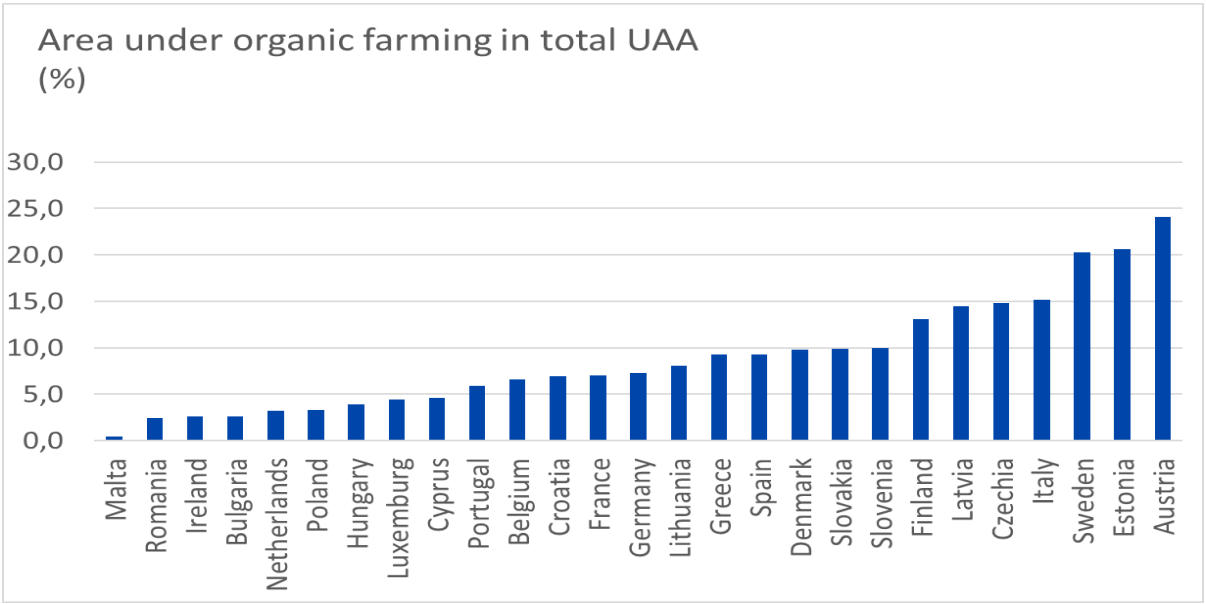
is important to note that the current shares of agricultural land under organic farming vary substantially from one MS to another (***Figure 3.11***).

Figure 3.10: Share of agricultural land under organic farming in the EU-27, 2012-2018 evolution and projection by 2030



Source: Own elaboration from Eurostat data (Eurostat, 2020g).
Notes: The target (grey bar) corresponds to a share of agricultural land under organic farming equal to 25% in 2030. The red point in 2030 corresponds to the linear prolongation of the 2012-2018 trend.

Figure 3.11: Share of agricultural land under organic farming in the different MS in 2018



Source: Own elaboration from Eurostat data (Eurostat, 2020g).
Note: UAA for Utilized Agricultural Area.

The capacity of the EU, and of its different MS, to reach the target set out for organic farming is a central issue. Indeed, any significant increase in the share of agricultural land under organic farming will contribute (by definition of its technical specifications that prohibit the use of chemical pesticides and mineral fertilizers, and severely restrict the use of antibiotics in livestock) to reducing the total use of chemical pesticides, mineral fertilizers and antibiotics. For GHG emissions, the outcome is less clear if organic farming expansion requires the total agricultural area in the EU to be expanded or agricultural imports from third countries to be increased for the purpose of maintaining unchanged production and consumption levels in the EU. This is because the GHG emissions produced by organic agriculture

are lower per hectare, but generally higher per kilogramme of product, compared to "*conventional*" agriculture.[24]

As already mentioned, achieving the target for organic farming is perhaps not yet out of reach. Organic farming has rapidly expanded in numerous MS. It remains low, and even very low, in several countries, with resulting large margins of progress. In many locations, current farming systems are not far from meeting organic requirements, notably in mountains and extensive grass-based areas. However, it will be more difficult to reach a sizeable share of agricultural land under organic farming in areas where intensive agriculture dominates, and where expanding organic production would likely have greater positive impacts on biodiversity, water quality and soil fertility. In practice, any large-scale expansion of organic farming raises three main issues. First, the technical dimension is notably related to the capacity of reducing current gaps between organic and "*conventional*" yields. Next, the economic dimension is notably linked to the numbers of consumers who are willing to pay price premiums for organic products, and last, the political dimension is linked to the support of organic farming in the future CAP.

3.2.5. Protected areas and restoring agro-ecosystems

As part of the EU Biodiversity Strategy for 2030, an enlarged coherent network of protected areas is promoted, involving: first, the legal protection of a minimum of 30% of EU land area; second, the strict protection of a minimum of 10% of EU land area; and third, the establishment of ecological corridors. MS must also ensure that there is no deterioration in conservation trends and status by 2030 of all habitats and species listed under the Birds and Nitrates Directives, and that there is an improvement for at least 30% of habitats and species not currently at a favourable status (EC, 2020b). The restoration of ecosystems across land and sea is also covered by a commitment in the F2FS to bring back "*at least 10% of agricultural area under high-diversity landscapes features*", including, among other elements, "*buffer strips, rotational and non-rotational fallow land, hedges, non-productive trees, terrace walls, and ponds*". In addition, each MS will translate "*the EU target to a lower geographical scale to ensure connectivity among habitats*" (EC, 2020c).

Today, legally protected areas represent 26% of total EU land area (18% for areas under the Natura 2000 network and 8% for areas under national schemes). The gap with the corresponding Green Deal target is thus equal to 4 percentage points. The gap is much higher for the target related to strictly protected areas, as these areas are currently equal to only 3%.[25] As regards the status of habitats and species, trends are rather pessimistic, although there is an extension of habitat protection in some MS. Habitats at an unfavourable status have increased from 68.7% in 2007-2012 to 72.1% in 2013-2018.[26] This percentage should decrease to 50.5% by 2030 in order to achieve the target of the EU Biodiversity Strategy for 2030 related to habitat status (***Figure 3.12a***). In the same way, species at an unfavourable status (that were globally constant between 2007-2012 and 2013-2018), should decline to 38.5% by 2030 in order to reach the target related to species' status (***Figure 3.12b***). In these related domains, reaching the Green Deal objectives and targets will require voluntary policies, and for all of the items

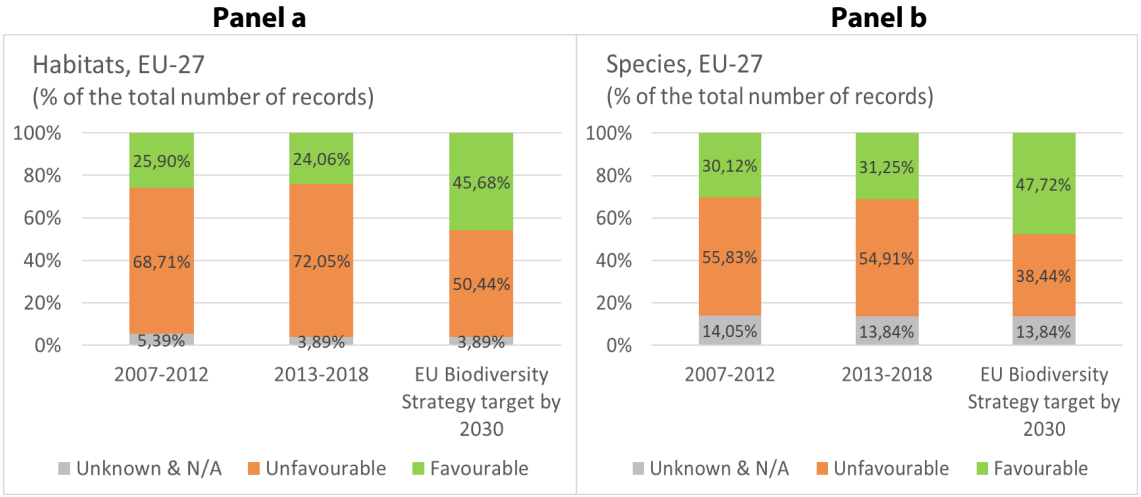
[24] An important, albeit often overlooked debate is whether it is preferable to expand organic (or low input agriculture) in all areas, or to concentrate expansion in particular regions and/or for particular products. This relates to the debate on "*land sharing*" *versus* "*land sparing*" among conservationists. Some argue that one way to protect the environment is to dramatically increase yields in the most productive areas in spite of environmental consequences, in order to free resources for ambitious conservations policies. Others argue that their pollution spill overs are not local and expand through air and water, and that sacrificing the environment in particular areas is not a satisfactory option, even if the goal is to promote stricter conservation in other areas. The overall impact of the two strategies is discussed in the scientific literature, which shows that the most efficient conservation policy depends on the shape (degree of concavity) of the response function of biodiversity to the intensification of farm production, which is specific to each taxon (Phalan, 2018).

[25] Percentages drawn from the EU Biodiversity Strategy for 2030 (EC, 2020b).

[26] For both habitats and species, figures in 2007-2012 and 2013-2018 are not strictly and directly comparable because methods have changed, and data quality has improved.

listed, the two issues related to their definition and the setting of thresholds will be particularly important, with the risk of "*watered down*" definitions and protection criteria potentially allowing a lax commitment to "*reach objectives and targets*".

Figure 3.12: Status of habitats and species in the EU-27, past evolutions and Green Deal targets for 2030



Source: Own elaboration from data of the EEA (EEA, 2019b).
Note: Figures in 2007-2012 and 2013-2018 are not strictly and directly comparable because methods have changed and data quality has improved. Records (or assessments) refer to single assessments made by a MS in one biogeographical region. As a result, on species or habitat type occurring in more than one biogeographical region in one MS can have more than one assessment. For definitions, see OJEC (1992).

Assessing the share of agricultural area under high-diversity landscape features is difficult, notably because the Green Deal does not precisely define what constitutes a high-diversity landscape feature. From that perspective, one issue of the future CAP is to encourage farmers to declare such features for all agricultural areas and not only for areas under arable crops. This point will be further detailed in Chapter 5. However, lessons can be drawn from data related to Ecological Focus Areas (EFA) within the framework of the greening requirements of the current CAP. These data present numerous limitations: for example, they are not available for all MS, and their quality varies significantly from one MS to another (EC, 2017a). In addition, they cover 70% of EU arable land only, as the EFA greening requirement applies only to arable crops with exemptions. According to these data, 13% of EU arable land was declared as EFA in 2015. Three types of EFA corresponding to productive or potentially productive agricultural land uses accounted for 96% of total EFA; that is, nitrogen fixing crops, catch crops and lands lying fallow. Thus, areas dedicated to other EFA types, such as buffer strips, hedges or trees, were only marginal. In other words, at least for arable crops, the share of agricultural land devoted to actual high-diversity landscape features is very low, much lower that the Green Deal target of 10%.

3.3. Promoting a circular bio-economy

3.3.1. The EU bio-economy

The Green Deal sees circular economy principles as being of major importance for achieving sustainable food systems whereby all actors of the food chain, from producers to consumers, play a crucial role. The Circular Economy Action Plan, published by the EC in March 2020, includes one section devoted to food, water and nutrients (EC, 2020d). It distinguishes actions supporting the sustainability of renewable bio-based materials, the reduction of food waste, packaging and reusable products in food services, water and reuse efficiency (including in processing), and a nutrient management plan.

In the 2018 Bio-economy Action Plan, the EC considers that "*a sustainable bio-economy is the renewable segment of the circular economy*" (EC, 2018a).

The circular bio-economy is highlighted in the F2FS, where it is considered as an essential vector to facilitate the transition towards more sustainable food systems through the development of carbon-neutral food chains, the reduction of food packaging and food waste, the development of bio-refineries, bio-fertilisers, protein feed, bioenergy, bio-chemicals, etc. However, the F2FS explicitly establishes only one quantitative target related to the EU commitment to halve per capita food waste at retail and consumer levels (according to Sustainable Development Goal (SDG) 12.3).

The term "*bio-economy*" can have different interpretations. For the EC, it covers all sectors that rely on biological resources (animals, plants, microorganisms and derived biomass, including organic waste), their functions and principles. It includes the services provided by land and marine ecosystems, primary production sectors (agriculture, forestry, fisheries and aquaculture), as well as economic sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. Currently, agricultural production and the manufacture of food, beverages and tobacco dwarf the other elements of the bio-economy, even though bio-based chemicals and plastics have a significant economic weight (***Table 3.1***). In 2015, the value added of the bio-economy was equal to around €173 million for agriculture and to around €233 million for the manufacture of food, beverages and tobacco (Kuosmanen et al., 2018).

Table 3.1: Contribution of bio-economy sectors to the bio-economy labour market, turnover and value added, in percent, EU-28, 2015

Sectors	Workers	Turnover	Value added
Agriculture	51.0	16.8	28.0
Forestry	3.0	2.2	3.8
Fishing	1.2	0.5	1.1
Manufacture of food, beverages and tobacco	25.1	51.0	37.6
Manufacture of bio-based textiles	5.6	4.6	4.7
Manufacture of wood products and furniture	7.8	7.7	7.6
Manufacture of paper	3.6	8.3	7.3
Manufacture of bio-based chemicals, pharmaceuticals, plastics and rubber (excluding biofuels)	2.5	7.8	9.1
Manufacture of liquid biofuels	0.1	0.5	0.4
Production of bioelectricity	0.1	0.5	0.4

Source: JRC (*https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html*).

In the 2018 Bio-economy Action Plan, biomass is projected to play an important role in meeting the climate targets set at the Paris Agreement, as way for some industries (chemicals, road transportation, airlines) to replace fossil fuel with renewable resources and reduce GHG emissions. However, the biomass potential to contribute to the Green Deal objectives is controversial (Pfau et al., 2014). The industrial bio-economy, for example, can cause direct and indirect land-use changes, and require the use of techniques with more intensive applications of chemical inputs, thereby generating GHG emissions and other pollutants; an issue that has been particularly documented in the case of biofuels (Valin et al., 2015). More generally, imports of biomass and biomaterials for the EU bio-economy (paper pulp, woodchips, palm oil, soybean, etc.) have negative consequences for ecosystems in distant places, through imported deforestation and biodiversity loss ("*pollution leakages*"). Indeed, the EU is a net-importer of the four major natural resource categories; materials, water, carbon and land. It has been estimated that, because of the high per capita cropland footprint, expanding the European bio-

economy is highly dependent on agricultural areas in other world regions, notably in Asia and South America. In addition, the EU uses increasingly non-food biomass feedstocks from tropical regions, which have been identified as "*hotspots*" of both deforestation and biodiversity loss. O'Brien et al. (2017) and Bruckner et al. (2019) stressed that the dependence of EU consumption on foreign land areas is particularly high for non-food sectors. They found that while 86% of the land used to satisfy domestic food demand was located in the EU, only 35% of the land providing non-food products to the region is cultivated within the EU, resulting in net imports of up to 18 million hectares per year.

With the "*circular bio-economy*" concept, the EC intends to avoid potential negative impacts of the EU bio-economy strategy on the environment, both in the EU and abroad. A "*circular bio-economy*" is defined as minimizing the generation of waste, and maintaining the value of products, materials and resources for as long as possible. From that perspective, the EC has introduced some provisions in the Renewable Energy Directives, notably for biofuels. However, there is evidence that because of the "*domino effect*" between sectors (biofuels, food, cosmetics, detergents) and the fact that some of them are not constrained, sustainability criteria imposed on one particular sector, such as biofuels, have only a limited impact (Bellora et al., 2020). Environmental groups have also raised questions as to the effectiveness of environmental certifications, for palm oil as well as for forest stewardship. The strategy of encouraging the use of waste as a source of biomass also requires close monitoring. For example, the price gap introduced by the "*double counting*" of biofuels made from used cooking oil against the blending mandate (included in the Renewable Energy Directives) may provide incentives to heat palm oil so as to make it eligible for double counting as used cooking oil, with a resulting poor environmental balance. While such a phenomenon may be anecdotal, it shows the difficulty of ensuring that any bio-economy expansion will remain circular.

3.3.2. Food losses and waste, packaging and recycling

Food losses and waste

Reducing food losses and waste[27] is a world issue of major importance, as illustrated by the 2019 FAO report on "*The State of Food and Agriculture*" that was specifically devoted to this question (FAO, 2019) or the inclusion of the latter in the SDG. More specifically, SDG 12.3 calls for "*halving per capita global food waste at the retail and consumer levels and reducing food loss along production and supply chains (including post-harvest losses by 2030*". Reducing food losses and waste also has the potential to contribute to several SDG, notably SDG 2 ("*zero hunger*"), SDG 6 ("*sustainable water management*"), SDG 13 ("*climate change*"), SDG 14 ("*marine resources*") and SDG 15 ("*terrestrial ecosystems, forestry, biodiversity*").

Data and research results on food losses and waste show considerable inconsistencies in the size of the phenomenon. At the world level, some authors estimate that one-third of total food production is lost and wasted along the whole food chain, from production to consumption (Gustavsson et al., 2011). This suggests that diminishing food losses and waste could play a considerable role in reducing the environmental footprint of agriculture and food. Scenarios for the EU indicate considerable potential for reducing GHG emissions through the reduction of food losses and waste at the different stages of the food chain (Rutten et al., 2013). However, other authors point out that food losses and waste have been overstated because of measurement problems (Bellemare et al., 2017). In addition, while major food losses and waste seem to occur at the immediate post-harvest stages in developing countries, in

[27] Food losses refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Strictly speaking, food losses occur thus at production, post-harvest and processing stages in the food supply chain (Parfitt et al., 2010). Food losses occurring at the end of the food chain, at the retail and final consumption stages, are rather called "food waste" (Parfitt et al., 2010; Gustavsson et al., 2011).

developed countries like the EU, food losses and waste occur mainly at the distribution stage and, more importantly, at the final consumption stages (Parfitt et al., 2010). On the one hand, this shows that there is indeed a high potential for environmental benefits, since food lost and wasted by households at the end of the supply chain means that energy and materials put into production, processing, transportation, cooling and preparation have been in vain. However, this also means that reducing food losses and waste will require a complex set of policies, given the multiple causes that have been identified as determinants of food losses and waste at the household level (Shanes et al., 2018).

Quantifying food losses and waste in the EU is controversial. One reason is the lack of harmonised definition and methodology across MS. Vanham (2015) estimated that food losses and waste account for around 16% of all food-reaching consumers. Stenmarck et al. (2016) obtained a higher estimation of around 20%; that is, 173 kilogrammes per capita per year. Sectors contributing the most are household consumption (53%) and processing (19%), with the production sector accounting for only 11%. Despite these discrepancies, it appears that reducing food losses and waste could in fact diminish the negative environmental impact of the food system, and allow, for example, more environmentally friendly production techniques without displacement or leakage effects, "*simply*" by reducing demand. Food losses and waste are particularly important for specific goods, such as fruit and vegetables. While a reduction in such losses and waste could save significant resources, estimating the global impact in terms of calories, as well as the potential availability of waste material for bio-based industries, remains difficult to assess. From that perspective, Britz et al. (2019) propose a general framework aimed at analysing the climatic, environmental and economic impacts of reducing food losses and waste in the EU.

Packaging and recycling

According to Eurostat data, each European citizen (UE-27) has generated 174 kilogrammes of packaging waste in 2017, with large differences among MS (from 64 kilogrammes per capita in Croatia to 231 kilogrammes per capita in Luxemburg). National gaps suggest that significant savings could be achieved by adopting the most virtuous standards and practices. Paper and cardboard were the main types of waste at the EU level, followed equally by plastic and glass. Between 2007 and 2017, the recycling of paper and cardboard packaging rose from 59 to 67%, again with important differences depending on the MS. Recycling rates are the highest in Belgium and the Netherlands, and the lowest in Malta and Hungary. Regarding plastic packaging, the recycling rate is lower than 40% throughout MS, with a particularly low performance in France, Malta and Estonia, and higher recycling rates in Bulgaria and Lithuania (Eurostat, 2020c).

Overall, reducing losses and waste, as well as packaging, and increasing recycling should be encouraged in order to favour the transition towards more sustainable food systems relying explicitly on circular bio-economy principles. This will require significant changes in current practices and behaviours, accompanied by voluntary policies. Large margins of improvement appear to exist, given the considerable discrepancies between the various systems. In addition, a cumulative positive effect could be reached as current packaging processes appear to contribute to food waste at the consumer level (Shanes et al., 2018).

3.4. Towards healthier and more environmentally friendly food industries and diets

3.4.1. Sustainability trends in the food sector

In the framework of the F2FS, the EC explicitly acknowledges that food processors, food service operators and retailers shape the market and influence consumers' dietary choices, and that

stakeholders in the whole food chain impact the environmental and social footprint of local and global trade. Food processors and retailers must lead the way by increasing the availability and affordability of healthy and sustainable food options in order to reduce the overall environmental footprint of the food system (EC, 2020c). However, no quantitative objective or target is provided.

GHG emissions of the food industry

At the EU level, the gross value added of food processing, retailing and services is about €600 billion; that is, three times the gross added value of agriculture. The food industry accounts for about 10% of GHG emissions of the whole food basket, and for about 30% of water use. GHG emissions of the food industry (food processing, beverages and tobacco) were equal to 39 MtCO2eq in 2018, with the two first emitting industries being those of meat and dairy products (EEA, 2020a). This corresponds to a decrease of 24% compared to the 1990 level. In practice, emissions increased from 1990 to 1996, decreased from 1996 to 2008, and remained roughly stable from 2008 to 2018.

Food safety

It is widely acknowledged that the EU food industry has achieved a high level of product safety, even though consumers remain extremely sensitive to foodborne outbreaks and continue to demand higher levels of risk reduction. In terms of the number of human zoonoses, Campylobacter is the most commonly reported gastrointestinal bacterial pathogen in humans in the EU. In 2018, the number of reported confirmed cases of human campylobacteriosis was as large as 247,000, with an EU notification rate of 64 per 100,000 population and a notably low reported case fatality (0.03%). Salmonellosis is the second most common zoonosis, with a rate of 20 per 100,000 population. While still relatively rare (0.47 cases per 100,000 population), human listeriosis has a high morbidity rate among the elderly, with the EU case fatality rate at 15.6% (EFSA and ECDC, 2019).

Long-term trends in the EU depend on pathogens. Campylobacteriosis has shown an increasing trend over the period 2008-2016 but has stabilized since that date. A significant decreasing trend has been observed in salmonellosis cases since 2008, with some stability at the end of the period. Variations across MS can be partly attributable to heterogeneous reporting, and trends partly reflect better monitoring and improved control. There has been a statistically significant increasing trend of confirmed listeriosis cases in the EU/EEA over the period 2008-2016.

Even if the public health impact of foodborne pathogens is much lower than that of other food-related risk factors (for example, unbalanced diets), it remains a crucial issue that requires efficient prevention, monitoring and management of foodborne diseases relying on inter-sectoral and interdisciplinary collaboration, cooperation and information-sharing, at national, regional and international levels. Emergent pathogens potentially linked to international movement of people and goods, climate change, biodiversity erosion, as well as changes in production and consumption practices, reinforce the need to maintain intensive collaboration between governments, the food industry, academia and the citizens. They require increased awareness among all stakeholders about food safety risks in order to prevent them and to reduce them impacts when they occur.

Nutritional quality of foods

The EU policy on food nutritional quality is based on research and innovation projects, training, communication, enforcement, and control of existing regulations (EC, 2002; FCEC, 2013). One of the main objectives is to foster any reduction of negative nutrient intakes, and to promote food that reduces the prevalence of overweight and obesity rates, and associated diseases. Food product reformulation, based on a decrease in salt, fat or sugar contents of foods and an increase in the fibre content, is seen as one way to achieve such objectives.

Reports on implementing the European Food and Nutrition Action Plan 2015-2020 show some progress in the nutritional quality of food in some MS (WHO, 2018). There have been many developments in this area over the last decade, relying on public regulations and private voluntary commitments, and under an increasing level of consumer information and scrutinization. Significant progress has been achieved in implementing front-of-package labelling schemes in several MS (Denmark, Sweden, Finland, France), based, for example, on "*nutri-scores*" or "*traffic lights*", which have led some food processors to change their formulation of processed food. Phone-based applications have led to significant changes in consumer behaviour when shopping, and the industry has quickly reacted by removing the most controversial additives within numerous MS where a product's nutritional information was made available to software developers. Major improvements have also been made in the elimination of trans fatty acids through both legislative and voluntary measures. Several MS, including Finland, France, Denmark, Estonia and Hungary, have engaged in health-related taxes to promote healthier diets through price policies.

Despite these initiatives that are far from covering the whole food supply, the impacts on consumers' intakes remain quite low. For instance, the WHO has found only limited progress in the reduction of the overall sugar content of food products or the marketing of healthier food to children across Europe (WHO, 2018). In addition, the organization expressed its "*continuing*" concerns regarding trans fatty acids in some MS. More generally, there are significant differences among MS in terms of the breadth and depth of policies, notably in terms of product reformulation, with some countries adopting only a minimal approach (focusing on one nutrient and one product category only). The 2008 EU framework for salt initiatives has led to a decrease in excess sodium consumption in some MS (Finland, France, Lithuania) but not in others. The recommended intake level of less than five grams of salt per day, as well as the goal of a 16% sodium reduction within four years, have not yet been achieved.

According to the WHO (2018), more ambitious policies are essential in order to achieve the SDG related to the nutritional quality of food, and the related objectives related to nutrition and non-communicable diseases agreed upon by governments throughout the whole EU.

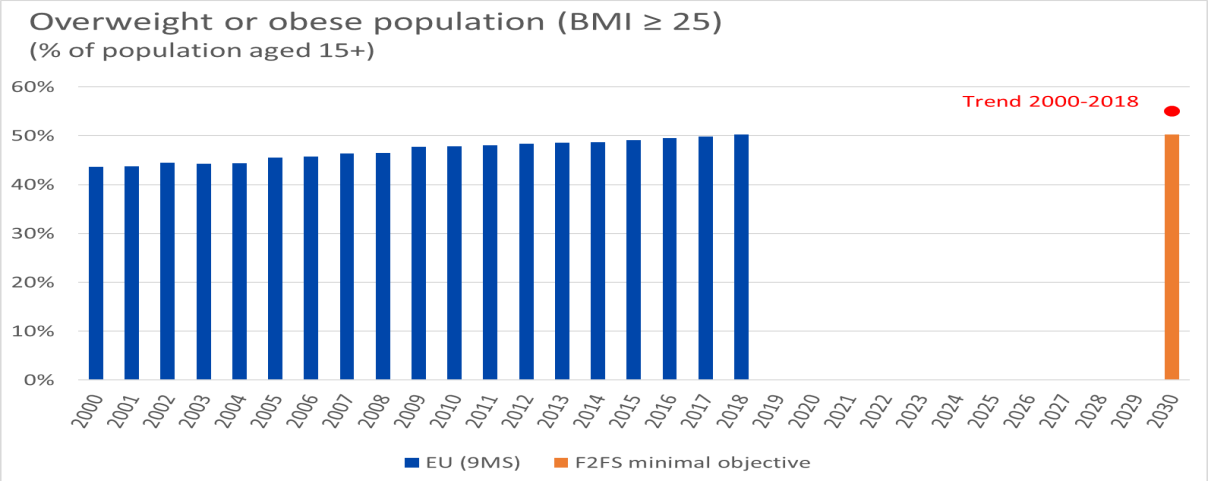
Healthier food diets

The F2FS explicitly acknowledges that current food consumption patterns are unsustainable from both a health and an environmental perspective. One objective of this strategy is to reverse the rise in overweight and obesity rates across the EU by 2030 (EC, 2020c).

There are considerable variations in food and nutrient intakes across the EU, between and within MS. Within countries, intakes vary according to individual characteristics, such as age, gender and educational level. Dietary habits, consumers' preferences and types of food items supplied to consumers also vary considerably between countries. In most MS, food-based dietary guidelines are not met by a large part of the population. Overall, intakes are too low for fruit and vegetables, but are too high for red meat, processed meat and sweet beverages. For nutrients, in most cases, intakes are too low for dietary fibres, vitamin D, potassium, and magnesium, and are too high for salt and saturated fats.

The share of the European population that is overweight or obese has increased over the last decades. This is illustrated in ***Figure 3.13*** for the period 2000-2018 for the nine MS for which sufficient data are available (see footnote of the figure). Prevalence values for overweight children exceed 25% in all MS, except Denmark and the Czech Republic. They exceed 40% in Greece, Malta, Spain and Italy (WHO, 2018). In all MS, some subgroups that are characterized by income and educational level, but also age and gender, show a higher percentage of overweight individuals. Among the EU adult population, 51% is overweight or obese (Body Mass Index ≥25) and 15% is obese (Body Mass Index ≥30).

Figure 3.13: Self-reported overweight and obese population (Body mass index ≥ 25), in percent of the population aged 15+



Source: OECD (2020).
Note: The 9 MS taken into account are countries for which there were at least information for 7 years between 2000 and 2018; that is, Estonia, Finland, France, Germany, Italy, Latvia, the Netherlands, Spain, and Sweden. The "target" (orange bar) assumes that the percentage of overweight or obese population in 2030 is equal to that of 2018. The red point for 2030 corresponds to the linear prolongation of the 2000-2018 trend. BMI for Body Mass Index.

3.4.2. Climatic and land-use impacts of food diets

Estimates of current food-related GHG emissions range from 1.4 to 2.7 metric tons CO_2 eq per capita per year in Western Europe, depending on data sources and assumptions on system boundaries. Overall, the intake of energy, total meat and (within the latter) the share of ruminant meat explain most of the variations in GHG emissions and agricultural land use of European diets (Mertens et al., 2019; Vieux et al., 2020a). Animal-sourced products, which represent between 27-37% of calorie intakes in typical EU diets, are the source of 63-69% of GHG emissions and 66-72% of agricultural land use, depending on the country. Among animal-sourced products, meat provides 9-14% of the calories for 34-46% of GHG emissions and 40-60% of agricultural land use, again depending on the country. Among meat, the ratios of GHG emissions and agricultural land use on calorie contributions are much higher for ruminant meat than for non-ruminant meat (Bryngelsson et al., 2016). Overall, intakes of energy, total meat and ruminant meat explain most of the variation in GHG emissions and agricultural land use of European diets. However, contributions of food groups to ecological footprints vary significantly from one MS to another, suggesting that cultural preferences exert an importance influence.

Trends observed in food intake in the EU are mixed. Available calories have increased from 3,000 kcal/capita/year in 1960 to 3,500 kcal in 2017. Calories intake from animal products have been plateauing at around 1,000 kcal/capita/year, while calories intake from plant products have slightly increased to reach 2,500 kcal/capita/year. Over the 2003-2018 period, there is a slight increase in meat consumption to reach 70.2kg/capita/year (in retail weight equivalent), with a net substitution of beef meat by pork and poultry meat. Per capita consumption of fresh dairy products has decreased, while the consumption of cheese has increased. In milk equivalent, per capita consumption has slightly increased. Per capita consumption of apples and oranges is globally decreasing, while per capita consumption of tomatoes fluctuates at about 35 kilogrammes per year. Overall, the evolution of the consumption of fruit and vegetables is not on the upward trend necessary to meet related nutritional recommendations.

3.4.3. Food expenditure and food insecurity

Food expenditure represents a declining share of households' total expenditure (13.2% in 2015 in the EU). This share decreases with income level. In some MS (in particular, Bulgaria, Croatia, Estonia, Latvia, Lithuania and Romania), the share is much higher and is greater than 30% for the lowest income households. Therefore, in these countries, any food price increase will have a significant impact on consumers and on the composition of diets.

Sustainable diets, that are better for health and the environment, are not necessarily more expensive (Pérignon et al., 2016). As shown by organic consumers, changes in dietary patterns may partially compensate for the higher organic prices, and limit the food expenditure increase that would result from the choice of organic baskets. In other words, the diet composition of organic consumers, which is lower in calories and in animal-based proteins, may partially offset the extra costs of organic products (Seconda et al., 2017; Boizot-Szantai et al., 2017).

Household food insecurity is defined when food availability and access are insufficient or uncertain. A common measure is given by the prevalence of households that are unable to afford meat (or a vegetarian equivalent) every second day. Based on this definition, around 7.5% of the EU population would be affected (Eurostat, 2020e). Indicators of people in "*severely materially deprived*" status (that is, facing involuntary restrictions in their daily purchases because of budget constraints) give a slightly lower figure of 5.8%. By contrast, using the indicator of people "*at risk of poverty or social exclusion*" leads to a much higher figure; that is, 21.7% of the EU population and more than 30% in Romania, Bulgaria and Greece.[28]

Food insecurity is more prevalent among women, older people, renters, one-person and alone-parent households, as well as among people with lower education, with disabilities or those who are out-of-work. Food insecurity is also more prevalent for social benefit recipients. Over the long term, food insecurity tends to decrease in the EU. However, over the recent period, segments of the population have faced increasing restrictions in their capacity to buy food (Depa et al., 2018). Research suggests that it is not necessarily in the poorest MS that food insecurity has increased, but in countries with a high proportion of disadvantaged groups and a lower welfare state (Davis and Baumberg-Geiger, 2017).

[28] *https://www.eurofoodbank.org/en/poverty-in-europe.*

4. CHANGES IN AGRO-FOOD SYSTEMS REQUIRED TO ACHIEVE THE GREEN DEAL TARGETS

KEY FINDINGS

- To reach Green Deal targets, a first set of coordinated actions promotes the adoption of innovations to induce efficiency gains at the farm level and within food chains:
    - These actions will improve both the environment and the economic dimension. When adopted, precision farming could allow a reduction by 10 to 20% of pesticide use and by 10% of fertilizer use. The use of feed additives in cattle feeding could see a decrease of 10% in the associated CH_4 emissions;
    - To encourage their adoption, accompanying actions are required, which include information gathering, dissemination, advisory actions, as well as, in some cases, investment aid;
    - However, these actions will not of themselves be sufficient to reach Green Deal targets related to agriculture and food.
- A second set of actions aims to re-design production systems based on agro-ecological principles:
    - These actions may significantly improve the biodiversity, environment and health impacts of food systems, especially in relation to the use of chemical inputs (pesticides, fertilizers and antibiotics). Due to lower yields, the impacts on total GHG emissions from the farm sector, including emissions linked to land-use changes, are more ambiguous;
    - Specific actions in favour of carbon storage in soils are requested. Some may be implemented at relatively moderate costs (the preservation of soils with high carbon stocks, the use of cover crops and techniques such as no tillage, etc.). Other techniques (such as agroforestry) should be encouraged as they increase overall efficiency, though at a higher cost of implementation;
    - Reaching the Green Deal target on pesticide use is unlikely unless strong incentives are implemented;
    - In the absence of policy support, the de-intensification process induced by the Green Deal could have detrimental impacts on producers' incomes. Consumers' reactions could weaken producers' incentives to implement radical changes required in agricultural practices;
    - Producers' commitment to the re-design of production systems will also depend on the vertical relationships in chains between producers, processors and retailers, which will all affect the value sharing between stakeholders; and
    - The upscaling of agro-ecological and organic production systems needs voluntarist and assertive policies, creating the appropriate incentives at the producers' level;
- A third set of coordinated actions targets changes in consumers' behaviours and dietary patterns in order to induce public health benefits and reduce the climate and environmental impact of the food sector:

KEY FINDINGS

- Dietary changes could favour fruit and vegetable producers and disfavour meat producers. They could reduce meat producers' incentives to commit to environmental improvements;
- Food and retail industries can help facilitate the shift towards healthier and more environmentally friendly food diets, using responsible marketing, advertising limitations and food product reformulation;
- Policies that increase consumers' awareness about the health and environmental impacts of food choices, such as education and information campaigns, nutritional and environmental labelling, are important to implement; and
- Fiscal policies that modulate final prices, thanks to taxes or subsidies, could also be used. In relation to climate issues, price modulation should favour the adoption of more plant-based diets. Subsidizing the sustainable consumption within low-income households must complement price policies.

To reach the major objectives of the Green Deal related to climate neutrality, biodiversity, health, and resources, the F2FS and the EU Biodiversity Strategy for 2030 set quantitative targets that concern agriculture as well as downstream levels of the food chain (processors and consumers). As shown in the previous chapter, three main quantitative targets are defined: first, an important reduction in the use of pesticides, fertilizers and antimicrobials; second, an increase in agricultural land under organic farming as well as protected areas; and third, the restoration of semi-natural habitats. It also sets non-quantified objectives for the improvement of animal welfare, a better use of the circular bio-economy principles, a reversal of the overweight and obesity trend, and a shift towards healthier and more environmentally friendly diets. Regarding the reduction of GHG emissions no specific targets have, to date, been defined for agriculture or for the food system. However, as agriculture provides almost half the total methane emissions and more than 70% of nitrous oxide emissions, the EC's updated Climate Ambition (EC, 2020g), which includes a 35% reduction in non-CO_2 gases between 2015 and 2030, should strongly - at least in theory - impact the farm sector. Agriculture and food are critical in order to contribute to the overall efforts towards carbon neutrality in the EU.

By considering the food system as a whole and by setting objectives and quantitative targets that concern the different components of the food system, the Green Deal and its associated strategies are clearly an important step forward. Possible trade-offs between objectives reinforce the necessity to consider the entire system, from agriculture up to food. This means that the analysis of actions and solutions identified in the various Green Deal documents must be conducted by considering, in a wholly integrated way, both the contributions of changes in agricultural practices and changes in consumers' diets.

In ***Section 4.1***, we analyse the potential impacts of each of the coordinated actions considered in the Green Deal documents, notably in the F2FS (EC, 2020c), from producers to consumers, and then assess their relative and combined potential contributions in reaching Green Deal targets and objectives. In ***Section 4.2***, we discuss the economic mechanisms induced by the use of these coordinated actions and identify the optimal set of policies that would have to be implemented to reach the targets. This will define the "*optimal*" or "*ideal*" policy framework within which the CAP must take place.

Table 4.1: Technical solutions identified in the different Green Deal documents to achieve climate, environment and health targets and goals

Levers	Green Deal targets	Impacts on				Comments
		CC mitigation	Biodiversity	Other env. dimensions	Health	
4.1.1. Precision farming (efficiency gains)						
• Precision farming & fast broadband internet access across rural areas • Farm sustainability tools for nutrients	-50% pesticides -20% fertilizers -50% nutrient losses					-This is most likely insufficient to reach the targets. However, by using several precision farming solutions together, there is the possibility of reducing pesticide use by around 10-20% and fertilizer use by 10%. -The adoption of precision farming technologies requires broadband coverage and new equipment.
4.1.2. Agroecology (redesign of production systems)						
• Integrated Pest Management (IPM)	-50% pesticides					- There is a need for profound changes in crop systems with potential adverse effects on yields and incomes, notably in the short term. - Reaching the target related to pesticide use is unlikely without strong economic incentives and/or market recognition.
• Balanced fertilisation & sustainable nutrient management	-50% for fertilizer losses -20% for fertilizer use					- Significantly reducing fertilizer losses and uses requires profound changes in crop and livestock systems, with potential production relocation and adverse effects on production levels and farm incomes, notably in the short term. Reaching the target on fertilizer use may be possible. -The impact on climate change is likely to be positive (less GHG emissions) when evaluated per unit of area but becomes more uncertain when evaluated per unit of output.
• Organic farming	25% of total farmland					- Negative impacts on yields will be compensated for by product price premiums and specific support aids. - There is a question around the willingness to pay higher prices in the scenario of a rapid and significant expansion of organic farming. - This will lower the variable costs but will possibly see an increase in fixed costs.
4.1.3. Veterinary products (efficiency and redesign)						

• Better reporting and monitoring, and increased responsibility of veterinarians	-50% in the use of antimicrobials					- The reporting and monitoring require improved information systems. - The efficiency of the solution will be influenced by new regulations related to the prescription of antimicrobials - Possibility to reduce the use of antimicrobials, but not by -50%
• Alternative treatments (probiotics, prebiotics, etc.)	-50% in the use of antimicrobials					- The development and efficiency will be influenced by new regulations. - It is difficult to assess the reduction in antimicrobial use that this solution could achieve. It is likely that the solution alone will not allow target to be achieve.
• Rethinking livestock systems	-50% in the use of antimicrobials					- By "construction", the development of organic livestock will help to achieve the target. - This will lead to positive ecological consequences, but with potential adverse economic effects, notably on farm incomes.
4.1.4. Carbon balance (essentially redesign)						
• Feed additives	Climate mitigation					- This solution does not require livestock systems to be redesigned. - It allows a 10% reduction in GHG emissions from ruminant livestock.
• Carbon sequestration in agricultural soils	Climate mitigation					- The stocks of carbon in agricultural soils are sizeable, notably in peatlands but also in permanent grasslands. Maintaining these stocks is of high importance. - Arable lands have lower carbon stocks. Different techniques/practices can increase the carbon stocks of arable lands, such as the use of cover crops and catch crops (at a moderate cost), the introduction of temporary grasslands in rotations, the use of no-tillage techniques, etc. - Higher carbon levels in agricultural soils have other environmental benefits, on water use efficiency, in particular.
• Agroforestry	Climate mitigation					- This solution may also be promoted as a part of agroecology. - The complementarity between crops and trees improves the total efficiency of agroforestry systems. - These systems can be more difficult to manage and may require specific equipment. In addition, there is a potential negative impact on farm incomes if the products of trees are not well valorized.
• Adapted management and restauration of wetlands and peatlands	Climate mitigation					- Very high stocks of carbon are involved: maintaining the large carbon stocks in undisturbed peatlands is a priority. - This solution has also biodiversity co-benefits by providing habitats for wild fauna and flora.
4.1.5. Circular bio-economy (essentially efficiency)						
• Energy production from manure management						- The solution provides organic fertilizers that can replace mineral fertilizers. It also provides a complementary source of income for farmers.

						- In the event that methanisers are also (importantly) fed with plant products, competition with food production should be avoided.
• Development of bio-based products						- A large number of technologies are available to produce numerous bio-based products. - The main issue is the competition with food production (through land use) as an important development of bio-based products from agricultural feedstocks may induce deforestation and the conversion of virgin areas to agriculture. These adverse effects could significantly reduce the positive effects of the solution on the climate and the environment.
• Reduction of food losses and waste	Decrease by 50% per capita waste at distribution and consumption level					- There will a reduction in agricultural land use, GHG emissions and water use. - The magnitude of these positive effects will depend on the size of loss and waste reduction, which itself depends on solution costs and market adjustments. First estimates with global models suggest a resulting small impact only (Britz et al., 2019).
4.1.6. Food products and diets (consumers' demand)						
• Food product reformulation	Stop the increase in overweight and obesity rate Towards sustainable diets					- The reformulation of food products can be directed towards healthier products but also towards lower climatic and environmental impacts ("*product eco-conception*"). - The solution impacts all consumers and does not (strongly) depend on their behaviours.
• Change in diets	Stop the increase in overweight and obesity rate Towards sustainable diets					- A reduced consumption of animal products and a higher consumption of plant-based products would see a reduction of GHG emissions of the food system of around 10-15%. - This requires significant changes in consumption that are unlikely to occur without strong coordinated policies.

Source: Own elaboration.
Notes: Green: (generally) positive impact; Yellow: undetermined impact; Red: (generally) negative impact; White: not relevant (or only very marginally). The colour grid does not capture the magnitude of impacts, which means that, for example, a green cell may correspond to a small or large impact.

4.1. Impacts of technical solutions on Green Deal targets and goals

In this first section, we analyse the impact of technical solutions proposed in the Green Deal documents on quantitative targets and non-quantified objectives of the initiative. In particular, we evaluate the impact of these solutions on the major goals of the Green Deal related to climate mitigation, biodiversity preservation and environment protection in the agriculture and food sector. When possible or when reaching scientific consensus, we provide the order of magnitude of the impact of each solution or group of solutions on the related targets or major goals. For the 12 identified solutions, ***Table 4.1*** provides the solution, the related target(s) and a qualitative appraisal of their impact on the major goals, allowing the identification of convergence *versus* divergence between the different goals. This table includes a key message related to the solution. In ***Sub-Sections 4.1.1 to 4.1.6***, we discuss in more detail the impacts of the various solutions and provide insights regarding the challenges in mobilizing them.

4.1.1. Precision farming and fast broadband internet access in rural areas

Efficiency gains would allow a decrease in pesticide and fertilizer uses by about 10-20% and 10%, respectively

When pesticides and fertilizers are overused, a reduction in their use is possible without impacting yields and production levels. This can be achieved without changing farming systems in a significant way, following the principle of "*the right dose at the right time in the right place*". This may require new competences (observation of plots and animals, use of precision farming equipment), an increase in total working time and new investments (precision farming).

Studies in Denmark (Pedersen et al., 2012), the Netherlands (Skevas et al., 2014) and France (Jacquet et al., 2011) have estimated the overuse of pesticides at 10 to 20%. Efforts have already been made to reduce the use of phosphorus and potassium over the past years. Nitrogen surpluses and losses remain important and are not on a decreasing trend (see Sub-Section 3.2.2). Approximately 50% of the nitrogen applied is tapped by crops, while the other 50% leaks into the environment (air and water), suggesting that many farmers over-apply nitrogen. A decrease of about 10% could be expected by adjusting fertilizer application rates to yield targets and application dates to crop requirements, and by making better use of organic fertilisers with the help of decision support tools (Pellerin et al., 2017).

Digital and precision farming technologies would help to reduce agricultural GHG emissions

Thanks to the reduction of chemical input use, more specifically nitrogen fertilizers, precision farming can contribute to climate mitigation. According to Moran et al. (2011), the abatement potential of the improved timing of mineral nitrogen application can reach 0.3 tCO2eq per hectare. According to Balafoutis et al. (2017), precision agriculture practices could positively contribute to a reduction in GHG emissions of the farm sectors by three main channels: first, by enhancing the ability of soils to operate as carbon stock reserves through less tillage and reduced nitrogen fertilisation; second, by reducing fuel consumption through the reduction of in-field operations; and third, by diminishing the use of fertilizers.

Digital and precision farming technologies are not yet widely adopted

The adoption of precision farming requires specific equipment and broadband coverage in order to monitor the spraying of pesticides and the spread of fertilizers in order to better fit the exact needs of the plants in the field. Broadband coverage of the European rural territory is far from complete, which constitutes a significant barrier to the large-scale development of digital and precision farming

technologies. Overall, the uptake of precision farming in the EU remains low (Barnes et al., 2019). For instance, according to the European Agricultural Machinery Association (EAMA), only 35% of fertilizer spreaders are today sold with a precision weighing instrument included, which is the essential component in adjusting the quantity and direction of spread. Decision support tools are also made available to farmers to enable this significant optimisation. These tools have led to considerable progress in better adjusting pesticide use, according to epidemiological risk models and algorithms, or by optimising nitrogen fertilizer inputs in relation to nitrogen requirements. The higher the ratio of pesticide and fertilizer prices on agricultural product prices, the more profitable the digital and precision farming technologies.

4.1.2. Agro-ecology: integrated pest management, nutrient management, organic farming

Redesign of farming systems is required to achieve the Green Deal targets related to input use

Precision farming is part of the solution but will likely contribute to only partially achieving the targets. A redesign of farming systems is required: integrated pest management (IPM), nutrient management, organic farming and agroforestry offer solutions based on agro-ecological principles. Numerous studies have shown that in most cases, the redesign of cropping systems achieves a simultaneous significant decrease in pesticide and fertilizer use (see, for example, Nemecek et al., 2008; Preissel et al., 2015, Lamichhane et al., 2016). By combining balanced fertilization and changes in cropping patterns, a 20% decrease in nitrogen fertilization can be achieved with only a limited impact on yields but with an increase in yield variability. A reduction of 50% in pesticide use would be much more difficult to achieve without a significant negative impact on yields.

Implementing semi-natural habitats should be considered simultaneously with the redesign of farming systems

Semi-natural habitats are considered to be the main source and reservoir of biodiversity in agricultural landscapes. They enhance the natural bio-regulations that can substitute some pesticide requirements. However, it has been shown that high local pesticide use can lessen the expected positive effects of semi-natural habitats. The solution is that the (necessary) pesticide use reduction should be associated with semi-natural habitat enhancement in order to establish the effective and natural regulation of pests (Ricci et al., 2019).

Diversification is key for IPM and nitrogen management

Diversification is one of the most effective actions toward a decrease in pesticide and nitrogen fertilizer use. This can be achieved by various means, including diversification inside the field, of crop sequences, as well as at the landscape level by managing spatial heterogeneity and field mosaics. An increase in the proportion of leguminous crops and temporary grasslands on arable lands is crucial in order to decrease both pesticide use and nitrogen fertilization (Andert et al., 2016; Lamichhane et al., 2016; Lechenet et al., 2017). Diversifying crops lengthens the rotation period and increases the time lapse before the same crop returns to a particular plot, with the accompanying beneficial effects for crop health. In such situations, disease inoculum is greatly reduced.

There are strong barriers to IMP adoption

IPM principles have been largely documented, demonstrated and disseminated throughout Europe. Despite the numerous studies showing that they can allow a significant pesticide reduction without significant yield losses, the level of adoption remains low among EU farmers. This is mainly explained by economic aspects; namely, production risks, investment needs and the necessity to acquire new skills (Barzman et al., 2014; Lefebvre et al., 2015). Furthermore, IMP practices increase the observation

time required to detect disease symptoms early enough for (partially) effective treatment techniques to be used. As for precision farming, the higher the price ratio of pesticides on agricultural products, the higher the adoption of IPM techniques.

Increasing agricultural land under organic farming will help to reduce pesticide and fertilizer use

The Green Deal reduction effort demanded of conventional farms is higher for pesticides than for fertilizers. Any increase in the land area devoted to organic farming will mechanically decrease the use of pesticides and fertilizers. Based on the EU-28 Farm Accountancy Data Network (FADN), per hectare expenditure of pesticides is about 4.6 times lower in organic production than in conventional farms, while per hectare expenditure of fertilizers is about 3.2 times lower. Assuming 25% of the European agricultural area would be used for organic farming, the overall reduction in purchases would amount to 14.5% for pesticides and 12.7% for fertilisers, all other things being equal. Given these reductions, to achieve a 50% reduction in overall pesticide use, conventional farms would have to diminish their per hectare pesticide expenditure by around 45%, and to reach a 20% reduction in overall fertilizer use, conventional farms will have to diminish their per ha fertilizer expenditure by around 9% (***Box 4.1***).

Organic farming has a positive impact on the environment, but an ambiguous impact on GHG emissions

Regarding nutritional and safety dimensions, available studies note some differences between conventional and organic products (Średnicka-Tober et al., 2016; Popa et al., 2019; Lairon, 2010). Organic plant products contain more dry matter, more minerals (such as iron and magnesium) and more antioxidant micronutrients (such as phenols and salicylic acid). Organic animal products contain more polyunsaturated fatty acids. Data on carbohydrate, protein and vitamin levels are insufficiently documented. Organic products do not contain pesticide residues, but animal products may contain more environmental contaminants. Organic vegetables contain far less nitrates (about 50% less). Organic cereals contain similar overall levels of mycotoxins as do conventional cereals. Epidemiological studies suggest that the difference in product qualities could be correlated to lower health risks (Baudry et al., 2018; Mie et al., 2017; Baudry et al., 2019; Rebouillat et al., 2020). However, a large part of the health benefits of organic diets could be linked to the fact that organic consumers have healthier diets overall (they consume more fruit and vegetables, legumes and whole-grain products, and less processed meats, alcoholic beverages, etc.) than conventional consumers, rather than as a result of product characteristics. This statement deserves further examination.

In relation to the impacts of organic production on the environment, positive relationships are attested in relation to biodiversity, water pollution, soil erosion and pollution, except for the use of copper in some production systems. The benefits in terms of GHG emissions are less certain. Indeed, the emissions per hectare are lower than in conventional agriculture, but due to lower yields, the emissions per product unit are larger for some products (Tuomisto et al., 2012; ADEME, 2020). However, this depends on the products themselves (Treu et al., 2017). According to Suciu et al. (2019), there is no significant difference between the carbon footprint of organic and conventional food, while Smith et al. (2019) finds significantly higher emissions for organic farming in England and Wales with identical production levels. They point out that there is a lot of uncertainty about the comparison.

Organic farming has a negative impact on yields

Several meta-analyses address the issue of the yield gap between organic and conventional farming. They found organic yields to be 20-25% lower than conventional yields, but with large variations among crops and regions (De Ponti et al., 2012; Seufert et al., 2012; Ponisio et al., 2015). Agricultural production diversification practices, multi-cropping and crop rotations may substantially enhance the productivity of organic farming per unit area and reduce the yield gap between organic and

conventional yields (Ponisio et al., 2015). At the EU level, farms' observations suggest a higher yield gap for wheat (from 60% in Germany to 15% in Italy) than for grain maize and milk (EC, 2019d).

Box 4.1: Impacts of an increase in organic farming area up to 25% on overall expenditures (uses) of pesticides and fertilizers in the EU-28

According to the EU-28 FADN, in 2019, crop protection product expenditures per hectare of UAA were €87 for conventional farms and €19 for organic farms (4.6 times less), and fertilizer expenditures per hectare of UAA were €120 for conventional farms and €37 for organic farms (3.2 times less).

Table 4.2. describes the mechanical impact on overall expenditures of pesticides and fertilizers of extending farmland under organic farming up to 25% from a base level of 7.5% in 2019 (13.4 million hectares on 178.0). This mechanical impact would allow the achievement of a 14.5% reduction in overall pesticide expenditures (from €14.57 to €12.46 billion). To achieve the 50% reduction target of the Green Deal, conventional farms would thus be constrained to reduce their pesticide use by 44.5%. The same calculations for fertilizers suggest a 12.7% reduction in total fertilizer expenditures (from €20.25 to €17.67). As a result, conventional farms would be compelled to reduce their fertilizer expenditures by 9.2% to reach the Green Deal reduction target of 20%.

Expenditure reductions would be equal to use reductions if input prices remain unchanged. This very simple analysis suggests that the Green Deal target is much more ambitious (difficult to achieve) for pesticides than for fertilizers, even after taking into account the induced effects on pesticide and fertilizers expenditures (uses) linked to the target related to organic farming.

Table 4.2. Impacts of expanding farm land under organic farming up to 25% on pesticide and fertilizer expenditures (uses), and additional effort demanded of conventional farms to reach the corresponding Green Deal targets (-50% for pesticides, -20% for fertilizers)

	Expenditures (M €)			% of reduction for conventional farms
	Current	With 25% organic	Target	
Plant protection products				
Organic	254	845	845	
Conventional	14,320	11,614	6,442	44.5%
Total	14,574	12,459	7,287	
Fertilizers				
Organic	496	1,647	1,647	
Conventional	19,752	16,020	14,551	9.2%
Total	20,248	17,667	16,198	

Source: Own elaboration from the EU-28 FADN.
Note: Expenditures and uses are equal if input prices are assumed unchanged

4.1.3. Veterinary products

The reduction in the use of veterinary products places them on track to reach the corresponding Green Deal target

Total sales of veterinary products across the EU dropped by more than 35% between 2011 and 2018 (EMA, 2018). Prolongation of this trend could allow the F2FS target related to the reduction of 50% in the use of antimicrobials in agriculture by 2030 to be reached (see Sub-Section 3.2.3). However, the

European average figure masks important differences among MS, both in terms of current uses of veterinary antibiotics and in terms of their past evolutions of veterinary antibiotics since the beginning of 2010s, with six MS experiencing no reduction in use (EMA, 2019).

The Green Deal does not explicitly mention technical solutions to achieve the target related to antimicrobials. However, the F2FS emphasizes that "*the new regulations on veterinary medicinal products and medicated feed provide for a wide range of measures to help achieve this [target]*" (EC, 2020c). These new regulations will influence veterinary antimicrobial prescribing and usage throughout the EU and into the future (More, 2020). In a general way, the use of veterinary antibiotics can be reduced through actions aimed at: first, better reporting and monitoring, and by increasing the responsibility of veterinarians (separation of prescriptions and sales); second, using alternative treatments that rely on probiotics, prebiotics, bacteriophages or organic acids; and third, rethinking the livestock systems (EMA and EFSA, 2017). In addition, the increase in organic farming will help to achieve the target on veterinary antibiotics. In practice, the main question is to what extent mobilising the first two solutions will be sufficient, or whether it will also be necessary to use the "re-design" solution, with then (highly likely) positive ecological consequences but also with potential adverse economic effects. A second issue is related to the situation in a few MS that exhibit no decreasing trend in the use of veterinary antibiotics.

4.1.4. Carbon balance: feed additives, carbon sequestration, afforestation and agroforestry, restauration of wetlands and peatlands

The use of feed additives in intensive ruminant livestock might decrease their enteric methane emissions by up to 10%

Two feed additives can significantly reduce enteric methane emissions of ruminants. Adding 3.5% of fatty acids, especially unsaturated fatty acids, into ruminant diets reduces enteric methane emissions by 14% (Martin et al., 2011). However, the agricultural production of corresponding oilseed generates nitrous oxide emissions corresponding to half of this reduction. In the same way, adding 1% of nitrates into the diet reduces emissions by 10%. Again, the nitrous dioxide emissions associated with the nitrate production must be considered. Overall, feed additives cannot reach an emission abatement of much more than 10% for unchanged animal production levels.

Carbon sequestration in agricultural soils represents a significant potential to be exploited, but some options might be costly

Stocks of carbon in agricultural soils represent huge amounts of carbon. In the EU-28, there is estimated to be about 75 billion tonnes of carbon, with around 50% located in Ireland, Finland, Sweden and the United Kingdom due to the large areas of peatlands in these countries.[29] Stocks fluctuate as a function of carbon inputs (litters, organic residues, etc.), biotransformation and the duration of stabilization in the soil, as well as outputs that are principally due to the respiration of decomposer organisms. Estimates of these variations are highly sensitive to calculation hypotheses.

Different practices, such as agroforestry, the planting of hedges, the use of cover crops and low or no tillage practices, have the potential to increase carbon sequestration in agricultural soils. According to Aerstens et al. (2013), the greatest potential to increasing carbon sequestration in the EU (in both soils and biomass) is to develop agroforestry on both arable lands and grasslands, representing about 90% of the overall potential. Introducing hedgerows contributes to 4%, cover crops to 4% and the no tillage option to 1.4%. In the case of France, Pellerin et al. (2019) estimate that new farming practices could

[29] *https://www.eea.europa.eu/data-and-maps/indicators/soil-organic-carbon-1/assessment.*

allow French agricultural soils to store 21 million tonnes of CO_2 per year more, as compared to the total gross GHG emissions of French agriculture of 80 $MtCO_2eq$ in 2016. Arable lands (where current stocks are the lowest) have the greatest potential based on six new agricultural practices, among which cover crops and catch crops account for 35% and could be developed at a moderate cost. At the EU level, Lugato et al. (2015) estimate that cover crops and catch crops are two of the best options available for arable land. Agroforestry and the extension of temporary grasslands in crop rotations also have considerable potential (19 and 13% of the whole potential, respectively), but their development is estimated to be at a "*high*" cost level. The development of direct sowing could account for 12%. For permanent grassland, it is mostly a moderate intensification with fertilizers that could potentially achieve additional carbon storage (12% of the whole potential).

Guenet et al. (2020) highlighted that the climate mitigation induced by increased carbon storage in agricultural soils is generally overestimated if associated N_2O emissions are not taken into account. Nevertheless, the gain linked to increased carbon storage in agricultural soils is never fully offset by the additional nitrous oxide emissions linked to the increased fertilization required for higher sequestration.

There are also some possible improvements in the soil carbon storage of vineyards and orchards. According to Pellerin et al. (2019), in vineyards, grasses as a permanent or winter cover crop between rows has displayed significant potential for a low (or even) negative cost. However, land area in vineyards is rather limited in France as in other European countries. More generally, some studies reported a carbon sequestration potential for fruit tree ecosystems similar to that of forests (Montanaro et al., 2017a). The abandonment of tillage and the use of sustainable practices, such as the mulching of crop residues, can increase soil carbon content to levels comparable (or higher) to those under native vegetation (Nieto et al., 2010; Montanaro et al., 2017b).

Finally, given the amount of carbon today stored in agricultural soils, especially in permanent grassland, it is essential to maintain and protect existing stocks through appropriate practices, and not to permit any depletion by halting the tillage of permanent grassland (Lugato et al., 2015).

Agroforestry is part of the solution, but the rate of adoption might be slow

In addition to the potential of agroforestry to increase carbon stored into the soil, agroforestry increases biomass production and the efficiency of this production by exploiting the complementarity between crops and trees to allow a better use of resources. Agroforestry usually increases the Land Equivalent Ratio (LER). The counterpart lies both in the increased complexity of managing the respective growth of the two plants and the movement of agricultural machinery. Trees can substantially contribute to carbon storage. Kay et al. (2019) suggest that the total contribution, ranging from hedgerows on field boundaries to fast growing coppices or scattered single tree systems, could compensate for between 1.4 and 43.4% of European agricultural GHG emissions. This large variation is due to the wide range of practices that were studied. A key issue for implementation is the current lack of knowledge, as well as the high level of investment needed (Hernandez-Morcillo et al., 2018).

The maintenance of large carbon stocks in undisturbed peatlands should be a priority

Out of all of the natural wetland types, peatlands are by far the most important ecosystems affecting the global balance of agricultural GHG emissions. In the EU, most peatlands are found in Scandinavia, Germany, Ireland, Poland and the United Kingdom. Around half of the peatlands are subject to a variety of land uses, which are often associated with drainage: 20% are drained for forestry, 16% are drained for agriculture (mainly in Germany, the Netherlands and Poland), and 0.5% is used for peat extraction (Drösler et al., 2008).

The GHG balance of a wetland is the outcome of the rate of net CO_2 uptake (CO_2 sequestration) and the rates of CH_4 and N_2O emissions. This outcome may be positive or negative. The dynamics of GHG exchange are largely determined by specific site conditions, including hydrological conditions, soil types, vegetation, management, as well as meteorological and climatic conditions, plus variations of these conditions over time.

Two types of impacts considerably affecting the GHG balance of wetlands are hydrology changes and nutrient enrichment. More frequent summer droughts have increased the frequency of situations under which wetlands, especially peatlands, act as sources of CO_2. At the same time, the CH_4 emissions decrease. There is also evidence that peatlands that have been ''*reclaimed*'' for agricultural use are releasing significant amounts of N_2O.

In a general way, there is insufficient information to provide simple guidelines for management aimed at achieving a positive balance of GHG in the existing types of wetlands. From this perspective, the maintenance of large carbon stocks in undisturbed peatlands should be a priority (Joosten and Clarke, 2002).

4.1.5. Circular bio-economy, losses and waste

A decrease in food waste and losses slightly lowers GHG emissions of the food system, decreases land use and water use

Philippidis et al. (2019) showed that a decrease in food waste by consumers leads to increased resource savings, price changes and a decrease in food production, with a small macroeconomic impact only at the global level. Environmental indicators are improving; for example, agricultural land use and water abstraction are decreasing, as well as GHG emissions but, because of market adjustments, by a small amount only. GHG emissions in foreign countries are also decreasing due to a reduction in food and feed imports.

An increased use of co-products from agricultural production allows an improved management of nutrients, reduces energy consumption and GHG emissions

A study of farms implementing methanization shows that the valuation of co-products through the methanization process leads to improved fertilizer management and would allow a reduction of 20% of nitrogen inputs (Solagro, 2016). Energy consumption would decrease by 10%, and GHG emissions would decline by 23%. The loading practices of digesters determine the magnitude of these positive environmental impacts. In the same way, implementing intermediate crops may offer several ecological benefits, with, however, possible trade-offs between different ecosystem services (Justes and Richard, 2017).

The main challenge of bio-based products is to limit their competition with food production

The technological progress of bioconversion on various feedstocks makes it potentially possible to replace fossil-based products by bio-based products. These bio-based products offer numerous climatic and environmental benefits by storing carbon, reducing gross GHG emissions and diminishing pollution throughout their production cycle. In addition, the waste can be recycled or used as feedstuffs or fertilizers. Technically, the potential of bio-based products is remarkably large, covering the production of bioplastics, biomaterials, biochemical and bioenergy. Many studies have reviewed the different sources of raw materials, such as starch and vegetable oil, but also the by-products from different food industries (Loannidou et al., 2020). However, all by-products are not necessarily currently wasted as some of them are used for animal feed or as feedstuff for fermentation processes, for example. There is still the potential to improve microbial strains with enhanced hydrolytic capacities,

allowing the direct conversion of agricultural, food and forestry residues, algal biomass, and the extraction of value added products for the polymerisation process (Hatti-Kaul et al., 2020).

There is significant evidence from life cycle analyses that show that the energy and GHG balances are much lower for bio-based products than for their petroleum counterparts, notably in the sectors of bio-fibres, biomaterials and bioplastics. High potential GHG savings have been found for chemicals derived from starch, vegetable oil or sugar-based products that can be used as materials for bio-based plastics (Dunn et al., 2015). On other aspects of pollution, though, findings are more mixed.

However, as exemplified by the case of biofuels, a key issue is the competition with food production. This competition occurs through land use and land-use changes. Thus, the GHG balance of "*first-generation*" biofuels has been shown to deliver much fewer GHG emission reductions than initially expected, notably when indirect land-use change effects are included in a global life cycle analysis (Valin et al., 2015).[30] Indeed, the land use effects have been found to be significant, and a large expansion of "*first-generation*" biofuels from agricultural feedstocks has been seen as having potential negative impacts in terms of imported deforestation, agricultural intensification and the conversion of pastures into feedstocks. A related issue is the positive impact on prices of this additional demand for foodstuffs, which has a negative impact on consumers' buying powers and drives increased conversion of virgin areas into agricultural land. The issue is therefore developing bio-based products from co-products that compete less with food production; a challenge that partly depends on innovation.

4.1.6. Food diets

In this last sub-section, we discuss the likely impacts on the main Green Deal targets of a change in diets if the production technology remains unchanged. We thus assume that the per unit impact of the different food products is constant.

Reducing meat consumption as a driver to reduce climatic and environmental impacts of diets

There is strong evidence that modifying diets is a way to reduce GHG emissions and resource use from food consumption. Reviewing studies based on simulations, Aleksandrowicz et al. (2016) show that replacing meat with plant-based alternatives or ruminant meat with monogastric meat leads to a significant reduction in GHG emissions, land use and water use (between 10 and 30%, depending on the magnitude of the substitution). Studies based on actual diets clearly highlight the link between the level of meat consumption and associated GHG emissions. For example, Scarborough et al. (2014) showed that GHG emissions associated with low meat diets (less than 50 grams per day) were 35% lower than GHG emissions associated with high meat diets (more than 100 grams per day). Pérignon et al. (2017) confirmed that reducing meat consumption is one of the main factors in mitigating the diet-related environmental impact. However, this systematic review also revealed that the choice of meat replacement is crucial. Meat reduction per se does not necessarily lead to less GHG emissions. The decrease depends on what food substitute is selected to compensate for the energy loss.

More climate friendly diets are not necessarily healthier, and healthier diets are not necessarily more climate friendly

Studies on the climatic impact of actual diets (self-selected diets) found a weak correlation or sometimes a divergence between the nutritional and climatic dimensions. The negative correlation between GHG emissions and diet healthiness may arise from the fact that energy dense products are unhealthy but have lower GHG emissions (Vieux et al., 2020b).

[30] "*Indirect land use*" or "*Indirect land-use change*" refers to land whose ultimate purpose is changed from its previous use, for example a forest land or a grassland that is cleared for the cultivation of food or biofuel crops.

Adherence to dietary guidelines (which is an indicator of the healthiness of the diet) is not necessarily associated with a lower climatic impact. The healthy DASH[31] diet has been found to be associated with higher GHG emissions, but with lower land us (Biesbroek et al., 2017). In the same way, different studies based on simulation results suggest that an increase in the healthiness of the diet might increase its GHG emissions (Vieux et al., 2018; van de Kamp et al., 2018).

Diets with more plant-based products (notably much more fruit and vegetables) and less meat (notably less ruminant meat) are healthier and more climate friendly

As shown by Vieux et al. (2020b), it is possible to identify win-win diets (diets that are healthier and with lower GHG emissions) among self-selected diets in five European countries (Finland, France, Italy, Sweden, and the United Kingdom). In the whole sample, GHG emissions are equal to 4.52 $kgCO_2eq$ per capita per day. In the "*more sustainable*" cluster, they are 3.55 $kgCO_2eq$ per capita per day, which represents a 15% reduction in GHG emissions.[32] In addition, the diets of the cluster are healthier than the average diet.

Significant changes in diets are needed to obtain healthier and more environmentally friendly diets

The same study (Vieux et al., 2020b) shows that the "*more sustainable*" diet contains more plant-based products and, in particular, much more fruit and vegetables (+57%); more legumes, nuts and oilseeds (+29%); less meat and notably much less ruminant meat (-43%) and processed meat (-16%); and less cheese (-11%) but more fresh dairy products (+17%). These changes are notable when compared to average diets in the EU and the current trends of these diets (see Section 3.4).

Food product reformulation could contribute to healthier diets for the whole population

By decreasing the salt, sugar and fat contents in foods, product reformulation has the potential to decrease (respectively, increase) consumers' exposure to unfavourable (respectively, favourable) nutrients. Should it be implemented by the entire food industry, this means of action could contribute to an increase in consumers' compliance with nutritional recommendations and the healthiness of current diets. Industry-wide food product reformulation, which does not depend on consumers' behaviour, could benefit the entire population, including the more disadvantaged households (Réquillart and Soler, 2014). Many studies attest to these potential benefits and highlight the relevance and cost-effectiveness of this means of action (Leroy et al., 2016; Federici et al., 2019). In the last years, private and public initiatives have been implemented in MS in order to encourage food product reformulation by food companies (Gressier et al., 2020). A positive trend has been identified. This must be reinforced in order to get more significant results at the consumer level.

There are also possibilities of improvements at the processing level in order to diminish energy consumption and/or environmental impacts. In particular, the so-called "*eco-conception*" is a means of action that may contribute to this progress.

4.2. Policies

Means of action identified in the previous section have been classified into three groups: first, innovations favouring efficiency gains at the farm level and within the food chain; second, solutions that contribute to the re-design of production systems and thus correspond to more radical changes;

[31] DASH stands for Dietary Approaches to Stop Hypertension.

[32] From that perspective, ***Annex A.4.2*** attempts to assess the reduction in GHE emissions of the European food system that could be achieved using the three means of action related to efficiency gains (E), the re-design of production systems (R) and changes in dietary patterns (D).

and third, changes in dietary patterns and consumers' behaviours. Each solution may have economic consequences that must be considered in order to determine the optimal set of public policies to promote.

4.2.1. Efficiency gains

Efficiency gains induced by the adoption of innovations at the farm level may reduce the negative climatic and environmental impacts of agricultural practices. For example, the development of precision farming and broadband coverage may contribute to a reduction in pesticide and fertilizer use. In so doing, such innovations have the potential to reduce variable production costs. On the other hand, they require investments that increase fixed costs. The reduction of losses and waste, as well as some actions developed following the principles of a circular bio-based economy, will likely have similar impacts; that is, a decrease in variable production costs and an increase in investment expenditure. ***Overall, these "efficiency" actions may induce climatic and environmental benefits in a cost-efficient way. However, they will not be sufficient to reach the various Green Deal targets.***

The impact on farm income is likely to be more or less neutral, as decreased variable costs would be globally compensated by increased fixed costs linked to investment needs. However, as shown previously, the uptake of these innovations is low today. A lack of information and skills, a lack of infrastructure (broadband coverage), the reluctance to invest in new technologies, uncertainties about their performance and impacts may go some way to explain the low rates of adoption. To encourage their uptake, in addition to better infrastructures, accompanying actions that include information gathering, result dissemination and adapted agricultural advice services are required. Depending on the economic balance, public support, notably in the form of targeted investment aids, may also be required to favour the adoption of these innovations. However, information seeking and investment in skills and equipment are unlikely if relative prices make labour saving practices and input intensive techniques more profitable (Femenia and Letort, 2016; Dupraz et al., 2020).

These solutions aimed at achieving efficiency gains appear to be relevant and generally correspond to a "*win-win*" strategy for both the environment (despite some possible trade-offs, for example, between energy consumption and pesticide use) and economic indicators, for both the farmer (under the condition that fixed costs are not too high and that variable costs are effectively reduced) and the final consumer (as consumption prices and food expenditure should be not significantly impacted). However, as already mentioned, these actions will not be sufficient to achieve the Green Deal targets.

4.2.2. The re-design of production systems

The Green Deal and its associated strategies, notably the F2FS, propose the re-design of agricultural production systems as a second means of achieving the objectives and targets. The re-design implicitly relies on a de-intensification of farming practices that can be moderate (for example, in the case of IPM) or more substantial (for example, in the case of organic farming).

The set of re-design actions may have important and positive impacts on the environment, especially in relation to biodiversity, air and water protection issues, and, as a consequence, on health. Their impacts on climatic change are more ambiguous. Carbon sequestration practices and agroforestry may contribute to reducing the net GHG emissions of the farm sector. However, lower yields induced by less intensive production processes may increase agricultural GHG emissions per product unit.

In the absence of policy support, the de-intensification process induced by the re-design of farm systems could have detrimental impacts on farmers' incomes, at least in the short term

Overall, the de-intensification process will very likely lead to an increase in per-unit production costs (because of lower yields), which could be lessened in the long term thanks to productivity gains, the restoration of soil fertility and the reinforcement of eco-systemic regulations. In the short term, higher production costs may diminish farmers' incentives to switch towards agro-ecological and organic systems. The final impact on farmers' incomes will depend on the balance between a positive price effect (that depends on the size of the population willing to pay more for healthier and more environmentally friendly food products) and a negative cost effect.

Producer's commitments to implement more demanding agricultural practices are strongly dependent on the possibility of rewarding environmental efforts. Regarding the adoption of IPM, for example, it is likely that a better use of pesticides will have a positive impact on gross margins. However, the net impact on farmers' incomes will depend on work skills and investment expenditure required to achieve such improvements. Indeed, despite the numerous studies showing that IPM principles can allow a significant pesticide reduction without significant losses in yields (Lamichhane et al., 2016), the level of adoption remains low among EU farmers. Economics aspects mainly explain this; more specifically, production risks, investment needs and the human costs required to acquire new skills[33] (Barzman et al., 2014; Lefebvre et al., 2015). Furthermore, many economic studies (Skevas et al., 2014; Fadhuile et al., 2016; Böcker and Finger, 2016; Bareille and Dupraz, 2020) conclude that pesticide demand elasticities are low, which highlights the farmers' reluctance to reduce pesticide uses.

Market prices of organic food products are substantially higher than those of conventional products. Thanks to higher prices and specific CAP or national payments, organic agricultural systems globally achieve a similar profitability than conventional agricultural systems even if the latter have generally higher and less variable yields (EC, 2013, 2019, Offerman et al., 2000; Smith et al., 2019). The price premium has tended to increase over the most recent years leading to higher agricultural margins for organic products (Sanders et al., 2016). Margins are higher per product unit, but not necessarily per unit of labour, as organic farming requires more labour for the same number of hectares or animals. Subsidies play a key role in sustaining the income of organic farms.[34] Calculations based on the FADN for 2018 show that European organic and non-organic farms have, on average, similar economic results, with higher levels of direct aids for organic farms (***Box 4.2***).

This statement suggests that organic farming profitability and development depend on price premiums and support direct aids. This is also the case for agro-ecological systems in a more general way. From that perspective, it is anything but certain that European consumers are ready to accept higher price premiums for "agro-ecological" food products. In other words, in the absence of policy support, the de-intensification process could have negative impacts on farmers' incomes, at least in the short term.

Producers' commitments to the re-design of their production systems will also depend on the vertical relationships in food chains between producers, processors and retailers, which affect the price transmission along these food chains and the value sharing between stakeholders. Long-term contracts in the framework of chain agreements between producers' organizations and food processors and retailers may be required in order to favour investments at the farm level and provide multi-annual price and/or market access guarantees. Such contractual relationships already exist, but they are mainly implemented for private labels or national brand differentiation. The possibility to generalize such approaches to the whole food supply, in order to drive massive changes at the farm

[33] This is because results of preventive actions are difficult to observe and assess, compared to effects of curative actions provided by pesticides.

[34] Currently, only the Netherlands do not provide a specific subsidy to organic farms (Agence Bio, 2019).

level, remains a challenge that has been identified in the F2FS (EC, 2020c) and requires attention from policy makers.

Box 4.2: Incomes of organic *versus* conventional farms in the EU-28

The total organic area in the EU-28 was 13.4 million hectares in 2018 (7.5% of the UAA). Four MS accounted for more than half of all organically farmed land; that is, Spain (16.7%), France (15.1%), Italy (14.6%) and Germany (9.1%), together making up 55.5% of the total EU-28 organic area.

The share of agricultural land under organic farming was over 20% in Austria (24%), Estonia (21%) and Sweden (20%). On the other hand, this share is less than 5% in several MS; namely, Cyprus, Luxembourg, Hungary, Poland, the Netherlands, the United Kingdom, Ireland, Bulgaria, Romania and Malta (see Figure 3.11).

The share of organic farms in the total number of farms is higher for orchard fruit, wine, olive, sheep and goat orientations, and lower for farms specialised in cereals and oilseeds, as well as in dairy production

Based on the 2018 FADN,[35] it appears that, on average, European organic and conventional farms have a similar size in hectares and similar employment levels. The production value of organic farms is lower (-9%) than that of conventional farms, which means that lower yields are not compensated for by higher prices. Organic farms use fewer inputs and receive a higher amount of direct aids (+€8,700 per farm, that is, +66%). Finally, farm incomes are comparable.

Annex A.4.1 provides a more extensive analysis of structural and economic characteristics of conventional *versus* organic farms by distinguishing four classes: (1) the holding does not apply organic production methods (class 1 of "*conventional*" farms); (2) the holding applies organic production methods for all of its products (class 2); (3) the holding applies both organic and non-organic production methods (class 3); and (4) the holding is converting to organic production methods (class 4).

In the absence of policy support, consumers' reactions could weaken producers' incentives to radically change their agricultural practices and systems

Overall, the de-intensification of the agricultural process will likely lead to an increase in per-unit production costs that, in the short term, could affect (increase) food prices leading to consumers' welfare losses. Price increases could have detrimental effects, especially on poor and disadvantaged European households that are confronted with strong food insecurity challenges. A recent study showed that in 16 out of 24 MS, at least 10% of households experience financial constraints in order to eat healthy food. Income-related food insecurity is especially prevalent in Eastern and Southern Europe (Penne and Goedemé, 2020). Furthermore, it is clear that the food insecurity challenge has been reinforced because of the Covid-19 global crisis, the end of which cannot foreseen.

Under budgetary constraints, consumers could react to food price increases by shifting towards lower-price products within each food category (for example, from high- to low-quality fruit and vegetables). This reaction could have negative ecological impacts if the environmental quality of lower-price products is also lower.

Consumers' responses could directly affect producers' decisions. Indeed, consumers' shifting to lower-quality products could reduce producers' incentives to adopt more environmentally friendly farming

[35] We warmly thank the European Commission (DG AGRI) for kindly and quickly providing us access to the EU FADN.

practices, and could possibly lead them to reduce their costs by lowering the quality of the product and the production processes.

Additional risks related to imports must be mentioned. If a significant number of consumers react to a price increase by shifting towards lower-price and lower-quality products, then the competitive pressure on domestic agricultural and food producers could increase due to the entry of the "*lowest bidder*" non-EU products. In the absence of sufficient trade protection, this would also undermine the European producers' incentives to commit to more environmentally friendly production practices and systems.

A solution could be to disconnect the compensation of producers' efforts from the market; in other words, to compensate their efforts by direct aids funded by the taxpayer, notably thanks to the CAP. The payment for environmental services could allow for the covering of the additional production costs of more environmentally friendly practices. The higher the payment for environmental services, the lower the impact on final prices and the subsequent loss of consumers' welfare. This would mean a transfer of the economic burden of internalizing the climatic and environmental impacts of agricultural practices and food systems from the consumer to the taxpayer.

The upscaling of agro-ecological and organic systems requires voluntarist and assertive policies to create the right incentives for producers

The economic mechanisms identified above suggest that in the absence of voluntarist policy support, the transition toward re-designed agricultural production systems will be difficult to conduct, and that there will remain some distance from reaching the Green Deal objectives and targets. As a result, policy instruments should be designed and implemented to:

1. Create strong and perennial incentives (taxes and subsidies) to favour changes in production systems and to compensate for the higher production costs of more environmentally friendly agricultural practices and systems. This first recommendation conditions the effectiveness of the other accompanying measures proposed below, because farmers will not invest in agro-ecological skills and equipment if their expected future profit is negative and/or highly uncertain and variable (Dupraz and Guyomard, 2019);
2. Improve farmers' skills through training and advisory actions in order to disseminate the best agro-ecological and organic practices;
3. Reinforce investment aids to favour the adoption of agro-ecological equipment;
4. Favour vertical agreements and fair value sharing between stakeholders within the food chains to accompany the agro-ecological transition at the farm level; and
5. Strengthen trade regulations and agreements to protect European domestic producers committed to climatic and environmental efforts.

The first recommendation invites the implementation of a European tax on the main determinants of agricultural GHG emissions (that is nitrogen fertilizers and animals), based on the associated emission factors of the national inventories. Such a tax will equalize the marginal costs of abatement of one tonne of CO_2 equivalent between farmers and, as a result, minimize the total abatement cost for a given objective of reduction of agricultural GHG emissions (De Cara and Jayet, 2011). This is because what is not mitigated by agriculture will have to be mitigated by other economic sectors (and inversely). In order to minimize the overall abatement cost in the EU, the tax rate in agriculture should be equal to the marginal abatement cost in other sectors. Such a tax should be applied at the European level because the climate is a global public good; and to minimize competitiveness distortions among MS.

This is also why it is necessary to complete the device by a carbon border adjustment mechanism (recommendation 5).

According to the same logic, a European tax on pesticides and veterinary drugs calibrated according to their ecological toxicity is justified so as to protect biodiversity (and health). Setting the rate of this second tax is a difficult question, due to the lack of precise and easy-to-gather references available related to the marginal damages caused by the use of these chemical inputs. A pragmatic solution is to apply a rate that increases over time until biodiversity indicators show a recovery in agricultural ecosystems. Because of the response delay of ecological processes, the decline in pesticide and antimicrobial sales may provide an initial guide to adjust the tax rate over time. As for climate mitigation, trade regulations and agreements should include "*equivalent*" provisions and requirements for foreign competitors.

There is no need to emphasize how widely unpopular tax schemes are; however, they do have a number of virtues. For the same climatic, environmental and/or health objective, the administrative costs of the taxes proposed above are very low (negligible) compared to those of direct payments granted only if criteria and/or objectives are used and respected, as is currently the case for Agri-Environmental and Climatic Measures (AECM) of the second pillar of the CAP. This is because the taxes apply to operators, such as mineral fertiliser distributors and slaughterhouse companies, who already collect taxes. Transaction costs for farmers are zero, which is far from being the case with cross-compliance requirements, the greening and AECM of the current CAP, as they require detailed declarations of agricultural land and land uses, livestock herds or farming practices. By avoiding these declarations, which are often difficult to establish and verify, the taxes respond (at least partially), to the growing recriminations of farmers and the CAP managing authorities against the bureaucracy and administrative burdens of the CAP. In addition, taxing potentially polluting inputs provide incentives to reduce their waste linked to an excise use. Finally, the product of the tax could be maintained within the farm sector in order to increase financial resources required for implementing ambitious payments for climatic and environmental services (France Stratégie, 2019). Reinforcing conditionally requirements within the future CAP is a "*second best*" policy option that seeks to mimic the effects of the climate and biodiversity tax scheme described above (see Chapter 5 for further elaboration).

Our first recommendation also includes positive incentive payments for climatic and environmental services, which are provided by permanent grassland, agricultural land permanent cover, crop diversity and landscape fixed features. From that perspective, two priorities for efficient action are:

- First, to proportion the payments to indicators that are closely correlated with soil carbon sequestration and the implementation of biodiversity-friendly agricultural practices, systems and landscapes. This implies payments that are proportional to both the areas targeted and the contributions of each area to climatic and environmental benefits;
- Second, to ensure the time consistency of the scheme, so that the public payments for climate and biodiversity are not lost because of changes in the economic situation. This concerns, for example, the conversion of permanent grassland to arable crops in response to a rise in cereal prices. The fact that the obligations and the payments of the current CAP are attached to the farmer is another problem: the climatic and environmental benefits generated on a particular parcel of land may be cancelled when the land is sold, without the seller or the buyer having to reimburse the aid received in return for the provision of these benefits.

Policy actions aimed at favouring supply side changes are needed. They will not be sufficient to achieve the Green Deal objectives and targets in the most efficient way as the transformation of production systems also depends on changes on the consumption side.

4.2.3. Changes in diets and consumption behaviours

Several arguments explain why achieving the Green Deal ambition also requires policy actions aimed at changing consumers' dietary patterns and behaviours. The first reason is clearly that current eating patterns are not healthy or sustainable (see Sub-Sections 3.3 and 3.4). Second, the need to reward climatic and environmental efforts of farmers in order to reduce the negative impacts on farm incomes raises the issue of the consumer Willingness to Pay (WTP) for more environmentally friendly food products, if the payments for environmental services do not fully cover the increase in production costs. Third, the re-design of production systems asks questions about changes in consumers' dietary patterns, as a potential price increase may lead to diet readjustments by consumers as budgetary constraints are binding for a large majority of households. Indeed, changing diets by consuming smaller quantities of higher-price product categories (meat-based products, alcoholic beverages, prepared meals) and larger quantities of lower-price product categories (fruit and vegetables, legumes) may be a way to lessen the impacts of higher prices on food expenditure.

This type of reaction is already observed among organic consumers. Recent studies dealing with organic consumption show that the dietary patterns of organic consumers differ from those of conventional consumers, as organic consumers buy greater quantities of fruit and vegetables, legumes, whole-grain products, plant-based proteins, and buy lower quantities of meat, processed meat, alcoholic and sweet beverages (Baudry et al., 2017). These dietary changes allow consumers to lessen the impact of higher organic prices on food budgets (Boizot-Szantai et al., 2017). Thus, the potential price increase induced by the re-design of production systems could favour changes in the dietary patterns of consumers. An increased awareness of the relationships between food practices, health and the environment could support the shift towards more sustainable diets.

Changes in dietary patterns are major tools for action in order to improve the health, climatic and environmental benefits of the food system

Changes in dietary patterns are important to consider in order to reduce the climatic and environmental impacts of the food sector in addition to actions focused on farmers' practices and systems, as well as food product reformulation and food processors (Tilman and Clark, 2014; Bryngelsson et al., 2016; Röös et al., 2017; Springmann et al., 2018; Poore and Nemececk, 2018; IPCC, 2019; Rabès et al., 2020). Many recent publications converge towards the statement that ambitious climatic and environmental goals require changes in consumers' diets. This is notably the case for climate mitigation (see Section 4.1).

For instance, Poore and Nemececk (2018) note that climate mitigation at the farm level is complicated by trade-offs, multiple ways for producers to change their practices and interactions throughout the supply chain. Producers then have limits as to what extent they can reduce their ecological impacts. Even if they adopt more sustainable agricultural practices, the impact of the lowest-impact animal product typically exceeds that of vegetable substitutes, providing evidence for the importance of dietary changes. Bryngelsson et al. (2016) add that "*agriculture can improve in productivity and through implementation of specific mitigation measures to cut significantly current food-related methane and nitrous oxide emissions. However, also dietary changes will almost certainly be necessary. Large reductions in ruminant meat consumption are, most likely, unavoidable if the EU targets are to be met*". Springmann et al. (2018) analysed several options for reducing the climatic and environmental impacts of the food system, including dietary changes towards healthier and more plant-based diets, improvements in technologies and management, as well as reductions in food losses and waste. They show that no single measure is sufficient to keep these effects within all planetary boundaries simultaneously, and that a synergistic combination of supply and demand measures are needed to sufficiently mitigate the

projected increase in environmental pressures. IPCC (2019) and Röös et al. (2017) converge towards the same statement, which raises the issue of consumers' willingness to change food diets and behaviours.

Combining changes on the supply and demand sides may be a way to address the Green Deal ambition related to agriculture and food at lower social costs. Indeed, reaching the Green Deal objectives and targets through efficiency gains and the re-design of production systems only would be too costly for producers with, in addition, potentially strong impacts on final prices and consumers. Reaching the same objectives and targets through changes in consumers' food diets and behaviours only is also unrealistic in the short term. As food practices are deeply grounded in social and individual preferences, widespread behavioural changes would be challenging to achieve, and will induce large losses in consumers' welfare. Combining both would provide an intermediary and less costly pathway to targeting ambitious goals, with smaller changes on the demand and supply sides.

For most consumers, dietary changes will not occur without policy support

To what extent could changes in consumers' preferences and dietary patterns be spontaneous, driven only by societal changes and a progressively more acute awareness about the health and environmental impacts of their food diets; and to what extent must these changes on the demand side be accompanied and even driven by food chain stakeholders and public interventions?

Recent European studies (Macdiarmid et al., 2016; Bouwman et al., 2016; Weinrich, 2018; Sanchez-Sabate and Sabaté, 2019) show that increasingly more consumers are aware of the links between diet, health and the environment. They are particularly aware of the role of meat consumption. However, the willingness to shift towards healthier and more environmentally friendly diets, with more plant-based products and less animal-based products, is, for now, only acknowledged by specific consumer groups (for example, organic consumers). Taste preferences and sensory dimensions, eating habits and convenience are also impediments to a change in dietary patterns towards more plant-based diets. Thus, the main limitation is not, at current prices, the cost of alternative diets - as diet adjustments may compensate for higher prices to some extent , but the gap with current preferences (sensory and taste, food habits, etc.). This means that for most consumers, moving from current diets to more plant-based diets induces a loss of welfare. Is it then justified that public authorities intervene in order to lead people to change their diets?

Irz et al. (2016, 2019) addressed this question in three European MS by computing the consumers' welfare loss due to changes in diets and the economic value of climatic, environmental and health benefits. Their results showed that: first, for most consumers, especially the poorest, the loss of welfare may prevent significant dietary changes; and second, the economic value of climatic, environmental and health benefits is much higher than the consumers' loss of welfare. This means that the recommendation of dietary changes would in fact be justified (from the point of view of public economics), as benefits exceed the consumers' welfare loss. This also implies that because of this welfare loss, most consumers will not shift towards modified diets without any policy intervention.

From that perspective, the EC proposed modulating Value Added tax (VAT) rates in order to send the right price signals, for instance, to promote the consumption of organic fruit and vegetables (EC, 2019a). The question behind this proposal is to determine which substitutions between food products must be prioritized in order to maximize the climatic and environmental benefits at the lowest social cost. Thus, two strategies must be considered:

- The first favours consumers' substitutions from conventional to agro-ecological and/or organic food products, for example, by decreasing corresponding VAT rates; and

- The second is to favour food product substitutions to foster the adoption of more plant-based diets. In this case, VAT rates of meat products must be increased, and VAT rates of plant-based products must be decreased (whether they are organically produced or not). The tax modulation may be based, for instance, on the carbon footprint of the final products.

The first strategy may be justified by lower chemical contaminant exposures of organic consumers. However, it would not provide the attested benefits of the nutritional quality of the diets or lower the climate change impacts. Moreover, by enlarging the population of organic consumers, it would mainly benefit higher-educated and higher-income consumers. The second strategy is likely to be more efficient in reaching climate goals, as organic products are not necessarily superior in terms of GHG emissions, at least per product unit (see Sub-Section 4.1.6). Of course, depending on the choice between these two policy orientations, the consequences on producers and notably their incomes will be different.

Dietary changes could favour fruit and vegetable producers thanks to higher demand and potentially higher prices, and modify meat producers' trade-offs between domestic and export markets

The means of targeting changes in consumers' dietary patterns may have important impacts for agricultural producers. A growing demand for fruit and vegetables may benefit corresponding producers. On the other hand, dietary changes may undermine meat producers' incentives to adopt agro-ecological practices, because their response may be to decrease production costs and final prices in order to limit the consumers' shifts towards more plant-based products. This could lead to more intensive livestock production systems rather than to de-intensification. A way to limit this effect is to develop environmental labelling in order to distinguish between producers based on their production systems (if consumers are willing to valorise best practices). This will also depend on the incentives provided to producers to de-intensify their production systems.

The decrease in the domestic demand for meat-based products may contribute to lower prices and quantities that would negatively impact livestock producers' incomes. This could cause a reduction in the size of animal activities and may lower the prices of meat-based products. The main response of producers may be to increase meat exports in the world context of an increase in meat consumption, provided that their competitiveness is high enough. In that case, the total value of the meat sector could be preserved (or, at least, the loss would be reduced). This nevertheless raises two important questions:

- What will the consequences of the development of the export market on producers' incentives be to invest in agro-ecological practices? This will depend on the specificity of each market and the substitutability of products delivered on the domestic and export markets, as well as on the incentives provided in favour of less intensive production methods; and

- Will the overall climatic and environmental performance be improved? Indeed, should environmentally friendlier techniques result in a lower output per hectare in the EU, market driven effects could generate incentives to produce more intensively in other parts of the world, including in high natural value areas. To assess the extent to which local environmental benefits are offset by indirect ones in foreign countries, Bellora and Bureau (2014) analysed the market and environmental impacts in a scenario where 20% of EU land devoted to arable crops is converted to organic farming. Simulation results show that production displacements would take place unless the yield gap between organic and conventional farms is significantly reduced. The negative indirect effects on the environment appear limited compared to the local benefits of adopting "*greener*" forms of agriculture in the EU. However, in the specific but

important case of climate mitigation, the increase in indirect GHG emissions more than offsets the local benefits of the development of organic agriculture in the EU.

Demand side policies may facilitate the adoption of healthier and more sustainable food choices and diets in the EU

The economic mechanisms identified above suggest that, as a complement to supply side policies, demand side actions are necessary so as to encourage the adoption of healthier and more sustainable food choices and diets.

One way to reduce the consumers' loss of welfare and facilitate a shift towards healthier and more sustainable diets lies in the hands of the food industry and retail actors (Réquillart and Soler, 2014; Leroy et al., 2016; Federici et al., 2019; Gressier et al., 2020). By reducing the promotion of less healthy and less sustainable products, limiting advertising and developing responsible marketing, these actors may decrease the distance in order to reach more sustainable diets. Initiatives aimed at food product reformulation with, for example, a decrease in the salt or sugar contents in foods, and the launching of new products favouring, for instance, affordable access to plant-based proteins, may facilitate the consumers' transition towards healthier and more environmentally friendly diets.

A second possibility is to facilitate an increased awareness about the health, climate and environmental consequences of food choices through education and information campaigns or through better information on the production processes of quality products. Nutritional and environmental labelling are key issues from that perspective. It is worthwhile to note that food labelling may have (modest) impacts on consumers' choices, but above all, may affect producers' and stakeholders' decisions. Labelling can also support food reformulation efforts by the food industry. Within the environmental dimension, it can contribute to the setting up of monitoring processes within the food chains and create incentives to more environmentally friendly practices at the producer level, including for farmers.

A third option would be to modulate final prices, thanks to taxes or subsidies, in order to favour substitutions between food products. Recent works have assessed the impacts of such instruments on consumers' food choices and welfare; see Doro and Réquillart (2020) for a review. In any case, the low price elasticity of food demand leads to moderate impacts of "*realistic*" tax rates. In addition, food taxes may be regressive, with larger impacts on the budgets of low-income households. However, targeted subsidies may be used to compensate for the additional food expenditures due to taxes, especially for the poorest households. The essential point is that, overall, the loss of consumers' welfare induced by these policies is smaller than the economic value of the health, climatic and environmental benefits, which legitimates the intervention of public authorities.

4.2.4. Synthesis

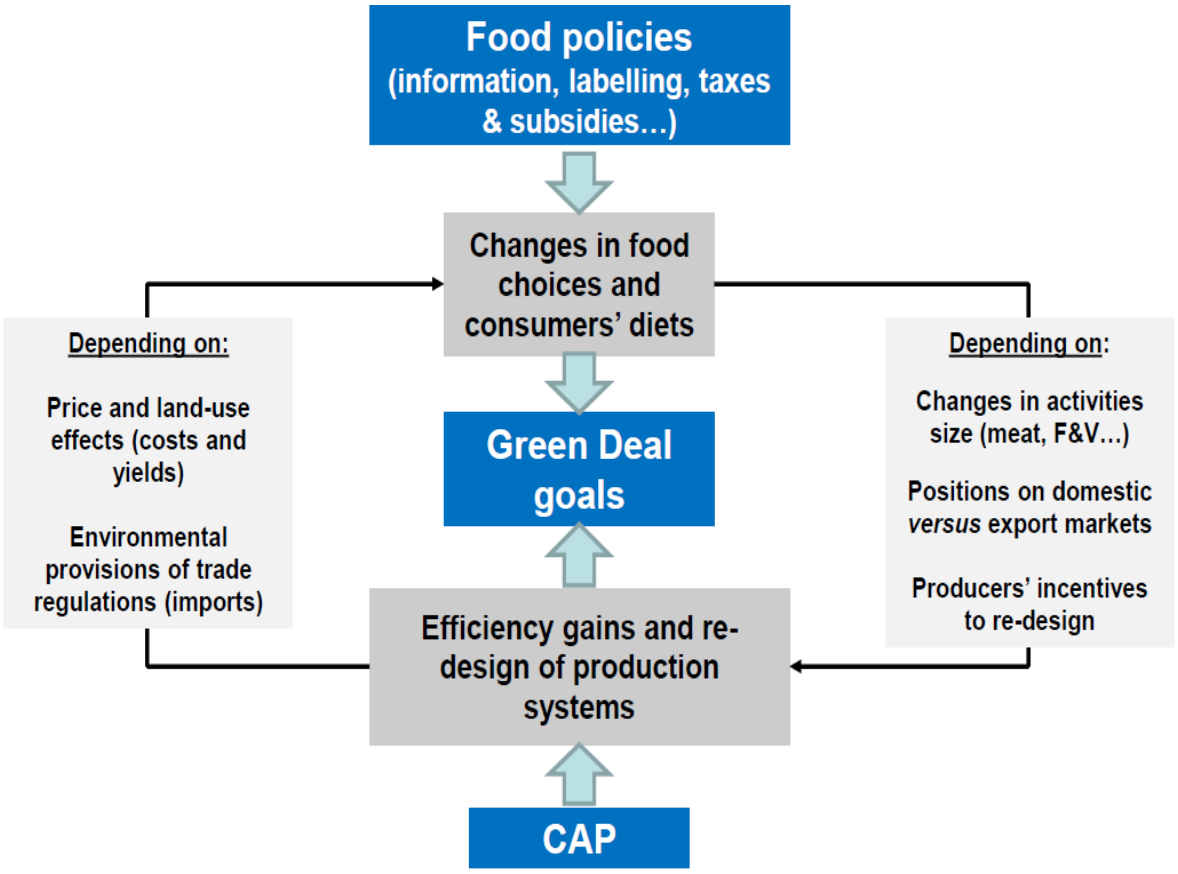
Combining efficiency gains (through improvements in technologies and management, as well as a better use of co-products, a reduction in food losses and waste, and, more generally, an augmented use of circular economy principles), the re-design of production systems (based on agro-ecological principles), and dietary changes at the consumer level may place the European food system on the right track to reach the Green Deal objectives and targets related to agriculture and food.

To that end, voluntarist polices are required on both the supply and the demand sides: these policies cannot be designed in a fragmented way. As discussed in this section and summarized in ***Figure 4.1***, the actions used to address the climatic, environmental, health and economic issues at the farm level will have impacts on consumers' decisions and their welfare, mainly through price effects. Conversely, policies targeting changes in dietary patterns through a large variety of policy tools, from information

to taxes and subsidies, may affect the consumers' demands for quality and quantity, which may then have strong impacts on producers' incentives to adopt more environmentally friendly production processes. The content and the instruments of the CAP must be discussed within this general framework.

Two specific issues must be addressed. The first is related to livestock and meat production, as reaching ambitious targets for climate change and health will not be possible through changes in agricultural practices only. The reduction of meat consumption will raise major challenges related to livestock producer incomes, export issues and the possible adaptation of meat actors that will have to be accompanied by the CAP or other public policies. The second issue is related to the price effects and their consequences on households' food expenditures, in a context of social inequities aggravated by the Covid-19 global crisis.

Figure 4.1: How agricultural supply and food demand policies interact



Source: Own elaboration.

5. HOW THE FUTURE CAP COULD SUPPORT THE GREEN DEAL AMBITIONS, OBJECTIVES AND TARGETS

KEY FINDINGS

- There is a good match between the coverage of the agricultural part of the Green Deal and its associated strategies, notably the F2FS and the EU Biodiversity Strategy for 2030, and the future CAP. The matching is much less straightforward for issues and policies beyond the farm gate.
- The legislative proposals for the future CAP presented by the Commission more than two years ago have recently been the subject of intense debate within both the Council and the European Parliament. Within the Council, the desire of numerous MS to alleviate several climatic and environmental provisions of the initial proposals, *a fortiori* of the enhanced provisions emphasized by the Commission itself in its own analysis of the links between the CAP and the Green Deal, will have the effect of undermining the climatic and environmental ambition of the CAP, *a fortiori* of the Green Deal.
- According to the Commission, the three main initial provisions that must be maintained include an enhanced conditionality, mandatory eco-schemes and a minimum spending of 30% of the second pillar budget on climate- and environment-related interventions (excluding payments for areas with natural constraints). Enhanced provisions requested by the Commission encompass greater clarity regarding the scope of eco-schemes, by means of recommendations by the Commission on agricultural practices that could be supported in achieving the Green Deal targets related to pesticides, fertilizers and organic farming, and the integration in the CAP of the EU legislation on the use of antibiotics in livestock and animal welfare. The Commission would ask each MS to demonstrate how its national strategic plan will achieve greater climatic and environmental ambition than at present (application of the "*no backsliding*" principle) and to set national values (at the level of the CAP impact indicators) for the various Green Deal agricultural targets.
- The distinct compromises for the future CAP adopted by the Council of European Agricultural Ministers on 21 October 2020 and by the European Parliament on 23 October 2020 pave the way for trilogue negotiations to kick start, since these compromises are not very different from the initial proposals of the Commission in terms of both architecture and instruments. Both confirm that eco-schemes would be mandatory and add that a minimum spending should be devoted to this new instrument (20% of the Pillar 1 budget for the Council, 30% for the European Parliament). However, these compromises do not reflect a strong will to enhance the climatic and environmental ambition of the CAP. Worse still, some provisions weaken the initial proposals of the Commission.
- Our general recommendation is, on the contrary, to strengthen the initial proposals for the future CAP as regards their climatic and environmental objectives and instruments.
- Detailed recommendations are based on simple principles of public economics and fiscal / environmental federalism that require, in particular:
    - To reinforce the application of the polluter-pays principle to better legitimise the increased use of the provider-gets principle;
    - To distinguish between global and local public goods.

- The polluter-pays principle underlines the conditionality of direct payments in Pillar 1. Conditionality requirements should be strengthened as follows:
    - Exemptions to mandatory requirements should remain highly restrictive because it is important that corresponding obligations apply to a maximum of farms and cover a maximum of agricultural area;
    - Applying enhanced conditionality requirements at the EU level is a condition for maintaining a common level playing field, and ensuring that the provisions on "*Good Agricultural and Environmental Conditions*" (GAEC), which replace the eligibility criteria to the green payments of the current CAP, reflect, at least, the same level of climatic and environmental ambition (in accordance with the "*no backsliding*" principle);
    - Some GAEC proposals should be reinforced; in particular, GAEC #2 related to the protection of wetlands and peatlands and GAEC #9 related to high-diversity landscape features; and
    - New GAEC should be introduced in order to increase farmers' awareness of the need to consider how their practices and systems impact the climate and the environment: in order to meet the Green Deal objectives and targets on climate mitigation and the use of pesticides and antibiotics, the need to report emissions and input uses should be introduced, as has already been trialled in a few Member States.
- The provider-gets principle underlines both the eco-schemes in Pillar 1 and the climate- and environment-related interventions in Pillar 2. What we propose for conditionality defines which part of the effort required to match the Green deal objectives and targets should be remunerated by Pillar 1 or 2 payments. From that perspective, the fiscal / environmental federalism theory recommends that the eco-scheme measures, totally financed by the EU budget, target the global public goods; that is, climate mitigation, biodiversity preservation and restoration, and animal welfare. The eco-scheme measures would be complemented by climate- and environment-related interventions in the second pillar, co-financed by national authorities, focused on local public goods such as water quantity and quality, soil quality, open and diversified rural landscapes, etc.
- As far as the eco-schemes are concerned,
    - We recommend to introduce four types of measures related to climate mitigation issues targeting permanent grasslands (without possible ploughing), wetlands and peatlands, high-diversity landscapes (excluding nitrogen-fixing crops and catch crops), and farmers whose farms have lower GHG emissions than the mean or the median.
    - In the same way, the public good characteristic of biodiversity motivates a second set of measures that would support European farmers for high levels of crop diversity and maximal soil coverage, and for pesticide and antimicrobial uses that are below the mean or the median.
    - The eco-scheme framework would also be an appropriate means by which to reward livestock producers' efforts in terms of animal welfare.

- For the CAP regulations to match the Green Deal objectives and targets related to agriculture, it is necessary to provide the right incentives. The CAP budget provides significant leverage if targeted in an appropriate way. It is difficult to consider that there will be "*no backsliding*", let alone some inflexion of the CAP towards the Green Deal ambition, unless budgets are ring-fenced for climate and environment action. This would imply a minimum of 35% of the Pillar 2 budget to be devoted to climatic and environmental measures (we suggest including payments for areas with natural constraints but with a reduced weight of 0.4). This would also imply reserving at least 15% of the Pillar 1 budget for eco-schemes measures targeting climate mitigation, as well as at least 15% of the Pillar 1 budget for eco-scheme measures targeting biodiversity preservation and restoration. Furthermore, the eligibility criteria to assess whether or not the CAP devotes 40% of its total budget for climate interventions should be strengthened, compared to what the Commission currently uses in the framework of the "*Rio markers*".
- In addition to technical aspects and ring-fenced budgets, much of the capacity of the future CAP to match the Green Deal ambition related to agriculture will depend on effective governance. At this stage, several key Green Deal targets related to agriculture and food are non-legally binding. Others are defined in a rather vague way and could easily be circumvented or "*watered down*". More binding and precise commitments in national strategic plans are necessary in order to align the CAP with the Green Deal targets.
- The four sets of indicators that the Commission intends to use to monitor progress appear to have limited effectiveness. If it is well understood that the "*result*" indicators that are presented as determinants in monitoring and releasing payments are focused on criteria that are directly under each MS's control, they depart considerably from what would be necessary to ensure a *"budget for results"*. A more focused and precise set of indicators that clearly state the base period from which reductions will be calculated and which proxies will be used for milestones to match actual change are necessary. The "*effort sharing*" between the different Member States to meet the EU objectives and targets needs to be made more specific. In its current form, the indicators do not seem to allow the effective reporting, monitoring and enforcing of progress, nor is there an effective corrective action plan if progress does not meet its targets. Without these clarifications and strengthening of the monitoring, the Green Deal targets will remain "*aspirational*" only and the New Delivery Model of the future CAP is unlikely to significantly achieve the greater climatic and environmental ambition of the Green Deal related to agriculture, *a fortiori* to food.
- Finally, the last section of the chapter provides an economic analysis of our climatic and environmental recommendations for the future PAC, with special attention to potential impacts on farm incomes.

This chapter presents our recommendations for the future CAP so that the latter can efficiently contribute to the climatic and environmental ambitions of the Green Deal related to the agricultural sector. Attention is focused on: first, conditionality requirements that must be strengthened; second, eco-scheme measures in Pillar 1 that need to be ambitious and targeted on global public goods (climate mitigation, biodiversity preservation and restoration, animal welfare protection); and third,

climate- and environment-related interventions in Pillar 2 that should mainly target local public goods (water quantity and quality, soil fertility, open and diversified landscapes). Recommendations also concern several ring-fenced budgets and the efficiency of the new delivery model for the CAP. All of these recommendations are presented in ***Section 5.2***. We have previously summarized the EC June 2018 proposals for the future CAP and discussions that have followed this launch, up to the time the decisions of the Council of European Agricultural Ministers and the EP are made at the end of October 2020 (***Section 5.1***). ***Section 5.3*** addresses the governance issues while ***Section 5.4*** analyses how our recommendations could impact farm incomes.

5.1. The proposals for the future CAP

5.1.1. The EC June 2018 proposals for the future CAP

Ambition and objectives of the future CAP

After the distribution of a future vision communication in November 2017 (EC, 2017b), the EC presented its legislative proposals for the future CAP on 1 June 2018. These proposals include a regulation on National Strategic Plans (NSP), a horizontal regulation on financing, managing and monitoring the CAP, and a regulation on the Single Common Market Organization (EC, 2018b, c, d).

Reflected in the general objectives for the CAP is the ambition to foster a smart, resilient and diversified agricultural sector, ensuring food security, a bolstered environmental care and climate action plan, a contribution to the climate- and environment-related objectives of the Union, and a reinforcement of the socio-economic fabric of rural areas. This ambition translates into nine specific objectives, three for each sustainability dimension (***Table 5.1***). Economic objectives are to: (i) ensure a fair income for farmers; (ii) increase competitiveness; and (iii) rebalance the power in the food chain. Environmental objectives aim to: (iv) contribute to climate change mitigation and adaptation, as well as sustainable energy; (v) foster sustainable development and the efficient management of natural resources, such as water, soil and air; and (vi) contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes. Social objectives are to: (vii) support generational renewal in agriculture; (viii) develop jobs and growth in rural areas; and (ix) improve the response to societal demand for food and health. These nine specific objectives are completed by two cross-cutting (that is, transversal) objectives. The first is related to innovation, and the second to CAP modernization and simplification.

There is no dispute around both the general and specific objectives proposed by the EC for the future CAP. The main question then is knowing to what extent the CAP instrumentation proposed by the EC could achieve these objectives, simultaneously and in the most efficient way.

Table 5.1: The nine specific objectives of the future CAP as defined in the EC June 2018 proposals

Economic objectives
(a) Support viable farm income and resilience across the Union to enhance food security (Eco 1)
(b) Increase competitiveness and agricultural productivity in a sustainable way to meet the challenges of higher demand in a resource-constrained and climate uncertain world (Eco 2)
(c) Improve farmers' position in the value chain (Eco 3)
Climatic and environmental objectives
(d) Contribute to climate change mitigation and adaptation, as well as sustainable energy (Env. 1)
(e)Foster sustainable development and efficient management of natural resources such as water, soil and air (Env. 2)
(f) Contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes (Env. 3)
Social objectives
(g) Modernise the agricultural sector by attracting young people and improving their business development (Social 1)
(h) Promote employment, growth, social inclusion and local development in rural areas, including bio economy and sustainable forestry (Social 2)
(i) Improve the response of EU agriculture to societal demands on food and health, including safe, nutritious and sustainable food, reducing food waste, as well as animal welfare (Social 3)

Source: EC (2018b).

Instruments

The two-pillar structure of the CAP would be retained. The first pillar support (Pillar 1) would be granted in the form of a basic payment, a redistributive payment in favour of small- and medium-sized farms,[36] a specific payment for young farmers, plus an additional payment in the form of a new instrument, called the eco-scheme (***Table 5.2***). Each MS would have the opportunity to maintain a part of Pillar 1 direct aids coupled to certain productions; up to 10% plus 2% for protein crops (compared to 13% plus 2% within the current CAP). As with current cross-compliance requirements, conditionality would set the standards that farmers must adhere to in order to receive the first pillar payments.

As today, conditionality would include Statutory Management Requirements (SMR) and standards for Good Agricultural and Environmental Conditions (GAEC). It would be strengthened, notably by integrating - possibly in a modified form - the three criteria of the green payments of the current CAP.[37] All direct payments of the first pillar would be reduced according to a progressive scale as soon as they exceed €60,000 per farm ("*digressivity*"), and would be capped at a maximum of €100,000 per farm ("*capping*").[38]

Market measures would remain globally unchanged. They would include public intervention on markets (purchase and storage) but at very modest levels, aids for private storage, a crisis reserve, and

[36] The redistributive payment, optional in the current CAP, at the choice of the MS, would be compulsory in the future CAP.

[37] Green payments were introduced in the 2014-2020 CAP, rewarding farmers for respecting three mandatory practices related to crop diversification, permanent grassland and ecological focus areas. They have been criticized, notably for their complexity and their low environmental effectiveness (see, for example, ECA, 2017). However, the fact that they introduced, for the first time, a degree of conditionality to practices that went beyond standards in a "*horizontal*", EU regulation was welcomed as an important regulatory step.

[38] However, the aid redistribution that would be achieved through "*digressivity*" and capping mechanisms should be only modest thanks to the possibility of increasing thresholds in line of labour costs. For more details on this point, see Matthews (2018a).

sectoral programmes for fruit and vegetables, wine, hops, olive oil and beekeeping, with possible extensions to other agricultural sectors, for a maximum amount equal to 3% of the first pillar budgetary envelope. Similarly, the objectives and the instruments of Pillar 2 would be largely unchanged with, however, changes in co-financing rates by national and/or regional authorities.

Table 5.2: Structure of the first pillar of the current and planned CAP (according to the EC June 2018 proposals)

Current CAP	Future CAP
Payments	
Basic payment (mandatory for MS)	Basic income support for sustainability (mandatory)
Green payment (mandatory for MS)	/
Redistributive payment for small- and medium-sized farms (optional, at the choice of the MS)	Redistributive payment for small- and medium-sized farms (mandatory)
Bonus for young farmers (mandatory for MS)	Bonus for young farmers (mandatory)
/	Eco-scheme (mandatory at MS level, optional for the farmer)
Coupled aids	Coupled aids
Payment conditionality	
Subject to compliance with environmental, animal health and welfare regulations and the use of GAEC	Conditionality theoretically reinforced and integrating, to a greater or lesser extent, the three measures of the current green payment

Source: Own elaboration from EC (2018b, c, d)).

The eco-schemes

Eco-schemes appear as the main novel instrument in the EC June 2018 draft regulations. It would be compulsory for MS to introduce national eco-schemes, but they would be optional for farmers. National eco-schemes would *"have to address the CAP environment and climate objectives in ways that complement the other relevant tools available and go beyond what is already requested under the conditionality requirements"* (EC, 2018b).

Eco-schemes have several features in common with Agri-Environmental and Climatic Measures (AECM) currently available through the second pillar (***Table 5.3***). However, eco-schemes are instruments of the first pillar and are thus fully funded by the EU budget. Eco-scheme aids would be granted per hectare, in compensation for extra costs incurred or income foregone induced by the adoption of more environmentally friendly practices, or as fixed top-up payments to basic income support aids. This second option opens the door for the implementation of Payments for Environmental Services (PES); in other words, for the remuneration of climatic and environmental services. However, such PES would be essentially determined on the basis of agricultural practices (that is, an obligation of means) rather than on climatic and environmental benefits (that is, an obligation of results). Eco-scheme payments would be annual, even if the EC June 2018 proposals offer the possibility to grant them on a multi-annual basis.

Independent of similarities and differences, the important point here is that eco-schemes and AECM, as well as conditionality requirements, should be designed and implemented in a coordinated and consistent manner. This would be achieved through National Strategic Plans (NSP), which are the

second main novelty of the EC June 2018 proposals aimed at developing a New Delivery Model (NDM) for the CAP.

Table 5.3: Comparison of Pillar 2 AECM and Pillar 1 eco-schemes (as defined in the EC June 2018 proposals)

	AECM	Eco-scheme
Focus	Climatic and environmental specific objectives of the future CAP	Climatic and environmental specific objectives of the future CAP
Mandatory/voluntary	Mandatory for MS, optional for beneficiaries	Mandatory for MS, optional for beneficiaries
Beneficiaries	Farmers	Farmers, other land managers
Funding	Pillar 1 (100% by the EU budget)	Pillar 2 (co-financing by MS)
Payment basis	Per hectare	Per hectare
Payment calculation	Compensation for costs incurred or income foregone, or fixed top-up payment to the basic income support	Compensation for costs incurred or income foregone
Nature of commitments	Annual, possibly multiannual	Multi-annual contracts (usually of 5-7 years)
Minimum spending requirement	At least 30% of the second pillar budget for measures addressing the climate and the environment	No requirement

Source: Adapted from EC (2018e), Lampkin et al. (2020).

The New Delivery Model (NDM) for the CAP and National Strategic Plans (NSP)

The EC June 2018 proposals for the future CAP intend to establish a new governance model for the PAC in the form of renewed relationships between the European and national levels. The EU would set the common framework, notably the general, specific and transversal objectives and the broad categories of instruments that could be used to achieve the latter. This common framework would be deployed in each MS through NSP.

Based on a SWOT[39] analysis and the identification of ensuing priority needs, each NSP would set quantified targets, select the most appropriate instruments and propose monitoring milestones and indicators of success. As part of its NSP, importantly, each MS must explain how its choice will contribute to achieving the CAP objectives. In the context of the Green Deal and the contribution of the CAP to the latter, each MS would therefore explain how its choice could contribute to the Green Deal ambition, objectives and targets. Each MS would be responsible for the implementation of its NSP, which responds to the logic of increased subsidiarity to better respond to local needs. The EC would nevertheless have to approve the plans and monitor their implementation and results over time. For the first time, this approach would apply to both Pillar 1 and Pillar 2, and not only to the second pillar as is the case today.

[39] SWOT for Strengths, Weaknesses, Opportunities and Threats.

The EC adds that "*an essential part of this framework will be an explicit obligation on MS to clearly show greater ambition than at present with regard to care for the environment and climate*" (EC, 2018e).This statement must be questioned and analysed in the context of the Green Deal in order to demonstrate an increase in this environmental and climatic ambition, notably if (as recent declarations on EC officials suggest) the Green Deal targets are "*aspirational*" only.

5.1.2. More than two years of discussions on the future CAP

The new CAP was expected to come into force on 1 January 2020. However, this will not now be the case. The current CAP will have to be extended for at least two transitional years. On 21 July 2020, the European Council came to an agreement based on its own version of the CAP budget in the framework of the MFF. On 21 October 2020, the Council of European Agricultural Ministers came to an agreement on amendments on the draft regulations for the future CAP. For its part, the EP has rejected the idea of scrapping the EC June 2018 proposals altogether and several parliamentary groups have agreed on revised regulations for the future CAP at the end of October 2020.

Conclusions of the special meeting of the European Council of 17-21 July 2020

The conclusions of the special meeting of the European Council of 17-21 July 2020 summarize the two years of budgetary discussions within the European Council (European Council, 2020). The Heads of States agreed on their own version of the MFF and, in particular, a budget for the CAP. It is worthwhile to note that both the MFF and CAP budgets still have to be approved by the EP (see Section 2.3).

Council discussions concerning CAP expenditure can be summarized as follows. At least 40% of CAP expenditure should be dedicated to climate action. MS could transfer up to 25% of Pillar 1 national envelopes to Pillar 2. This threshold could be increased by 15 percentage points, provided that MS use this increase to finance climatic and environmental measures in the second pillar, and by 2 percentage points, provided that MS use this increase to finance second pillar interventions for young farmers. Symmetrically, MS could use up to 25% of second pillar expenditure to finance Pillar 1 direct payments. Minimum co-financing rates on second pillar measures by the EAFRD would be 20%. However, the co-financing rates would be 80% for second pillar payments for climate, environment and other management commitments, area-specific disadvantages resulting from certain mandatory requirements, non-productive investments, the PEI-AGRI and LEADER. Rates would be 100% for funds transferred from the first to the second pillar.

Compromise within the Agriculture and Fisheries Council of 19-21 October 2020

Since June 2018, the Agriculture and Fisheries Council has amended the June 2018 EC proposals in a way that reflects MS positions. Under both the Croatian and German Presidencies, attention has been mainly focused on the NDM, the system of indicators, and climate- and environment-related provisions. Discussions have shown a lack of agreement between MS on conditionality, eco-schemes and their budgets, and climate- and environmental-related interventions in the second pillar. On these three subjects, as well as on direct payments, there has been particular opposition between those MS that defend uniform rules at the EU level and MS that plead for increased flexibility.

MS disagreed on the setting of a uniform EU-wide minimum percentage of arable land devoted to non-productive features, catch crops or nitrogen-fixing crops as part of the conditionality requirements (GAEC # 9). On this point, it is worthwhile to note that the EC initially intended to apply the (new) GAEC #9 on all agricultural areas in the future CAP, and not only on arable land as is the case today in the greening measure related to EFA that GAEC #9 would replace in the future CAP.

MS stated differing views on the mandatory *versus* voluntary character of eco-schemes. All MS agreed on the importance of not losing funds in situations where the uptake of eco-scheme measures by

famers would be lower than the provisions. This explains why several MS were opposed to a minimum budget for eco-schemes, expressing concern that this might lead to the loss of part of their Pillar 1 budgetary envelope and reduce their room for manoeuvre. At this stage, it is worthwhile to note that the EC initial proposals for the future CAP made the eco-schemes mandatory for MS (however, optional for farmers), but did not include a minimum budget for this instrument (EC, 2018b). It is within the framework of its 2020 staff working document, which analyses the links between the future CAP and the Green Deal, that the EC has expressed the wish to introduce a ring-fenced budget for the eco-schemes (EC, 2020i).

MS disagreed on the status of the indicators proposed by the EC. Some MS argued that only result indicators set out in Annex XII of the regulation on strategic plans (EC, 2018b) should be mandatory for performance review; again, in order to reduce "*the risk of losing funds*" (Croatian Presidency of the Council of the European Union, 2020). Overall, a significant number of MS argued for reducing the effectiveness of the performance-based approach.

In July 2020, the Ministers of Agriculture of six MS (Bulgaria, Czechia, Hungary, Poland, Romania and Slovakia) released a joint declaration on the reform of the CAP in the light of the Green Deal, the F2FS, the EU Biodiversity Strategy for 2030 and the Covid-19 pandemic. They stressed the need for a properly funded CAP and wished to adopt the CAP reform as quickly as possible. From that perspective, they stated that significant differences in the levels of first pillar direct payments among MS would no longer justified; and that the EC recommendations in relation to the Green Deal strategies "*should only serve as a guidance document helping MS throughout the planning process and should not influence legally the formal approval of the NSP*" (Council of the European Union, 2020a). During discussions, the EC "*reiterated the importance of including the objectives and targets of the F2FS in the future CAP NSP through specific country recommendations*" (Council of the European Union, 2020b). In response to questions from Ministers, the EC added that these recommendations would not be legally binding but only "*aspirational*".

Finally, some MS (in particular Germany, taking advantage of its Presidency of the EU since July 2020) pushed animal welfare and food labelling issues forward.

Reaching a compromise therefore required difficult final negotiations under the German Presidency of the EU. A compromise between Agricultural Ministers was reached on 21 October 2020 (***first column in Table 5.4***).[40] Conditionality rules would be simplified for smaller agricultural holdings, with a €2,000 threshold above which financial discipline would apply. A threshold of 10 hectares without additional restrictions in GAEC #8 (crop rotation) and GAEC #9 (landscape features) is proposed. For GAEC #1 (that replaces the current greening criterion related to permanent grassland), the tolerance of a 5% decline in the ratio of permanent grassland to total agricultural area is maintained. Requirements of other GAEC are either deleted (GAEC #5 related to the use of nutrient management tools) or watered down (GAEC #2 related to wetlands and peatlands, and GAEC #10 on permanent grassland in Natura 2000 sites). The Ministers of Agriculture agreed to make eco-schemes mandatory, with 20% ring-fencing under the direct payments' budgetary envelope. In order to accommodate the concerns of numerous MS, a two-year initial pilot phase would allow the redeployment of unused funds for "*specific environmental and climate-related objectives*". In the eco-schemes, MS would be free to design their own instruments based on their specific needs. MS might cap the basic income support at €100,000 per farm, with a voluntary mechanism to reduce direct payments beyond €60,000 (up to an increased maximum of 85%

[40] Delegations delivered a qualified majority for the package, with Lithuania voting against (essentially because of the 20% ring-fencing for eco-schemes that "*would lead to a reduction in basic payments for [Lithuanian] farmers - already below the EU average -*") and Bulgaria, Latvia and Romania abstaining (Latvia for the same reasons as Lithuania; Bulgaria and Romania because of "*provisions for national transitional aid, requesting a more recent reference year*"). Quotations are drawn from AGRA (2020).

for sums of direct aid per beneficiary above €90,000). Voluntary coupled aids would remain largely unchanged compared to the current CAP provisions. Finally, MS might decide to grant up to 1% of Pillar 1 direct payments, subject to the condition that this amount is used to support farmers' contribution to a risk management tool.

At the same date, more precisely on 23 October 2020, MEP adopted their position on the three regulations for the future CAP (EP, 2020c). Their position is summarized in the ***second column of Table 5.4***. The main points concern conditionality requirements (that are also weakened relative to the initial EC June 2018 proposals, but to a lesser extent than Council decisions), the eco-schemes (that are mandatory with a minimum budget of 30% of EAGF spending and cover a large spectrum of measures, including measures that aim at "*enhancing the economic performance of farmers*"), and ring-fenced budgets (with the introduction of several ring-fenced budgets; namely, for eco-schemes in P1 and climate- and environment-related interventions in P2, but also for P2 measures aimed at developing an intelligent, resilient and diversified agricultural sector, P1 direct aids and sectoral interventions, and P1 coupled direct aids).

Immediate reactions to the votes of both the Council and the EP have been widely differed. While Non-Governmental Organizations (NGO) are highly disappointed,[41] most farmers' organizations defend the votes and contest the "greenwashing" claims formulated by the NGO. IEEP agrees with the latter.[42] Its (preliminary) assessment concludes that the two votes undermine four out of six points that are essential for keeping the CAP and *a fortiori* Green Deal climatic and environmental ambitions alive (that is, conditionality requirements, safeguards against spending potentially environmentally damaging actions, interventions that count towards the EAFRD contribution to climatic and environmental objectives, and the use of unspent funding for eco-schemes). In addition, the provisions related to the two other points (ensuring that eco-schemes are ambitious in scope and the ring-fencing of funds for eco-schemes) "*do not contain sufficient safeguards to firmly preserve or build on the environmental and climate proposals put forward by the EC*" (IEEP, 2020). Matthews is more prudent, arguing than "*[i]n some areas the negotiating mandates go further than the Commission proposal, in other areas the Commission proposal has been watered down*". He adds that "*{a] detailed analysis is required to assess the impact*" (Matthews, 2020b). From that perspective, it is now interesting to describe the EC analysis of the compatibility between the CAP and the Green Deal (EC, 2020i).

Table 5.4: Main decisions adopted by the Council of European Agricultural Ministers (21 October 2020) and the EP (20-23 October 2020)

Vote of the Council of European Agricultural Ministers (21 October 2020)	**Vote of the European Parliament (20-23 October 2020)**
Conditionality	
Simplified control procedures for small farms	
GAEC #1 (permanent grassland): maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area at national, regional, sub-regional, group-of-holdings or holding	

[41] This can be illustrated by quotations draw from Agra (2020b) and Matthews (2020b). Friends of the Earth Europe described the two votes as being a historically bad week for the future of farming in the EU. Similarly, ARC2020 concluded that the two votes ignore the Green Deal and its climate, biodiversity and environment ambitions. BirdLife Europe stressed that the EP decision is "the kiss of death" for nature and EU Green Deal ambitions while Greta Thurnberg described it as "*greenwashing [at] its finest*".

[42] IEEP for Institute for European Environmental Policy.

level, with a tolerance of -5% relative to a base year 2015 or 2018 (at the choice of the MS)	
GAEC #2 (wetland and peatland): "*minimum*" (instead of "*adequate*" in the EC June 2018 proposals) protection of wetland and peatland at the latest by 2024-2025 (dates added)	GAEC #2: the "*protection*" of these areas is replaced by their "*maintenance*"
GAEC #5 (nutrient management tool): deleted	
GAEC #8 (crop rotation): possible exemption of small farms with less than 10 hectares of arable land	
GAEC #9 (landscape features): only for arable land (total agricultural land in the EC June 2018 proposals); inclusion of productive features such as catch crops and nitrogen-fixing crops that should however be grown without pesticides; possible exemption of small farms with less of 10 hectares of arable land	GAEC #9: only for arable land; inclusion of productive features such as catch crops and nitrogen-fixing crops that should however be grown without pesticides;
GAEC #10: Ban on ploughing permanent grassland restricted to "*only some permanent grassland in Natura 2000 areas*"	GAEC #10: removal of the ban on ploughing permanent grassland in protected areas
Ecoschemes	
Mandatory for MS	Mandatory for MS [Article 65(2)] *(1)*
Ring-fenced budget: at least 20% of P1 budget, with the possibility for MS such Austria and Finland that devote important funds to AECM in P2 to reduce the share of P1 budget targeted on eco-schemes	Ring-fenced budget: at least 30% of P1 budget [Article 86(4c]
For the two years 2023 and 2024, a possibility to use (to transfer) non-used eco-scheme funds for other climatic and environmental interventions [Article 86(a)]	
Freedom for the MS to choose its eco-scheme measures that must contribute to the climate and environmental specific objectives (d), (e) and (f) of the CAP, but can also address the specific objective (h) related to employment and growth and the specific objective (i) related to societal demands on food and health *(2)*	Eco-schemes (explicitly) extended to animal welfare [Article 28] MS shall offer a broad variety of eco-schemes in order to ensure that farmers are able to participate in and be rewarded for different ambition levels [Article 28] List of practices eligible for eco-schemes in the sense that they should address: climate change mitigation, carbon sequestration, other gases, water quality and quantity, soil erosion and fertility, protection and restoration of biodiversity, pesticide use, non-productive features and areas without pesticides and fertilizers, animal welfare, precision farming, etc. [Article 28(b) new] Support granted as "*incentive payments going beyond the compensation of additional costs incurred and income foregone*" [Article 28] Possibility of measures aimed at "enhancing the economic performance of farmers" [Article 28(b) new])
Other measures	
Possibility for each MS to provide a complementary redistributive income support for sustainability	

(which would no longer be mandatory as in the EC June 2018 proposals) [Article 26(6) new]	
Non-mandatory capping of first pillar direct aids	
Minimum amounts set out in Annex X of CAP NSP to be used for one or more of the following types of interventions targeted at young farmers: basic income support for young farmers, investments for young farmers, installation of young farmers [precisions related to Article 86(4)]	
Voluntary coupled support: up to a maximum of 13% + 2% (protein crops) of P1 budget, with no climatic or environmental conditions	Voluntary coupled support: up to a maximum of 10% + 2% (protein crops) of P1 budget, with no climatic or environmental conditions
Ring-fenced budget in P2: at least 30% of EAFRD budget reserved for interventions of all types addressing the specific environmental and climate-related objectives of the CAP (including payments for areas with natural and specific constraints that were excluded in the June 2018 draft regulations of the EC)	Ring-fenced budget in P2: at least 35% of EAFRD budget reserved for interventions of all types addressing the specific environmental and climate-related objectives of the CAP (including payments for areas with natural and specific constraints with a weight of 0.4) [Article 86(2)]
	Ring-fenced budget in P2: at least 30% of EAFRD budget reserved to interventions aimed at fostering the development of an intelligent, resilient and diversified agricultural sector (in particular, investments) [Article 86(2a)]
	Ring-fenced budget in P1: at least 60% of EAGF budget for basic income support, complementary basic income support, coupled income support, and sectoral intervention [Article 86(4a)]
	Ring-fenced budget in P1: at least 6% of EAGF budget for coupled income support [Article 86(4b)]
	Flexibility between the two pillars: up to 12% from P1 to P2 (instead of 15% in the draft regulations of June 2018], up to 5% from P2 to P1 (instead of 15%)
	Review of CAP NSP by 31 December 2025 by MS [Article 107(a)], and mid-term review by the EC on the same date (report to the Council and the EP) [Article 139(a)]
Miscellaneous	
Statement on CAP simplification: request to the EC to provide the Council, before or during the trilogues, with a report on ways to simplify the CAP	
Statement on protein crops: reminder of the importance and the efficiency of coupled income support in that domain	

Sources: Own elaboration from European Council of Agricultural Ministers (2020), European Parliament (2020c), Agra (2020a, b), Matthews (2020b), Meredith et al. (2020).
Note: (1) Articles refer to the draft regulation on CAP NSP (EC, 2018b); (2) The nine specific objectives of the future CAP are displayed in Table 5.1.

5.1.3. Is the future CAP on track to achieve greater climatic and environmental objectives?

Climatic and environmental objectives of the Green Deal and the ensuing strategies are consistent with those of the EC June 2018 proposals for the CAP. The Green Deal and its strategies are, however, more

ambitious, notably through the setting of quantitative targets for pesticides, fertilizers, antibiotics, organic farming, protected areas and high-diversified features in agricultural areas. Before analysing the conditions under which this new green architecture of the CAP could help achieve the Green Deal objectives and targets that will lead us to formulate a set of recommendations (see Section 5.2), we first comment on the EC's analysis of the compatibility between the CAP and the Green Deal.

The EC compatibility analysis of the CAP and the Green Deal

Following a request from the EP, in May 2020 the EC released its own analysis of the links between the CAP and the Green Deal (EC, 2020i). The document concludes that the EC proposals for the future CAP are (would be) compatible with the Green Deal and its associated strategies and have "*the potential to accommodate the Green Deal's ambitions*". The document mentions three essential requirements that need to be maintained for that purpose: first, the enhanced conditionality; second, the compulsory eco-schemes; and third, the commitment to allocate at least 30% of funds of the second pillar to climate- and environment-related interventions (excluding payments for areas with natural and specific constraints). The EC suggests two additional measures that would help to achieve the climatic and environmental ambitions of the Green Deal: first, to have greater clarity regarding the scope of eco-schemes, by means of recommendations by the Commission on agricultural practices that could be supported in achieving the Green Deal targets related to pesticides, fertilizers and organic farming; and second, integration in the CAP of the EU legislation on the use of antibiotics in livestock and animal welfare. Finally, the EC states that "*it could consider taking additional practical action to make implementation of the future CAP more efficient to help to achieve the ambition of the Green Deal*" (EC, 2020i). From that perspective, each MS would have the obligation to demonstrate in its CAP strategic plan how their plan will achieve greater climatic and environmental ambition than at present (application of the "*no backsliding*" principle). The EC would ask MS to set national values (at the level of impact indicators) for the Green Deal targets related to pesticide, antibiotic and nutrient loss reductions, organic farming area increase, internet access in rural areas, and to agricultural areas under high-diversity landscape features.

The EC analysis of the links between the CAP and the Green Deal does not provide a quantitative assessment of the ability of the CAP to help achieve the climatic and environmental ambitions, objectives and targets of the Green Deal related to agriculture and food. The analysis identifies key elements of the EC June 2018 proposals that would need to be maintained, and some elements that need to be added, so that, according to the EC, the future CAP contributes to the Green Deal ambitions related to agriculture (and to agriculture only). However, the analysis does not demonstrate that the future CAP - even augmented by the additional elements proposed - would lead to a reduction of the climatic and environmental footprint of EU agriculture, to a proportion compatible with the Green Deal. There is also no analysis provided of the possible impacts of strengthened climatic and environmental provisions on the three economic and the three social specific objectives of the future CAP (see Table 5.1).[43] Much is left to be completed in the initial impact assessment of the EC June 2018 proposals, while the Green Deal sets a higher level of ambition and would require more stringent conditionality requirements (even compared to the option 4a of the EC "*impact assessment*").

In line with the Commission's attempt, a comprehensive assessment of the compatibility of the CAP draft regulations and the Green Deal is extremely difficult due to the multiplicity of objectives, and the fact that establishing reliable causal relations between policy instruments, actors' behaviours, practices and impacts runs into data and models that are currently lacking. ***Annex A.5.1*** provides a short analysis

[43] The EC (2020i) adds that the quantitative results of its "*impact assessment*" should be considered with caution, and in particular that income reductions are overestimated as structural changes, price feedbacks and productivity benefits linked to more environmentally friendly farm systems that should play in the longer term are not taken into account.

of the principal weaknesses of existing modelling tools that could be used to carry out a quantified impact assessment, together with the data needs.

Overall, the EC states that "the CAP reform proposal is compatible with the Green Deal and its associated strategies such as the Farm to Fork Strategy and the Biodiversity Strategy, and that it has the potential to accommodate the Green Deal's ambitions"; a conclusion that appears questionable given the lack of analysis on several key issues. The EC nevertheless acknowledges that much will depend on the actual implementation in NSP, and stresses the need to maintain all of the conditionality measures proposed in the draft regulations. It is also critical to impose "*an adequate 'no backsliding' principle obliging MS in their CAP Strategic Plans to show an increased level of ambition than at present with regard to environmental- and climate-related objectives; as well as a ring-fenced spending for the environment and climate for both eco-schemes and rural development budgets for each CAP Strategic Plan*" (EC, 2020i).

It is instructive to analyse the EC compatibility document in light of Council and Parliament recent decisions summarized in the previous sub-section. To the extent that these decisions do not reinforce several climatic and environmental provisions of the initial EC June 2018 proposals - except that they impose a ring-fenced budget for eco-schemes (20% of EAGF spending for the Council, 30% for the EP) - but open the door to eco-scheme measures that would be not explicitly targeted at climatic and environmental objectives, one can conclude that the compatibility has decreased. Indeed, several of the provisions that the EC considered as necessary for the CAP draft regulations to be compatible with the Green Deal have in fact been removed (new provisions recommended by the EC in its compatibility analysis) or watered down by the Council and the EP.

5.2. Strengthening CAP proposals to achieve the Green Deal objectives related to agriculture

For most policies that focus on agriculture, quantitative targets have been proposed within the Green Deal and its associated strategies, for which there is a corresponding CAP instrument. Here, the challenge is to make CAP provisions coherent with the level of ambition of the Green Deal. This involves designing indicators, incentives and governance to ensure that the future CAP efficiently addresses the various objectives and targets of the Green Deal related to agriculture. With that in mind, the three main questions are: first, whether the Green Deal objectives and targets will be indicative ("*aspirational*") or indeed actually binding; second, where the *"cursor"* should be set between what is mandatory and what should lead to extra payments; and third, whether the proposed indicators will make it possible to reflect, monitor and control the Green Deal ambition.

5.2.1. General framework

In the framework of the theory of public economics, market failures justify the intervention of public authorities (Laffont, 2008). The agriculture and food sectors are characterized by a number of these market failures: lack of fair competition, incomplete markets, externalities (positive or negative) and public goods,[44] etc. Simple principles can be derived from this framework to guide recommendations for the future PAC.

[44] A public good is an example of a specific consumption externality where all people should "*consume*" the same quantity of the good. More precisely, a good is said to be public when its use by an actor does not prevent its use by other actors. A public good is global (respectively, local) when the externality concerns a large geographical population (respectively, is limited to a small geographical area). See Cooper et al. (2009) for an analysis of public goods in agriculture.

An issue of central importance is determining what should be required for farmers and what they should be paid for, in order to achieve a particular target in terms climate or biodiversity, for example. In economic terms, this means that there is a need to set the dividing line below which the Polluter-Pays Principle (PPP) should apply and above which the Provider-Gets Principle (PGP) should apply (for a clear presentation of the two principles, see Nault, 1996). In the first case, climatic and environmental objectives will be addressed within the CAP through conditionality (that is, through SMR and GAEC), and in the second case, through the eco-schemes in Pillar 1 and climatic and environmental measures in Pillar 2.[45]

Simple and robust guidelines for fixing the dividing line between, on the one hand, conditionality and, on the other hand, eco-schemes and AECM can be derived from public economics and fiscal federalism.[46]

The polluter-pays and provider-gets principles

At the agricultural producer level, the challenge is to sort out which part of the effort needed to reach a particular target should be achieved as a reduction of existing negative externality, plus what should lead to extra remuneration. It is rarely a simple matter to draw a line between what is a reduction of a negative externality and what is an increase provision of a positive externality. In addition, there are potential trade-offs between the different climatic and environmental compartments and setting a particular cursor can have (very) large economic and distributional effects.

The PPP defines the correct benchmark against which negative externalities should be counted. A more stringent application of this principle requires taxing the main determinants of agricultural GHG emissions (nitrogen fertilizers, cattle) and biodiversity loss (mineral and synthetic fertilizers, pesticides, veterinary products). By internalizing the costs of climatic damages, such a taxation scheme will send the right price signals to farmers and to all actors within the food chain, including consumers. Environmental federalism theory (Oates, 1972) distinguishes policy intervention levels depending on whether the considered public good is global or local. Since climate is a global public goods, taxes should be designed and implemented at the EU level. This level of intervention would have the additional benefit of limiting unfair competition among MS and avoiding a "*race to the bottom*".

In the EU, taxation policies are the sovereign prerogatives of MS. It is highly likely that it will be difficult to obtain political agreement on such a taxation scheme at the European level. A reasonable alternative that, at least in theory, can lead to the same result - albeit with higher administrative costs - is that of reinforcing conditionality requirements. Furthermore, a stricter application of the PPP would enhance the legitimacy and acceptability of the more ambitious implementation of its counterpart, the PGP, which underlines both the eco-scheme and AECM.

The same logic applies to biodiversity. While, ideally, pesticides and veterinary products should be taxed at a high level so as to internalize the cost to the society linked to biodiversity loss, an alternative is an increased conditionality, targeted at biodiversity preservation.

Eco-schemes in Pillar 1 and climate- and environment-related interventions in Pillar 2 can be viewed as an application of the PGP, through the compensation of additional costs or profit foregone induced by the use of more climate friendly and environmentally friendly agricultural practices and systems. However, the application of the PGP is weak when subsidies only compensate the extra costs or profit losses without proportionality to climatic or environmental benefits. On this point, it is interesting to

[45] See Figure 5.1 for a graphical presentation of the green architecture of the future CAP.

[46] In addition, fiscal federalism theory helps distinguish climatic and environmental aids that should be supported through the eco-schemes totally financed by the EU budget, and *"similar"* aids that should be funded through second pillar measures, notably climate- and environment-related intervention, co-funded by national and regional authorities.

note that the EC June 2018 proposals for the future CAP open the door for implementing payments for climatic and environmental services in the framework of eco-scheme measures. Indeed, eco-scheme payments could be granted under the form of payments, additional to the basic income support (Article 28 (6) a of the draft regulation for CAP NSP; EC, 2018b).

Global *versus* local public goods

The eco-schemes will be totally funded by the EU budget. They should therefore target global public goods, notably climate and biodiversity. Animal welfare, which is a growing concern for European citizens, also falls into that category (**Box 5.1**)[47]. As for taxation and conditionality, setting ambitious and common rules at the EU level is important in order to reflect the significant Green Deal ambition, to avoid a "*race to the bottom*" by some MS and to limit potential competition distortions. Agri-environmental and climatic schemes measures of the second pillar are co-funded by national and regional authorities. As a result, they should target local public goods, such as water quality and quantity, soil protection or the maintenance of open and diversified landscapes.

Box 5.1: Animal welfare as a global public good

The welfare of farmed animals is a primary concern of European citizens: 94% value animal welfare and 82% consider that farmed animals should be better protected (EC, 2016). For several decades, this concern was limited to the repression of acts of cruelty. It now extends to all conditions relative to the rearing, transport and slaughtering of farmed animals. Advances in scientific knowledge on the pain, suffering and the consciousness of animals have led to the official recognition of animals as sentient creatures, both at the EU level (enshrined in the EU Treaty of Amsterdam in 1997) and in several MS. At the EU level, several conventions of the Council of Europe and several Directives reflect this recognition (Mormède et al., 2018).

Regulations seek to limit - and, if possible, to eliminate - the negative emotions of pain and suffering, fear and frustration that may be experienced by farmed animals, and to promote the positive emotions of comfort, joy, pleasure, etc. Are these regulations sufficient? To answer this question, it is important to set the limits between what is acceptable and what is not. Science alone cannot answer this question, although it can shed light on the debate by proposing objective indicators of animal welfare based on the internal emotional state of animals and by analysing how different farming, transport and slaughtering practices may have an impact on these indicators.

The two practical questions that must be addressed are: first, what is the optimal level of farm animal welfare; and second, what are the modalities of public intervention required to achieve this level at the lowest possible cost for society as a whole? As noted by the Farm Animal Welfare Committee (FAWC), public intervention is required in a context where animal welfare is a public good. Improving animal welfare benefits all those who demonstrate concern (FAWC, 2011).

Intervention at the EU level is justified in order to avoid the double penalty of unilateral actions by a single country: First, an economic penalty induced by competitiveness distortions; and second, an animal penalty insofar as competing countries that are less regulated would have an incentive to produce more animal products so that, ultimately, animal welfare would be globally degraded (Treich, 2018).

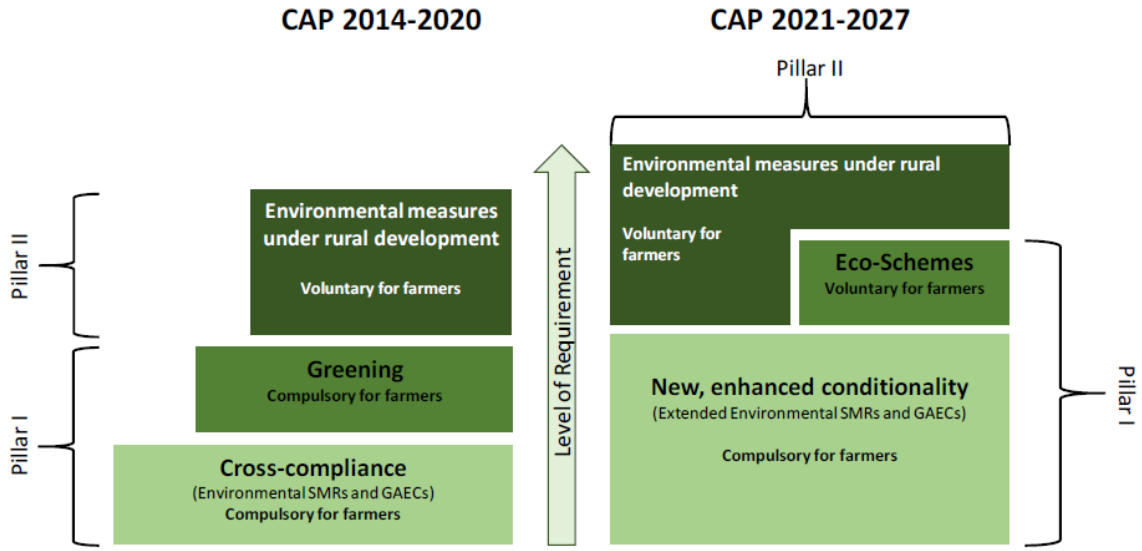
[47] Box 5.1 derived from Guyomard et al. (2020).

We are fully aware that the theoretical distinction between global and local public goods faces practical difficulties, as many public goods include both global and local characteristics. However, this distinction offers useful guidelines to distinguish the ecological items that should be supported through the eco-schemes, with possible complements through climate- and environment-related interventions in Pillar 2.

5.2.2. The need to adapt the CAP draft regulation instruments

The green architecture of the current and future CAP combines mandatory and voluntary measures (**Figure 5.1**). In the future CAP, mandatory measures correspond to conditionality, while voluntary measures include the eco-schemes in the first pillar and climatic and environmental measures under rural development in the second pillar.

Figure 5.1: The green architecture of the current and proposed post-2020 CAP



Source: Lotz et al. (2019).

The provisions introduced in the 2014-2020 CAP have had an extremely limited positive impact on the climate and the environment (See Chapter 3). As explained above, it is unlikely that the proposals for the future CAP, in the versions of the EC, the Council or the EP, will lead to significant improvements in this area. In that general context, we now provide ***a detailed assessment of the need to adjust CAP draft regulations to meet the Green Deal objectives for climate, biodiversity, pollution and animal welfare.*** More specifically, we present some recommendations for strengthening the conditionality requirements (***Table 5.5***) and for developing ambitious and pertinent eco-schemes focused on global public goods (***Table 5.6***) that have to be completed by climate- and environment-related interventions in Pillar 2 focused on local public goods. This is done by successively considering climate mitigation (Sub-Section 5.2.3), biodiversity preservation and restoration (Sub-Section 5.2.4), other environment compartments (Sub-Section 5.2.5), and animal welfare (Sub-Section 5.2.6). A specific sub-section is devoted to climate- and environment-related interventions in Pillar 2 (Sub-Section 5.2.7).

Within this framework, our first general recommendations for conditionality are as follows:

- The minimum should be not to weaken the conditionality and eco-scheme provisions of the June 2018 draft regulations, as both the Council and the EP appear to intend, at least for conditionality);

- The Green Deal targets related to biodiversity require more stringent provisions for GAEC #2 (wetlands and peatlands) and GAEC #9 (high-diversity landscape features) over the future programming period;
- It is important to ensure that the new GAEC introduced in place of the three greening criteria encompass, at the very least, the requirements of the current greening measures, with adequate improvements: see specific suggestions in Table 5.5 for GAEC #1 (permanent grassland), GAEC #8 (crop rotation) and GAEC #9 (high-diversity landscape features);
- GAEC must develop farmers' awareness of the need to consider the impacts of their practices on the climate and environment: see specific suggestions for the new GAEC we propose to introduce targets at pesticides, antibiotics and GHG emissions;
- It is important to maintain that there is no exemption (for example, for small farms) in order to cover all farms and the entire agricultural area.[48]

5.2.3. More effective instruments for climate change mitigation

Measures

The current CAP targets carbon sequestration in agricultural soils with conditions on the green payment and cross-compliance requirements, especially Green Measure (GM) #2 aimed at maintaining permanent grasslands and GAEC #6 aimed at protecting and restoring soil organic matter in arable lands.

There is more re-numbering rather than new measures to be found in the draft regulations for the future CAP, which contributes to making an assessment of the changes even more confusing.[49]

The new GAEC #2 targets the protection of wetlands and peatlands, in addition to the SMR #3 and #4 related to the Bird and Habitat Directives. Some of the current requirements to obtain the green payment would be introduced as GAEC. This is the case of new GAEC #9 that replaces both the current GAEC #7 and GM #3 related to the protection of permanent landscape features, which are also carbon sinks. New GAEC #10 would replace GM #1 and prohibit the ploughing of permanent grassland in Natura 2000 areas.

Mandatory measures targeting soil quality, as well as the preservation of biodiversity and landscapes, can also have climate mitigation effects. GAEC that are now numbered #6 and #7 focus on the use of appropriate tillage practices and soil coverage in order to avoid soil erosion and the related losses in soil organic carbon in arable lands.

Mandatory measures that protect the water quality may also have climate mitigation impacts. GAEC renumbered as #4 imposes buffer strips along water courses that allow the reduction of soil erosion and the maintenance of grassland carbon sinks. SMR renumbered as SMR #2, which is associated with the Nitrate Directive, limits levels of over-fertilization and the related emissions of soil nitrous oxide.

Analysis and improvements (recommendations)

Maintaining permanent grassland appears to be the most important provision impacting the climate within the draft regulations for the future CAP. Preventing the conversion of permanent grassland to

[48] As initially proposed by the EC in the June 2018 proposals even if, as noted by Matthews (2018a), the latter offer the possibility to MS to define exemptions for certain types of farmers in their NSP.

[49] In the future CAP, GM #2 would be replaced by the new GAEC #1, and GAEC# 6 by the new GAEC #3. New GAEC #6 and #7 correspond to current GAEC #5 and #4, while new SMR #3 and #4 correspond to current SMR #2 and #3. New GAEC #4 replaces current# GAEC #1. SMR #1 is renumbered SMR #2.

arable crops and/or temporary grassland avoids an increase of GHG emissions. In the current GM #2, the tolerance of up to 5% of permanent grassland is a major source of the inefficiency of the measure, given the incentives farmers face to get rid of permanent grassland in favour of more profitable crops. We propose that the new GAEC #1 in the future CAP be applied at the farm level for all farms, without exemptions or derogations, and that the tolerance threshold be reduced, possibly to 2%. A second shortcoming of the current GM #2 is linked to the possibility of renewing the permanent grasslands by ploughing and re-seeding, except in Natura 2000 areas. These practices maintain grassland productivity but result in soil carbon and biodiversity losses. This issue could be addressed by means of a first eco-scheme measure (ES #1), under which farmers who do not plough any grassland plots and *de facto* turn them into permanent pasture, would be remunerated.

The new GAEC #2 introduces a more widespread (at least in theory) protection of wetlands and peatlands, not only in Natura 2000 areas but in all locations. This measure is justified because both wetlands and peatlands are rich in organic carbon and are biodiversity "*hot spots*". The first challenge raised with this measure is linked to the inventory of existing wetlands and peatlands, and the designation of relevant corresponding areas at the farm level. The second challenge is to restore former wetlands and to potentially create new wetlands as compensation for past losses. A second eco-scheme measure (ES #2) could be introduced for that purpose. The registration of farm wetlands implies the mobilization of public authorities and the accompanying policy measures in order to train farmers and conduct field appraisals.

The current GM #3 aims to devote at least 5% of arable areas of each medium-sized and large farm to EFA. Current EFAs have contrasting effects on the climate. On the one hand, the replacement of GHG-emitting land use with a use that sequesters carbon in the soil has a direct mitigation effect. On the other hand, an indirect effect is possible if EFA induce the displacement of production towards less productive lands, leading to higher GHG emissions per unit of production. The EC highlights the first effect, including through the introduction of legumes that capture atmospheric nitrogen under EFA. It also notes that the indirect effect is likely to be small, as the measure has not led to significant reductions in cereal areas through the EU and has had no effect on their prices (EC, 2017a). However, MS choices regarding the implementation of this greening measure depend much more on production, economic and administrative considerations than on climatic and environmental concerns. In particular, climate objectives are poorly, if at all, documented. High-diversity landscape features (ponds, ditches, hedges, isolated or aligned trees, groves, etc.) and woody formations are reportedly under-declared and, as a result, imperfectly protected by this greening measure. In practice, "*productive*" EFA, which correspond to nitrogen-fixing crops and/or catch crops, allow the majority of farms to comply with the constraint easily enough.

Under the present implementation of GM #3, climate and biodiversity objectives are somewhat inconsistent. It appears necessary to remove nitrogen-fixing crops and catch crops from EFA in the new GAEC #9 that replaces GM #3. By contrast, we propose that these "*productive*" EFA are integrated in the new GAEC #8 on crop rotation, as well as in the eco-scheme measure ES #3 on bare soils that should be defined in line with the new GAEC #8.

In the case of France, Pellerin et al. (2014) showed that the current greening measures, introduced in the 2014-2020 CAP, could only promote seven out of the 23 mitigation actions they identified and would enable a mitigation potential limited to 23% of what is achievable with very limited production loss. The poor efficiency of the current CAP greening in terms of the climate is due to the fact that measures do not directly target those agricultural practices and systems that induce the main agricultural GHG emissions; that is, nitrogen fertilization and ruminants. To address the issue, we

propose to introduce a new GAEC #13 and a corresponding eco-scheme measure ES #7 that more explicitly target GHH emissions.

More precisely, this proposed GAEC #13 would require each farm to report their GHG emissions, based on nitrogen fertilization practices and cattle herds.[50] The calculation of farm level GHG emissions could be relatively straightforward, by relying on the emission factors of national GHG inventories. For cattle, information is readily available due to current traceability requirements. For fertilizer use, the counting of nutrients is widespread in some MS, but not in others. In addition, monitoring could be difficult in the MS where there is a large number of very small farms or farms with a limited administrative capacity. In such cases, the upstream taxation of nitrogen fertilisers at a level that internalises externalities could be a requirement so that farmers are exempt from reporting (provided that the taxation is at a level that internalises externalities in a way that is comparable to what is done in other MS with other instruments).

This proposed GAEC #13 would present several advantages. First, it would make every farmer aware of GHG emissions linked to their own farming activities. Second, it would constitute the baseline for the proposed eco-scheme measure ES #7 that would remunerate farms with the highest sales per GHG emission unit. The aim is to reduce the emissions corresponding to the less profitable activities and, as a result, put the farming sector on the right track to contribute to the reduction in non-CO_2 GHG emissions by 35% over the 2015-2030 period (EC, 2020g). GHG abatement costs are heterogeneous in in agriculture (Pellerin et al., 2017), including in livestock (Dakpo et al., 2017), suggesting that there is significant room for improvement with the right economic incentives. For consistency reasons, coupled support for ruminant livestock should be removed (Dupraz and Guyomard, 2019).[51] Some abatement techniques, such as feed additives for dairy cows, are not currently taken into account by the usual GHG inventory methods. The proposed eco-scheme measure ES #7 would provide an incentive to develop finer inventory methods to account for significant abatement opportunities. This new measure may also help to reduce levels of over-fertilization and nutrient losses that are harmful for both water quality and biodiversity.

5.2.4. More effective instruments for biodiversity

Measures

In accordance with the Bird and Habitat Directives, the SMR renumbered #3 and #4 in the future CAP prohibit the destruction of wetlands and peatlands in Natura 2000 areas. In addition, new GAEC #10 that replaces some provisions of the current GM #2 prohibits the ploughing of permanent grassland in these same Natura 2000 areas.

Permanent grasslands, wetlands and peatlands also need to be protected outside Natura 2000 areas. In the future CAP, the current GM #2, which aims to maintain permanent grassland, would be replaced by the new GAEC #1. In addition, the new GAEC #2 aims to develop the protection of wetlands and peatlands. Current GM #2 is not automatically associated with improvements in habitat quality. Outside of sensitive areas, agricultural practices that are potentially detrimental to biodiversity, such as tillage,

[50] Fertilization practices are also covered by the requirements of the new GAEC #5 aimed at developing the use of farm sustainability tools for nutrients (in order to reduce nutrient losses).

[51] As summarized by Guyomard et al. (2020), coupled direct aids to livestock - slightly more than €3 billion per year - suffer from other drawbacks. They are less efficient income support measures than decoupled direct aids and second pillar payments, partly because they generate high administrative costs (Ciaian et al., 2013). They do not provide incentives to optimise animal performance, nor the total productivity of production factors (Rizov et al., 2013). They contribute to maintaining livestock farmers in the productions that are supported in this way, and in doing so, limit the necessary adaptation and reorientation in response to market demands and consumer expectations. In addition, investments in livestock materials and buildings are designed with these coupled directs aids in mind, which increases the fixation in beneficiary productions.

fertilisation and the reseeding of permanent grassland, are permitted without particular constraints. Our proposals, as defined above, for conditionality and eco-scheme measures targeted at permanent grasslands, wetlands and peatlands are in all likelihood as important for biodiversity protection as they are for climate mitigation. Any natural grassland accommodates more biological diversity than arable land (Pe'er et al., 2014). A large portion of flora and fauna species depends on wetlands (Jantke et al., 2011).

Several mandatory measures aim to protect biodiversity in arable lands. New GAEC#9 (that replaces current GAEC #7 and GM #3) protects landscape permanent features that maintain semi-natural habitats favourable to wild fauna and flora. New GAEC #4 related to buffer strips and new GAEC #8 related to crop rotation can also be beneficial for biodiversity.

Analysis and improvements (recommendations)

The positive effects on biodiversity of current GM #1, #2 and #3 are strongly limited by their low level of ambition and lax implementation modalities (see, for example, ECA, 2017).

GM #1 on crop diversity is the most criticized measure. In practice, this diversity is minimal: three crops for farms with more than 30 hectares of arable land, with the main crop not exceeding 75% of arable area and the two main crops not exceeding 90% of arable area. This lack of ambition allows the majority of European farms to comply with the constraint and obtain the green payment without changing crop rotations. In addition, several studies have questioned the number of crops in the crop rotation as a relevant indicator of biodiversity. Indeed, this number considered in isolation has no significant effect on wild biodiversity, particularly for birds or insects (Hiron et al., 2015). Biodiversity depends more on the types of crops present in a particular landscape and on their management methods. The introduction of legume crops or fallow land, combined with lower levels of fertilization and longer crop rotations, would have extremely positive effects on biodiversity. On the contrary, the introduction of new crops carried out with heavy chemical uses would have no effect, or even a negative effect, on biodiversity, as has been observed in the case of pollinating insects (Hass et al., 2018).

In the same way, several studies have shown that the implementation of EFA through GM #3 is not ambitious enough for biodiversity preservation, *a fortiori* restoration. Requiring only 5% of arable land to be devoted to EFA is not sufficient to maintain viable populations, as shown, for example, by the case of the hare in Denmark (Langhammer et al., 2017). EFA vary a lot in nature, ranging from buffer zones and topographical elements to catch crops and nitrogen-fixing crops. In the current CAP, each type of EFA is assigned a weighting factor to aggregate the full set of EFA and verify compliance with the requirement. The scale of weights, based on the ability of each type of EFA to protect biodiversity, is contested by scientists, for the most part because the weights assigned to catch crops and nitrogen-fixing crops are too high (Pe'er et al., 2016). European farmers have sought to comply with the constraint primarily by introducing such crops (54% of EFA weighted areas and 70% of physical EFA areas). As a result, the 26% of physical areas in fallow and the 4% of topographical landscape features, buffer strips, forest edges and wooded land are unlikely to have significant benefits on biodiversity (EC, 2017). Moreover, landscape level actions with high biodiversity benefits have rarely been adopted by MS. Two countries only (the Netherlands and Poland) have allowed farmers to pool their efforts by creating spatially contiguous EFA that are potentially more beneficial for biodiversity.

With the ending of the green payment in the proposed post-2020 CAP, part of the current conditions for the green payment would be introduced in new GAEC #9. The latter would apply to all agricultural areas in the EC June 2018 proposals, but again, as for the current greening requirement, to arable lands only in both the Council and EP votes of October 2020 (see Table 5.4). Shifting cross-compliance from a GM to a GAEC is unlikely to guarantee the better delivery of public goods. In particular, compliance

to GAEC is subject to random inspection, while the conditions under which the green payment are delivered are subject to an *ex ante* check, with conformity controls covering all candidate farms. This change could have a significant impact and dilute the global impact of the requirement on diversity.

In order to increase high-diversity landscape features to up to 10% of agricultural area in 2030 (as stated in the EU Biodiversity Strategy for 2030; see Chapter 3), we propose a strengthening of the new GAEC #9. First, we propose the removal of nitrogen-fixing crops and catch crops from the list of eligible EFA. Second, the target would be to reach 10% of farm total agricultural area at the end of the programming period of the future CAP, with the area requirement gradually increased over the period. The eco-scheme measure ES #4 would accompany this in order to comply with a strengthened GAEC #9, by introducing payments to remunerate higher landscape diversity features. This would take into account diversity not only at the farm level but also at the landscape level by introducing two bonuses: the first bonus, to reward the scarcest landscape features; and the second bonus, to reward coordination between neighbouring farms (in order to maximize the spatial continuity of highly-diversified landscape features).

The new GAEC #8 devoted to crop rotation should be further elaborated so as to take into account the limitations of the CAP information system. Imposing crop diversity over time requires monitoring of the sequence of past crops for each plot. This information will require data management and storage that could be beyond the capacities of information systems in some MS. That is why we propose a different wording of new GAEC #8, based on an improved crop diversity index and a limited rotation requirement (avoiding a repeat of the same crop in the same parcel of land from one year to the next). The proposed GAEC#8 would be a complement of the eco-scheme measure ES #3 that would remunerate farmers for a higher crop diversity index, including catch crops and nitrogen-fixing crops. In addition, two bonuses would be introduced: one bonus for low plot size; and a second bonus for the limitation of bare soil areas. Strong scientific evidence supports the fact that small plot sizes are beneficial for biodiversity (Fahrig et al., 2015; Sirami et al., 2019; Martin et al., 2020). In addition to providing food for pollinators and other wild species throughout the year, avoiding bare soils is also beneficial for nutrient management (that is, the reduction of nitrate leaching).

This set of measures, however, does not account for the regulation of pesticide use, which is a key determinant of biodiversity decline. This issue is addressed in the next sub-section.

5.2.5. More effective instruments for a toxic-free environment

Measures

The F2FS sets ambitious reduction quantitative targets for pesticides. As shown in Chapters 3 and 4, reaching these targets is likely to require significant changes and could be extremely costly. The extension of the areas under organic farming - a target of the EU Biodiversity for 2030 - would partly contribute to reaching pesticide and antimicrobial targets. Furthermore, the extension of organic farming can be counterbalanced by a more intensive use on conventional farms, in the same MS or in others.

The trend of antimicrobial use in livestock is much more favourable in the vast majority of MS, even though the "*low-hanging fruit already seems to have been collected*" with a strong reduction due to the use interdiction as growth activators in livestock (see Chapter 3). MS have implemented, albeit unevenly, measures targeting better farming practices with improved livestock housing, breeding and feeding. Some MS have also introduced measures regarding the legal conditions for antimicrobial sales in order to avoid collusion between the prescribers and the sellers of veterinary drugs.

Analysis and improvements (recommendations)

We propose to introduce a new GAEC #11 associated with the eco-scheme measure ES #5, which will encompass the support of organic farming in a more consistent way.

The proposed GAEC #11 would impose the calculation of a pesticide load index at the farm level. Compared to other indicators, such as the treatment frequency index, this indicator takes into account the pesticide toxicity for flora, fauna and humans. The calculation of such indexes requires some improvement of the CAP information system in many MS. However, it would also provide useful information to farmers and help reduce inefficient spraying. Organic farmers should not be exempted, since significant improvement in total pesticide use is also possible on organic farms.

This proposed GAEC #11 presents two advantages. First, it will make each farmer aware of the pesticide impacts of her/his farming activities. Second, the measure is needed to calculate the reference level for ES #5 that would reward those farms with the best performances in pesticide use for each type of crop. Using a multilevel payment rate would reward organic farms with the highest rate per hectare. Using the median to trigger the basic payment would tighten this threshold from one year to the next. Other things being equal, this mechanism is an incentive to promote continuous progress and innovation on a large share of farmland that displays the best performances in terms of pesticide use.

The proposed GAEC #11 would impose additional transaction costs and could be beyond the reach of some MS that have a large number of very small farms or have limited administrative capacity. In such cases, the upstream taxation of pesticides at a level that internalises externalities could be a requirement for exempting farmers from reporting, in which case ES #5 should not be proposed. In addition, MS that decide to implement a significant pesticide tax scheme might be exempt from GAEC #11 (and ES #5), as long as their taxation is calibrated to reach the same target. While this possibility clearly departs from our recommendation that derogations and "equivalent schemes" should be removed, so as to make cross compliance more effective than in the current CAP, there is a rationale for allowing MS to choose a simple instrument, such as a tax. Nevertheless, the condition should be that the level of the tax is consistent with the stringency of requirements in other MS, in terms of the internalization of pesticide externalities.

Regarding antimicrobials, in order to secure the recent positive trends and provide incentives to promote continuous progress, we propose to introduce a new GAEC #12" (through the calculation of an antimicrobial use index) and an eco-scheme measure ES #6 (aimed at remunerating farmers for more important antimicrobial reduction than the average or the mean). The proposed GAEC #12 and ES #6 would be articulated in the same way as the proposed GAEC #11 and ES #5 for pesticides.

5.2.6. Animal welfare

There are different perceptions of animal welfare across MS. Some degree of subsidiarity would make it easier for measures to be accepted by farmers. However, numerous measures such as decreasing the number of animals per square meter of building can be extremely costly. Too much subsidiarity could lead to competition distortions. Concern for animals is growing throughout the EU, with animal welfare increasingly appearing as a global public good (see Box 5.1). This has already motivated several SMR included in conditionality requirements. We propose to introduce an eco-scheme measure ES #8 for efforts that go beyond the law and that will use the animal welfare SMR as a baseline. Eco-scheme payments would reward livestock producers for actions aimed at reducing animal density in livestock buildings, providing access to natural light, facilitating outdoor access and eliminating mutilations.

5.2.7. Climate- and environment-related interventions in Pillar 2

Pillar 1 payments are non-contractual. Their basis must be simple, which limits the possibility of introducing climatic and environmental conditions that go beyond relatively generic criteria and justifies a significant budget in Pillar 2 to be maintained for more tailored measures.

Pillar 2 includes a large variety of measures, among which AECM are clearly the most important from a climatic and environmental point of view. Designing and implementing AECM is mandatory for MS. AECMS are voluntary for farmers. Pillar 2 encompasses numerous other measures, such as payments supporting investment for productivity improvement or income support aids for farmers in areas facing natural or specific constraints, which can have unintentional impacts on the climate and the environment. The EC, Council and EP legislative proposals for the future CAP do not introduce significant changes for second pillar measures (see Section 5.1).

There is only limited scientific evidence on the overall impact of rural development measures on climate mitigation. Payments for areas facing natural and specific constraints focus on maintaining agricultural activity in mountainous, Northern European and Mediterranean regions. While these payments contribute to provide other environmental public goods (biodiversity, water, landscapes), from a strict climate point of view, afforestation is often a better alternative for climate mitigation in these regions. AECM payments, including support for organic farming, mainly promote more extensive farming practices and systems. They are climate-friendly, as long as their effects are assessed per area unit, compared to the "*business-as-usual*" farming methods. This is no longer the case when the decrease in yields is higher than the decrease in net GHG emissions per hectare, resulting in production shifts and GHG leakages (Smith et al., 2019; Dupraz et al., 2020). Support for investment and the setting-up of young farmers can have climate mitigation effects when the modernisation of farming and rearing practices increases the ratio of production volumes in relation to GHG emissions. There are, however, examples where investments are mainly used to increase farm labour productivity by enabling the increase of the farming area and herds without the accompanying technical progress to reduce the use of polluting inputs and GHG emissions per unit of product (Veysset et al., 2019).

By contrast, there is scientific evidence of the positive effect of AECM on biodiversity. Extremely positive impacts have been reported when such schemes target non-productive habitats, such as woodlands, hedgerows or grassed areas. This is not always the case for other schemes with their impact on biodiversity more limited (Batáry et al., 2011, 2015). Chabé-Ferret and Supervie (2013) and Cullen et al. (2018) summarized the main shortcomings in this area. They point out frequent overlapping and inefficiencies in the design of the AECM. There is a failure to gather a critical mass of contracting farmers, while there remains a clear need for areas under conservation to be large and connected in order to preserve biodiversity. Some of the most recent AECMs are more effective in this respect, particularly because they encourage the creation of consortia of farmers who are able to act in a spatially-coordinated manner and/or because they condition part of the payment on observable environmental impacts (Westerink et al., 2017).

In addition and from a more general point of view, AECM suffer from three weaknesses (Dupraz et al., 2020). First, the fact that they cover extra costs and foregone income only limits the capacity of the schemes to provide significant incentives to engage farmers in efforts that go beyond standard practices. Second, because the information on costs of compliance is asymmetric, designing schemes leads to "*windfall gains*" for those farmers who would have made environmental efforts at a much lower cost, while they fail to attract farmers whose costs are higher. Third, AECM are complex to manage, monitor and control for MS. Furthermore, the need for national co-financing is an obstacle for some MS.

Our proposals for the AECM in the future CAP are in line with fiscal federalism lessons (see Sub-Section 5.2.1). The introduction of additional payments by national or regional public authorities is justified in order to support the provision of local public goods, such as water, air or landscape quality, including taking into account the influence of these local public goods on health. AECM must use the strengthened conditionality requirements as the baseline and use additional indicators that are better adapted to local issues, when necessary. In many cases, AECM will reinforce eco-scheme measures in sensitive areas since the protection of water quality is closely correlated to the objectives of toxic-free environments and biodiversity preservation. For instance, AECM may bring additional support to organic farming in water catchment areas. The efforts to improve the design of these measures and their environmental efficiency should be strengthened in combination with research projects and the EIP-AGRI programmes.

The payments of improved or innovative AECM, incorporating results-based payments and the spatial coordination of farmers' efforts, do not have to comply with the "*extra cost and profit forgone rule*".[52] The choice of the targeted areas and the monitoring of the targeted environmental effects should bring together all the relevant stakeholders, that is, in addition to farmers, actors such as regional councils, nature associations, etc. Collaborative governance is often regarded as an important added value of AECM in a wide range of situations (Westerink et al., 2017). Collaboration in these cases has increased not only between groups (for example, public authorities, farmers, NGO), but also within groups (in particular, between farmers). In successful schemes, this development has been coupled with an increased involvement of farmers in governance tasks, including the spatial coordination of activities in land management and nature conservation. Governments could invest in capacity building, to promote peer-to-peer exchanges and social learning processes between the different types of actors.

[52] The EC motivates the need to strictly respect this condition because of World Trade Organization commitments (Annex II of the 1994 Marrakech agreement). Bureau (2017) questions this issue.

Table 5.5: Cross-compliance and greening requirements in the current CAP *versus* conditionality requirements in the future CAP (as defined in the EC June 2018 proposals), and improvement suggestions in order to achieve greater climatic and environmental results

Current CAP	Future CAP	Comments and Suggestions (Links with eco-scheme measures in bold)
Climate change		
GM #2: Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area (decline limited to a maximum of 5% from a reference level)	New GAEC #1: Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area	- New GAEC #1 replacing GM #2 on the maintenance of permanent grassland - At the very least, the same requirements as GM #2 ("*no backsliding*" principle) - Implementation at the farm level (individual references) with reduced tolerance at 2% - In addition to stored carbon, maintenance of permanent grassland provides additional environmental benefits, notably in terms of biodiversity and water quality - Except in Natura 2000 areas (see new GAEC #10), new GAEC #1 will not prevent permanent grassland from being ploughed in a given area as long as an equivalent area is converted into permanent grassland, with a negative impact on carbon storage and biodiversity (Lotz et al., 2019). The older a grassland area, the higher carbon storage and flora and fauna diversity. **Issue taken into account through an eco-scheme measure (ES #1; see Table 5.6)**
	New GAEC #2: Appropriate protection of wetlands and peatlands	- Necessity of a clear definition of wetland and peatland: recording and mapping wetlands and peatlands at the farm level is the first requirement of GAEC #2 according to relevant local references - Define what is an "appropriate" protection: no destruction (as these two types of land are carbon-rich soils), maintenance of water tables at adapted levels according to location and season **- Introduction of an eco-scheme measure aimed at remunerating the restoration of current organic soils and the creation of new wetlands and peatlands (ES #2; see Table 5.6)**
GAEC #6: Maintenance of soil organic matter level through appropriate practices including ban on burning arable stubble, except for plant health reasons	New GAEC #3: Ban on burning arable stubble, except for plant health reasons	- Marginally adapted GAEC (narrower definition) - In addition to climate objective, measure that will have also benefits on soil quality by increasing organic matter in soils

		- Introduction in eco-schemes of a measure aimed at minimizing bare soils (ES #3; see Table 5.6)
Water		
SMR #1: Nitrate Directive 91/676/EEC of 12 December 1991 (articles 4 and 5 related to agricultural sources of pollution by nitrates)	New #SMR 2: Nitrate Directive 91/676/EEC of 12 December 1991 (articles 4 and 5 related to agricultural sources of pollution by nitrates)	- Identical SMR - Why is this SMR restricted to some articles only and not to the whole Directive? - Generally, the implementation of the Directive is centred on organic fertilisation: the importance of considering organic and mineral fertilisation together and the N/P ratio, notably from a consistency perspective with new GAEC #5 on the use of sustainability tools for nutrients - Compulsory catch crops in nitrate vulnerable zones in appropriate periods that should be defined in CAP NSP
GAEC #1: Establishment of buffer strips along water courses	New GAEC #4: Establishment of buffer strips along water courses	- Identical GAEC - More details/requirements on the characteristics of buffers strips are required in order to achieve increased water and biodiversity benefits (width, floristic composition)
GAEC #2: Where use of water for irrigation is subject to authorisation, compliance with authorisation procedures		- Reintroduce the old GAEC #2 into new GAEC requirements, or as part of SMR requirements related to "*water*" directives (Water Framework Directive, Groundwater Directive, Priority Substances Directive, as well as the Nitrate Directive)
GAEC #3: Protection of groundwater 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		- Reintroduce the old GAEC #3 into new GAEC requirements, or as part of SMR requirements related to "*water*" Directives (Water Framework Directive, Groundwater Directive, Priority Substances Directive, as well as the Nitrate Directive)
	New SMR #1: Water Directive 2000/60/EC of 23 October 2000 (articles 11(3)e and 11(3)h related to sources of pollution by phosphates)	- New SMR - Why is this new SMR restricted to some articles only and not to the whole Directive? - Complete this requirement by adding other Directives, notably the Groundwater Directive and the Priority Substances Directive

	New GAEC #5: Use of farm sustainability tools for nutrients	- New GAEC linked to one target of the F2FS (on the reduction of nutrient losses) and corresponding to one means of action proposed by the EC to achieve this target - This is a welcome addition, including the details on elements and functionalities that such tools should provide (see Annex III of the EC regulation proposal on CAP NSP) - Setting national quantitative targets on nutrient loss reduction that should be achieved, in relation to the corresponding F2FS target
Soil (protection and quality)		
GAEC #5: Minimum land management reflecting site specific conditions to limit erosion	New GAEC #6: Tillage management reducing the risk of soil degradation, including slope consideration	- Define the tillage management options that effectively allow reducing the risk of soil degradation
GAEC #4: Minimum soil cover	New GAEC #7: No bare soil in the most sensitive period(s)	- Define more precisely what the "*most sensitive periods*" are - Overlapping with new SMR #2 in nitrate vulnerable zones
GM #1: Crop diversity (at least two crops for farms with more than 10 hectares of arable land; at least three crops for farms with more than 30 hectares of arable land)	New GAEC #8: Crop rotation	- New writing of the greening measure related to crop diversity - Potential benefits also on biodiversity - Rewrite the criterion based on: - Diversity requirements of the current greening measure on crop diversity ("no backsliding principle") - Crop rotation requirements: because diversity is an *a priori* favourable but not sufficient criterion (by outlining, the same outcome in terms of diversity can be achieved through a juxtaposition of monocultures or through a single succession including all crops on all farm plots): as a result, the proposal to define this GAEC in terms of both diversity and rotation, with minimum requirements for rotation corresponding to no repetition of the same crop for two consecutive years on the same plot **- In order to achieve greater climatic and environmental ambition, proposal to complement this GAEC #8 by an eco-scheme measure (ES #3; see Table 5.6)**
Biodiversity and landscapes		

SMR #2: Bird Directive 2009/147/EC of 30 November 2009 (articles 3(1), 3(2)b, 4(1), 4(2) and 4(4))	New SMR #3: Bird Directive 2009/147/EC of 30 November 2009 (articles 3(1), 3(2)b, 4(1), 4(2) and 4(4))	- Same SMR
SMR #3: Habitat Directive 92/43/EEC of 21 May 1992 (articles 6(1) and 6(2))	New SMR #4: Habitat Directive 92/43/EEC of 21 May 1992 (articles 6(1) and 6(2))	- Same SMR
GAEC #7: Retention of landscape figures, including where appropriate hedges, ponds, ditches, trees in line, in groups or isolated, field margins and terraces, and including a ban on cutting hedges and trees during the bird breeding and nesting season and, as an option, measures for avoiding invasive plant species	New GAEC 9: Minimum share of agricultural area devoted to non-productive features or areas; retention of landscape features; ban on cutting hedges and trees during the bird breeding and rearing season	- New GAEC outlining, with a different wording, the old GAEC #7 and GM #3 related to landscape figures and ecological focus areas - Importance to maintain a requirement writing for the whole agricultural area and not for arable land only - Coefficients used to weight the different ecological focus areas in current GM #3 are highly criticized (see, for example, Pe'er et al., 2017) - Proposal to define the requirements of new GAEC #9 <u>Either as follows (option A):</u> - 7% of the utilised agricultural area of the farm, for all farms without exception or exemption (small farms, organic farming, etc.) - Inclusion of the same landscape features as current GM #3 (thus including certain productive land uses such as catch crops and nitrogen-fixing crops but then without the use of plant protection products) - Requirement of 7% progressively increased to 10% in 2027 based on scientific evidence that 10% represents a threshold for providing biodiversity benefits - Revision of weights to count the different ecological focus areas based on scientific evidence (references) **- In order to achieve greater climatic and environmental ambition, proposal to complement this GAEC #9 by an eco-scheme measure (ES #4; see Table 5.6)** <u>Or as follows option B):</u> - Exclusion of catch and nitrogen-fixing crops from ecological focus areas (these crops will be eligible in new GAEC #8 on crop diversity and rotation; in addition, mandatory catch crops in some areas in order to respect new SMR #2 and new GAEC #7)
GM #3: On farms with more than 15 ha of arable land, obligation to devote at least 5% of arable land to ecological focus areas (land lying fallow, catch crops, nitrogen-fixing crops and several types of landscape features such as trees, hedges, etc.)		

		- Inclusion of buffer strips of new GAEC #4 provided they do not receive plant protection products and fertilizers so that the buffer strips contribute in a more important way to biodiversity preservation and water quality - Fallow land and fixed landscape features today represent percentages around 1.5% of arable land (around 1% of utilised agricultural area). This percentage is much lower than the requirement of current GM #3. Adding buffer strips of old GAEC #1/new GAEC #4 will increase the percentage to around 4.5% of arable land (around 3% of utilised agricultural area) - Exclusion of permanent grassland that can be grazed and fertilized along the rivers and cannot be counted either as fallow land or as buffer strips (even if some are close) - Based on this revised definition of ecological focus areas, new GAEC #9 requires a threshold of 4% of agricultural area in ecological focus areas, progressively increasing to 10% at the end of the programming period **- In order to achieve greater climatic and environmental ambition, proposal to complement this GAEC #9 by an eco-scheme measure (ES #4; see Table 5.6)**
GM #1: Ban on converting and ploughing permanent grassland in areas that are the most sensitive (from an environmental point of view)	New GAEC #10: Ban on converting or ploughing permanent grassland in Natura 2000 sites	- See above comments and suggestions for new GAEC #1
Public health, animal health, plant health		
Same SMR		
New requirements/criteria that should be included		
		- New SMR related to the Drinking Water Directive, the Plant Protection Products Regulation, the Framework for the sustainable use of pesticides, the Directive and regulation on veterinary medicinal products
		- New GAEC #11 targeting pesticide in relation to the F2FS targets on the reduction of pesticide use (-50% by 2030) and the reduction of the most harmful pesticide use (–50% by 2030) - Calculation at the farm level of the pesticide load index (PLI). This index takes better account of active molecules in pesticides than indicators based on

	pesticide weight or expenditure; it also takes greater account of pesticide toxicity for flora, fauna and humans **- Introduction of an eco-scheme measure aimed at remunerating farmers with lower PLI per hectare than the national or regional mean (ES #5; see Table 5.6)**
	- New GAEC #12 targeting the use of antibiotics in livestock in relation to the F2FS target on the reduction of this use by 50% in 2030: calculation at the farm level of an antimicrobial use index (AUI) **- Introduction of an eco-scheme measure aimed at remunerating farmers with lower AUI per livestock unit than the national or regional mean (ES #6; see Table 5.6)**
	- New GAEC #13 targeting GHG emissions: calculation at the farm level of GHG emission indexes according to the herds and fertilisation practices **- Introduction of an eco-scheme measure aimed at remunerating farmers with lower GHG emissions per euro produced than the national or regional mean (ES #7; see Table 5.6)**

Source: Own elaboration based on EU Regulation N° 1306/2013 (OJEU, 2013a), EU Regulation N° 1307/2013 (OJEU, 2013b), Annex III of the EC Draft Regulation on CAP strategic plans (EC, 2020b), Matthews (2018b), Lotz et al. (2019), Dupraz and Guyomard (2019) for columns 1 and 2; using material in ECA (2017), Lotz et al. (2019) for the third column.

Table 5.6: Proposals and recommendations for the eco-schemes

Eco-scheme measure	Main objective (additional benefits)	Description	Related conditionality requirements
ES #1: Maintenance / increase of permanent grassland without ploughing at the plot level	Climate (biodiversity, water quality)	- No ploughing of permanent grassland at the plot level - Payment rising with the age of the permanent grassland plot using three levels (< 10 years, between 10 and 20 years, > 20 years) - Payment variable depending on the location (lower for less-favoured areas that will simultaneously benefit from payments for areas with natural constraints in P2) - Bonus for grassland including legumes	New GAEC #1 (also new GAEC #10)
Justification of ES #1 - In a general way, the longer a permanent grassland is maintained, the higher the ecological benefits: (i) Carbon storage increases significantly and linearly with time until around 40 years; it continues to increase but less importantly after around 40 years when it reaches a plateau for around 100 -120 years (Smith, 2014); (ii) This is also the case for specific biodiversity and soil microbial activity (Petitjean et al., 2018); (iii) This is also the case for water quality (purification); in addition, soil erosion risks are likely to decrease because of the development and densification of aerial parts of vegetation and of their root systems; (iv) This is at the expense of a possible diminution of grassland productivity and, as a result, with potential adverse effects on economic results. - Legumes offer additional benefits that justify a bonus for grassland areas with legumes: (i) Reduction of GHG emissions (N_20 and CO_2), since legumes rarely require fertilization as they are able to fix atmospheric nitrogen and conserve other essential nutrients (IPCC, 2006; Barneze et al., 2020); (ii) Biodiversity gains linked to the use of melliferous plants; (iii) In addition, grassland meadows with legumes are generally more productive (Barneze et al., 2020) and provide forages well valorised by livestock (Luscher et al., 2018).			
ES #2: Maintenance / increase of wetlands and peatlands	Climate (biodiversity, water regulation)	- Basic per payment level to map and register unofficial wetlands and potential wetlands to be covered by GAEC 2 - Maintenance payment level for appropriate farming practices, including the water table management, in the registered wetlands - Restoration payment level to convert potential wetlands in well-managed peatlands or wet permanent grasslands	New GAEC #2
Justification of ES #2 Wetlands and peatlands have very high soil carbon stocks. They accommodate rich biodiversity and rare species, several times as many as dry land.			

<table>
<tr><td colspan="4">- More than three-quarters of European wetlands disappeared in the 20th century because of agricultural development. Stopping the biodiversity decline needs the restoration of some of these wetlands. Jantke et al. (2011) assessed wetlands inside and outside the Natura 2000 areas, as well as potential wetlands. Peatlands and wetlands that are outside Natura 2000 areas must also be restored.</td></tr>
<tr><td>ES #3: Crop diversity and maximal soil coverage</td><td>Biodiversity (soil protection)</td><td>- Based on a classification of crops in a reduced number of functional groups (7 to 9) depending on the country (climate)
- Measurement of crop diversity thanks to an appropriate index, for example the Shannon index (Kruse et al., 2016; Donfouet et al., 2017; Uthes et al. , 2020) which starts from 0 (a single group of crops) and is equal to a maximum when the inter-plot repartition of the considered functional groups is homogeneous
- Basic ES #3 payment increasing with the value of the indicator
- Introduction of a first bonus for farms where the average size of plots is lower than four hectares: proposal to double the basic ES #3 payment
- Introduction of a second bonus for farms that maintain permanent soil coverage: bonus amount to be defined at the national/regional level</td><td>New GAEC #8 (also new GAEC #6 and #7)</td></tr>
<tr><td colspan="4">Justification of ES #3
- This eco-scheme measure is aimed at developing and remunerating crop diversity beyond minimal requirements, including in GAEC requirements, in order to increase ecological benefits associated with significant crop diversity. Current crop diversity requirements have been highly criticized as being noticeably insufficient to generate significant ecological benefits, particularly for biodiversity (ECA, 2017), while academic literature points out the negative ecological consequences of reduced diversification (Kleijn et Sutherland, 2003; Whittingham, 2007; Elts et Lõhmus, 2012).
- Justification of the first bonus is because it can be shown that environmental benefits increase for low plot sizes relatively to larger plots sizes (Fahrig et al., 2015; Sirami et al., 2019; Martin et al., 2020). In addition, taking into account the size of cultivated plots, even in the simplified way that we propose, allows the connectivity of biological needs' satisfaction at a low scale to be captured, and by so doing, improving the provision of environmental services and the accommodation capacity for the fauna, which must find food, shelter and water (Baudry et al., 2003).
- Justification of the second bonus is related to "permanent" soil coverage, as it generates numerous environmental benefits: increased organic matter of soils (provided that intermediate crops and crop residues decompose on the plot); improved structure and fertility of soils, thanks to different root systems (relatively to principal crops) and atmospheric nitrogen fixation when cover crops are legumes; plus cover crops help the fight against wind and water erosion (Loubes et al., 2016). However, there are possible drawbacks, in particular, when cover crops are destroyed using pesticides or when water needs of cover crops limit water availability for the next crop. As a result, there is a need to define in the CAP NSP (at the national or regional level) the eligibility criteria and situations suitable for this second bonus. The second bonus will be in addition to the first bonus, but it will not be necessary to perceive the first bonus to receive the second, and inversely.</td></tr>
</table>

ES 4: Ecological focus areas (EFA)	Biodiversity (climate change, water quality, fight against erosion)	- ES #4 measure defined at farm level - Measure takes into account fixed landscape features only and as a result, excludes productive land uses like catch crops and nitrogen-fixing crops (option A for GAEC #9), as well as buffer strips (option B for GAEC #9) - Three payment levels for EFAs (as defined above) representing less than 5% of the agricultural area of the farm, between 5 and 10%, and more than 10% - First bonus-malus for rare *versus* abundant landscape features at the regional level - Second bonus when landscape features ensure spatial continuity	New GAEC #9 (also new GAEC #7)
Justification of ES #4 - Exclusion of productive land uses of these measures is because of their lower positive impact on biodiversity preservation (ECA, 2017; Pe'er et al., 2016; MacDonald et al., 2019; Nilsson et al., 2019). - Justification of the first bonus-malus is based on the fact that different types of EFA do not equivalently target different biodiversity dimensions (Andersson et al., 2013). This means that there is an ecological interest, in any given territory, to invite EFA maintenance and development of relatively rare EFA. A farm will thus benefit from a bonus (respectively, will suffer from a malus) when its EFAs are relatively rare (respectively, relatively abundant) at a small geographical scale that should be defined as part of the CAP NSP. - Justification of the second bonus should take into account the fact that EFA spatial continuity increases the environmental benefits (Burel et al., 1998; Michel et al., 2006; Fuentes-Montemayor et al., 2011; Aviron et al., 2018). In addition, numerous academic works underline the interest of a "*critical mass*" at the territorial level, encompassing several farms (Franks et al., 2007; Kramer et Watzold, 2018; Groeneveld et al., 2019). By simplicity and in continuity with the first bonus-malus, this second bonus would be implemented at the same geographical scale as the first bonus-malus.			
ES #5: Pesticides	Biodiversity and Health	Payment according to the pesticide load indicators (PLI) for each crop type. First payment level for a PLI per hectare lower than the national or regional median, second level for a PLI per hectare lower than the first quartile and third level for a PLI lower than the first 10% percentile (that will benefit most organic farms).	Additional GAEC #11 (see Table 5.5)
ES #6: Antibiotics	Biodiversity and Health	Payment according to an antimicrobial use index (AUI) for each type of reared animal. First payment level for AUI per livestock unit (or per ha?) under the national or regional median, second level for AUI under the first quartile and third level for AUI under the first 10% percentile (that will benefit most organic farms).	Additional GAEC #12 (see Table 5.5)
ES #7: Greenhouse gas emissions	Climate change	Payment according to non-CO_2 emissions per production value (in Euros). First payment level for GHG emission index per production unit under the national or regional median, second	Additional GAEC #13 (see Table 5.5)

		level for indexes under the first quartile and the highest payment for the first 10% percentile.	
Justification of ES #5, ES #6 and ES#7 - Eco-scheme measures defined in relation to Green Deal objectives and targets for pesticides, antimicrobials and climate mitigation (in the farm sector).			
ES 8: Animal welfare		Payment according to animal density in livestock buildings, access to natural light, outdoor access and elimination of mutilations.	Additional to the SMR corresponding to animal welfare provisions
Justification of ES #8 - Animal welfare is a global public good corresponding to a growing concern of European citizens. Significantly improving animal welfare can be extremely costly.			

Source: Own elaboration.

5.2.8. Three ring-fenced budgets within the CAP for the climate and the environment

Measures

The CAP budget agreement reached by the European Council on 21 July 2020 covers the seven-year period, 2020-2021. It amounts to €343.9 billion, of which 75% (€258.6 billion) is for Pillar 1 and 25% (€85.3 billion) is for Pillar 2, with the possibility of important transfers between the two pillars that are detailed in Sub-Section 2.3.4.

The EC June 2018 EC draft regulations for the future CAP sets two ring-fenced budgets for the climate and the environment:

- Article 87 of the draft regulation on NSP stipulates that 40% of overall expenditure of the future CAP must contribute to climate change mitigation "*through the application of specific weightings differentiated on the basis [of] whether the support makes a significant or a moderate contribution towards climate change objectives*" (EC, 2018b). The weighting factors are 40% for decoupled aids in Pillar 1 (basic income support for sustainability and complementary income support), 100% for eco-scheme payments in Pillar 1, 100% for expenditure under the schemes for the climate and the environment in Pillar 2, and 40% for expenditure corresponding to payments for natural and other area-specific constraints in Pillar 2.[53]
- Article 86 of the draft regulation on NSP stipulates that 30% of EAFRD expenditure shall be reserved for interventions addressing the three specific environmental and climate-related objectives of the future CAP, excluding interventions for natural and other area-specific constraints (EC, 2018b).

As we write (vote of 23 October 2020), the EP proposes to increase the second ring-fencing to 35% but includes aids for areas with natural and specific constraints. In addition, the EP proposes to introduce other ring-fencing, including one for eco-schemes in Pillar 1. Indeed, both the EP and the Council wish to reserve a minimum budget of P1 spending on eco-schemes (at least 30% for the EP and at least 20%

Analysis

The total contribution of the EU budget to climate change action would be equal to 19.3% for the 2014-2020 MFF period; that is, €205.8 billion from a total of €1,066.4 billion (EC, 2019e; Lotz et al., 2019). On this amount of €205.8 billion, climate interventions of the CAP would amount to €57.0 for the EAFRD (27.7%) and €45.7 billion for the EAGF (22.2%), which represents a total contribution of the CAP budget of around 50%. This means that around 25% of 2014-2020 CAP spending would be allocated to climate change interventions. This percentage is much lower than the 40% target. Note also that climate markers that applied to expenditure under both pillars were found to overestimate the CAP contribution to climate mainstreaming (ECA, 2016; Lotz et al., 2019).[54]

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[53] The climate tracking of EU policies in general, of the CAP in particular, follows the OECD approach of the "*Rio markers*" that assigns three weighting factors to activities, and underlying policy measures, on the basis of their hypothetical/potential contribution towards climate change objectives with weights of 100% when the contribution is significant, 40% when it is moderate and 0% when it is insignificant. However, the EC does not strictly follow the approach of the "*Rio markers*", notably for EAFRD expenditure considering, for example, that a climate coefficient of 40% is too low for the priority of the current second pillar of the CAP aimed at "*restoring, preserving and enhancing ecosystems related to agriculture and forestry*". As a result, the EC currently applies a climate coefficient of 40% for 10% of EAFRD expenditure and a climate coefficient of 100% for the remaining 90% of EAFRD expenditure.

[54] The EC estimates that the contribution of decoupled direct payments of the current CAP to climate mainstreaming would be 20% with a weighting factor of 40%, while the contribution of greening payments would be 100% for permanent grassland, 40% for ecological focus areas and 0% for crop diversification, in the three cases with a climate coefficient of 100%. The ECA considers that there is "*a lack of quantifiable elements justifying the 20% applied to non-greening payments*" and suggests to use a lower percentage of 10% that would lead to diminish the contribution of EAGF spending by around €9 billion (ECA, 2016). On this point, Lotz et al. (2019) analyse the potential contribution to climate change mitigation of the different GAEC requirements of the future CAP in order to assign them better justified climate coefficients. Their analysis clearly shows that this is a very difficult exercise as the weighing factors they propose vary from zero

Ring-fencing 30% of EAFRD spending of the future CAP to climatic and environmental interventions would act as an incentive to increase second pillar expenditure on climatic and environmental measures and to make the commitment ambitious and possibly constraining (ECA, 2018). However, if payments for areas with natural constraints were to be counted against the 30%, this would considerably weaken the commitment, given that around more than 15% of EAFRD expenditure is currently granted in the form of payments for natural constraints, with large discrepancies among MS.[55]

Recommendations

Implementing common and ambitious common rules at the EU level for global public goods requires minimum budget ring-fencing, as well as enforcement, reporting and monitoring indicators aligned with the climate, biodiversity and environment targets of the Green Deal. Leaving the setting of such targets to MS has the potential for distortions of competition. However, defining what is a fair sharing of the burden among MS remains an open question. In particular, there is the sensitive question of taking into account past efforts that were very heterogeneous from one MS to another.

In order to strengthen the climatic and environmental ambitions of the future PAC, we recommend the ring-fencing of three budgets within this policy, as follows:

- ***A 35% ring-fencing of P2 spending for interventions addressing the specific climate- and environment-related objectives of the future CAP***, including interventions for natural and other area-specific constraints but with a lower weighting factor of 40%;
- **A 20% ring-fencing of P1 spending for interventions addressing climate mitigation,** with a very low weighting factor for decoupled direct payments (less than 10%) that would oblige each MS to implement a significant eco-scheme and to devote around half of the latter to climate change mitigation;
- ***A 20% ring-fencing of P1 spending for interventions addressing biodiversity preservation and restoration***, again with a very low weighting factor for decoupled direct payments (less than 10%) in order to oblige each MS to implement an ambitious eco-scheme and to devote around half of the latter to biodiversity objectives.[56]

These three ring-fenced budget items with the CAP are consistent with our recommendations related to conditionality, eco-schemes in Pillar 1 and climate- and environment-related interventions in Pillar 2 presented in the previous sub-sections. They will help the CAP to achieve the commitment to devote 40% of Pillar 1 and Pillar 2 budgets to climate change mitigation.

More generally, the first strengthening of the climatic and environmental ambition of the CAP would be to make *any* ***budgetary ring-fencing effectively constraining*** so as to oblige each MS, in the framework of its NSP, to implement corrective measures if budgetary commitments are not respected.

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to 100% for a many GZEC depending on their design and implementation. In the same way, for EAFRD spending, the ECA considers, for example, that it would be more prudent (reasonable) to use a climate coefficient of 40% instead of 100% for payments for areas under natural constraints. This specific recommendation has been taken into account by the EC in its proposal for the future CAP. Globally, the corrections prosed by the ECA for second pillar coefficients would lead to reduce the contribution of current EAFRD measures to climate mainstreaming by about €24 billion, from around €57 billion to around €33 billion euros (ECA, 2016).

55 In passing, it is important to note that it is not consistent to count the payments for areas with natural constraints against the 40% ring-fencing for climate mainstreaming in pillars one and two, and not against the 30% ring-fencing for climatic and environmental actions in the second pillar.

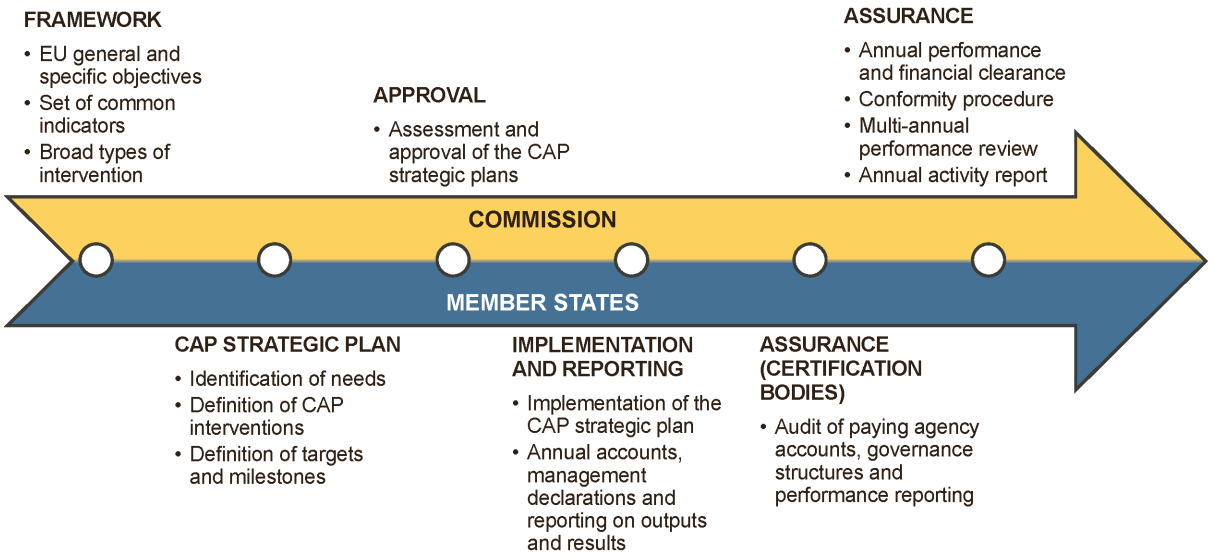
56 Eco-schemes measures devoted to biodiversity may also, but not necessarily, contribute to climate change mitigation, and *vice-versa*. It will be necessary to precisely define these contributions in order to assign adapted weighting factors to biodiversity eco-scheme measures against the 20% climate ring-fencing in the first pillar, and, reciprocally, in order to assign adapted weighting factors to climate eco-scheme measures against the 20% biodiversity ring-fencing in the first pillar.

5.3. Governance issues

5.3.1. The New Delivery Model for the CAP

The future CAP will be implemented through a New Delivery Model (NDM). The principles surrounding the latter are explained in Sub-Section 5.1.1 and illustrated in ***Figure 5.2*** below that summarizes the process of definition, approval, implementation, reporting and assurance of CAP National Strategic Plans (NSP).

Figure 5.2: the New Delivery Model of the future CAP



Source: ECA (2018).

Each MS must draw up its NSP setting out how it will direct CAP funding towards specific targets, and how these targets will contribute to the overall and specific objectives of the future CAP. In a first stage, each MS must define its specific needs based on an extensive SWOT analysis involving consultations with stakeholders and experts. National authorities competent with the climate and environment must also be involved. From that analysis, each MS will define CAP instruments it intends to use in relation to these specific needs and CAP objectives, accompanied by targets and milestones. Each MS must notably set quantified national targets against the CAP specific objectives and design interventions for achieving them. As part of this process, MS have the legal obligation to clearly show greater climatic and environmental ambition than at present, so as to avoid any "*backsliding*" in the contribution of the CAP to care for the climate and the environment (EC, 2018e). All NSP will be submitted to the EC for evaluation and approval before they are implemented. One NSP are approved, the EC will annually monitor progress against the targets, and request adjustments of NSP if necessary. This could lead to suspensions and, eventually, to reductions of European funds if the planned results are not achieved.

A "*performance bonus*" is included in Article 123 of the EC draft regulation on CAP NSP (EC, 2018b). It would be attributed to each MS in the year 2026 to reward satisfactory performance in relation to the specific objectives (d), (e) and (f) of the CAP related to the climate and the environment (see Table 5.1). The performance bonus shall be equal to 5% of the MS CAP envelope for the financial year 2027, as set out in Annex IX of the regulation proposal for CAP NSP. This provision appears limited both in scope and in the level of incentives.

Several analyses have focused on the adequacy of the NDM to ensure that the objectives of the future CAP will be realised. Both the ECA (2018) and Ervajec et al. (2018) consider that the NDM can be a step in the right direction. This is because the NDM should improve evidence-based policy making thanks to increased subsidiarity given to MS that would allow a reduction of CAP inefficiencies. But they also converge in their strong criticisms about the ability of the proposed model to implement the stated objectives of the EC. They point out potential drawbacks notably linked to the complexity of the NDM, the "*limited capability, or willingness, of the policy system to implement*" (Ervajec et al., 2018), and the risk of a "*race to the bottom*" as regards the specific climatic and environmental objectives of the future CAP. The ECA states that the EC claim for how the CAP would contribute to EU climatic and environmental objectives appeared to be "*unrealistic*", in particular because of the delivery mechanism, the indicators and monitoring (ECA, 2018). Ervajec et al. (2018) points out issues related to: first, weak accountability mechanisms between objectives and interventions; second, the non-quantification of specific objectives at the EU level (targets); third, the risks that increased subsidiarity and flexibility could lead to competitiveness distortions among MS (the issue of a level playing field), notably if some MS opt for lower climatic and environmental objectives than at present; fourth, the heterogeneous administrative capacity and empowering of the different MS in developing and implementing planning; and fifth, monitoring and evaluation procedures at both the MS and EU level.

Many observers share the ECA's low confidence in the ability of the NDM will ensure that the CAP objectives, a fortiori those of the Green Deal related to agriculture and food, will be met. They find that the way MS must show that they (will) increase their climatic and environmental ambitions, compared to current policies, is unclear, as is the way they need to measure progress in this area (see, for example, BirdLife, 2018; Marechal et al., 2020).

5.3.2. Turning Green Deal objectives and targets into CAP commitments

Concerns regarding the ability of the NDM to deliver the specific objectives of the CAP are magnified when it comes to implementing the broader and more ambitious objectives of the Green Deal, in terms of climate, environment, health and diet.

In May 2020, in response to a question of the EP, Commissioner Wojciechowski responded that "*[t]he Commission will ensure that these national strategic plans fully reflect the ambition of the Green Deal and the Farm to Fork Strategy*", and "[*will be*] *assessed against robust climate and environmental criteria*".[57] The EC has committed to a rigorous assessment of NSP to guarantee their compatibility with the Green deal ambitions, objectives and targets. From that perspective, the EC has provided an analysis of the links between the Green Deal and the CAP, highlighting the key provisions of its proposals that must be maintained and a few provisions that should be added (see Sub-Section 5.1.3). In particular, the EC proposes a table linking some Green Deal targets related to the agricultural sector to CAP indicators (***Table 5.7***).

The EC claim that the NDM ensures that MS will implement strategic plans in line with the ambition of the Green Deal on climate, biodiversity and pollution issues are (as we write) hardly convincing. Much will depend on the ability of the NDM governance to ensure that this ambition is met, together with the indicators proposed by the EC to effectively monitor progress towards a more sustainable agricultural sector.

[57] *https://www.europarl.europa.eu/doceo/document/E-9-2019-004515-ASW_EN.html.*

Table 5.7: Links between the Green Deal targets related to agriculture and context, impact, output and result indicators of the CAP (as defined in the EC June 2018 draft regulation on NSP)

Green Deal targets related to the agricultural sector	Impact (I) or context (C) indicators	Output (O) and result (R) indicators
Reducing by 50% the use and the risk of chemical pesticides by 2030 Reducing by 50% the use of high-risk pesticides	I.27. Sustainable use of pesticides: reduce risks and impacts of pesticides	R.37. Sustainable pesticide use: share of agricultural land concerned by supported specific actions which lead to a sustainable use of pesticides
Reducing by 50% the sales of antimicrobials for farmed animals and in aquaculture by 2030	I.26. Limiting antibiotic use in agriculture: sales/use in food producing animals	R.36. Limiting antibiotic use: share of livestock units concerned with supported actions to limit use of antibiotics
Reducing nutrient losses by at least 50% in 2030	I.15. Improving water quality: gross nutrient balance on agricultural land	R.21. Sustainable nutrient management: share of agricultural land under commitments related to improved nutrient management
Achieve 25% agricultural area under organic farming by 2030	C.32. Agricultural area under organic farming	O.15. Number of ha with support for organic farming
Completing the reach of fast broadband internet access in rural areas		R.34. Connecting rural Europe: share of rural population benefitting from improved access to services and infrastructure through CAP support
Increasing land for biodiversity, including agricultural area under high-diversity landscape features	I.20. Enhanced provision of ecosystem services: share of UAA covered with landscape features	R.29. Preserving landscape features: share of agriculture land under commitments for managing landscapes features, including hedgerows

Source: EC (2020i).

Two main questions must be addressed. They are linked to the completeness and relevance of Green Deal climatic and environmental targets related to agriculture and food, and to their legally binding character (or not).

On the first point, one will note that Table 5.7 does not include one or several targets related to the reduction of gross/net GHG emissions from the agricultural sector. Potential targets in that domain have been defined as recently in September 2020 (EC, 2020g, j), but their precise setting for the agricultural sector remains, as we write, an open question. Changes in the policy architecture are needed to ensure that the agricultural sector is fully included in the overall reduction targets, and this involves complex interactions between the future LULUCF regulation (carbon sinks) and the Climate Law; or the creation of an "*Agriculture, Forestry and Land Use*" sector with its own specific policy framework covering all emissions and removals of these activities (Matthews, 2020c). Table 5.8 is restricted to the agricultural sector, which highlights that the compatibility analysis performed by the

EC does not include the other stages of the food chain. This is unfortunate because, as shown in Chapter 4, it will be more effective to act at the same time on supply and demand to reach the Green Deal ambitions. Indeed, even greater disparities can be observed between the legislative proposals for the future CAP and the food and nutrition aspects of the Green Deal. Finally, at least some of the indicators proposed in Table 5.7 remain rather vague, raising the question of their capacity to correctly measure progress against the targets of the Green Deal related to agriculture.

Second, and possibly more importantly, no mention is made of the legally binding character (or not) of the Green Deal targets for agriculture. Decisions on the CAP are expected at a stage where most Green Deal objectives remain proposals from the EC rather than binding legislation. It is requested that MS include them in their SNP, by setting national quantified targets against the nine specific objectives of the CAP. Not only is this a significant gamble on the goodwill of MS, but the EC will lack the enforcement power without a more substantial legal basis. From this point of view, the need to align the NSP with the SDG could lead to more binding commitments (Peer et al., 2019; Matthews, 2020b).

Moreover, recent declarations of EC officials suggest that the Green Deal targets related to agriculture will not be legally binding, but only "*aspirational*". In addition, they will be "*subject to impact assessments, with permanent monitoring regarding the consequences of their implementation on food security, agricultural incomes, and the competitiveness of the EU farm sector in order to take into account potential trade-offs*". This means that the targets could be "*sacrificed*", at least weakened to food security, economic and/or competitiveness considerations. This does not mean that these considerations are not important. From that perspective, the next section of this chapter provides an analysis of the potential economic of our recommendations aimed at strengthening the climatic and environmental ambition of the future CAP. The point we want to make here it that it would have been preferable that the EC thinks in terms of corrective actions to be implemented in case of adverse effects on food security, farm incomes or agri-food competitiveness rather than in terms of a watering-down of the Green Deal ambitions, objectives and targets.

According to the EC, the F2FS and the EU Biodiversity Strategy for 2030 are thus "*the beginning of a discussion, not an end*" (Burtscher, 2020). In these circumstances, there is a risk that the national targets of the CAP NSP do not fully reflect the climatic and environmental ambition of the Green Deal, especially if the targets of the latter are "*aspirational*" and only reveal the desire to achieve greater climatic and environmental ambition. This provides MS with a potentially considerable degree of latitude to set not only their policy priorities (which is one of the primary purposes of the NDM), but also the depth of their commitment to Green Deal objectives. This opens the door for the setting of CAP NSP targets not being sufficiently specific to match the climate, environment and health objectives of the Green Deal.

The flexibility introduced in NSP does not compel MS to deliver a comparable level of ambition on any of the nine specific objectives of the future CAP, notably the three climatic and environmental specific objectives (d), (e) and (f). While the green payment introduced in the 2014-20 CAP was later recognized as having very limited impact (ECA, 2017), it was seen (and presented by the EC) as a major step forward because, for the first time, it introduced a horizontal conditionality in Pillar 1 that went beyond the bounds of the existing legislation. Many observers saw it as a wedge introduced for conditionality to be extended in the future. With the NDM, however, this common framework disappears. Much relies on the confidence that MS would voluntarily deliver some degree of "*greening*" through their NSP. The NDM can therefore be seen as a reversal in the convergence of climatic and environmental standards and ambitions across the EU.

5.3.3. Performance indicators

The EC June 2018 draft regulation for CAP NSP states that "*a shift towards a more performance-oriented policy requires the establishment of a solid performance framework that, based on a set of common indicators, will allow the Commission to assess and monitor the performance of the policy*" (EC, 2018b). Additionally, "*a new performance monitoring and evaluation framework will cover all instruments*", and an annual policy performance follow-up will rely on indicators. More specifically, the NDM will be organised around ***context, output, result and impact indicators***.

Context indicators provide information on general trends in the economy while impact indicators will be used to assess the "*overall policy performance*" only. Those indicators that are intended to make performance reviews operational are output and result indicators, which have to be jointly submitted in an annual performance report. More specifically, MS will report annually on realised output and expenditure, as well as distance to targets set for the whole period distance expressed as values of result indicators. The EC can make observations on the annual performance reports within one month of their submission. Result indicators are supposed to play an important role since "*where the reported value of one or more result indicators reveals a gap of more than 25% from the respective milestone for the reporting year*", the EC "*may ask the MS to submit an action plan*" describing the intended remedial actions and the expected timeframe. This could "*lead to suspensions and, in the end, reductions of the Union funds if the planned results are not achieved*" (EC, 2018b).

In spite of the wording of Article 106 of the June 2018 draft regulation on CAP NSP, the criteria under which the EC could refuse to approve a NSP are still largely unclear. One important criterion is whether the NSP addresses the specific objectives of the CAP. However, given the very general and global nature of these specific objectives, the legal basis for rejecting a NSP is uncertain.

The same Article 106 states that *"in duly justified cases, the Member State may ask the Commission to approve a CAP Strategic Plan which does not contain all elements*". Such a vague provision opens the door to a self-tailored definition of a NSP, and possibly to some "*cherry picking*" of CAP instruments. In addition, the mere idea that a MS could have some of its NSP funded without meeting global requirements fundamentally departs from the consistency that the Commission has managed to introduce between the different Green Deal components.

The draft regulations for the next CAP give more flexibility to MS. For this flexibility to be consistent with the Green Deal, it must be accompanied by credible and strong accountability mechanisms that the CAP NSP contribute to common policy objectives and guarantee a level playing field. Clearly, the reporting, especially of those indicators focusing on outputs and results, is intended to be a major pillar of the "*budget focused on result*" idea that inspired the NDM (EC, 2017).[58] This makes it particularly important that indicators be fully operational and in line with the Green Deal targets**.**

From that perspective, most academics and think tanks question the relevance and effectiveness of the performance indicators proposed by the EC. BirdLife states that "*unclear and vague definitions*" will weaken the new system and will lead to the implementation of measures by the MS that do not contribute to the improvement of climatic and environmental conditions (BirdLife, 2018). The ECA considers that "*the proposal does not contain the necessary elements of an effective performance system. The absence of clear, specific and quantified EU objectives creates uncertainty about how the Commission would assess MS CAP strategic plans. It also means that achievement of EU objectives cannot be measured. The framework proposed provides relatively weak incentives for performance. Targets could be missed by a*

[58] The idea of a "*budget for result*" was central in the 2017 EC Communication on the "*Future of Food and Farming*" (EC, 2017) that was released eight months before the June 2018 EC proposals for the future CAP.

considerable margin with little impact on EU financing. Successful performance could trigger, at best, a marginal performance bonus" (ECA, 2018). Hart and Bas-Defossez (2018) share, to a large extent, these conclusions.

While MS are required to report on distance to targets, for several indicators, the reference period against which progress is supposed to be assessed does not seem to be defined at this stage. This could be an important point since, in the past, negotiations and the strategic choice of a particular reference period have significantly reduced the ambition of the CAP policy instruments (that is, of past CAP reforms).

Impact indicators do not measure the actual impacts of the measures taken under the CAP NSP. Results indicators that could trigger payment suspensions are very general. They focus on the areas under some form of agreement (for carbon, biodiversity, soils, water, etc.) rather than assess the quality of the management and therefore the real contribution that the CAP makes towards achieving the climatic and environmental objectives.

An illustration can be given with the specific objective (f) of the CAP: "*contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes*". The corresponding result indicator (R28) aimed at "*preserving habitats and species*" relates to the "*share of agricultural land under management commitments supporting biodiversity, conservation and restoration*". The corresponding impact indicators relate to "*farmland bird population index*" (I.18), "*percentage of species and habitats of community interest related to agriculture with stable or increasing trends*" (I.19), and "*share of agricultural area covered with landscape features*" (I.20). While the impact indicator clearly reflects the objectives, the result indicators will not necessarily translate into more climatic and environmental benefits.

More generally, the performance framework is not linked to the Green Deal targets in a way that ensures effective implementation. For example, the share of agricultural area under the commitments for managing landscape features contains potentially more ambiguities than, say, the actual surface area covered with these elements. Furthermore, in some cases, there is simply no indicator that matches the objectives; this is the case, for example, of animal welfare or pollinators.

Overall, the actual governance scheme, illustrated in Figure 5.2 above, does not allow the EC to impose MS to suspend payments if there is a lack of actual results.

Some potential exists to complete the result indicators with quantitative targets and thresholds. Several proposals have been made (ECA, 1018; BirdLife, 2018; Hart and Bas-Defossez, 2018). They would require that the link with the data mentioned by the Commission in the proposed regulation on NSP be more effective, in order to build on the significant amount of results gathered by the experiments on result-based payments in Pillar 2.[59] Note also that in addition to the large set of data that the EC has made available to national governments (in particular, satellite data), technical progress in data management, crowdsourcing, and environmental DNA[60] (that makes it possible to assess the presence, and increasingly, the abundance, of the whole set of living organisms in a given area or watershed) raise possibilities for novel indicators.

[59] On this point, see the EU pilot projects: *https://ec.europa.eu/environment/nature/rbaps/index_en.htm*.
[60] DNA for deoxyribonucleic *a*cid.

5.4. Economic considerations

5.4.1. Assessing the possible impacts of our recommendations for the future CAP on farm incomes

In this sub-section, we provide a rough estimate of the possible impacts of our recommendations for the future CAP on farm incomes. The estimate is illustrative only. Its objective is to "*put on the table*" the main economic points that should be addressed through sound impact assessments considering all the sustainability dimensions. From that perspective, ***Annex A5.1*** provides a short analysis of data and modelling needs that are summarized in ***Box 5.2*** below.

Box 5.2: Data and modelling needs

With the exception of the EC's own impact assessment (EC, 2018g), few quantitative analyses have been carried out on the economic consequences of the EC June 2018 CAP proposals, and even fewer analyses of the economic consequences of the Green Deal proposals of the different actors of the food chain are available.

It is worth noting that at this stage, any quantitative assessment of CAP regulation proposals against the Green Deal objectives and targets must be subject to caution. Modelling runs into the need to rely on scenarios and assumptions. Indeed, how the future CAP will be implemented, and how the Green Deal targets will be made more comprehensive and constraining is unclear. As an illustration, for the GHG emissions from the agricultural and food sectors, questions remain regarding reference periods, possible interim targets to match the time frame of the MFF, the choice of methods and indicators to be used for measuring reductions, etc. In addition, assumptions need to be made on the policy mix that will be used to bring about the suggested/required changes for all stages of the food chain. This policy mix includes not only the CAP, but also other food and bio-industry policies at the EU and/or MS level.

Several available models provide some insights that can be used for such impact assessments. Past simulation exercises based on these models are mobilized in Section 5.4 as they shed light on certain economic mechanisms that, *in fine*, will determine the impacts of policy changes on farm incomes (these mechanisms have been described in Section 4.2).

Even if the models currently available can provide useful insights regarding the possible impacts of policy changes on economic, climatic and environmental indicators, taking into account, at least for some models, induced effects linked to land-use changes and price feedbacks, quantifying several issues remains particularly difficult.

Matching the Green Deal targets related to agriculture and food will require some structural changes on both the production side (mainly through the adoption of more agro-ecological practices and systems, including organic farming systems) and the demand side (mainly through changes in consumers' preferences and dietary patterns). In a general way, existing models are poorly equipped to include such structural changes in their simulations. On the supply side, particular attention should be devoted to risk attitudes of farmers. For the whole food chain, particular attention should be devoted to "*price formation*" in a context of information asymmetries and potential market powers.

Box 5.2: Data and modelling needs (continued)

One particular issue relates to the ability of the CAP instruments to reduce pollution. The research community is developing integrated projects that combine technical models (including modules related to soils, plant growth, biogeochemical flows, etc.) with economic models that make it possible to account for new equilibria resulting, for example, from a reduction in fertilizer use. However, at this stage, such efforts are mainly in the research phase.

In terms of biodiversity, quantification runs into the lack of a common metric on which indicators could be built. One can only infer indirect effects through land-use changes between different categories of land with which some biodiversity indicators are associated.

The various models can hardly provide a quantification of the impacts on agricultural production of a reduction in pesticide use, which involve complex and imbricated mechanisms at different scales (from the plot to the landscape).

In coherence with our recommendations for the climatic and environmental provisions for the future CAP detailed in Section 5.2, we consider the Green Deal ambition related to agriculture and food concerns to be only the E (efficiency of agricultural systems) and the R (redesign of agricultural systems) levers of the three-stage ERD analytic framework of Section 4. In other words, we assume that policy measures on the demand side are neither ambitious nor constraining, and thus correspond to "*a business as usual*" scenario. This assumption allows us to focus attention on the possible economic consequences of an ambitious CAP in terms of climatic and environmental measures. One key point for the acceptance of the proposed measures is their impact on the agricultural and food economy in the EU, notably farm incomes.

To get an order of magnitude of this impact, ***Annex 5.2*** provides some insights based on rough estimates relying on the 2018 FADN. More specifically, we assume a threefold increase of the number of European organic farms that increases from 258,600 to 775,700. As we assume that the total number of farms is constant, the number of conventional farms decreases from 3,614,300 to 3,097,100. We then assume that farms that were conventional and remained conventional decrease fertilizer use by 15% and pesticide use by 30%. The reduction in chemical input use generates a drop in plant yields by 10%. As less crops and fodders are available for animal feed, we assume that animal production decreases by 12% for ruminant meat, 8% for milk, and 4% for pig and poultry meat, as well as for eggs. Finally, we assume that prices and trade are constant: we will discuss these two points in the following sub-sections.

"*Simulation*" results show that the previously conventional farms that convert to organic farms would gain since their income (including CAP payments) would increase by €5,690 per farm. This positive outcome assumes that the prices of organic products are unchanged. However, the price premium of organic products is not sufficient to offset the decrease in physical yields associated with the shift to organic production systems. It is because organic farms receive more CAP payments than conventional farms that the income of farms that convert to organic farming increases. It is therefore because our calculations assume that CAP payments per organic farm are maintained constant that the income of the farms that convert to organic farming can increase. Indeed, total CAP payments to organic farming would increase by about €20 billion over the 2021-2027 period (around 6% of planned CAP budget). This average figure masks differences depending on main productive orientations of organic farms.

Obviously, all these figures and results must be interpreted with caution and in line with assumptions that define the simulated scenario.

For the farms that were and remained conventional, the picture is less optimistic since the average income would decrease €5,740 per farm (-25%). Assuming that input and output prices are constant, as well as CAP subsidies per farm, this means that the reduction in fertilizer and pesticide costs does not compensate for the (assumed) decrease in production levels. Annex 5.1 provides a sensitivity analysis corresponding to a "*favourable*" scenario (lower decreases for production levels in response to identical decreases for fertilizer and pesticide use) and an "*unfavourable*" scenario (higher decreases for production levels). The "*unfavourable*" scenario was also calibrated in order to analyse the impacts on conventional farms' incomes of an additional scenario where around 10% of agricultural area would be devoted to high-diversified landscape features (assuming the same use and production reductions as in our central scenario described above). In that case, the income of farms that were and remained conventional would decrease by €9,500 per farm (-42%), with large variations depending on the main productive orientation of the farm (see Annex 5.1). At this stage, it is important to recall that this analysis does not take into account redistributive effects on incomes linked to changes in CAP payment distribution induced by our climatic and environmental recommendations for the future CAP.

Our central scenario would lead to an 8.7% reduction of agricultural GHG emission (-34 $MtCO_2eq$), mainly thanks to farms that were and remained conventional (-25 $MtCO_2eq$).

Finally, we calculated the product price increases that would allow the compensation of farm income drops. In the central scenario, farm-gate price increases required to maintain constant the income of farms that were and remained conventional would range from +4.6 % for farms specialized in Cereals, Oilseeds and Protein Crops (COP) to around +11% for livestock farms specialized either in sheep and goats or in pigs, poultry and eggs. These farm-gate price increases are not "*out of reach*" and are in line with those derived from studies that analysed the consequences of past CAP reform scenarios, provided that increased EU imports from third countries do not cancel the increases in domestic prices. This is discussed in the following sub-sections.

5.4.2. Feedback effects linked to land-use and price changes

Several studies find that the "*greening*"[61] requirements of the current CAP have (very) little impacts on farm incomes (Cortignani and Dono, 2015; Vosough-Ahmadi et al., 2015; Louhichi et al., 2017).[62] Some even find that positive price effects fully offset negative production effects (Czekaj et al., 2014), which allows Gocht et al. (2017) to conclude that "*the more restrictive the "greening" is, the higher is the positive impact on farm income*". In other words, "*greening*" the CAP would be a win-win strategy in the sense that it would allow the environmental footprint of EU agriculture to be reduced while sustaining farming incomes. The mechanisms behind this conclusion can be summarized as follows.

The direct impact of the "*greening*" is to decrease production levels that induce production price increases. As the positive price effect dominates the negative production effect, farm profitability increases. This results in increases in marginal returns to land from agricultural land use that, given the assumption of an upward sloping land-supply function, translates into a (slight) increase in total used agricultural area and land-use reallocation between the different agricultural activities, including fallow land. This indirect impact of the "*greening*" can have ambiguous effects on levels and prices of the different outputs depending on land-use reallocation. Overall, the direct impact dominates the second

[61] Greening here refers to the green payment of the 2014-2020 CAP.

[62] This can be explained by the fact that the greening requirements of the current CAP are not really or strongly constraining for the majority of European farms. Accordingly, the studies quoted in brackets found also (very) limited environmental benefits. This is unlikely to be the case if the climatic and environmental targets of the Green Deal are (legally) binding.

impact, and production price increases. As price increases outweigh production decreases, farm incomes increase too.

Past analyses that focus on the strengthening of environmental requirements of the 2014-2020 CAP, through cross-compliance and "*greening*", do not exactly match what we propose for the future CAP. However, they provide two lessons that apply to our recommendations. They show that both the land allocation effect and the price effect must be taken into account. Because the demand for the majority of agricultural goods is notoriously inelastic, the price effect can be significant.

5.4.3. Feedback effects linked to trade and trade regulations

Avoiding leakages

The importance of the border measures when making the post-2020 CAP come into line with the Green Deal objectives and targets can be illustrated by the work of Fellmann et al. (2018). These authors analyse the consequences on agriculture and food of an EU-wide reduction in agricultural non-CO_2 GHG emissions of 28% by 2030, compared to 2005, using the CAPRI modelling framework. A lesson of this work is to highlight that an ambitious climatic and environmental ambition that would lead to a (large) "*de-intensification*" of EU agriculture would lower domestic production levels and raise domestic prices (in accordance with the analysis developed in the previous sub-section). In addition, Fellmann et al. (2018) show that without sufficient border protection measures, this would lead to an increase in EU agricultural imports that has two unwanted consequences. First, EU producers do not benefit from a large price increase as the latter is (partially) cancelled by increased imports. Second, there would be a significant leakage effect, with extra pollution and GHG emissions in non-EU countries.

Useful insights can also be found in studies that use a general equilibrium modelling framework that captures land-use, price and trade feedbacks, including the displacement of production in non-EU countries through cascading price changes following the EU policy change. From that perspective, Bellora and Bureau (2014) simulate the consequences of a shift from 6% to 30% of organic agriculture in the EU based on the general equilibrium model MIRAGE. In the same way, Pelikan et al. (2014) simulate the global impacts of setting land aside as EFA in the EU, using both the CAPRI and GTAP models.[63] Even though their scenarios differ significantly from any Green Deal scenario, both studies provide estimates that can help gauge the potential impacts of our proposed changes in the CAP regulations.

Bellora and Bureau (2014) find that a significant shift of EU arable crop production towards organic agriculture reduces EU output and leads to an increase of the world price for wheat (+3%). If they find positive impacts within the EU in terms of biodiversity and pollution, some of these effects are offset by land-use changes in non-EU countries driven by the (modest) rise in world prices and resulting in, uncertain outcomes in terms of word GHG emissions. In the same way, Pelikan et al. (2014) find that conservation efforts in the EU could be partially compensated for by an increase of cropland, as well as increased fertilizer applications, in other regions of the globe.

In summary, the improvement of the environmental status in the EU can come at the price of global intensification, as well as the loss of forest and grassland areas outside the EU.[64]

Regarding the economic aspects, the orders of magnitude derived from these modelling efforts suggest that, unless there is a strong enforcement of similar standards for imports, matching the Green

[63] CAPRI is an agricultural partial equilibrium model while GTAP is a general equilibrium modelling platform (see Annex 5.1).

[64] Thus, Fellmann et al. (2018) conclude that GHG emission leakage would considerably downsize the net effects of their European climatic scenario on total agricultural GHG emissions since "*the share of EU mitigated emissions offset by emission leakage [would be] as high as 91%*", essentially in the form of increased EU imports of animal products.

Deal targets might negatively impact the trade balance of EU agriculture.[65] Larger imports might offset the positive impact of a price increase on farm incomes.

Two main conclusions must be drawn:

- First, considering the sustainability issue, it is important that measures to make EU agricultural production more sustainable will be accompanied by changes in demand. If demand remains unchanged, the leakage effects will lead to shifting pollution, biodiversity losses and GHG emissions abroad.
- Second, a key condition for the Green Deal objectives not to have perverse displacement effects, and to be accepted by farmers, is to design border mechanisms that will set equivalent climatic, environmental and health requirements on EU imports from non-EU countries. If not, the risk is high that imports from less environmentally committed countries could lead to lower prices and, thus, penalize European farmers.

In terms of border mechanisms, the EU shows good and laudable intentions in the wording of its trade agreements, but their effective translation into trade agreements (notably in bilateral trade agreements) remains to be seen (Ambec et al., 2020; Bellora et al, 2020). In addition, many agricultural products, especially those used in animal feed, enter with no or minimal duties under the *erga omnes* regime. This means that any strengthening of the environmental and climatic clauses in the EU trade agreements would have no impact, with soybean imports being a case in point. The need to ensure a level playing field for all imports, whether they enter under a preferential tariff regime or under the Most Favoured Nation (MFN) clause, is rightly stressed by farmers' organizations. With the exception of the proposed border adjustment tax for some sectors, not much has been proposed by the Commission in this area.

Border adjustment mechanisms and trade policy

The previous discussion legitimates the inclusion of agriculture and food in the sectors that would benefit from the ***carbon border adjustment mechanism***, to be introduced "*for selected sectors*", using the wording of the EC (2019a).[66] The legitimation would be two-fold: climatic and economic. Identical arguments lead to the recommendation of the introduction of a ***biodiversity border adjustment mechanism***, in order to limit the risk of biodiversity leakage through increased imports and competition distortions. It is for the same reasons that we also recommend the application of the climate and biodiversity measures of the eco-schemes at the EU level, in order to reduce leakages and distortions between MS.

However, border adjustment measures are likely to be delayed (if ever implemented), notably because not all MS agree with such a mechanism. Hence, we recommend to progressively increase conditionality requirements over the programming period of the new CAP (see Section 5.2). In practice, the absence of the effective translation of EC intentions related to any border mechanism into concrete instruments can be viewed as the "*Achilles heel*" of the Green Deal initiative, not only for agriculture and food but more generally for the whole EU economy and all European activity sectors.

The current EU tariff structure leaves some room to strengthen the conditionality criteria of the future CAP because of duties and regulatory barriers. However, taking into consideration that many tariff lines have a zero *erga omnes* duty, and that imports enter duty free or with reduced duties under a variety

[65] See Annex 3.3 for a synthetic presentation of EU agri-food trade statistics.

[66] A specific concern must be paid to less developed countries, because of the objective of economic development and "*food diplomacy*". However, these countries are essentially concerned by the questions of securing their imports (food availability at the global scale) and access to food for all.

of preferential agreements, Table 5.8 shows that only a fraction (roughly 20% of the value of imports) are subject to actual tariffs.[67]

Table 5.8: Average applied MFN tariffs in the EU in 2019 [tariff range in %]

WTO non-agricultural products	4.2% [0-26]
WTO agricultural products	14.2% [0-172]
Among which are:	
Dairy products	32.3% [1-161]
Sugar and confectionary	27.0% [0-149]
Animal and meat products	19.0% [0-117]
Cereals and preparations	17.2% [0-100]
Fruit, vegetables and plants	13.0% [0-163]
Beverage, spirits and tobacco	12.9% [0-119]
Coffee, tea, cocoa and preparations	11.5% [0-19]
Oilseeds, fats, oils and their products	6.3% [0-94]
Cotton	0.0%
Other agricultural products	5.9% [0-172]

Source: WTO (2019).

[67] For a more detailed analysis, see, for example, Matthews (2020d).

CONCLUSION

Proposals for the future CAP and the European project

A meeting of Ministers in Annecy in 2008 demonstrated an early lack of shared vision for the future of European agriculture. Ten years on, these differences seem to have only increased, and it is difficult to see how a truly common project for European agriculture could be shared by all Member States. This led the European Commission in 2018 to propose a highly decentralised governance system for the future CAP, in which Member States would have considerable freedom of action through the drafting of national strategic plans, financed by the European budget upon their approval.

Since the release of the draft regulations, there have been fears that, despite the Commission's drive to uphold common objectives, the CAP would become a mere cover under which Member States could conduct very different policies. However, neither the Council nor the Parliament have rejected the core of the Commission's proposals, most likely because it was perceived as the sole common denominator that would be accepted by Member States.[68]

The 2013 CAP introduced many options that Member States could include (or not) in their national policy. The Commission's June 2018 proposals for the future CAP further extended the application of the subsidiarity principle. With limited progress on key issues (such as common fiscal rules, financial solidarity and mutual emissions), the proposals for the post-2020 CAP can be viewed as a demonstration of the gradual "fading away" of the European project, in which the CAP has been a central pillar. Many observers have predicted that the CAP would become (if not remain) largely a function by which to distribute undifferentiated forms of aid on the basis of land, with a view to supporting farming income. With little legitimacy in social terms and in terms of public goods provision, the CAP justifications appear to arise chiefly from the fact that payments represent such a high share of farm incomes, making in-depth reform enormously challenging, if not impossible.

The European Green Deal

With the introduction of the Green Deal, "*Europe's 'man on the Moon' moment*," to quote President von der Leyen, the entire process has evolved. The Commission intends to revive the European project, with the aim to involve the current young generation towards the objective to "*reconcile our economy with our planet*". During 2020, a succession of legal proposals and strategies has led to the creation of an ambitious and far-reaching plan to act as the new growth strategy for the EU, by cutting greenhouse gas emissions, protecting the environment and delivering jobs.

Upon receiving the European Parliament's endorsement and with the adoption of the Next Generation EU (NGEU) recovery plan by the Heads of States, the Green Deal is no longer simply the hazy aspiration of climate action enthusiasts. It is now a set of detailed and credible policy documents affecting every sector, including agriculture and food. The funding of the NGEU plan strengthens the European project by lifting institutional obstacles and by allowing the Commission to use its strong credit rating to borrow hundreds of billions of euros. Not only does the combination of the NGEU and the MFF result in a much-needed boost for a strong economic recovery, it does so by reinforcing European solidarity. Additionally, the NGEU plan contains extremely innovative intervention instruments that could represent a step towards reforming and completing Europe's institutional set-up (Blesse et al., 2020).

The project for the future CAP lags behind the Green Deal impetus

[68] The Council *de facto* endorsed the main provisions of the June 2018 Commission's proposals for the CAP when adopting its own version of the MFF in July 2020. The newly elected Parliament chose, in 2019, not to go back to a blank page but to endorse most of the outcomes negotiated by the former Parliament.

Making the post-2020 CAP compatible with the Green Deal objectives will require major changes to the June 2018 draft regulations for the future CAP. Matching the degree of ambition of the Green Deal will require a major leap from what was previously regarded as, effectively, the continuation of the current CAP, however, with increased subsidiarity.

First, the CAP proposals do not cover the whole spectrum of what the Green Deal assigns to agriculture in the European project. The CAP provisions on climate seem too limited and out of touch to tackle the global solutions required to reach the climate objectives of the Green Deal. It is a particularly difficult topic, given the role of the livestock sector in agricultural greenhouse gas emissions and the utility of this livestock sector for other objectives of the Green Deal, such as ensuring that agro-ecological systems on a large scale can be sustained while limiting the environmental damages resulting from synthetic fertilizers. Reaching the level of agricultural greenhouse gas emissions required by the Green Deal objectives would require the significant regulation of non-$C0_2$ emissions through the Emissions Trading System or the implementation of higher levels of taxation, while simultaneously finding innovative technical solutions. This clearly raises some considerable adjustment challenges for the livestock sector, in particular, which must be anticipated and supported, both economically and technically. The CAP proposals contain some useful elements in that regard, but so far, mostly on the innovation side. However, the level of ambition of the Pillar 1 eco-schemes and the Pillar 2 agri-environmental and climatic measures is left to Member States, and not all States seem to grant priority to climate issues in their strategic plans.

A change in the diet of European consumers is a fundamental way to improve the health and environmental impacts of the food system. Combined with efficiency gains at the farm and food chain levels (for example, through improvements in technologies and management, reduction in food losses and waste, etc.) and the re-design of production systems (based on agro-ecological principles), dietary changes at the consumer level may place the food system on the right track to achieve the Green Deal ambition. However, some of the objectives of the Green Deal and its associated strategies in this area fall outside the scope of the current CAP (which has never in fact been a food policy). The proposals of the CAP regulations would need to be completed by a more globally directed food policy that goes beyond the few food aid provisions of the 2013 Regulations and the Omnibus Regulation.

Voluntarist policies are required on both the supply and demand sides and must be designed jointly. Actions to address economic and environmental issues at the farm level will likely have impacts on consumers' decisions and welfare through their price effects. Conversely, policies targeting changes in dietary patterns (through information campaigns, labelling, etc.) may affect consumers' demands in terms of quality and quantity, which may have, in return, an impact on producers' incomes and incentives to adopt more environmentally friendly production processes. While the Farm to Fork Strategy provides the foundations for defining a global policy within a common framework, neither the Commission nor the Council nor the European Parliament seem to have attempted to match this new ambition with significant enough supplementary provisions in the post-2020 CAP.

Similar comments can be made regarding the circular economy objectives of the Green Deal. The instruments for reduced food losses, food waste and packaging are beyond the scope of the current CAP proposals. It would be an unfortunate lost opportunity if the CAP proposals did not integrate them.

There is a great deal of demand directed by other industries towards the agricultural and food sector as a source of bio-energy or bio-sourced material. The Green Deal climate policy seems to hold high expectations in this area. There is clearly some potential for the more effective use of agricultural by-products and co-products. Recent promising innovations suggest that bioplastics could be a significant outlet for starch or ethanol sourced products, together with other bio-economy sectors, such as bio-enzymes. This could help to solve the economic dilemma faced by farmers who will need to fund the

transition toward more sustainable systems. However, a major caution is necessary regarding the potential direct, as well as indirect, land use effects. It is essential to consider that such effects are driven by changes in relative prices and can have complex and undesirable consequences. From a climatic and environmental standpoint, past experiences with biofuels have been varied, and it is important to keep in mind that some successful agri-environmental schemes were abandoned when farmers received price incentives to grow maize for methane production.

Ambitions of the Green Deal on nutrient leaching, chemical pollution and antimicrobial resistance involve a significant reduction in the use of synthetic fertilizers, phytosanitary products and antibiotics. The CAP proposals do not appear sufficient to meet this challenge. Part of the problem is that the objectives are too vaguely defined, there is a lack of precise quantitative targets and the devolution of measures is left to Member States with relatively few (at least, vague) guidelines, and even fewer roadmaps and milestones.

However, the CAP proposals provide important opportunities for implementing the Green Deal

On the positive side, the proposals for the post-2020 CAP do contain the necessary ingredients for a renewed policy in line with the European agricultural model. The results-oriented approach put forward is highly recommended for use in the future CAP, however, it is not compatible with the simplification of the policy requested by Member States and, effectively, all stakeholders. The large degree of freedom left in the New Delivery Model opens the door for innovative solutions in line with the Farm to Fork Strategy. In particular, the eco-schemes could lift the constraint (largely self-imposed by the Commission for Pillar 2 measures) that states that farmers can only be compensated for extra costs or income losses, and could pave the way for potentially ambitious payments for ecosystem services and the provision of public goods. This long overdue change would, eventually, make the "*multifunctional*" role of agriculture effective, as put forward by the Commission in the 1990s.

If properly governed at the EU level, the proposed decentralisation of policies could help to achieve a transition in line with the Green Deal objectives. One main discrepancy between the latter and the CAP proposals is the proposed system of governance. The targets are frequently too loosely defined, allowing an opportunity for Member States to circumvent them, plus there is often a lack of legal basis by which to enforce them. In addition, the indicators proposed by the Commission seem highly ineffective, as do the provisions for withholding payments, with the proposed bonus scheme disproportionate to the challenges at stake. In brief, much of the Green Deal ambition is left to the goodwill of the Member States.

Negotiations within the Council suggest that on these issues, European Agriculture Ministers have fundamentally proposed to weaken the accountability and performance monitoring mechanisms of the New Delivery Model. In a similar way, the most technical proposals (on minimal requirements, thresholds, mandatory percentages, etc.) tend to dilute environmental conditionality to a point where it is hard to see any real progress, compared to the current provisions of green payments made under the current CAP. A same observation can be made for the European Parliament.

There are clearly a number of potentially conflicting consequences of the Green Deal on the economy, for the different actors of the food chain (from agricultural producers to final consumers). Simple calculations presented in this report show that there are genuine concerns that the changes required to match the Green Deal ambition (for example, in terms of land protection and organic agriculture), are not matched by economic gains.

A compelling point raised by farmers' organizations and some Member States is that in a globalized economy, there is a risk that the more "*virtuous*" European behaviour would displace the various issues through higher imports and be worsened by distortions of competition. From this point of view, the

elusive "*border adjustment*" tax and the (barely enforceable) environmental and social clauses in recent trade agreements show little guarantee against a loss of competitiveness. Land use shifts and imported deforestation, biodiversity loss or water depletion would do little to help the planet.

However, the CAP budget provides a significant degree of leverage to stimulate changes. Over 30 years of painful reforms, farmers have well proven their adaptability. Technology is flexible, land is multifunctional, and there are outlets in the bioeconomy as well as in payments for ecosystem services. If a large portion of the first pillar budget were to be earmarked for a contract with farmers concerning the provision of public goods, they would certainly be the winners.

Circumventing the objectives of the Green Deal with a "*business as usual*" CAP could be seen as a short-term victory for the more conservative agricultural interests of some Member States. Yet, in the longer term, it is difficult to see why taxpayers would accept the financing of a policy that no longer provides a public good, and for which the European added value has been significantly diminished as a result. Making the CAP more coherent with the Green Deal is perhaps the best guarantee for its own sustainability.

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ANNEX A1.1. COMPOSITION OF THE THREE EXPERT PANELS AND SYNTHETIC REPORTS OF THE FIVE EXPERT MEETINGS

Members of the three panels

Experts of the technical panel	
Name	**Institution**
Marc Benoit	INRAE
Nicole Darmon	INRAE
Luc Delaby	INRAE
Hugo de Vries	INRAE
Christian Ducrot	INRAE
Emmanuelle Kesse-Guyot	INRAE
Paul Leadley	Orsay University
Jean-Louis Martin	CNRS
Sylvain Pellerin	INRAE
Jean-Louis Peyraud	INRAE
Clelia Sirami	INRAE
Alban Thomas	INRAE
Experts of the policy analysis panel	
Name	**Position and institution**
Hrabrin Bachev	Professor, Institute of Agricultural Economics, Sofia, Bulgaria
John Finn	Senior Researcher, TEAGASC and Agriculture and Food Development Authority, Ireland
Xavier Irz	Professor, Natural Resources Institute (Luke), Finland
Roel Jongeneel	Senior Scientist and Business Developer, LEI-WUR, The Netherlands
Cathie Laroche-Dupraz	Professor, Agrocampus Ouest
Alan Matthews	Professor Emeritus, Trinity College of Dublin, Ireland
Costică Mihai (Ticu)	Professor of the "Alexandru Ioan Cuza" University of Iasi, Romania
Bernhard Osterburg	Senior Researcher, von Thünen Institute, Germany
Tomas Ratinger	Senior Scientist, Technology Centre of the Czech Academy of Sciences, Czechia
Tania Runge	Senior Researcher, von Thünen Institute, Germany
Sophie Thoyer	Senior Researcher, INRAE, France
Davide Viaggi	Professor, University of Bologna, Italy
Panel of stakeholders' representatives	

Name	Position and institution
Cécile Bauzy	Director of Scientific Affairs, Regulatory and Nutrition, Nestlé France
Francesca Bignami	Senior Manager for Economic Affairs, in charge of the Farm to Fork Strategy watch, Food Drink Europe
Katharina Brandt	Agricultural specialist, German Watch, Germany
Alice Budniok	Director of legal & Administrative Affairs, LIFE+/Natura2000, H2020, Marie Curie, European Land Owners
Fabien Delaere	Dietary Impact Team Leader, Danone
Samuel Feret	Board Member of ARC 2020: Agricultural and Rural Actors Working Together for Good Food, Good Farming and Better Rural Policies in the EU, Mediterranean Agronomic Institute of Montpellier, France
Trees Robijns	Expert for Agriculture Policy, Nature and Biodiversity Conservation Union, Germany
José Fernando Robles	Senior Advisor for Environment, ASAJA – Agricultural Association of Young Farmers, Seville, Spain
Marc Rosiers	Director at MR F&A Consult, Belgium

The following summaries try to get closer to what has been said during the experts' meetings and these retranscriptions apply only to the authors of the report.

1. First meeting of the technical expert panel (26/08/2020)

In order to reach carbon neutrality, N_20 leakages have to decrease, which is harder in intensive farming areas and requires structural measures. The number of ruminants should also decrease – to limit enteric CH_4 emissions – while reducing productivity. However, if the reduction in the number of ruminants is too significant, then intensive livestock production risks being replaced with crops, which need a lot of fertilizers. Ruminants should be bred with locally grazing systems to decrease imported or locally produced N_20 emissions because of the use of soybeans. Finally, bare grounds should be avoided so that carbon sequestration and storage are sufficient. For example, intermediate crops, permanent grassland or agroforestry practices could contribute to this storage if they represent more than the 10% of protected areas mentioned in the F2FS.

As regards antimicrobials, the following actions levers have been suggested:

- Monitoring the use of antimicrobials on a European scale;
- Upgrading regulations in alternative medicine; and
- Generalisation of separating the sale from the prescription of medicines.

An indicator defined at the MS level might be more relevant than at the EU level one because past efforts strongly vary from one MS to another. The reference period could start from when the sales of antimicrobials peaked. Finally, it is essential to apply the same regulations to importations from non-European countries to avoid a distortion in competition.

A 25% reduction in the overall use of pesticides seems possible without significant changes in crop production systems and farmers' income while a reduction beyond 25% requires such changes – crop rotations, reallocation of different productions among lands, etc. – and strong public policies. In addition, the future CAP has to find an EU shared method to measure the reduction of pesticides. Finally, the toxic-free environment objective by 2050 will not be achieved through innovation only or using a circular bio-economy: it requires more radical changes in agricultural systems with direct implications on incentives' (conditional) distribution.

Several European countries seem to struggle to go over 20% of organic farming areas. Today organic food is hardly affordable for low-income families and the main way to increase its share is to decrease meat consumption. The following action levers are suggested to decrease costs of organic production: robotics to decrease labour force costs, for example in market gardening; research to increase organic farming yields and thus, keeping production costs low; and a better organization of the entire organic sector.

Reducing food losses and waste and setting appropriate public policies – for example, significant aids per hectare to decrease the use of synthetic pesticides (to be removed in the case of organic farming) – could help to decrease organic food prices. Finally, could the organic food supply and demand lower the price of organic food in the future? Would the farmers continue to shift to organic farming if the products no longer profit from higher prices?

Concerning the restoration of agroecosystems, the EU Biodiversity Strategy for 2030 should detail the definition and the scale of "high-diversity landscapes features". Heterogeneous features of rural landscapes, size of plots, crop diversifications are interesting levers for biodiversity if they are used on several geographical scales, such as plot, farm and rural landscape. However, going over 10% of agricultural area under high-diversity landscapes features (10% of semi-natural areas and elements) seems to be the target to reach significant and more visible effects.

Concerning diets, research results clearly show that reducing the carbon impact of diets by 30%, while increasing their nutritional quality, could be relatively easy to achieve by a combination of dietary changes, such as the substitution of meat (especially red meat) with other animal products, the increase of fruit and vegetables and other plant-based unrefined products, and the reduction of high fat-high sugar foods and alcoholic drinks. These changes required to increase diet sustainability are fully in line with food based dietary guidelines (FBDG) worldwide. However, going beyond a 30% carbon impact reduction would involve more changes in diets (red meat avoidance, predominance of whole cereals and legumes) than what the majority of the population might currently accept. Nutrition education – especially on dietary balance – could help to go beyond the 30% CO_2 reduction threshold, by helping each individual to take a step further, starting from where he/she is currently standing. An increasing number of countries are currently revising their national FBDGs in order to better incorporate the sustainability objectives. There should be a shared recommendations' baseline in the EU in terms of sustainable and healthy diets. Finally, food labelling can remain hazardous, because the best functional unit to consider in order to improve the sustainability of tomorrow's diets is the whole diet, not 100g, nor 100kcal nor 100g proteins of individuals' foods.

To conclude, a major point at stake is ruminant production, where numbers could be reduced and whose management could be reconsidered to optimize its role and impact, noting these changes can also have positive effects on health, climate and environment. In addition, the Green Deal should include quantitative objectives for changes in diets and food loss and waste. Moreover, food prices could be redesigned taking externalities into account, but raising food prices is a societal question (if the price of food has to be increased, social and redistributing policies should be implemented given that an increasing number of people are already experiencing food insecurity and dietary unbalance

due to cost constraints). Finally, today we produce considerably more than we need, and perhaps one of the highest stakes of this century is to rethink production and reject "*productivism*".

2. First meeting of the policy analysis expert panel (31/08/2020)

Agriculture GHG emissions in the EU have barely changed since 2005. They are mostly due to nitrous oxide and methane. The latter acts as a short-lived climate forcer, and there is a growing debate on how to weight its impact. Note that taking into account GHG emissions of a more integrated agriculture and land-use sector would be more relevant than agriculture emissions on their own. Land-use shifts are needed in order to reach climate neutrality by 2050. In addition, the EU should set specific objectives for both climate mitigation and climate adaptation. The CAP could propose price policies such as carbon pricing or a nitrogen tax. The EU must be vigilant if policies lead to a decrease in activity – which could be linked to de-intensification or a reduction in livestock production, for example – as this could lead to carbon leakage effects outside of Europe and worsen the current global climate. Note that policies involving a livestock reduction must be differentiated from one MS to another on historical (newer and older MS, for example) and on an environmental and climate basis (northern and southern countries, for example).

Reducing the use of fertilisers has a positive impact on GHG emissions' reduction. The EU should explicit the reference year for the objective of reducing the use of fertilizers by 20% by 2030 for each MS. The following action levers have been suggested to reduce nutrient losses and the use of fertilisers:

- Increasing nitrogen efficiency by a better management of the nitrogen cycle: in Germany it could lead to a 10-15% reduction in N_2O emissions but going beyond this would require a reduction in activity;
- Using innovative manure storage technologies, which might imply biogas production;
- Using denitrification inhibitors; and
- Developing agro-ecological alternatives to nutrients: research is lacking because fertilisers are cheap and quality criteria are still linked to fertilizer levels (protein content).

All of these levers have to be cost-efficient and adapted to local needs. If not, they will not be implemented.

Subsidies for organic farming have mainly led to an increase in organic land in the EU and, globally, the EU seems to be on track to increase its organic land share. However, the net effects of organic farming on the climate are still unclear. There is carbon capture, a reduction in chemical inputs and antimicrobials, but yields are lower. In several countries:

- Most of these new organic lands are livestock pastures and grasslands so their transition does not contribute to the reduction in chemical inputs. Thus, the EC should better specify its target for organic farming;
- The organic market and demand are very limited so organic products are often sold as conventional products, which incites farmers to go back to conventional methods and products; and
- If subsidies are not maintained then organic farming might decrease: because of the costs of labelling and controls, generally lower yields, even the steal effect, etc.

Efforts have been made in several European countries to decrease the use of pesticides. However, climate change does not help (pesticides will be an insurance tool for bad weather and new diseases), and innovations are needed. There are fewer opportunities to reduce pesticides on the same crop than

changing the crop mix or even the land use. Plus, the reduction in pesticides would be more efficient for the environment at the landscape level rather than at farm or plot levels.

Concerning biodiversity, the EC should specify precisely what the 10% of high-diversity landscapes features are. However, it is more and more documented that 10% is a minimum target area in order to reach more significant effects. There should be also more focus on biodiversity outside of these protected areas. Note that corridors could have a significant positive impact on biodiversity if put at landscape level; a smart subsidy scheme could support that.

There is an increasing debate around the environmental and health impacts of diets. The Green Deal should specify more precise targets on dietary changes. Up to 30% decrease in GHG emissions through dietary adjustments seems achievable though it would require major changes in current diets in the EU. Campaigns or high taxes – beyond 20% – could be used to influence dietary habits, for instance, to decrease meat consumption. The latter could also be influenced by animal welfare duty. However, in several newer MS, encouragement to decrease meat production might be difficult because considerable efforts have been already made. Note that beef meat and dairy productions are closely linked. Plus, aquaculture could be investigated as a potential source of more sustainable proteins.

Several trade-offs have been highlighted, such as:

- There is increasing pressure to afforest in order to capture and store carbon. Afforestation could be in competition with keeping high nature grasslands that are sinks for biodiversity; and
- De-intensification incited by the Green Deal might lead to an increasing demand for land outside of the EU, especially if changes in diets do not happen at the same speed that agricultural practices are changing. This indirect land-use change is very difficult to control, even with trade policies.

To conclude, governance of the policy implementation is very important. Many rules and policy instruments are not properly enforced and miss their stated targets. Policy assessment and policy design must address governance as well. How to implement EU policies at national levels should be part of the future CAP.

3. First meeting of the panel of stakeholders' representatives (09/09/2020)

To reach climate neutrality by 2050, it seems necessary that the F2FS sets specific targets in terms of the number of farm animals. Reducing the use of fertilizers by 20% by 2030 might induce a decrease in feed production and thus, an increase in the importations of feed from outside the EU if the European consumption of animal products does not decrease simultaneously. In terms of trade, note that there is still an important issue with the EU exportations of animal products. If the reduction of EU feed production reduces EU exports only, this might be an emission leakage as well. A tax on meat consumption has been discussed in Germany to improve animal welfare. A side effect might be the reduction in meat consumption with climate benefits. For the diets to remain healthy and nutritionally balanced, meat alternatives might need further research and innovation.

It might be relevant to set differentiated objectives for pesticide reduction in the different MS. It would be even more relevant to distinguish the different supply chains and the different pesticides to assess each situation with a SWOT analysis, from the farm to the food industry, and from 2020 to 2027. To find pesticide alternatives in each specific issue (alternatives to glyphosate, for example), the CAP could reinforce the EIP-AGRI to further support innovations and the exchange of experiences between farmers. Note that several representatives of European scaled organizations or companies would ideally like to see the same rules applied in all MS.

In order to stop the decline of biodiversity, the EC should specify and revise the definition of high-diversity landscapes features in the future CAP. It might be relevant to remove cropping elements – such as nitrogen fixing plants and catch crops – within the ecological focus areas. Plus, there is a need for relevant indicators in order to assess the performance of biodiversity elements. The participation of farmers and landowners in such policy decisions (definition of the features, how to implement them so that it is feasible and how to assess biodiversity) could help considerably. Incentives could come from different CAP instruments, such as eco-schemes, cross-compliance, agri-environmental and climate schemes, training measures, EIP-AGRI programmes, etc., provided there is more synergy between them and substantial funds available. In addition, delays in terms of payments (which have reached more than two years in the present CAP) are not acceptable in terms of business and accountancy.

All stakeholders have to work hand-in-hand to reach the Green Deal and F2FS objectives. For example, manufacturers have to work with farmers to manage and share the risks of switching to more agro-ecological practices. Such environmentally friendly practices imply higher costs for farmers. A major debate that is still ongoing is how to include externalities – positive and negative – in prices. The CAP must accompany the farmers, financially and with adapted training schemes. The relevant information about these changes in practices at the farm level needs to be relayed to consumers. Indeed, higher costs for farmers might induce higher food prices. There is a need to raise consumers' willingness to pay. This question might be included in the CAP, but it is more generally a societal question, and can have huge impact, especially on low-income consumers, who might switch to the cheapest products and end with non-healthy diets.

It might be possible to change the diets to more sustainable ones – for the health and the environment – with a relatively small increase in cost. It requires switches between food categories: less meat and fish but more nuts, legumes, fruit and vegetables. Such changes have to be supported and accompanied in order to be accepted and affordable. An appropriate tax scheme could be designed to induce dietary changes and its tax income could be used to help lower income families to afford these new diets. Note that the recommended diets could be similar in terms of nutrients intakes all over the EU, but the pathways (that is, the recommendations in terms of shifting from one range of food products to others) must be different across the MS.

Some manufacturers believe in a harmonised and simple nutritional label across the EU. Using a label requires communication towards consumers to raise their awareness. Moreover, labelling has to be feasible and affordable for all stakeholders. Indeed, manufacturers are aware that labelling adds constraints and costs at the farm level. This is also the reason why such a process requires a participatory approach with all of the parties – including farmers – that will use this labelling system.

In terms of food waste and losses, the EC should propose a harmonized tool in order to have reliable and comparable data across the EU. The EU, MS and regions should work hand-in-hand to achieve this because managing waste is a regional competence. Therefore, regional authorities have to be included in the talks. Efforts are necessary along the whole food chain. Farmers can have losses due to bad weather so alternatives to pesticides are crucial, especially if some of them are forbidden. Manufacturers can work on reusable or compostable packaging but this requires the harmonisation of the legal rules regarding packaging for food safety, to facilitate the use of recycled plastics, the collection of packaging waste, etc. There are many research projects on the circular bioeconomy and a major point at stake is that there is a real need at the EU level to ease the process in terms of legislation and to work on the acceptance waste products, such as the re-use of water. Moreover, research and innovations are needed to deal with the competition between bioenergy or biomaterials on the one hand, and food and feed productions on the other hand. Finally, the Green Deal offers the opportunity

to reframe the issue of food waste to a more circular economy perspective, so that the EU goes beyond food redistribution schemes.

In terms of trade-offs:

- This transition in the EU should be accompanied by a transition at the world level so that the EU agri-food sector remains a competitive player on a global level;
- Forbidding the use of some pesticides should not induce a food safety issue; and
- Healthier and more sustainable diets have to be affordable and accepted.

4. Second meeting of the policy analysis expert panel (07/10/2020)

The study team introduces the session with the comparison between the Green Deal ambition and the observed trends of key indicators describing the EU farm and food sector. The team also presents its proposals to adapt the future CAP, especially the CAP green architecture, in order to address these Green Deal challenges. Three rounds of debates successively discuss: first, the requirements for the National Strategic Plans (NSP); second, the indicators and procedures to monitor, coordinate and enforce the NSP in the new delivery model; and third, the need for additional policy tools to address nutritional stakes, waste and circular bioeconomy goals and trade effects.

It is important to articulate the CAP architecture with the sustainable development goals (SDG) through the Green Deal actions. To do so, the NSP must clearly distinguish the measures and expenses targeting global public goods and global issues from the measures targeting local public goods and local development supports. The stakes at the EU level are clear with few favourable trends in organic farming development and a decline in antimicrobial use, and big challenges regarding the recent trends in GHG emissions and sequestration, pesticide use and the increase in overweight and obesity rates. However, several MS diverge from the EU average. A clear view of the different MS regarding each Green Deal target is necessary, firstly, to calibrate their NSP and secondly, to calibrate the effort sharing between MS. In NSP, the proposal clearly combines the mandatory requirements of the new conditionality and the eco-scheme measures, which are optional for farmers. However, the articulation between eco-scheme and the rural development measures, especially the agri-environment and climate measures (AECM), must be better elaborated and explained. Referring to fiscal federalism, the eco-scheme payments must target global public goods (that is, climate mitigation and biodiversity recovery), and rural development measures must target the local public goods (such as water quality and the adaptation to climate changes). The provision of local public goods and the provision of global ones are not independent of each other. In many cases, water quality correlates with biodiversity protection; therefore, AECM may reinforce or complement the eco-schemes where necessary. In other cases, the high local stakes may conflict with global ones and AECM can be justified to address them in geographically designated areas. The NSP design should articulate those local conflicting objectives as smoothly as possible.

The NSP design already started in MS. Given the available information, the NSP are elaborated on a very heterogeneous basis across MS, regarding two main aspects. The first aspect concerns the weak enforcement of conditionality in the Netherlands and in Bulgaria, for instance. In the Netherlands, the enforcement of the private standards of the value chains largely dominates the CAP inspection and penalty system. In Bulgaria, the conditionality requirements are very weakly implemented to fight unbalanced fertilization. In Romania, the same problem occurs for pesticide use. Clearly, a level playing field does not exist in the EU and the NSP may increase competition distortions due to environmental dumping. Different MS are elaborating their NSP with very different priorities and strategies. For example, Germany targets biodiversity with few well-designed measures and Ireland raised its climate

mitigation goals shifting from a 3% to a 7% yearly reduction in net emissions. However, the NSP includes no agricultural production reduction; voluntary measures, especially AECM, will enhance better technology adoption.

In its 2018 legislative proposals for the future CAP (annex XII), the EC produced a long list of context, output, result and impact indicators to monitor, coordinate and enforce the NSP in the so-called New Delivery Model (NDM). Note that only output and result indicators are binding in the EC proposal. This list and its indicators face many criticisms. Experts believe that the indicators do not meet several key policy objectives of the Green Deal. For example, there are no indicators for production losses and food waste. The indicator quality looks quite poor and even inadequate for climate mitigation. For biodiversity, only research projects are able to report sound indicators. Therefore, the CAP must set up independent assessment schemes rather than rely on national administrative reports. Some MS government and lobbies have very different points of view. Stating that many Green Deal objectives are not legally binding, many CAP indicators are useless and should be deleted because the EC will not have any legal tool to set and enforce National targets. Gathered experts agree on the high necessity of common indicators across the EU. In addition, they prefer a reduced list of efficient and better-focused indicators. However, the indicator list must integrate key directives such as the National Emission Ceilings Directive. This is important for the effort sharing between MS in the CAP implementation and avoid deleterious effects regarding land use and land-use changes. Action is needed at the EU level to improve the trust in the CAP indicator list.

The CAP mainly focuses on the farm sector. International trade may well offset the CAP achievements for climate and the environment if no consistent action targets food and energy consumption within the EU. The average EU diet must evolve towards sustainability at the same pace as the agricultural sector. To avoid pollution leaks, the global climate and land-use effect of international trade must be scrutinized commodity-by-commodity, and international trade agreements adjusted accordingly. Within the CAP, the public support for EU farm product promotion must take into account the climatic and environmental impact of those products. This is far from being the case presently. Accordingly, the support to producers' organizations could be modulated according to the joint public goods. Shifting the human diet remains challenging. Climate and environmental labelling of food products might help but will not be sufficient in the Green Deal schedule. Research produces more and more evidence to calibrate food tax schemes for climate-friendly diets. Reconciling the average climate-friendly diet with individual heathier diets remains a challenge that requires voluntarist policy and collective efforts in out-of-home catering, education and social cohesion.

5. Second meeting of the panel of stakeholders' representatives (08/10/2020)

Several stakeholders agree on the fact that there should be incentives within the CAP for farmers and other stakeholders for horizontal cooperation between farmers and vertical cooperation along the food chain. This could lead to better results, such as increasing biodiversity, increasing crop diversification (by analysing market opportunities), etc.

A representative of an association explains that there should be at least 10% of non-productive area in the conditionality (excluding nitrogen-fixing crops or catch crops from the ecological focus areas). Plus, 50% of the first pillar and 50% of the second pillar should be dedicated to environment, climate and nature measures.

In general, the feasibility of each proposed measure for the CAP should be easy to implement and easy to monitor by the administration in order to be effective, efficient and bring added value to taxpayers.

If not, this could lead to a delay in payments to farmers and a misuse or waste of public money. For example, a GAEC to calculate GHG emissions at farm level could be interesting to identify possible changes in fertilisation, manure management and herd practices, but it might not be easy to implement. Using the UNFCCC GHG inventory rules could be a first step to take into account both regional heterogeneity and climate-friendly techniques.

Several stakeholders ask for a level playing field as much as possible. This is needed for the future eco-schemes: the EC could set a guideline to help the MS understand what practices could be funded by the eco-scheme in order to harmonize them across the EU. More generally, setting a level playing field within the CAP requires dialogue among all MS and not only bilateral negotiations between each MS and DG AGRI.

There is also a need for a legislation in which the EC would clarify the F2FS targets by detailing some requirements, target values and quantification methods for some indicators, etc. Plus, the set of indicators proposed by the EC should be simplified to be more understandable and improved because they are poorly aligned with Green Deal action objectives. Moreover, new indicators could be introduced in order to take into account viability or competitiveness objectives.

In addition to changes on the supply side, dietary changes are needed to reach the ambitious climate goals of the Green Deal. In the EU, there is a need for a reduction in global energy intakes, meat intakes, added sugars, etc., and an increase in various plant-based products, such as legumes, grains, fruits, etc. Changes in diets is occurring among the higher social classes of the population but for economic reasons, these dietary changes do not occur in the whole population.

Dietary changes will not be driven by spontaneous changes in consumers' preferences. Education is important but has no sufficient impact to change current diets. Moreover, in the short term, given the current food production and agricultural practices, there is a risk that healthier and more sustainable products will be more expensive and affordable for a niche market only. That is why there must be a long-term and systemic transition with a scaling up of agricultural practices to produce such products and economic incentives so that this food is affordable by the whole population.

The private sector and the public sector should work together to achieve this transition.

The private sector could improve the products, improve the ingredients within the products, influence the supply, promotion and broader distribution of healthier and more sustainable products at retailers' level, etc. Efficient promotion requires dialogue and partnerships between producers, processors and retailers. Moreover, a private stakeholder calls for a European common scheme for nutritional and environmental labelling, which would help to create trust with consumers. Plus, there could be restrictions in terms of advertising, placements, digital marketing, etc., especially to children for products that have the lowest nutritional quality. Finally, the private sector can also incite changes in practices through long-term contracts or contracts that value the efforts of farmers that are achieved. Note that premium prices could be an economic incentive for farmers who produce such products but one has to be careful not to go against the competition.

Actions of the public sector are also needed to give a general context that favours healthier and more sustainable food products, that limits those that are not and valorises efforts made by the private sector. The public sector can build a level playing field across the EU and among sectors and create a food environment that makes healthier and more sustainable food choices easier and more accessible than they currently are.

Policies beyond the CAP could be useful. It could involve establishing new policies (such as a Common Food Policy as proposed in the IPES-Food report), or by using existing policies (such as the EU obesity

policies, trade agreements, the EU school food schemes, carbon policies, etc.). There should also be European food based dietary guidelines that include local and cultural angles.

Moreover, there could be an added or increased tax for products that have the lowest nutritional quality and an exemption or reduced level of tax for fruit and vegetables or no-added sugar products, etc. Some representatives of the food industry consider that positive incentives, rewarding virtuous commitments, are better than penalizing actions and negative interventions through taxes. In case of a tax policy implementation, such a tax should be accompanied by a redistribution scheme at the national level to use the collective revenue in order to make the total policy less regressive. Redistribution could be within the food chain: increasing the price of some products but decreasing the price of other products. It could also be within the food chain as the German government have established: a levy on meat, which could be used to invest back into the sector to change animal housing, animal welfare and environmental aspects.

There should also be a global coordination. Indeed, if efforts are only made at the EU level, the EU risks to facing competition from outside its borders that may cancel out the effectiveness of its efforts.

ANNEX A3.1. AGRICULTURAL SUBSIDIES IN EU AGRICULTURE

Table A3.1.1: Direct aids granted to EU farms in function of their economic size class (2018)

Economic size classes	Number of farms	Direct aids (total)			
		Per farm (€)	Per AWU (€)	Per hectare of UAA (€)	% of agricultural production
(1) 2 000 - < 8 000 EUR	867 800	1 900	1 900	324	27%
(2) 8 000 - < 25 000 EUR	1 373 900	5 400	4 700	375	29%
(3) 25 000 - < 50 000 EUR	574 900	11 300	8 100	400	27%
(4) 50 000 - < 100 000 EUR	496 300	18 700	11 400	340	24%
(5) 100 000 - < 500 000 EUR	610 900	33 500	14 200	328	15%
(6) >= 500 000 EUR	112 000	95 200	11 900	350	9%
Total	**4 035 700**	**13 900**	**8 700**	**347**	**16%**

Source: FADN 2018 – Authors' calculations.
Note: AWU for Agricultural Work Unit; UAA for Utilized Agricultural Area.

Table A3.1.2: Direct aids granted to EU farms in function of their specialisation (2018)

Types of farming		Number of farms	Direct aids (total)			
			Per farm (€)	Per AWU (€)	Per ha of UAA (€)	% of agricultural production
15	Specialist COP	653 800	18 900	14 600	265	27%
16	Specialist other field crops	426 500	14 500	9 600	373	18%
20	Specialist horticulture	140 000	2 800	800	420	1%
35	Specialist wine	224 300	4 500	2 600	287	4%
36	Specialist orchards - fruits	259 600	5 500	3 200	483	10%
37	Specialist olives	173 200	7 800	7 700	566	28%
38	Permanent crops combined	97 800	5 100	4 500	449	17%
45	Specialist milk	438 600	20 600	10 900	439	13%
48	Specialist sheep and goats	328 000	14 400	10 200	297	33%
49	Specialist cattle	356 800	22 800	17 000	401	36%
50	Specialist granivores	111 200	16 900	7 000	399	4%
60	Mixed crops	180 400	7 100	4 500	335	15%
70	Mixed livestock	100 400	10 700	6 800	357	13%
80	Mixed crops and livestock	545 100	12 100	8 100	353	21%
--	**Total**	**4 035 700**	**13 900**	**8 700**	**347**	**16%**

Source: FADN 2018 – Authors' calculations.

Table A3.1.3: Direct aids (total) granted to EU farms in the different MS (2018)

	Number of farms	Direct aids (total)			
		Per farm (€)	Per AWU (€)	per ha of UAA (€)	% agricultural output
Austria	70 790	20 400	13 600	616	21%
Belgium	28 230	22 800	10 800	439	8%
Bulgaria	61 440	18 800	6 500	276	26%
Croatia	72 440	7 100	4 200	417	25%
Cyprus	10 510	4 800	3 400	449	12%
Czechia	18 160	98 200	19 000	511	31%
Denmark	26 090	40 000	20 500	359	9%
Estonia	7 630	30 000	16 600	214	24%
Finland	34 120	54 500	44 300	810	46%
France	296 730	27 900	14 100	316	14%
Germany	179 750	38 000	17 100	417	14%
Greece	336 790	6 600	6 500	691	31%
Hungary	110 820	16 600	11 100	370	22%
Ireland	93 170	18 200	16 300	374	24%
Italy	559 540	9 800	7 300	455	13%
Latvia	25 020	16 900	8 300	255	26%
Lithuania	62 530	11 100	7 000	225	30%
Luxembourg	1 410	53 300	30 100	623	23%
Malta	3 100	2 200	1 700	844	6%
The Netherlands	46 710	17 300	5 800	440	3%
Poland	746 110	6 400	4 100	326	22%
Portugal	106 580	7 800	4 800	345	20%
Romania	525 600	4 100	3 300	234	19%
Slovakia	4 150	142 800	13 500	321	24%
Slovenia	44 390	6 500	5 400	620	23%
Spain	434 500	11 600	7 200	249	14%
Sweden	28 620	39 700	26 100	372	22%
United Kingdom	100 770	39 600	18 300	250	15%
UE	**4 035 680**	**13 900**	**8 800**	**347**	**16%**

Source: FADN 2018 – Authors' calculations.
Note: AWU for Agricultural Work Unit; UAA for Utilized Agricultural Area.

ANNEX A3.2. FERTILIZER AND PESTICIDE COST FOR EU FARMS

Table A3.2.1: Cost of fertilizers in 2007-2018 and 2018 according to farm specialisation (million euros)

		Average 2007-2018			2018		
		Per farm	Per hectare of UAA	% of agri. Production	Per farm	Per hectare of UAA	% of agri. Production
15	Specialist COP	9 390	137	14.4%	9 290	130	13.2%
16	Specialist other field crops	6 150	169	9.0%	6 400	165	8.0%
20	Specialist horticulture	5 730	880	3.4%	6 630	999	2.9%
35	Specialist wine	1 910	132	2.4%	2 280	145	2.1%
36	Specialist orchards - fruits	2 020	191	4.6%	2 630	231	4.8%
37	Specialist olives	1 500	125	6.7%	2 100	152	7.6%
38	Permanent crops combined	1 370	119	4.9%	1 550	135	5.3%
45	Specialist milk	3 640	100	3.5%	4 590	98	2.9%
48	Specialist sheep and goats	1 100	27	3.1%	1 240	26	2.8%
49	Specialist cattle	2 680	53	4.9%	2 750	48	4.3%
50	Specialist granivores	3 860	112	1.3%	4 570	108	1.1%
60	Mixed crops	2 680	133	6.8%	2 960	140	6.2%
70	Mixed livestock	1 270	79	3.5%	2 190	73	2.6%
80	Mixed crops and livestock	3 250	110	7.2%	3 610	106	6.3%
--	**Total**	**3 820**	**114**	**5.6%**	**4 480**	**112**	**5.1%**

Source: FADN 2018 – Authors' calculations.

Table A3.2.2: Cost of crop protection products in 2007-2018 and 2018 according to farm specialisation (million euros)

		Average 2007-2018			2018		
		Per farm	Per hectare of UAA	% of agri. production	Per farm	Per hectare of UAA	% of agri. production
15	Specialist COP	5 870	86	9.0%	6 500	91	9.2%
16	Specialist other field crops	4 820	133	7.1%	5 430	140	6.8%
20	Specialist horticulture	4 200	643	2.4%	5 370	809	2.4%
35	Specialist wine	3 680	255	4.6%	4 490	286	4.1%
36	Specialist orchards - fruits	2 950	280	6.7%	3 610	318	6.5%
37	Specialist olives	1 030	87	4.7%	1 170	84	4.2%
38	Permanent crops combined	1 310	114	4.7%	1 430	124	4.8%
45	Specialist milk	1 180	32	1.1%	1 500	32	1.0%
48	Specialist sheep and goats	220	5	0.6%	260	5	0.6%
49	Specialist cattle	710	14	1.3%	750	13	1.2%
50	Specialist granivores	3 170	92	1.1%	4 080	97	1.0%
60	Mixed crops	2 110	105	5.4%	2 430	115	5.1%
70	Mixed livestock	730	45	2.0%	1 440	48	1.7%
80	Mixed crops and livestock	2 060	70	4.5%	2 450	72	4.3%
--	**Total**	**2 540**	**76**	**3.7%**	**3 220**	**81**	**3.6%**

Source: FADN 2018 – Authors' calculations.

Table A3.2.3: Cost of fertilizers in 2007-2018 and 2018 in EU MS (euros and percent)

	2007-2018			2018		
	Per farm	Per hectare of UAA	% agricultural output	Per farm	Per hectare of UAA	% agricultural output
(BEL) Belgium	8 380	171	3.5%	8 360	161	2.9%
(BGR) Bulgaria	3 620	85	8.4%	6 370	94	8.7%
(CYP) Cyprus	1 610	171	4.4%	1 560	146	3.8%
(CZE) Czechia	19 380	94	6.7%	18 960	99	6.0%
(DAN) Denmark	11 780	118	2.9%	13 190	118	3.1%
(DEU) Germany	12 180	141	5.2%	10 360	113	3.9%
(ELL) Greece	1 430	157	6.3%	1 410	147	6.7%
(ESP) Spain	3 460	84	5.9%	4 270	92	5.2%
(EST) Estonia	9 310	71	9.2%	10 470	75	8.5%
(FRA) France	12 500	144	6.7%	11 280	128	5.5%
(HRV) Croatia	2 140	128	8.5%	2 270	133	8.0%
(HUN) Hungary	4 660	95	6.8%	4 400	98	5.7%
(IRE) Ireland	5 490	116	9.4%	6 360	130	8.3%
(ITA) Italy	2 460	135	4.0%	3 040	141	4.0%
(LTU) Lithuania	4 320	91	12.0%	4 800	97	12.9%
(LUX) Luxembourg	9 280	114	5.0%	8 580	100	3.8%
(LVA) Latvia	4 770	70	9.0%	5 100	77	8.0%
(MLT) Malta	780	277	2.0%	810	308	2.1%
(NED) The Netherlands	7 170	193	1.5%	7 090	180	1.3%
(OST) Austria	2 050	66	2.7%	2 320	70	2.3%
(POL) Poland	2 610	138	9.2%	2 880	147	9.9%
(POR) Portugal	1 480	60	4.8%	1 600	71	4.1%
(ROU) Romania	720	71	5.6%	1 420	80	6.6%
(SUO) Finland	6 670	115	7.0%	7 010	104	5.9%
(SVE) Sweden	10 210	101	5.7%	9 920	93	5.4%
(SVK) Slovakia	38 750	77	7.4%	39 330	88	6.5%
(SVN) Slovenia	930	88	3.7%	810	77	2.8%
(UKI) United Kingdom	15 310	97	6.5%	14 350	91	5.4%
UE	**3 820**	**114**	**5.6%**	**4 480**	**112**	**5.1%**

Source: FADN – Authors' calculations.

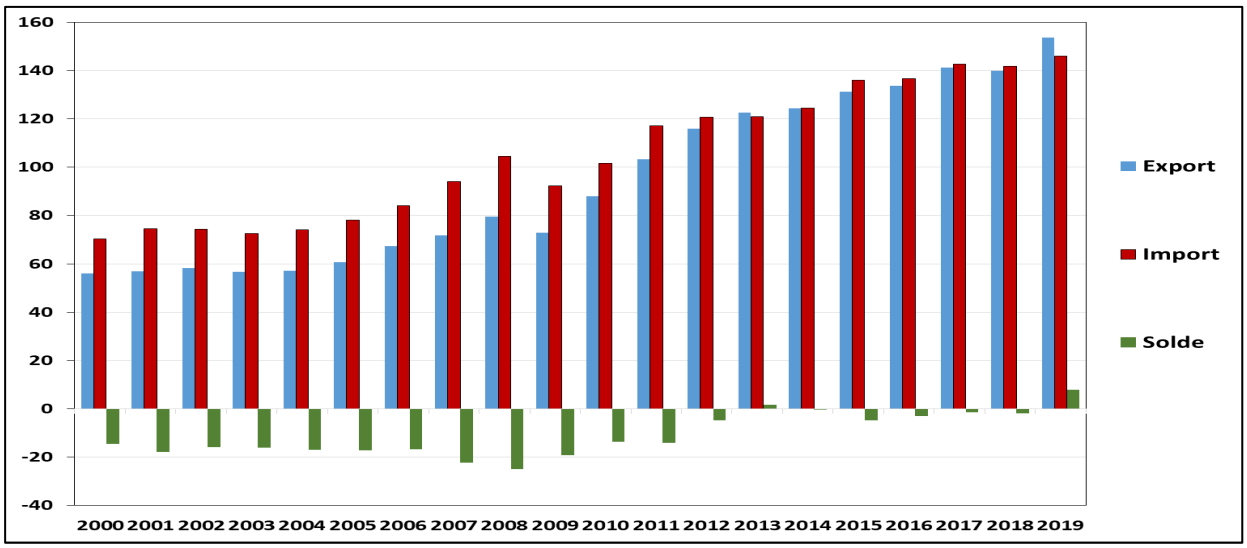
Table A3.2.4: Cost of crop protection products in 2007-2018 and 2018 in EU MS (euros and percent)

	2007-2018			2018		
	Per farm	Per hectare of UAA	% agricultural output	Per farm	Per hectare of UAA	% agricultural output
(BEL) Belgium	7 440	152	3.1%	8 420	162	2.9%
(BGR) Bulgaria	2 170	50	5.0%	4 190	62	5.7%
(CYP) Cyprus	970	104	2.7%	940	88	2.3%
(CZE) Czech Republic	17 410	84	6.0%	17 890	93	5.7%
(DAN) Denmark	8 690	87	2.1%	9 790	88	2.3%
(DEU) Germany	9 060	105	3.9%	8 900	97	3.4%
(ELL) Greece	930	101	4.1%	1 000	104	4.7%
(ESP) Spain	2 230	54	3.7%	3 170	68	3.8%
(EST) Estonia	3 190	24	3.1%	4 190	30	3.4%
(FRA) France	9 800	113	5.3%	10 220	116	5.0%
(HRV) Croatia	1 130	68	4.5%	1 390	82	4.9%
(HUN) Hungary	3 560	72	5.2%	3 520	79	4.6%
(IRE) Ireland	860	18	1.5%	950	20	1.2%
(ITA) Italy	1 910	105	3.1%	2 260	105	3.0%
(LTU) Lithuania	1 710	36	4.8%	2 030	41	5.5%
(LUX) Luxembourg	5 030	62	2.7%	5 040	59	2.2%
(LVA) Latvia	2 150	31	4.0%	2 640	40	4.1%
(MLT) Malta	670	239	1.7%	580	221	1.5%
(NED) Netherlands	8 510	229	1.8%	10 220	260	1.8%
(OST) Austria	1 410	45	1.8%	1 810	54	1.8%
(POL) Poland	1 120	59	4.0%	1 180	60	4.0%
(POR) Portugal	1 100	45	3.6%	1 320	59	3.4%
(ROU) Romania	420	41	3.2%	880	50	4.1%
(SUO) Finland	1 790	31	1.9%	1 980	29	1.7%
(SVE) Sweden	3 970	39	2.2%	4 020	38	2.2%
(SVK) Slovakia	34 050	68	6.5%	35 800	80	5.9%
(SVN) Slovenia	530	50	2.1%	560	53	1.9%
(UKI) United Kingdom	9 400	59	4.0%	10 220	64	3.8%
UE	**2 540**	**76**	**3.7%**	**3 220**	**81**	**3.6%**

Source: FADN 2018 – Authors' calculations.

ANNEX A3.3. EU TRADE IN AGRI-FOOD PRODUCTS

Figure A3.3.1: EU-28 exports, imports and trade balance in agri-food products (2000-2019, current billion euros)



Source: COMEXT – Authors' calculations.

Table A3.3.2: EU-28 exports, imports and balance in agri-food products in 2019 (billion euros)

	Exports	Imports	Trade balance
- Dairy products	24.11	1.96	22.15
- Cattle sector	2.12	1.79	0.33
- Sheep and goat sector	0.51	0.85	-0.35
- Pork sector	10.22	0.08	10.15
- Poultry sector	2.75	2.10	0.65
- Other animal productions	3.14	2.33	0.81
Animal productions	42.85	9.11	33.74
- Fruits	3.63	21.25	-17.61
- Vegetables	3.22	5.35	-2.12
- Fruit & Vegetable Preparations	6.30	5.57	0.73
- Cereals and mill products	10.60	7.19	3.41
- Cereal-based preparations	6.77	1.71	5.06
- Oilseeds	3.63	10.94	-7.30
- Sugars	2.28	1.86	0.42
- Horticulture	2.53	1.84	0.69
- Coffee, tea, cocoa	7.83	16.94	-9.11
- Other plant productions	25.05	30.56	-5.51
Vegetal productions	71.86	103.21	-31.35
Drinks (water, wine, spirit…)	33.04	6.57	26.47
Fish	5.92	27.02	-21.10
Total	**153.67**	**145.90**	**7.77**

Source: COMEXT – Authors' calculations.

Table A3.3.3: EU-28 trade in cereals and animal products in 2019 (million tonnes)

	Production	Consumption	Exports	Imports	Exports in % production	Imports in % consumption
Cereals	*312.1*	*288.0*	*39.8*	*23.4*	*13%*	*8%*
Wheat	154.0	126.6	26.6	5.7	17%	5%
Maize	66.7	82.8	2.9	16.0	4%	19%
Oilseed	29.7	49.7	0.8	20.9	3%	42%
Oilseed meal	30.5	52.0	1.2	22.6	4%	43%
Sugar	17.5	18.6	1.3	1.9	7%	10%
Milk	*165.3*	*147.1*	*19.1*	*0.9*	*12%*	*1%*
Meat	*48.7*	*44.8*	*5.1*	*1.3*	*10%*	*3%*
Pig meat	24.1	21.0	3.2	0.0	13%	0%
Beef meat	7.9	8.0	0.3	0.3	4%	4%
Poultry meat	15.6	14.8	1.6	0.8	10%	5%
Sheep and goat	0.9	1.0	0.0	0.1	4%	20%

Source: EC - DG-AGRI - EU agricultural outlook.

Table A3.3.4: EU trading partners in agri-food products in 2019 by continent (billion euros)

	Exports	Imports	Trade balance
Asia	61.67	37.12	24.54
Europe (others)	29.93	27.40	2.53
North America	29.16	16.20	12.97
Africa	18.19	22.05	-3.86
Oceania	4.68	4.96	-0,.8
South America	4.50	30.52	-26.02
Central America and the Caribbean	3.91	7.34	-3.43
Total	**153.67**	**145.90**	**7.77**

Source: COMEXT – Authors' calculations.

Table A3.3.5: EU trading partners in agri-food products in 2019 by country (billion Euros)

	Exports	Imports	Trade balance
Top 10 countries with an EU positive trade balance			
China	18.76	7.34	11.42
Japan	7.78	0.44	7.34
Russia	6.96	2.28	4.68
Switzerland	8.59	4.70	3.89
Saudi Arabia	3.62	0.08	3.54
South Korea	3.25	0.30	2.96
United Arab Emirates	2.66	0.09	2.57
Algeria	2.40	0.07	2.33
Singapore	2.42	0.47	1.94
Top 10 countries with an EU negative trade balance			
Thailand	1.26	2.64	-1.37
Vietnam	1.25	2.71	-1.46
Ecuador	0.25	1.87	-1.62
India	0.77	3.42	-2.64
Ivory Coast	0.63	3.30	-2.67
Norway	4.81	7.61	-2.80
Indonesia	0.93	4.29	-3.36
Ukraine	2.46	7.14	-4.68
Argentina	0.22	5.19	-4.97
Brazil	1.71	10.26	-8.56

Source: COMEXT.

Table A3.3.6:. EU MS exports, imports and trade balance in agri-food products in 2019 (billion euros)

	Trade with EU countries			Trade with non-EU countries			Total		
	Exports	Imports	Balance	Exports	Imports	Balance	Exports	Imports	Balance
The Netherlands	69.36	33.50	35.86	22.42	30.15	-7.72	91.78	63.64	28.14
Spain	36.99	21.18	15.81	14.47	16.45	-1.98	51.46	37.63	13.83
Poland	23.75	15.93	7.83	6.08	4.26	1.82	29.83	20.19	9.64
France	39.16	44.71	-5.55	24.63	12.43	12.19	63.79	57.14	6.64
Denmark	11.46	8.77	2.69	7.14	4.60	2.54	18.60	13.37	5.23
Belgium	31.61	24.92	6.69	6.90	8.48	-1.58	38.52	33.40	5.12
Ireland	9.78	8.27	1.50	4.37	1.40	2.96	14.14	9.68	4.47
Hungary	6.99	4.86	2.13	1.31	0.52	0.78	8.29	5.38	2.91
Lithuania	3.57	3.33	0.24	1.87	0.72	1.15	5.45	4.06	1.39
Bulgaria	2.95	2.53	0.42	1.58	0.90	0.68	4.52	3.43	1.09
Latvia	1.38	2.26	-0.87	1.46	0.34	1.11	2.84	2.60	0.24
Estonia	0.96	1.41	-0.44	0.37	0.13	0.24	1.33	1.54	-0.20
Malta	0.02	0.56	-0.54	0.23	0.10	0.13	0.25	0.66	-0.42
Austria	8.88	10.72	-1.84	3.13	1.83	1.30	12.01	12.55	-0.54
Greece	4.45	5.54	-1.09	2.14	1.72	0.42	6.59	7.26	-0.68
Italy	26.26	30.27	-4.00	16.39	13.10	3.29	42.65	43.37	-0.71
Cyprus	0.29	0.91	-0.61	0.14	0.25	-0.11	0.43	1.15	-0.73
Slovenia	1.53	2.04	-0.51	0.54	0.86	-0.32	2.06	2.90	-0.84
Romania	4.25	6.69	-2.43	2.64	1.25	1.38	6.89	7.94	-1.05
Croatia	1.33	2.79	-1.46	0.85	0.45	0.40	2.17	3.23	-1.06
Luxembourg	1.05	2.13	-1.09	0.06	0.11	-0.04	1.11	2.24	-1.13
Slovakia	2.57	4.42	-1.85	0.12	0.13	-0.01	2.69	4.55	-1.86
Czech R.	7.05	9.06	-2.00	0.70	0.75	-0.05	7.75	9.80	-2.05
Finland	1.14	4.26	-3.13	0.74	0.91	-0.17	1.88	5.17	-3.29
Portugal	5.34	9.05	-3.71	2.02	2.40	-0.38	7.36	11.45	-4.09
Sweden	6.52	9.06	-2.55	2.26	5.99	-3.73	8.78	15.06	-6.28
Germany	52.95	64.58	-11.63	17.63	18.39	-0.76	70.57	82.97	-12.40
United Kingdom	16.82	39.60	-22.77	11.48	17.26	-5.78	28.30	56.86	-28.55

Source: COMEXT.

ANNEX A4.1. ORGANIC AND NON-ORGANIC FARMS IN THE EU

This annex compares the structural and economic characteristics of conventional *versus* organic farms based on the EU FADN for the year 2018.[69] In ***Table A4.1.1***, holdings were grouped in three classes: (1) the holding does not use organic production methods (class 1 of "*conventional*" farms); (2) the holding uses organic production methods for all its products (class 2); and (3) other holdings including farms with both organic and other production methods, as well as farms in conversion to organic production methods (class 3). In other tables, we considered conventional farm, organic farm and all farms together.

Table A4.1.1: Number of European farms according to types of farming and conventional/organic production methods in 2018

Types of farming		Conventional farms	Organic farms (only)	Other farms	All farms
15	Specialist COP	622 000	19 100	12 700	653 800
16	Specialist other field crops	391 200	20 800	14 400	426 500
20	Specialist horticulture	128 100	5 100	6 800	140 000
35	Specialist wine	195 300	19 400	9 500	224 300
36	Specialist orchards - fruits	221 900	20 800	16 800	259 600
37	Specialist olives	112 500	29 300	31 400	173 200
38	Permanent crops combined	79 300	10 500	8 100	97 800
45	Specialist milk	400 100	32 500	6 000	438 600
48	Specialist sheep and goats	289 600	20 000	18 400	328 000
49	Specialist cattle	308 300	35 600	13 000	356 800
50	Specialist granivores	105 700	3 500	2 000	111 200
60	Mixed crops	158 800	13 200	8 500	180 400
70	Mixed livestock	95 200	3 200	1 500	100 400
80	Mixed crops and livestock	506 200	25 700	13 100	545 100
--	**Total**	**3 614 300**	**258 600**	**162 900**	**4 035 700**

Source: DGAGI - FADN 2018 – Authors' calculations.

[69] We gratefully thank the European Commission (DG AGRI) for kindly and quickly providing us access to the EU FADN.

Table A4.1.2: Average characteristics of organic and non-organic farms in 2018 in the EU-28 (all specialisations)

	Conventional farms	Organic farms (only)	All farms
Number of farms	3 614 260	258 560	4 035 680
Agricultural work unit (AWU)	1,58	1,59	1,58
- Family AWU	1,15	1,13	1,15
- Non Family AWU	0,43	0,46	0,44
Usable agricultural area (UAA in hectares)	40	41	40
- Cereals	15	7	14
- Forage crops	16	27	16
Yield of wheat (q/ha)	59	34	58
Livestock Units total (LU - total)	33	24	32
Grazing Livestock Units per forage UAA	1,30	0,79	1,23
Direct aids (€)	13 100	21 800	13 900
- Decoupled payments	8 910	9 790	8 970
- Subsidies on crops	380	320	390
- Subsidies on livestock	890	910	900
- Rural development measures	1 990	9 940	2 700
* Environmental subsidies	880	7 340	1 480
* Less Favourite Areas(LFA) subsidies	540	490	530
* Other rural development payments	150	380	170
- Other subsidies	930	840	940
Direct aids by AWU (€)	8 300	13 700	8 700
Direct aids by UAA (€)	330	528	347
Direct aids in % of agricultural prod. (with aids)	13%	21%	14%
Agricultural production, with aid (€)	102 800	103 500	102 500
- by AWU	65 100	65 100	64 700
- per hectare of UAA	2 596	2 503	2 568
Intermediate consumptions (€)	55 600	46 800	54 400
- per hectare of UAA	1 404	1 133	1 362
- In % of agricultural production (with aids)	54%	45%	53%
Fertilizers (€)	4 740	1 520	4 480
- per hectare of UAA	120	37	112
- In % of agricultural production (with aids)	4,6%	1,5%	4,4%
Plant protection products (€)	3 440	780	3 220
- per hectare of UAA	87	19	81
- In % of agricultural production (with aids)	3,3%	0,8%	3,1%
Specific Livestock costs / LU	611	613	608
Energy (€)	5 950	5 460	5 880
- per hectare of UAA	150	132	147
- In % of agricultural production (with aids)	5,8%	5,3%	5,7%
Gross Operating Surplus (EBE in French) (€)	34 500	42 700	35 200
- per family AWU	29 900	37 700	30 600
- per hectare of UAA	871	1 033	882
- In % of agricultural production (with aids)	34%	41%	34%
Agricultural income (€)	22 600	28 300	23 300
- per family AWU	19 600	25 000	20 300
- per hectare of UAA	572	685	584
- In % of agricultural production (with aids)	22%	27%	23%
Total liabilities (€)	416 500	489 700	418 800
General debt ratio (%)	16%	16%	16%

Source: DGAGRI - FADN 2018 – Authors' calculations.

Table A4.1.3: Average characteristics of organic and non-organic farms in 2018 in the EU-28 for farms of type 15 (cereals and oilseeds)

	Conventional farms	Organic farms (only)	All farms
Number of farms	621 970	19 110	653 790
Agricultural work unit (AWU)	1,29	1,23	1,29
- Family AWU	0,96	1,00	0,97
- Non Family AWU	0,32	0,23	0,33
Usable agricultural area (UAA in hectares)	71	55	71
- Cereals	45	32	44
- Forage crops	5	8	5
Yield of wheat (q/ha)	57	32	56
Livestock Units total (LU - total)	2	2	2
Grazing Livestock Units per forage UAA	0,78	0,62	0,76
Direct aids (€)	18 500	26 000	18 900
- Decoupled payments	15 100	13 440	15 130
- Subsidies on crops	540	780	560
- Subsidies on livestock	110	80	110
- Rural development measures	1 630	10 910	1 990
* Environmental subsidies	880	9 430	1 220
* Less Favourite Areas(LFA) subsidies	530	500	520
* Other rural development payments	100	210	100
- Other subsidies	1 120	790	1 110
Direct aids by AWU (€)	14 300	21 100	14 600
Direct aids by UAA (€)	260	473	265
Direct aids in % of agricultural prod. (with aids)	21%	33%	21%
Agricultural production, with aid (€)	89 400	78 200	89 300
- by AWU	69 400	63 400	69 100
- per hectare of UAA	1 258	1 426	1 254
Intermediate consumptions (€)	46 000	31 000	45 600
- per hectare of UAA	647	565	640
- In % of agricultural production (with aids)	51%	40%	51%
Fertilizers (€)	9 540	1 890	9 290
- per hectare of UAA	134	34	130
- In % of agricultural production (with aids)	10,7%	2,4%	10,4%
Plant protection products (€)	6 730	330	6 500
- per hectare of UAA	95	6	91
- In % of agricultural production (with aids)	7,5%	0,4%	7,3%
Specific Livestock costs / LU	533	445	535
Energy (€)	6 660	5 670	6 660
- per hectare of UAA	94	103	94
- In % of agricultural production (with aids)	7,4%	7,3%	7,5%
Gross Operating Surplus (EBE in French) (€)	30 500	36 600	30 800
- per family AWU	31 600	36 600	31 900
- per hectare of UAA	429	667	433
- In % of agricultural production (with aids)	34%	47%	34%
Agricultural income (€)	18 200	23 300	18 500
- per family AWU	18 900	23 300	19 100
- per hectare of UAA	256	426	259
- In % of agricultural production (with aids)	20%	30%	21%
Total liabilities (€)	450 900	511 300	451 000
General debt ratio (%)	14%	15%	14%

Source: DGAGRI - FADN 2018 – Authors' calculations.

Table A4.1.4: Average characteristics of organic and non-organic farms in 2018 in the EU-28 for farms of type 16 (other field crops)

	Conventional farms	Organic farms (only)	All farms
Number of farms	391 240	20 790	426 530
Agricultural work unit (AWU)	1,49	1,64	1,50
- Family AWU	1,08	1,00	1,08
- Non Family AWU	0,41	0,65	0,43
Usable agricultural area (UAA in hectares)	38	42	39
- Cereals	16	13	16
- Forage crops	8	16	8
Yield of wheat (q/ha)	69	38	67
Livestock Units total (LU - total)	2	2	2
Grazing Livestock Units per forage UAA	1,30	0,64	1,23
Direct aids (€)	13 800	21 200	14 500
- Decoupled payments	10 310	10 410	10 370
- Subsidies on crops	1 140	660	1 150
- Subsidies on livestock	100	20	100
- Rural development measures	1 540	9 700	2 130
* Environmental subsidies	790	7 700	1 290
* Less Favourite Areas(LFA) subsidies	390	130	370
* Other rural development payments	220	450	230
- Other subsidies	710	410	750
Direct aids by AWU (€)	9 300	12 900	9 600
Direct aids by UAA (€)	360	508	373
Direct aids in % of agricultural prod. (with aids)	15%	20%	15%
Agricultural production, with aid (€)	93 500	105 000	94 300
- by AWU	62 500	63 900	62 700
- per hectare of UAA	2 433	2 524	2 427
Intermediate consumptions (€)	44 500	44 500	44 500
- per hectare of UAA	1 158	1 070	1 144
- In % of agricultural production (with aids)	48%	42%	47%
Fertilizers (€)	6 600	2 850	6 400
- per hectare of UAA	172	68	165
- In % of agricultural production (with aids)	7,1%	2,7%	6,8%
Plant protection products (€)	5 730	1 010	5 430
- per hectare of UAA	149	24	140
- In % of agricultural production (with aids)	6,1%	1,0%	5,8%
Specific Livestock costs / LU	590	775	596
Energy (€)	6 080	6 220	6 130
- per hectare of UAA	158	149	158
- In % of agricultural production (with aids)	6,5%	5,9%	6,5%
Gross Operating Surplus (EBE in French) (€)	34 800	42 200	35 400
- per family AWU	32 100	42 300	32 900
- per hectare of UAA	906	1 014	911
- In % of agricultural production (with aids)	37%	40%	38%
Agricultural income (€)	23 300	30 400	23 900
- per family AWU	21 500	30 400	22 200
- per hectare of UAA	606	730	614
- In % of agricultural production (with aids)	25%	29%	25%
Total liabilities (€)	433 100	488 900	435 000
General debt ratio (%)	15%	11%	14%

Source: DGAGRI - FADN 2018 – Authors' calculations.

Table A4.1.5: Average characteristics of organic and non-organic farms in 2018 in the EU-28 for farms of type 35 (wine)

	Conventional farms	Organic farms (only)	All farms
Number of farms	195 330	19 390	224 260
Agricultural work unit (AWU)	1,70	2,22	1,76
- Family AWU	1,06	1,08	1,06
- Non Family AWU	0,64	1,14	0,70
Usable agricultural area (UAA in hectares)	15	16	16
- Cereals	2	1	2
- Forage crops	1	1	1
Yield of wheat (q/ha)	55	33	54
Livestock Units total (LU - total)	0	0	0
Grazing Livestock Units per forage UAA	0,80	0,51	0,71
Direct aids (€)	3 700	9 700	4 500
- Decoupled payments	2 210	3 500	2 390
- Subsidies on crops	190	120	210
- Subsidies on livestock	10	10	10
- Rural development measures	820	4 620	1 320
* Environmental subsidies	500	4 040	960
* Less Favourite Areas(LFA) subsidies	410	1 460	520
* Other rural development payments	180	440	200
- Other subsidies	470	1 450	570
Direct aids by AWU (€)	2 200	4 400	2 600
Direct aids by UAA (€)	246	598	287
Direct aids in % of agricultural prod. (with aids)	4%	5%	4%
Agricultural production, with aid (€)	104 500	197 100	113 400
- by AWU	61 500	88 600	64 300
- per hectare of UAA	6 924	12 100	7 223
Intermediate consumptions (€)	35 000	72 700	38 400
- per hectare of UAA	2 317	4 462	2 447
- In % of agricultural production (with aids)	33%	37%	34%
Fertilizers (€)	2 280	2 190	2 280
- per hectare of UAA	151	135	145
- In % of agricultural production (with aids)	2,2%	1,1%	2,0%
Plant protection products (€)	4 550	3 980	4 490
- per hectare of UAA	302	244	286
- In % of agricultural production (with aids)	4,4%	2,0%	4,0%
Specific Livestock costs / LU	368	425	366
Energy (€)	3 440	5 830	3 680
- per hectare of UAA	228	358	234
- In % of agricultural production (with aids)	3,3%	3,0%	3,2%
Gross Operating Surplus (EBE in French) (€)	51 000	86 900	54 600
- per family AWU	48 100	80 300	51 300
- per hectare of UAA	3 381	5 334	3 478
- In % of agricultural production (with aids)	49%	44%	48%
Agricultural income (€)	40 500	66 300	43 100
- per family AWU	38 200	61 300	40 500
- per hectare of UAA	2 683	4 072	2 748
- In % of agricultural production (with aids)	39%	34%	38%
Total liabilities (€)	419 100	715 000	444 500
General debt ratio (%)	12%	15%	13%

Source: DGAGRI - FADN 2018 – Authors' calculations.

Table A4.1.6: Average characteristics of organic and non-organic farms in 2018 in the EU-28 for farms of type 15 (*milk)*

	Conventional farms	Organic farms (only)	All farms
Number of farms	400 060	32 540	438 620
Agricultural work unit (AWU)	1,88	1,87	1,89
- Family AWU	1,52	1,49	1,52
- Non Family AWU	0,36	0,38	0,36
Usable agricultural area (UAA in hectares)	46	57	47
- Cereals	8	6	8
- Forage crops	36	50	37
Yield of wheat (q/ha)	60	36	59
Livestock Units total (LU - total)	69	61	68
Grazing Livestock Units per forage UAA	1,88	1,21	1,80
Direct aids (€)	19 300	32 400	20 600
- Decoupled payments	11 770	14 530	12 050
- Subsidies on crops	80	60	80
- Subsidies on livestock	2 520	1 850	2 520
- Rural development measures	3 400	14 310	4 380
* Environmental subsidies	1 220	10 020	2 000
* Less Favourite Areas(LFA) subsidies	880	630	870
* Other rural development payments	150	340	170
- Other subsidies	1 530	1 650	1 570
Direct aids by AWU (€)	10 300	17 300	10 900
Direct aids by UAA (€)	423	567	439
Direct aids in % of agricultural prod. (with aids)	11%	17%	12%
Agricultural production, with aid (€)	175 400	187 600	177 100
- by AWU	93 200	100 300	93 900
- per hectare of UAA	3 835	3 281	3 772
Intermediate consumptions (€)	103 600	99 800	103 700
- per hectare of UAA	2 265	1 744	2 210
- In % of agricultural production (with aids)	59%	53%	59%
Fertilizers (€)	4 900	1 030	4 580
- per hectare of UAA	107	18	98
- In % of agricultural production (with aids)	2,8%	0,5%	2,6%
Plant protection products (€)	1 620	170	1 500
- per hectare of UAA	35	3	32
- In % of agricultural production (with aids)	0,9%	0,1%	0,8%
Specific Livestock costs / LU	828	821	828
Energy (€)	9 000	9 350	9 080
- per hectare of UAA	197	163	193
- In % of agricultural production (with aids)	5,1%	5,0%	5,1%
Gross Operating Surplus (EBE in French) (€)	57 900	70 700	59 000
- per family AWU	38 000	47 300	38 800
- per hectare of UAA	1 266	1 236	1 257
- In % of agricultural production (with aids)	33%	38%	33%
Agricultural income (€)	36 100	39 400	36 400
- per family AWU	23 700	26 400	23 900
- per hectare of UAA	790	690	774
- In % of agricultural production (with aids)	21%	21%	21%
Total liabilities (€)	701 100	857 400	713 900
General debt ratio (%)	21%	25%	21%

Source: DGAGRI - FADN 2018 – Authors' calculations.

Table A4.1.7: Average characteristics of organic and non-organic farms in 2018 in the EU-28 for farms of type 48 (sheep and goats)

	Conventional farms	Organic farms (only)	All farms
Number of farms	289 600	20 040	327 970
Agricultural work unit (AWU)	1,38	1,60	1,41
- Family AWU	1,21	1,30	1,22
- Non Family AWU	0,18	0,30	0,19
Usable agricultural area (UAA in hectares)	47	71	49
- Cereals	3	4	3
- Forage crops	42	64	43
Yield of wheat (q/ha)	44	33	42
Livestock Units total (LU - total)	36	41	36
Grazing Livestock Units per forage UAA	0,76	0,56	0,75
Direct aids (€)	13 000	29 400	14 400
- Decoupled payments	7 910	12 850	8 330
- Subsidies on crops	60	160	90
- Subsidies on livestock	1 730	1 510	1 720
- Rural development measures	3 090	13 720	4 050
* Environmental subsidies	1 280	8 870	2 020
* Less Favourite Areas(LFA) subsidies	100	600	130
* Other rural development payments	120	420	140
- Other subsidies	210	1 160	210
Direct aids by AWU (€)	9 400	18 400	10 200
Direct aids by UAA (€)	275	417	297
Direct aids in % of agricultural prod. (with aids)	23%	32%	25%
Agricultural production, with aid (€)	55 400	90 700	58 000
- by AWU	40 100	56 700	41 200
- per hectare of UAA	1 177	1 286	1 194
Intermediate consumptions (€)	30 600	43 900	31 400
- per hectare of UAA	649	623	646
- In % of agricultural production (with aids)	55%	48%	54%
Fertilizers (€)	1 310	560	1 240
- per hectare of UAA	28	8	26
- In % of agricultural production (with aids)	2,4%	0,6%	2,1%
Plant protection products (€)	270	60	250
- per hectare of UAA	6	1	5
- In % of agricultural production (with aids)	0,5%	0,1%	0,4%
Specific Livestock costs / LU	506	464	502
Energy (€)	2 500	4 920	2 670
- per hectare of UAA	53	70	55
- In % of agricultural production (with aids)	4,5%	5,4%	4,6%
Gross Operating Surplus (EBE in French) (€)	20 600	38 200	22 100
- per family AWU	17 100	29 400	18 100
- per hectare of UAA	437	541	455
- In % of agricultural production (with aids)	37%	42%	38%
Agricultural income (€)	15 800	26 300	16 900
- per family AWU	13 100	20 200	13 800
- per hectare of UAA	336	372	348
- In % of agricultural production (with aids)	29%	29%	29%
Total liabilities (€)	257 800	493 900	268 700
General debt ratio (%)	8%	11%	8%

Source: DGAGRI - FADN 2018 – Authors' calculations.

Table A4.1.8: Average characteristics of organic and non-organic farms in 2018 in the EU-28 for farms of type 49 (cattle)

	Conventional farms	Organic farms (only)	All farms
Number of farms	308 290	35 550	356 850
Agricultural work unit (AWU)	1,32	1,53	1,34
- Family AWU	1,20	1,24	1,20
- Non Family AWU	0,11	0,29	0,14
Usable agricultural area (UAA in hectares)	53	80	57
- Cereals	5	5	5
- Forage crops	46	73	50
Yield of wheat (q/ha)	60	38	58
Livestock Units total (LU - total)	60	52	59
Grazing Livestock Units per forage UAA	1,26	0,68	1,15
Direct aids (€)	20 300	40 300	22 800
- Decoupled payments	11 910	16 730	12 510
- Subsidies on crops	40	100	50
- Subsidies on livestock	3 160	3 190	3 240
- Rural development measures	4 530	18 780	6 270
* Environmental subsidies	1 600	12 770	3 000
* Less Favourite Areas(LFA) subsidies	450	810	490
* Other rural development payments	170	140	170
- Other subsidies	660	1 500	730
Direct aids by AWU (€)	15 400	26 300	17 000
Direct aids by UAA (€)	384	503	401
Direct aids in % of agricultural prod. (with aids)	24%	42%	26%
Agricultural production, with aid (€)	85 700	95 400	87 000
- by AWU	65 000	62 400	64 900
- per hectare of UAA	1 619	1 191	1 528
Intermediate consumptions (€)	51 300	46 700	50 700
- per hectare of UAA	969	583	891
- In % of agricultural production (with aids)	60%	49%	58%
Fertilizers (€)	3 070	570	2 750
- per hectare of UAA	58	7	48
- In % of agricultural production (with aids)	3,6%	0,6%	3,2%
Plant protection products (€)	860	40	750
- per hectare of UAA	16	1	13
- In % of agricultural production (with aids)	1,0%	0,0%	0,9%
Specific Livestock costs / LU	414	334	406
Energy (€)	4 800	6 510	4 980
- per hectare of UAA	91	81	88
- In % of agricultural production (with aids)	5,6%	6,8%	5,7%
Gross Operating Surplus (EBE in French) (€)	27 800	38 200	29 200
- per family AWU	23 100	30 800	24 200
- per hectare of UAA	525	477	513
- In % of agricultural production (with aids)	32%	40%	34%
Agricultural income (€)	16 300	22 000	17 200
- per family AWU	13 600	17 700	14 300
- per hectare of UAA	308	274	302
- In % of agricultural production (with aids)	19%	23%	20%
Total liabilities (€)	540 500	540 300	536 900
General debt ratio (%)	11%	14%	11%

Source: DGAGRI - FADN 2018 – Authors' calculations.

ANNEX A4.2. THE "*DE-INTENSIFICATION*" OF AGRICULTURE AND FOOD SYSTEMS IN THE EU

Different studies (Röös et al., 2017; Poore and Nemecek, 2018; Springmann et al., 2018; Lóránt and Allen, 2019) have analysed possible options to significantly lower GHG emissions and the environmental impacts of agriculture and the food system. Most studies consider the means of action related to technical change, losses and waste reduction, and dietary changes. Overall, the main conclusions of these studies are that: first, combining these different solutions is required in order to reach ambitious climate and biodiversity goals; second, dietary changes have the potential to reduce GHG emissions through a reduction in meat consumption; and third, changes in production methods are required to improve biodiversity and the environmental impact of agriculture and the food system.

1. "*Intensification*" versus "*de-intensification*"

Regarding technological change and agricultural practices and systems, two main strategies can be identified:

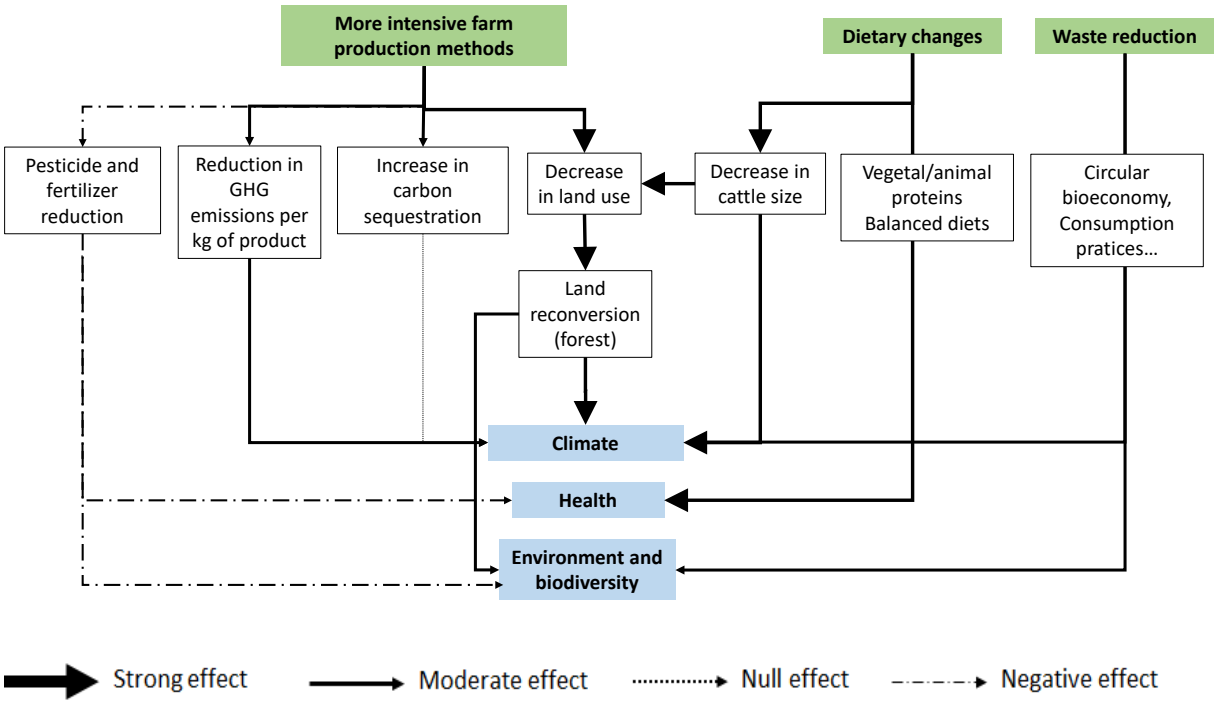
- The first strategy is based on an "***intensification" process***, which targets yield increases worldwide and aims at closing the yield gap between regions at the global level. Scenarios considered by Springmann et al., (2018) at the global level or Lóránt and Allen (2019) at the European level fall into this framework. In this first strategy, the choice is made to specialize large areas to agricultural production, with the objective of doubling agricultural yields using input intensive techniques, irrigation and a whole portfolio of innovations, including Genetically Modified Organisms (GMO). This strategy would make it possible to concentrate agricultural production on some specific areas (thanks to increased yields) and to reduce the number of farmed animals (thanks to increases in livestock production efficiency). From that perspective, it is worth noting that the reduction in GHG emissions observed in EU agriculture since 1990 arose mainly from productivity gains in the livestock sector (more dairy and meat output per livestock head). Intensification still has some way to go in the reduction of GHG emissions.
- The second strategy is based on the adoption of agro-ecological practices, and thus correspond to a form of "***de-intensification" process***. The Green Deal and associated strategies lie within this framework. This strategy places farmers at the centre of the management of ecosystems, thanks to practices relying more on biological cycles and using more sustainable agricultural techniques (soil conservation, integrated pest management, crop associations, afforestation, etc.).

The "*intensification*" strategy

Overall, the "*intensification*" strategy (***Figure A4.2.1***) is intended to have beneficial impacts on climate change through a productivity increase (that reduces GHG emissions per product unit) and a reduction in agricultural land use (thanks to yield increases) that frees up land for forest conversion. This land-use effect is amplified by dietary changes and the reduction of meat consumption. Note that in this first strategy, the solutions should not have large impacts on other environmental compartments than the climate (and possibly negative impacts) because the risks of over-applying chemical inputs remain (these risks could be reduced by precision farming and digital technologies). The impacts on biodiversity could be potentially extremely negative on farmland, but positive on spared agricultural land.

Increasing yields should be easier (technically possible) in low-yielding areas. This is much less obvious in already high-yielding regions. Regarding livestock intensification, concentration and scaling up in the livestock sector could contribute to the reduction of GHG emissions per product unit and allow manure to be managed more effectively. The impacts will differ depending on the regions and the use of permanent grassland to feed livestock. However, this raises concerns about the use of antibiotics, antimicrobial resistance, the spread of zoonotic diseases and animal welfare. In this strategy, the health effect is mainly due to dietary changes, as the increased use of pesticides and fertilizers is unlikely to be accompanied by an improved quality of air, water and soils. Indeed, the strong heterogeneity in farmers' skills and a low adoption rate of innovations may undermine the impacts of precision farming on nutrient management optimization. Finally, it is worth noting that if the freeing up of land is not used to reconvert cropland to forest but to increase EU exports, then the overall reduction of net European GHG emissions could potentially be much lower.

Figure A4.2.1. The "*intensification*" strategy - impact channels on the climate, the environment and health



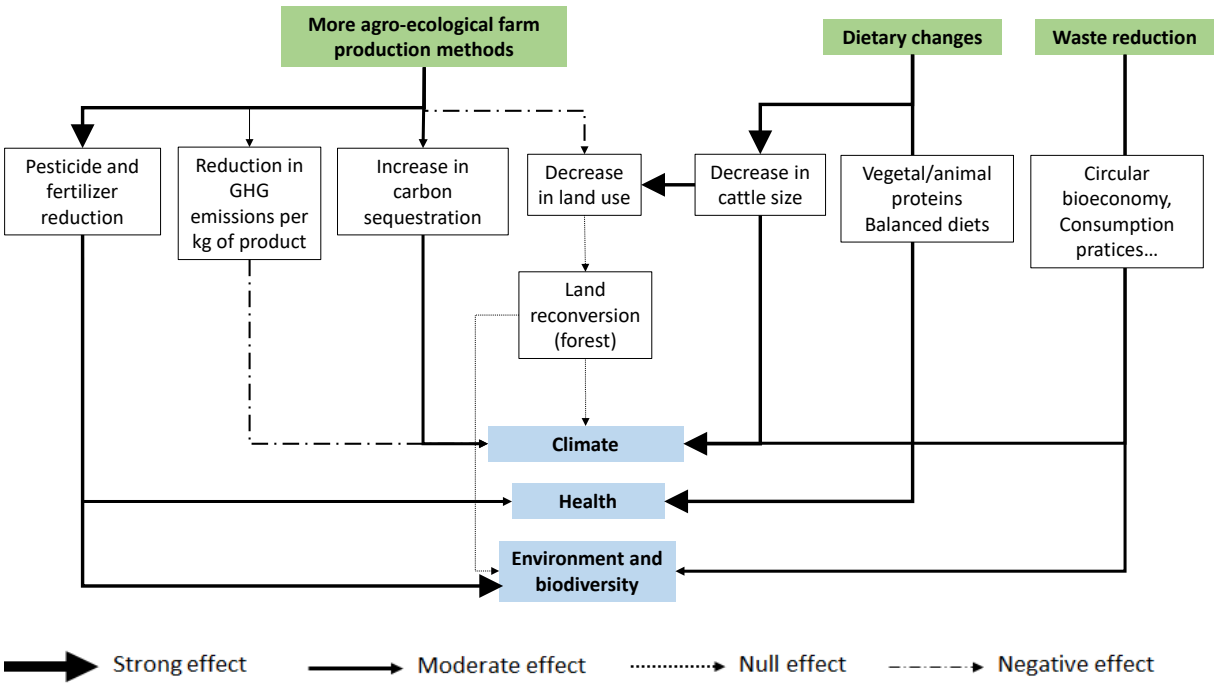
Source: Own elaboration.
Note: The scheme does not take into account changes in imports and exports, and their feedback effects (notably through price changes).

The "*de-intensification*" strategy

The "*de-intensification*" strategy (***Figure A4.2.2***) targets the positive impacts on the environment and biodiversity through the re-design of production systems, including agroforestry, carbon sequestration practices, product diversification, etc. This strategy, which is also based on IPM, efficient nutrient management and the development of organic farming, is intended to induce a reduction in the use of fertilizers and pesticides, which have positive impacts on biodiversity and on farmland and health. However, the likely decrease in yields induced by "*de-intensification*" does not allow a reduction in agricultural land use, nor a shift of land from crop to forest. Dietary changes are therefore required to complement the changes in production methods in order to reach ambitious climate, biodiversity and

environmental goals. In addition, changes in dietary patterns are likely to have positive impacts on public health.

Figure A4.2.2. The *"de-intensification"* strategy - impact channels on the climate, the environment and health



Source: Own elaboration.
Note: The scheme does not take into account changes in imports and exports, and their feedback effects.

Is there a "*best*" strategy?

Which of the two strategies is the most able to lead to carbon neutrality, biodiversity restoration and less pollution from the agricultural and food sector? There is no clear response to this question. Scientists are divided on the relative merits of the strategies, and the benefits of "*intensification*" *versus "de-intensification"* are divided, even within the framework of the IPCC.

More generally, this relates to a long-lasting controversy between the "*land sparing*" and "*land sharing*" strategies, which have mostly been studied in relation to biodiversity aspects. Both approaches have their defenders leading to disputed effects on biodiversity; see Salles et al. (2017) for a review of pros and cons). Some authors point out cases where "*land sparing*" seems more successful than "*land sharing*" (Phalan et al., 2011). Others point out that this result holds for specific ecosystems only and requires extremely large protected areas, so that it would not be successful in most EU countries. The corollary of land sparing is extreme intensification in non-protected areas and the sacrifice of biodiversity in areas devoted to agricultural production, the effects of which would leak far outside the cultivated area (through biogeochemical flows in rivers, pesticides and ammonia in the air, etc.; Foley et al., 2011).

As far as biodiversity is concerned, the overall interest of integrating its protection into human activities ("*land sharing*") as opposed to setting aside ("*land sparing*") depends on the shape (convexity) of the biodiversity response to the intensification of human activity. This form, which depends on each taxon, will not be the same for large mammals that are sensitive to a low intensity of human activity or for arthropods whose populations decline with a higher level of this intensity. That is, sparing can be a better solution than sharing in some cases but not in others, as Salles et al. (2017) explain in detail.

The "*land sharing*"/"*de-intensification*" strategy is one that seems to be *de facto* retained in the EC Green Deal. The reduction in the use of fertilizers, pesticides and antimicrobials and the increase in organic farming and high-diversified landscape features indicate that the EC intends to promote conservation by means of agricultural practices and systems that would be both more ecological and less intensive (less chemical inputs). However, technical innovations and an increase in total factor productivity can help in meeting the Green Deal targets related to agriculture. An increase in overall productivity of organic agriculture is an efficient way to avoid unwanted indirect land-use changes, such as those pointed out by Bellora and Bureau (2014).

2. Global challenges of the "*de-intensification*" strategy

GHG emissions

Changes in production methods induced by "*de-intensification*" include an increased efficiency and a re-design of production systems. Increased efficiency would lead to a decrease in GHG emissions per unit of product as it encompasses a (limited) reduction in the use of fertilizers and pesticides without impacting yields, as well as changes in animal feeding methods allowing a reduction of enteric methane emissions by ruminants. The associated reduction in GHG emissions could range between 5 to 8%, depending on the rate of adoption of corresponding techniques and practices. A reduction in food losses and waste corresponds to an improved efficiency of the food chain but acts differently. It allows a reduction in production levels and as a result, in agricultural land use. The impact of GHG emissions will depend on the size of the reduction in losses and waste. It can "*reasonably*" and "*prudently*" be estimated at 5%.

The re-design of production systems has ambiguous effects on GHG emissions. When compared to reducing pesticide and/or fertilizer use, organic farming can be viewed as the leading "*de-intensification*" process. Organic farming leads to a decrease in GHG emissions per unit of area as fewer chemical inputs are used (no mineral fertilizers). However, because of lower yields, organic farming leads to an increase in GHG emissions per unit of product (the magnitude of this increase depends on the type of product). Rabès et al. (2020) estimated that for an average meal, the requested land is about 30% higher for organic products than for conventional products. Practices such as mixed cropping could allow an alleviation of the negative impacts on yields and the associated increase in GHG emissions linked to land-use changes. The "*de-intensification*" process proposed for "*conventional*" farms in the framework of the Green Deal encompasses the same mechanisms, however, with more moderate direct and indirect effects.

Some specific agro-ecological practices, such as the use of cover crops and catch crops, the development of agroforestry and the use of no-tillage practices increase carbon sequestration in agricultural soils and biomass (see Section 4.1). However, it is difficult to provide an estimate of the potential of carbon sequestration associated with these practices at the EU level, given the information available for some of these practices in a particular context and/or country.

Overall, it is thus difficult to assess the impact of the re-design of production systems on GHG emissions. This will highly depend on the rate of adoption of techniques allowing an increase of carbon stocks into the soils. It will also depend on the long-term impact on yields of the "*de-intensification*" process, as this has strong consequences on land use for agriculture. However, when compared to a scenario based on intensification, the decrease in GHG emissions (if any) through the re-design of systems will be lower. As a result, significant changes in diets must be strongly encouraged in order to reduce GHG emissions of the entire food system.

Dietary changes towards more plant-based products, less meat and lower calorie intakes allow a reduction in GHG emissions and land use. From that perspective, Vieux et al. (2020b) compare the climatic footprint of an average European diet *versus* a healthier and more sustainable diet that would be adopted by a part of the population. The healthier and more sustainable diet corresponds to a reduction in beef meat consumption by 40% and in pig and poultry meat consumption by 10%, and an increase in fruit and vegetable consumption by 50% and grain consumption by 10%. Such a regime would allow a reduction in GHG emissions of up to 15%. However, this represents a considerable shift in eating habits that may be somewhat challenging to reach by 2030. Such dietary changes will also significantly reduce agricultural land use, without it being possible to assess whether or not this shift is enough to balance the negative impact of "*de-intensification*" on land use.

Economic issues[70]

In a general way, the Green Deal objectives and targets request "*de-intensification*" of farming systems that will very likely lead to reduced yields and partial productivities of labour and land, at least in the short term. Nevertheless, precise consequences of "*de-intensification*" are difficult to quantify, depending on degrees of transformation of farming systems, constraint levels, etc. Reduced yields would decrease domestic production levels and increase domestic prices, to the benefit of domestic farmers if the price effect dominates the quantity effect. To observe such a regime, it is of utmost importance to design border mechanisms that will set equivalent climatic, environmental and health requirements on EU imports from non-EU countries. If not, the risk is high that imports from less environmentally committed countries could lead to lower prices and thus, penalize European farmers by a quantity effect that would not be compensated for by a price effect. In addition, these increased imports would reduce the climatic and environmental benefits of more sustainable farming systems in the EU. A specific concern must be paid to less developed countries, because of the objective of economic development and "*food diplomacy*". However, these countries are essentially concerned by the issue of securing their imports (food availability at the global scale), and the question of access to food for all. In terms of border mechanisms, the EU shows fine and laudable intentions, but their effective translation into trade agreements, notably bilateral trade agreements, remains to be seen.

Even if an effective increase in prices occurs, it must compensate decreases in yields and changes in costs (less chemical inputs, but very likely more labour and equipment costs) so that farmers could gain in terms of incomes. In addition, this effective increase can be offset by changes in food consumption patterns towards less caloric and more balanced food diets, notably for animal products for which changes in diets would result in decreases in consumption levels and hence, in prices. This would benefit consumers to the detriment of livestock producers (but to the potential benefit of plant producers if changes in diets lead to an increased consumption of plant-based products).

Food security issues

On a related but different issue, there is the question of food security explicitly considered by the EC, notably in the F2FS, in the context of the Covid-19 crisis that, according to the EC, "*can place both food security and livelihoods at risk*". The EC adds that *"while there has been sufficient food supply in general, this pandemic has presented many challenges, such as logistical disruptions of supply chains, labour shortages, loss of certain markets and change in consumer patterns, impacting on the functioning of the food system*". In brief, the EC considers the food security issue essentially from an European point of view centred on risk questions, arguing that the Green Deal proposal will increase the resilience of

[70] Economic issues for European farmers (impacts on incomes) are developed in Section 5.4 of Chapter 5.

European farmers and adding that it "*will develop a contingency plan for ensuring food supply and food security to be put in place in times of crisis*" (EC, 2020b).

On the other hand, V. Sinkevičius, the European Commissioner for the Environment, Oceans and Fisheries, underlines that "*the Covid-19 pandemic has shown the resilience of the EU food supply*", with only very few shortages, adding that "*food security is no longer a major concern for the EU*".[71] However, European farmers and agri-cooperatives that regrouped under the umbrella of the COPA-COGECA organization warn that the Green Deal "*will jeopardise food security, European agricultural competitiveness and farming income*" (COPA-COGECA, 2020).

The problem is that no one has precisely defined what food security is, which, according to the more consensual definition proposed by the FAO, encompasses the four interlinked dimensions of food availability, access, utilisation and stability (FAO, 2006). Even if there is sufficient food supply at the EU level, economic impact assessments should include to what extent the Green Deal and its implementation could affect the four dimensions of food security for each MS of the EU (notably for low-income households) and outside of Europe, notably if the "*de-intensification*" process leads to higher EU prices and lower EU food exports that could impact (potentially jeopardize) food security in food-importing countries that depend on European exports.

The land-use issue

At least some farmers could try to limit the adverse effects of "*de-intensification*" on productions and incomes by increasing the size (in hectares) of their holdings, possibly by transforming grassland areas in crops or by converting some forest or semi-natural areas into agricultural areas. This potential increase in agricultural areas can be at odds with some objectives of the Green Deal, notably of the EU Biodiversity Strategy for 2030 regarding protected areas and high-diversity landscape features, and some means of action to reduce GHG emissions, notably through carbon sequestration in perennial plants and soils.

The new EU Forest Strategy, planned for the fourth trimester of 2020, will be delayed to 2021 because of the Covid-19 crisis. This might delay the design of a consistent and comprehensive framework that includes climate objectives for non-CO_2 gas emissions, LULUCF, and carbon sinks. EU forestry offers a large potential to sequester and store more carbon, and also to provide other ecosystem services (biomass supply, biodiversity preservation, water holding and filtration, etc. (ELO, 2020).

In other words, there is at least a potential trade-off linked to land-use changes that the Green Deal could induce at the EU and world levels. First, at the EU level if positive ecological impacts per hectare (that is, at the intensive margin of production) associated with less intensive farming practices and systems are cancelled, at least partially, by the increased cultivation of forests, natural and semi-natural land or permanent grassland (that is, by land-use changes less favourable to the climate and the environment with possible carbon destocking and biodiversity loss at the extensive margin of production).[72] Second, at the global scale if changes in production and consumption levels for the different food products are replaced by imports from non-EU countries, potentially less environmentally friendly at both the intensive and extensive margins of production. This second point again raises the question of the willingness of the EC (EU) to apply climate, environment and health border adjustment mechanisms to ensure fair ecological and health playing rules, within and outside the EU. The point can be extended to animal welfare issues.

[71] Quoted from EURACTIV (23 June 2020, updated 7 July 2020).
[72] For a presentation of the concepts of intensive and extensive margin of production, see, for example, Hardie et al. (2004).

ANNEX A5.1. DATA AND MODELLING NEEDS FOR ASSESSING THE CAP AND THE GREEN DEAL

1. Main characteristics of models used in CAP impact assessments

The main economic simulation models used in impact assessments of the CAP reforms are listed in ***Table A5.1.1***. These models are largely used to assess the impacts of EU policies in the fields of agriculture, climate, trade and environment. The models differ from one another in their focus, their spatial and temporal scales, how they represent agricultural supply and demand and how they take into account trade and inter-sectoral flows (Blanco et al., 2019).

In order to address the climatic and environmental impacts, notably in terms of GHG emissions, economic models are sometimes coupled with physical or biophysical models. For instance, the MITERRA model relies on the CAPRI and GAINS models, and includes a nitrogen leaching module, a soil carbon module and a climate change mitigation module. This makes it possible to assess nitrogen and carbon emissions from European agriculture (Velthof et al., 2009).

Recent impact assessments have often used a combination of several models, for example, AGMEMOD-CAPRI (Salomon et al., 2017) or AGMEMOD-MAGNET (Banse et al., 2016). In the EU reference scenario for energy, transport and GHG emission trends to 2050 (Capros et al., 2016), simulations were based on a set of different morels, that is, GLOBIOM, CAPRI, PRIMES and GAINS. The Scenar 2030 Foresight Study developed by the EC Joint Research Centre (JRC) uses an integrated modelling platform that combines MAGNET, GLOBIOM, IFM-CAP and IMAGE (M'barek et al., 2017).

2. Data and modelling needs

Table A5.1.2 shows how the various challenges of the Green Deal related to agriculture and food are covered by the models identified in Table A51.1 and as a result, could be taken into account in impact assessments. Based on Tables A51.1 and A51.2, we identify several issues where modelling efforts can be made. In some cases, lack of data is clearly the barrier to these developments. Modelling and data needs are summarized in ***Table A5.1.3.***

As far as the ability of the existing models to provide insights on the compatibility of the future CAP with the Green Deal objectives and targets, several obstacles persist.

Adoption of new practices/techniques by farmers

The changes required to match ambitious objectives (for example, reduction in pesticide and fertilizer uses, biodiversity restoration, etc.) involve changes in the agricultural technology itself. It is clearly a weak point for all models. While it is particularly true for econometric models, which, by definition, are estimated based on existing/past situations, it is also true for the calibration of Computable General Equilibrium (CGE) models and non-parametric supply side models. A similar problem arises for demand. For instance, it is unclear, within the existing models, how a large shift towards organic products will be welcomed and what would be the extent of any required price changes. Very few models have an explicit representation of consumers' preferences.

The representation of the cropping and livestock management systems is a point on which the models currently used in impact assessments differ from one other. Mathematical programming models are based on explicit representation of technology that facilitates the design of alternative technologies, compared to parametric functions. As a result, GLOBIOM and CAPRI appear more able to incorporate new technologies, notably because their structure makes it possible to include results from biophysical models. The bottom-up approach used in GLOBIOM allows the mobilization of several geospatial

databases on weather/climate, soil, topography, land cover/use, and production management for both agriculture and forestry, and the generation of input responses. However, the level of aggregation does not allow taking into account farmers' behaviours in contrast with a model such as IFM-CAP, which includes a set of individual farms. In the latter, one limitation is, however, that the FADN does not include the allocation of inputs to each agricultural activity (except in some MS). This makes it almost impossible to use farm level input/output coefficients, which are key in non-parametric representations of agricultural supply. In addition, the FADN includes mostly financial/economic data and provides little information on farming practices/systems and environmental issues. One limitation of IFM-CAP is the assumption of fixed organizational structures in its current version (Louhichi et al., 2018). The CAPRI model includes a representation of farm types inside each region. Better representation of new technology adoption is part of CAPRI's team agenda (Salamon et al., 2019).

Another issue that creates difficulties for assessing the impact of structural changes (technology) in agricultural models is the risk behaviour (Gohin and Zheng, 2020). Changes in technology (for example, a shift toward techniques relying less on chemical inputs) will change the level of risk in a way that is hard to assess and has considerable consequences on input use and investment. There is a sizeable body of academic literature on risk modelling in agriculture, but there is no large scale model that treats risks in a fully satisfactory way, even if some models (for example, IFM-CAP) include an explicit treatment of risk. One reason is the data availability on farmers' behaviour. Another is that risk aversion is an individual characteristic. As a result, aggregate models are hardly compatible with risk heterogeneity. Risk is not the only aspect that interacts with technology choice for determining innovation: other factors (such as individual and local constraints, farmers' skills, management capacity, etc.) also play an important role. While some of the calibration methods of non-parametric models (Positive Mathematical Programming (PMP), entropy) manage to account for some of these aspects in the estimated coefficients, their ability to deal with major changes remains uncertain.

Use and impact of pesticides

Pesticide use reduction is a specific target of the Green Deal. This issue is not addressed properly in the simulation models. This is due to the intrinsic difficulty to include pesticide as a production factor both in the econometric estimations of production functions and in biophysical crop growth models. Thus, the impact of pesticide use on yields is very poorly taken into account in modelling exercises (if it is taken into account at all). Most of the available estimates focus on particular MS or regions (Bareille and Gohin, 2020). Furthermore, there is a lack of observed data that allows both the pesticide use and the associated risks to be modelled and quantified.

On this issue, a major data effort is required for monitoring progress as well as for assessing the ability of the post-2020 CAP to reach the Green Deal target related to pesticide use and risk. Three types of indicators should be collected. First, indicators to measure pesticide uses at the farm and global level. This could be done through direct surveys or by supplementing the existing FADN survey. In addition, aggregated data at the aggregate level should be harmonized between MS, which is so far not the case. Second, indicators to measure the impact of pesticide use reduction on yields. Cropping management practices for each crop should be included in the FADN survey in order to characterize the input use intensity per activity and assess the economic results of low-input practices. Third, indicators to quantify the risk on health and the environment. Such indicators are missing in most MS. Quantitative indicators that are currently used (kilogrammes of active ingredients or the number of standard dosages) are the only ones that are available at the EU level. They allow *ex post* assessment but without quantifying the risk on health and the environment). Risk indicators should be defined at the EU level and implemented for each MS. We suggest using the Load Pesticide Index (LPI).

Biodiversity

Efforts have already been made in some modelling exercises to address the issue of the impact on biodiversity, through the assessment of the impact of more biodiversity-friendly practices such as crop diversification, fallow land, the use of nitrogen-fixing crops and cover crops, the extension of grassland and notably permanent grassland, etc. Specific biodiversity indexes such as the richness of habitats have been built to address this issue in models like CAPRI and GLOBIOM. However, all of these attempts suffer from a lack of direct biodiversity indicators. While some modelling efforts have attempted to measure the impact of land-use changes on particular indicators (mean species abundance, weighted species richness, etc.), so far results have been limited.

This calls for an effort to provide indicators related to the measurement of biodiversity (focused on species that are good indicators of biodiversity on a large geographic scale) and to the impact on biodiversity of different land management practices, land uses and land-use changes.

Gross and net greenhouse gas emissions

Farming intensity and land-use changes are key points to be take into account in order to calculate gross and net GHG emissions. Most of the simulation models consider these issues, however in differing ways. GLOBIOM and MAGNET make it possible to address some of the indirect land-use changes at a global scale (see, for example, Valin et al. (2015) from a study aimed at assessing land-use change impacts of the EU biofuel policy). They are able to address the indirect impacts due to demand substitution as well as price effects. GLOBIOM has a detailed representation of forests and thus offers a comprehensive framework for spatially detailed land-use changes among arable land, grassland and forests. MAGNET can address the cross-sectorial effects that can have a strong influence on GHG emissions (such as the impact of biofuel expansion on oil prices). However, the capacity of aggregate models to account for GHG emissions from the livestock sector is, nevertheless, limited by the changes in rearing practices that are likely to take place.

Nitrogen and phosphorus leaching are a considerable problem, which is poorly addressed by economic models. This is notably due to the "*nitrogen cascade*", which involves complex processes and is therefore very poorly modelled (OECD, 2018). Clearly, highly specific biogeochemical models are needed to take this into account. In the same way, the impact of changing nitrogen and phosphorus fertilisation on agricultural output requires coupling economic models with plant growth and soil models (for example, EPIC[73], STICS[74], ORCHIDEE[75]). These attempts are mostly at a research and experimentation stage. Note, however, that the CAPRI-MITERRA model allows to estimate flows of various). These attempts are mostly at a research and experimentation stage. However, the CAPRI-MITERRA model allows the estimation of the flows of various nitrogen and phosphorus pollutants, as well as methane, based on selected emission sources from agriculture (manure storage and management, N_2O emissions from agricultural soils, enteric CH_4 emissions from ruminants).

Consumers' behaviours and changes in food diets

Progress in modelling new food consumption patterns is required in order to understand how changes in diets can impact the climate, the environment and health. Most of the models currently used to assess the CAP reforms are originally based on a detailed description of the supply side. As shown in Chapters 3 and 4, changes in eating patterns are a major driver to address climate change. In most models, consumers' preferences are assumed to be stable, and there are few elements to gauge the extent that exogenous or structural changes in dietary regimes would involve. Attempts to develop a specific demand system for organic products in a computable general equilibrium model shows the

[73] *https://epicapex.tamu.edu/epic/.*
[74] *https://www6.paca.inrae.fr/stics_eng/About-us/Stics-model-overview.*
[75] *https://orchidee.ipsl.fr.*

difficulty of calibrating parameters on existing data (Bellora and Bureau, 2014). While some attempts to stimulate changes in consumers' preferences and demand based on explanatory variables have provided useful insights at the global level, much remains to be done at the EU and MS level.

Table A5.1.1: Key characteristics of selected economic models used for CAP assessments

Characteristics	**CAPRI (1)** Common Agricultural Policy Regionalised Impact	**MAGNET (2)** Modular Applied General Equilibrium Tool	**GLOBIOM (3)** Global Biosphere Management Model	**AGMEMOD (4)** Agricultural Member State Modelling	**IFM-CAP (5)** Individual Farm Model for CAP Analysis
Model type	Partial Equilibrium	General Equilibrium	Partial Equilibrium	Partial Equilibrium	Partial Equilibrium
Spatial coverage	National and regional within the EU	Global	Global (37 regions in the world, 7 European regions)	National for the majority of EU MS, simplified version for the ROW	EU-28
Temporal scale	Until 2050 in flexible time steps	Until 2100 in flexible time steps	Until 2050 in 10-year step intervals	Until 2030 year by year (recursive dynamic)	Until 2030
Focus	Impact assessment of the CAP at national and regional (NUTS2) levels	Economic impact assessment Modularity: can be tailored to specific research question	Land use and climate assessment Sectors: agriculture, forestry, bioenergy	Agricultural, fisheries and food sectors Country-specific models can be combined within the EU model	Policy impacts Assessment at the farm level
Supply side representation	Mathematical Programming Models (farm types and regions) Recent developments at the farm level	MS for the EU and aggregated regions for the ROW CES supply functions Endogenous land supply, and allocation of land over sectors (land-use module)	Bottom-up approach (land use, management systems) for more than 10,000 units worldwide) Different land covers and livestock systems Links to a biophysical model	Based on historical data at the MS level Equations linking yields, areas, productions, and agricultural land allocations	Mathematical programming on FADN data (farm level) Uncertainty in yields and prices
Demand side module Markets	Own and cross-price elasticities for 60 commodities Within a global trade model (Armington approach, explicit modelling of tariff rate quotas)	One consumer per region Price and income elasticities Trade: Armington, spatial equilibrium based on quality differentiation Capital and labour markets	Demand and trade modelling for 57 regions One representative consumer per region and per good Trade modelled according to the Takayama and Judge spatial equilibrium approach	Econometric multi-market model (commodity level) Endogenous prices	Exogenous prices

Source: Own elaboration
Note: (1) Britz and Witzke (2018); (2) Woltjer and Kuiper (2014); (3) Havlik et al. (2018); (4) Salamon et al. (2017); (5) Louhichi et al. (2018).

Table A5.1.2: Model coverage of Green Deal issues related to agriculture and food

Issues	**CAPRI** Common Agricultural Policy Regionalised Impact	**MAGNET** Modular Applied General Equilibrium Tool	**GLOBIOM** Global Biosphere Management Model	**AGMEMOD** Agricultural Member State Modelling	**IFM-CAP** Individual Farm Model for Common Agricultural Policy Analysis
Representation of alternative technologies (organic farming, low-input farming, etc.)	Two technologies available for most activities (low- and high-input faming)		Several management systems for crops, livestock and forests	Current technologies	Current technologies
Environmental impacts (pesticide and fertilizer uses, nitrogen balance)	Nitrogen balance Water CAP measures (P1 & P2) Greening indicators		Nitrogen balance Biodiversity indicators	Environmental indicators	Indicators calculated based on FADN data Study on impacts of CAP "*greening*"
GHG emissions Climate mitigation	GHG emissions (IPCC Tier2 method) Mitigation technology options (based on the GAINS database)	Climate module Study on GHG emissions and climate mitigation	GHG emissions (IPCC Tier2 methods, 12 sources including peatlands) Mitigation options (technologies and land-use changes)		
Bio-economy	Biofuel module Study on impacts of food waste reduction	Biofuel module Study on food losses and waste	Large number of conventional and advanced biofuel feedstocks and technologies		
Nutrition and diets	Study on impacts of changing diets on the environment	Long-term projection of households' consumption, including dietary patterns (price and income elasticities calibrated at each step) Nutrition module	Studies on SDG and healthier diets		

Source: Own elaboration.

Table A5.1.3: Modelling and data needs

Issues	Current covering	Modelling needs	Data needs
Representation of alternatives technologies	Partially	Need to include several alternative/complementary technologies (low-input production systems, precision farming, etc.)	Data on system performances (economy, environment, health)
Adoption of alternative technologies	Partially	Could be improved by opening the black box of non-linear costs in mathematical programming models, including fixed costs (labour, equipment)	Input requirement per activity (crops and livestock) at farm level for different production systems: fertilizers, pesticides, labour, investment
Risk, yield variability, extreme weather events	Very partially	Stochastic modelling Representation and calibration of risk behaviours	Yield variability in function of practices/systems and yield response to shocks
Fertilization (nitrogen balance)	Yes	Done through model coupling	Data on mineral and organic fertilization Nata on "*nitrogen cascade*"
Pesticides	No	Agronomic modelling of impacts of pesticides (pesticide use reduction) on yields	Harmonized indicators of pesticide use and risk
Biodiversity	Very partially	Impact of crop management and diversity, land use and landscape features on biodiversity indicators	Harmonized indicators of biodiversity
Gross/net GHG emissions	Yes	Could be improved by better representation of the impact of farming practices/systems on gross GHG emissions and carbon storage	Data on GHG emissions linked to agricultural practices
Bio-economy	Partially	Could be improved by better integrating food losses and wastes	Harmonized data on losses and waste at the various stages on the food chain (from agricultural producers to final consumers)
Food diets	Very Partially	Could be improved by a better representation of consumers' preferences, dietary patterns, and of their nutritional and environmental impacts (for the moment, essentially limited to GHG emissions)	Data on diets and impact of diets taking into consumers' heterogeneity

Source: Own elaboration.

ANNEX A5.2. CRUDE ECONOMIC ASSESSMENT OF OUR PROPOSAL FOR THE FUTURE CAP BASED ON EU FADN DATA

This economic assessment is illustrative only. Many technical modalities and quantitative targets remain yet to be defined. Hence, we rely on crude assumptions for changes in the EU-28 farm sector that would correspond with the alignment of the CAP to our recommendations in order to make it consistent with the F2FS. We carry out simulations on 2018 FADN[76] data with a two-fold scenario: under the first simulation (S1), we assume that organic agriculture expands by tripling the number of organic farms for every farm type; under the second simulation (S2), we assume the reduction in the use of fertilizers and crop protection products in the remaining conventional farms. The overall scenario combines S1 and S2. We also analyse the economic consequences of increasing the agricultural area under high-diversified landscape features up to 10%.

The presentation of our results follows the chronology of our simulations S1 and S2. However, it is important to understand that the dynamics of the changes in our scenario follows a different sequence. Our policy proposals increase the environmental requirements for all farms and implement eco-scheme payments targeted on climate, biodiversity and animal welfare objectives. Both these requirements and incentives favour the increase of organic farming.

The first key hypothesis is the sharp reduction in pesticide use, to which the increasing adoption of organic farming contributes. The second hypothesis is the reduction in fertilization, again made easier by increasing developments in organic farming. We assume that decreases in plant and animal production derive from pesticide and fertilizer limitations. We assume unchanged international trade and as a result, no leakage of pollution abroad. This means that we assume a decrease in the EU consumption of agricultural products concentrated in animal products that matches the decrease in EU production. Using EU-28 data, we did not attempt to integrate the Brexit consequences.

Table A5.2.1: Main assumptions of the simulated scenario compared to the 2030 quantitative targets of the Green Deal

Policy objectives	Green Deal targets	Development of organic farming (S1)	Changes in remaining conventional farms (S2)	Overall scenario
Pesticide reduction	-50%		-30%	-31%
Fertilizer reduction	-20%		-15%	-18%
Share of organic farming area	25%	20%		20%
Change in each plant production			-10%	NA
Change in milk production			-8%	- 9%
Change in ruminant meat			-12%	- 9%
Change in pig, poultry and egg production			-4%	- 6.5%

Source: Own elaboration.
Note: NA for not available.

[76] The FADN is an instrument for evaluating the income of European agricultural holdings. It is also used for analysing the impacts of CAP reform scenarios on farm incomes and, increasingly, on climatic and environmental indicators (often thanks to the use of complementary data and the coupling of different models; see Annex A5.1). The FADN consists of an annual survey carried out by the European MS. Derived from national surveys, the FADN is the only source of microeconomic data that is harmonized, i.e., the bookkeeping principles are the same in all MS. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the EU. The survey does not cover all of the agricultural holdings in the EU but only those that could be considered as "commercial" given their size. Currently, the annual sample covers approximately 80,000 holdings.

Table A5.2.1 displays the main assumptions of S1 and S2 as compared to some of the Green Deal targets. The right-hand side column of this table provides the combined change in input and output resulting from S1 and S2. As compared to the Green Deal targets, we assume a lower adoption of organic farming and lower reductions in input use. This is because our time horizon is 2027, whereas the Green Deal targets are for 2030. We do not report the changes in each plant production because changes differ across crops.

The presentation of our simulations begins with the first part (S1) of our scenario; that is, the conversion of 517,100 European conventional farms into organic farming. We then present the second part (S2) of our scenario concerning the 3,097,100 conventional farms that were initially conventional and remain conventional at the end of the scenario. We thus assume that the total number of farms is unchanged (see Table A52.2.2).

The simulations integrate a sensitivity analysis to address the uncertainties related to the impact on production of a reduction in input use in S2. For the same input reduction, the output reductions might be lower thanks to technical progress and an increase in technical efficiency. For the same input reduction, the output reductions might be higher, taking into account other policy targets that we did not explicitly specify, such as animal welfare and the parts of farmland dedicated to semi-natural habitats.

The simulations do not aim to predict the future situation but, more modestly, to provide insights for policy debate.

1. Simulation S1: Threefold increase in the number of EU organic farms

With S1, the number of farms engaged in organic farming in each farm type is multiplied by three. This means, for example, that the share of organic farms specialized in Cereals, Oilseeds and Protein crops (hereafter COP) increases from 3 to 9% under S1. Thus, we assume that the conversion into organic farming is easier for the farm types where organic production is already widespread (for example, from 17 to 51% for farms specialized in olive oil). We consider that tripling the number of organic farms remains coherent with the possibility to ensure enough field organic manure for every crop. This hypothesis ignores any possible ceiling in the demand for organic products.

In total, the number of organic farms increases from 258,600 (the current situation according to the FADN) to 775,700 (the situation after the application of S1). Only farms that are fully engaged in organic farming are considered here. Farms in the conversion process or those with both conventional and organic productions are not taken into account in the calculations. In S1, we thus consider that 517,100 European farms initially engaged in conventional agriculture would convert to organic farming (***Table A5.2.2***). Organic farms represent then 19% of the total number of EU farms compared to 6.3% in the initial situation.

With S1, the threefold increase in the number of organic farms concerns all production types. Farms that were in conventional agriculture and then convert to organic agriculture resume the same characteristics and results as farms that are currently engaged in organic agriculture; the calculation is carried out for each type of production. For example, in the case of European COP farms, it is assumed that the 38,200 farms switching from conventional to organic farming once the transition phase has been completed will have economic characteristics (surfaces, yields, etc.) and results (production levels, costs, etc.) equivalent to those of the 19,100 COP farms that were initially engaged in organic farming (See Annex A4.1). In particular, we do not assume any organic-price drop in response to the huge increase in the supply of organic products. In the same way, we do not assume changes in the per-farm

distribution of direct aids to organic holdings. These are obviously two (very) strong assumptions. As a result, caution is required to in reading the following results of S1.

Table A5.2.2: Number of conventional and organic farms before and after applying S1

		Number of farms (FADN)	Conventional farms		Organic farms		
			Initial situation	After S1	Initial situation	After S1	Share after S1
15	Specialist COP	653 800	622 000	583 700	19 100	57 300	9%
16	Specialist other field crops	426 500	391 200	349 700	20 800	62 400	15%
20	Specialist horticulture	140 000	128 100	118 000	5 100	15 200	11%
35	Specialist wine	224 300	195 300	156 600	19 400	58 200	26%
36	Specialist orchards – fruits	259 600	221 900	180 300	20 800	62 400	24%
37	Specialist olives	173 200	112 500	53 900	29 300	87 900	51%
38	Permanent crops combined	97 800	79 300	58 300	10 500	31 400	32%
45	Specialist milk	438 600	400 100	335 000	32 500	97 600	22%
48	Specialist sheep and goats	328 000	289 600	249 500	20 000	60 100	18%
49	Specialist cattle	356 800	308 300	237 200	35 600	106 700	30%
50	Specialist granivores	111 200	105 700	98 800	3 500	10 400	9%
60	Mixed crops	180 400	158 800	132 500	13 200	39 500	22%
70	Mixed livestock	100 400	95 200	88 800	3 200	9 600	10%
80	Mixed crops and livestock	545 100	506 200	454 900	25 700	77 000	14%
---	**Total**	**4 035 700**	**3 614 300**	**3 097 100**	**258 600**	**775 700**	**19%**

Source: FADN 2018 – Authors' calculations.

European expenditure on fertilizers currently amounts to €18.07 billion. COP farms account for 33.6% of this amount while those specialized in sheep and goats account for 2.3% only (***Table A5.2.3***). The application of S1 leads to a 6.6% decrease in fertilizer expenditure at the overall EU level (that is, €1.18 billion). This decrease is only due to the switch to organic farming where the use of mineral fertilizers is prohibited. The average decrease varies according to farm type (for example, -4.8% for COP farms and -18.2% for cattle farms).

Table A5.2.3: Impact of S1 on fertilizer costs

		Initial situation		After S1		Variation S1 / Initial situation		
		Million €	% EU	Million €	% EU	Million €	% EU	%
15	Specialist COP	6 074	33.6%	5 781	34.2%	-292	24.6%	-4.8%
16	Specialist other field crops	2 729	15.1%	2 573	15.2%	-156	13.1%	-5.7%
20	Specialist horticulture	928	5.1%	914	5.4%	-15	1.2%	-1.6%
35	Specialist wine	511	2.8%	508	3.0%	-3	0.3%	-0.7%
36	Specialist orchards – fruits	683	3.8%	665	3.9%	-18	1.5%	-2.6%
37	Specialist olives	364	2.0%	309	1.8%	-55	4.6%	-15.2%
38	Permanent crops combined	152	0.8%	164	1.0%	12	-1.0%	8.1%
45	Specialist milk	2 011	11.1%	1 759	10.4%	-252	21.2%	-12.5%
48	Specialist sheep and goats	407	2.3%	377	2.2%	-30	2.5%	-7.4%
49	Specialist cattle	981	5.4%	803	4.8%	-178	15.0%	-18.2%
50	Specialist granivores	509	2.8%	482	2.9%	-27	2.3%	-5.3%
60	Mixed crops	535	3.0%	506	3.0%	-28	2.4%	-5.3%
70	Mixed livestock	220	1.2%	211	1.2%	-9	0.7%	-4.1%
80	Mixed crops and livestock	1 967	10.9%	1 830	10.8%	-138	11.6%	-7.0%
---	**Total**	**18 070**	**100.0%**	**16 881**	**100.0%**	**-1 189**	**100.0%**	**-6.6%**

Source: FADN 2018 – Authors' calculations.

Regarding expenditure in crop protection products, we estimate the impact of S1 at -7.8% at the EU level (***Table A5.2.4***). The decline is equal to -5.8% for COP farms that account for nearly one third of pesticide expenditure. The decline is more significant in the olive sector (-25.5%) where the share of organic farms reaches 51% after S1.

The direct impact of S1 on the value of agricultural production is estimated at +0.4% (***Table A5.2.5)***. The impact is negative for some types of production (for example, -1.5% for COP farms), where the decrease in physical yield induced by the shift to organic production methods is higher than the price premium for organic products. It is positive for other productions (for example, +13.8% for farm specialized in wine production) where the price premium more than compensates for the decrease in physical yields.

Table A5.2.4: Impact of S1 on plant protection costs

		Initial situation		After S1		Variation S1 / Initial situation		
		Million €	% EU	Million €	% EU	Million €	% EU	%
15	Specialist COP	4 249	32.7%	4 005	33.5%	-245	24.1%	-5.8%
16	Specialist other field crops	2 315	17.8%	2 118	17.7%	-196	19.4%	-8.5%
20	Specialist horticulture	752	5.8%	712	5.9%	-40	3.9%	-5.3%
35	Specialist wine	1 006	7.8%	984	8.2%	-22	2.2%	-2.2%
36	Specialist orchards – fruits	938	7.2%	855	7.1%	-83	8.2%	-8.9%
37	Specialist olives	202	1.6%	151	1.3%	-52	5.1%	-25.5%
38	Permanent crops combined	139	1.1%	135	1.1%	-4	0.4%	-3.0%
45	Specialist milk	657	5.1%	562	4.7%	-94	9.3%	-14.3%
48	Specialist sheep and goats	84	0.6%	75	0.6%	-8	0.8%	-10.0%
49	Specialist cattle	269	2.1%	211	1.8%	-58	5.7%	-21.5%
50	Specialist granivores	454	3.5%	426	3.6%	-28	2.8%	-6.2%
60	Mixed crops	438	3.4%	387	3.2%	-51	5.0%	-11.6%
70	Mixed livestock	144	1.1%	136	1.1%	-9	0.9%	-6.1%
80	Mixed crops and livestock	1 336	10.3%	1 213	10.1%	-123	12.1%	-9.2%
---	**Total**	**12 984**	**100.0%**	**11 971**	**100.0%**	**-1 013**	**100.0%**	**-7.8%**

Source: FADN 2018 – Authors' calculations.

Table A5.2.5: Impact of S1 on the value of agricultural production

		Initial situation		After S1		Variation S1 / Initial situation		
		Million €	% EU	Million €	% EU	Million €	% EU	%
15	Specialist COP	46.06	12.9%	45.35	12.6%	-714	-50.9%	-1.5%
16	Specialist other field crops	34.04	9.5%	34.22	9.5%	176	12.6%	0.5%
20	Specialist horticulture	31.83	8.9%	31.14	8.7%	-689	-49.2%	-2.2%
35	Specialist wine	24.42	6.8%	27.78	7.7%	3 359	239.8%	13.8%
36	Specialist orchards – fruits	14.36	4.0%	14.21	4.0%	-157	-11.2%	-1.1%
37	Specialist olives	4.78	1.3%	4.35	1.2%	-434	-31.0%	-9.1%
38	Permanent crops combined	2.89	0.8%	3.04	0.8%	153	10.9%	5.3%
45	Specialist milk	68.63	19.2%	68.57	19.1%	-57	-4.1%	-0.1%
48	Specialist sheep and goats	14.29	4.0%	15.05	4.2%	755	53.9%	5.3%
49	Specialist cattle	22.88	6.4%	22.16	6.2%	-728	-52.0%	-3.2%
50	Specialist granivores	45.32	12.7%	44.94	12.5%	-375	-26.8%	-0.8%
60	Mixed crops	8.55	2.4%	8.75	2.4%	195	14.0%	2.3%
70	Mixed livestock	8.51	2.4%	8.76	2.4%	252	18.0%	3.0%
80	Mixed crops and livestock	31.11	8.7%	30.77	8.6%	-337	-24.0%	-1.1%
---	**Total**	**357.68**	**100.0%**	**359.08**	**100.0%**	**1 401**	**100.0%**	**0.4%**

Source: FADN 2018 - Author's calculations.

Table A5.2.6 presents the impact of S1 on incomes for the farms that were initially conventional and convert to organic production. Farm income (including CAP payments) increases by €5,690 per farm. The price premium of organic products is not sufficient to offset the decrease in physical yields. It is because organic farms receive more CAP payments than conventional farms (on average +€9,700 per farm) that the income of farms that convert to organic farming increases (+25%). This average increase masks differences depending on the productive orientation of farms. The income decreases for horticulture and olive farms. It increases for other farm types, notably by more the farms specialized in wine, sheep and goat, as well as for mixed-livestock and mixed-crop and livestock farms. These calculations do not take into account the cost of conversion to organic farming. S1 induces an increase in CAP organic payments of about €5 billion in 2027. Assuming that each year, the same number of holdings convert to organic farming, CAP organic payments would increase by about €20 billion over the 2021-2027 period, which represents around 6% of total CAP planned expenditure.

Table A5.2.6: **Economic impact of S1 for conventional farms converting to organic agriculture, in euros and in percent**

		Per farm	Per agricultural work unit	Per hectare of UAA	In % of agricultural production	In % of gross operation surplus	In % of family farm income
15	Specialist COP	+5 150	+4 000	+72	+7%	+17%	+28%
16	Specialist other field crops	+7 110	+4 760	+185	+9%	+20%	+31%
20	Specialist horticulture	-21 760	-6 340	-3 315	-9%	-29%	-37%
35	Specialist wine	25 860	+15 230	1 714	+26%	+51%	+64%
36	Specialist orchards – fruits	+4 920	+2 820	+487	+9%	+18%	+24%
37	Specialist olives	-1 330	-1 320	-96	-5%	-7%	-9%
38	Permanent crops combined	+6 700	+6 010	+659	+24%	+39%	+51%
45	Specialist milk	+3 330	+1 770	+73	+2%	+6%	+9%
48	Specialist sheep and goats	+10 460	+7 560	+222	+25%	+51%	+66%
49	Specialist cattle	+5 660	+4 290	+107	+9%	+20%	+35%
50	Specialist granivores	+20 900	+8 610	+491	+5%	+23%	+38%
60	Mixed crops	+6 550	+4 280	+333	+14%	+31%	+44%
70	Mixed livestock	+8 700	+5 610	+317	+11%	+36%	+67%
80	Mixed crops and livestock	+6 840	+4 600	+203	+12%	+35%	+64%
---	**Total**	**+5 690**	**+3 600**	**+144**	**+6%**	**+17%**	**+25%**

Source: FADN 2018 - Author's calculations.

At the EU-28 level, S1 leads to a decline in the number of Livestock Units (LU) by 2.0% on average (***Table A5.2.7***). The decrease in both the number of animals and in fertilizer use leads to a reduction of agricultural GHG emissions.

Table A5.2.7: Impact of S1 on the number of Livestock Units (LU)

		Initial situation		After S1		Variation S1 / Initial situation		
		Million LU	% EU	Million LU	% EU	Million LU	% EU	%
15	Specialist COP	1.52	1.2%	1.51	1.2%	-0.01	0.5%	-0.8%
16	Specialist other field crops	1.02	0.8%	1.00	0.8%	-0.03	1.0%	-2.5%
20	Specialist horticulture	0.04	0.0%	0.05	0.0%	+0.00	-0.1%	+8.4%
35	Specialist wine	0.04	0.0%	0.05	0.0%	+0.01	-0.5%	+28.5%
36	Specialist orchards – fruits	0.05	0.0%	0.05	0.0%	+0.01	-0.2%	+10.4%
37	Specialist olives	0.03	0.0%	0.03	0.0%	+0.00	0.0%	-3.6%
38	Permanent crops combined	0.04	0.0%	0.04	0.0%	-0.01	0.3%	-17.1%
45	Specialist milk	30.04	23.6%	29.53	23.7%	-0.50	19.8%	-1.7%
48	Specialist sheep and goats	11.96	9.4%	12.15	9.7%	+0.19	-7.4%	+1.6%
49	Specialist cattle	21.21	16.7%	20.59	16.5%	-0.62	24.3%	-2.9%
50	Specialist granivores	42.56	33.4%	41.11	33.0%	-1.45	56.9%	-3.4%
60	Mixed crops	0.32	0.3%	0.32	0.3%	+0.00	0.1%	-0.8%
70	Mixed livestock	5.96	4.7%	5.99	4.8%	+0.03	1.2%	+0.5%
80	Mixed crops and livestock	12.49	9.8%	12.33	9.9%	-0.17	6.5%	-1.3%
---	**Total**	**127.28**	**100.0%**	**124.73**	**100.0%**	**-2.55**	**100.0%**	**-2.0%**

Source: FADN 2018 - Author's calculations.

Impacts on agricultural GHG emissions

S1 entails a mechanical reduction in agricultural GHG emissions. Emissions of enteric methane decrease thanks to the reduction in dairy cows (-2.6%), other cattle (-0.6%), sheep and goats (-0.4%), and other livestock including pigs and poultry (-3%). Methane and nitrous oxide emissions from manure management decrease in line with the decrease in total livestock units (-2%). Soil nitrous oxide associated with organic fertilization (34% of soil emissions) decreases accordingly (-2%), while nitrous oxide associated with inorganic fertilization (39% of soil emissions) decreases according to the decrease in purchased fertilizers (-6.6%). This results in an overall decrease in soil nitrous oxide (-3.3%). Using the GWP_{100} of the 4th IPCC report (2006), agricultural GHG emissions decrease by 8.9 $MtCO_2eq$.

2. Simulation S2: Changes for conventional farms that remain conventional

S2 deals with farms that were initially conventional and remain conventional (3.097 million farms). S2 imposes on these conventional farms the constraints designed to reduce the use of polluting inputs (fertilizers and pesticides). More specifically, we assume:

- A drop in purchased fertilizers of -15% (at constant prices) and in crop protection products of -30% (at constant prices). We assume that this reduced use of chemical inputs leads to a 10% drop in physical yields of every plant production (cereals, oilseeds, wine, horticulture, etc.);
- A drop (at constant prices) in milk production by 8%, in ruminant meat production (beef, sheep and goat meat) by 12% and in non-ruminant production (pig, poultry and eggs) by 4%. This means that we assume that most of the decrease in plant production translates to the lower availability of animal feed. In the EU, about 60% of EU planted area is devoted to animal feed.

We assume that CAP subsidies perceived by each conventional farms are constant. Globally, the increase in CAP organic payments offsets the decrease in payments for conventional farms. Furthermore, our calculations do not take into account redistributive effects on farm incomes linked to changes in CAP payment distribution induced by our climatic and environmental recommendations for the future CAP. These redistribution effects should affect differently the different types of farms

defined on the basis of their productive specialisation. They should also affect the farms of a given specialisation depending on production practices and systems.

For the 3.097 million of conventional farms that remain conventional, S2 leads to an overall loss in gross margin of €17.76 billion (***Table A5.2.8***). The sales of farm products decrease by €23.32 billion while the purchases of farm inputs decrease by €5.58 billion. The decrease in chemical input expenditure (-€2.27 billion for fertilizers and -€3.31 billion for crop protection products) is thus significantly lower than the production value drop (-€14.65 billion for crop production, -€3.74 billion for milk, -€3.38 billion for beef, sheep and goat meat, and -€1.15 for non-ruminant livestock). The impact of S2 is particularly important for dairy farms (24.2% of total impact), horticultural farms (13.6%) and COP farms (10.3%).

The impact of S2 on conventional farms is estimated -€5,740 per farm, -€3,630 per average work unit and -€145 per hectare. This represents a drop by -6% of the production value, -17% of the gross operation surplus and -25% of the family farm income (***Table A5.2.9***).

Taking into account all farms in the EU (that is, the 3.097 million conventional farms before and after S1, the 258,600 farms already engaged in organic farming and the 517,200 farms that have switched from conventional to organic farming), the combined impact of S1 and S2 is estimated at -€12.9 billion euros. This corresponds to -€3,580 euros per farm, -€2,270 euros per agricultural work unit, -4% of the production value, -10% of the gross operating surplus and- 15% of the farm family income (***Table A5.2.10***).

Table A5.2.8: Impact of S2 on conventional farms (before and after S1), in million euros

	Changes in	Fertilizer cost	Plant protection cost	Plant production	Milk production	Beef, goat and sheep production	Pig, egg, and poultry	Gross margin
		Million €	Million €	Million €	Million €	Million €	Million €	Million €
15	Specialist COP	-835	-1 178	-3 605	-8	-77	-7	-1 684
16	Specialist other field crops	-346	-602	-2 440	-7	-43	-12	-1 554
20	Specialist horticulture	-116	-191	-2 517	-1	-2	0	-2 213
35	Specialist wine	-54	-214	-1 506	0	-1	0	-1 240
36	Specialist orchards – fruits	-71	-206	-934	0	-2	0	-660
37	Specialist olives	-19	-24	-151	0	-1	0	-110
38	Permanent crops combined	-13	-25	-147	0	-2	0	-112
45	Specialist milk	-246	-163	-624	-3 056	-657	-6	-3 934
48	Specialist sheep and goats	-49	-20	-214	-15	-884	-2	-1 045
49	Specialist cattle	-109	-61	-284	-136	-1 120	-2	-1 371
50	Specialist granivores	-70	-126	-402	-18	-28	-1 289	-1 541
60	Mixed crops	-59	-101	-545	-5	-11	-2	-403
70	Mixed livestock	-30	-40	-126	-148	-131	-96	-432
80	Mixed crops and livestock	-257	-355	-1 162	-349	-426	-139	-1 463
---	**Total**	**-2 274**	**-3 305**	**-14 658**	**-3 744**	**-3 385**	**-1 555**	**-17 762**

Source: FADN 2018 - Author's calculations.

Table A5.2.9: Impact of S2 on conventional farms (before and after S1), in euros and in percent

		Per farm	Per agricultural work unit	Per hectare of UAA	In % of agricultural production	In % of gross operation surplus	In % of family farm income
15	Specialist COP	-2 880	-2 240	-41	-4%	-9%	-16%
16	Specialist other field crops	-4 440	-2 970	-116	-6%	-13%	-19%
20	Specialist horticulture	-18 760	-5 470	-2 858	-8%	-25%	-32%
35	Specialist wine	-7 920	-4 670	-525	-8%	-16%	-20%
36	Specialist orchards – fruits	-3 660	-2 100	-362	-7%	-14%	-18%
37	Specialist olives	-2 040	-2 020	-147	-7%	-11%	-14%
38	Permanent crops combined	-1 910	-1 720	-188	-7%	-11%	-15%
45	Specialist milk	-11 740	-6 240	-257	-8%	-20%	-33%
48	Specialist sheep and goats	-4 190	-3 030	-89	-10%	-20%	-26%
49	Specialist cattle	-5 780	-4 390	-109	-9%	-21%	-35%
50	Specialist granivores	-15 600	-6 420	-367	-4%	-17%	-29%
60	Mixed crops	-3 040	-1 990	-154	-7%	-15%	-20%
70	Mixed livestock	-4 870	-3 130	-177	-6%	-20%	-37%
80	Mixed crops and livestock	-3 220	-2 160	-96	-6%	-16%	-30%
---	**Total**	**-5 740**	**-3 630**	**-145**	**-6%**	**-17%**	**-25%**

Source: FADN 2018 - Author's calculations.

Table A5.2.10: Impact of the overall scenario (S1+S2) for all arms, in euros and in percent

		Per farm	Per agricultural work unit	Per hectare of UAA	In % of agricultural production	In % of gross operation surplus	In % of family farm income
15	Specialist COP	-2 270	-1 760	-32	-3%	-7%	-12%
16	Specialist other field crops	-2 950	-1 970	-77	-4%	-8%	-12%
20	Specialist horticulture	-17 380	-5 060	-2 648	-8%	-23%	-30%
35	Specialist wine	-1 060	-620	-70	-1%	-2%	-2%
36	Specialist orchards – fruits	-1 750	-1 000	-173	-3%	-7%	-8%
37	Specialist olives	-1 080	-1 070	-78	-4%	-6%	-7%
38	Permanent crops combined	290	260	29	1%	2%	2%
45	Specialist milk	-8 470	-4 500	-185	-5%	-15%	-23%
48	Specialist sheep and goats	-1 910	-1 380	-41	-4%	-9%	-11%
49	Specialist cattle	-2 710	-2 060	-51	-4%	-10%	-16%
50	Specialist granivores	-12 560	-5 170	-295	-3%	-14%	-23%
60	Mixed crops	-1 280	-840	-65	-3%	-6%	-8%
70	Mixed livestock	-3 750	-2 420	-137	-4%	-16%	-27%
80	Mixed crops and livestock	-2 040	-1 370	-61	-4%	-10%	-18%
---	**Total**	**-3 580**	**-2 270**	**-90**	**-4%**	**-10%**	**-15%**

Source: FADN 2018 - Author's calculations.

Impacts on agricultural GHG emissions

Applied to the conventional farms (before and after S1), S2 entails a mechanical reduction in agricultural GHG emissions. Enteric methane decreases thanks to the reduction in dairy cows (-8%), other cattle (-12%), sheep and goats (-10%). Methane and nitrous oxide emissions from manure management decreases (-6.3%) more or less proportionally to the reduction in total livestock units. Soil nitrous oxide emissions associated with organic fertilization (35% of soil emissions given S1) decreases accordingly (-6.3%), while nitrous oxide associated with inorganic fertilization (38% of soil emissions given S1) decreases according to the drop in bought fertilizers (-15%); ending with an overall decrease in soil nitrous oxide (-7.9%). Using the GWP_{100} of the 4th IPCC report (2006), S2 leads to a decrease in agricultural GHG emissions by 25 $MtCO_2eq$.

Globally, S1 and S2 together result in a decrease of agricultural GHG emissions by 33.9 $MtCO_2eq$ (8.7% of 2018 agricultural GHG emissions), which are some distance from the target of a 35% decrease in non-CO_2 GHG emissions between 2015 and 2030.

It is important to note that we do not simulate the additional carbon sequestration in soils because FADN data are inappropriate.

3. Sensitivity analysis for S2

The first sensitive simulation (S2a) assumes that the S2 decrease in fertilizer and pesticide use leads to lower production decreases, more specifically -5% for yields, -4% for milk production, -6% for ruminant meat production and -2% for non-ruminant production. On the contrary, ***the second sensitivity simulation (S2b)*** assumes that the S2 decrease in fertilizer and pesticide use leads to higher production decreases, more specifically -15% for yields, -12% for milk production, -18% for ruminant meat production and -6% for non-ruminant production. The first option represents a favourable situation with efficient and productive farms despite the decrease in chemical inputs and the profound changes in agricultural practices. The second option represents a much less favourable situation with less efficient and less productive conventional farms, where the decrease in chemical inputs and the profound changes in agricultural practices are (as yet) imperfectly mastered by farmers. The second sensitivity simulation can also be interpreted as capturing the additional impact of devoting 10% of total farmland to high-diversified landscape features (a target of the EU Biodiversity Strategy for 2030) in the central S2 simulation. Results are displayed in ***Table A5.2.11*** (in percent of farm income) and ***Table A5.2.12*** (in euros per farm).

Table A5.2.11: S2 sensitivity simulation (in % of farm income)

		Conventional farms (before and after S1)			All farms		
		S2	**S2a**	**S2b**	**S2**	**S2a**	**S2b**
15	Specialist COP	-16%	2%	-33%	-12%	3%	-28%
16	Specialist other field crops	-19%	-4%	-34%	-12%	0%	-25%
20	Specialist horticulture	-32%	-14%	-51%	-30%	-15%	-46%
35	Specialist wine	-20%	-8%	-31%	-2%	5%	-10%
36	Specialist orchards – fruits	-18%	-5%	-31%	-8%	0%	-16%
37	Specialist olives	-14%	-4%	-24%	-7%	-4%	-10%
38	Permanent crops combined	-15%	-5%	-24%	2%	7%	-3%
45	Specialist milk	-33%	-15%	-50%	-23%	-10%	-37%
48	Specialist sheep and goats	-26%	-12%	-41%	-11%	-1%	-21%
49	Specialist cattle	-35%	-16%	-55%	-16%	-3%	-28%
50	Specialist granivores	-29%	-12%	-45%	-23%	-9%	-37%
60	Mixed crops	-20%	-6%	-34%	-8%	2%	-18%
70	Mixed livestock	-37%	-16%	-59%	-27%	-9%	-44%
80	Mixed crops and livestock	-30%	-9%	-51%	-18%	-1%	-35%
---	**Total**	**-25%**	**-9%**	**-42%**	**-15%**	**-3%**	**-28%**

Source: FADN 2018 - Author's calculations.
Note: Favourable (S2a) and unfavourable (S2b) simulations. For details on simulation assumptions, see text.

Table A5.2.12: S2 sensitivity simulations (in euros per farm)

		Conventional farms (before and after S1)			All farms		
		S2	S2a	S2b	S2	S2a	S2b
15	Specialist COP	-2 880	280	-6 050	-2 270	550	-5 100
16	Specialist other field crops	-4 440	-870	-8 020	-2 950	-20	-5 880
20	Specialist horticulture	-18 760	-8 080	-29 440	-17 380	-8 380	-26 390
35	Specialist wine	-7 920	-3 110	-12 740	-1 060	2 300	-4 420
36	Specialist orchards – fruits	-3 660	-1 060	-6 260	-1 750	50	-3 560
37	Specialist olives	-2 040	-630	-3 450	-1 080	-650	-1 520
38	Permanent crops combined	-1 910	-630	-3 200	290	1 060	-470
45	Specialist milk	-11 740	-5 260	-18 230	-8 470	-3 520	-13 430
48	Specialist sheep and goats	-4 190	-1 960	-6 420	-1 910	-210	-3 610
49	Specialist cattle	-5 780	-2 530	-9 030	-2 710	-550	-4 880
50	Specialist granivores	-15 600	-6 800	-24 390	-12 560	-4 750	-20 370
60	Mixed crops	-3 040	-920	-5 170	-1 280	280	-2 840
70	Mixed livestock	-4 870	-2 040	-7 690	-3 750	-1 250	-6 250
80	Mixed crops and livestock.	-3 220	-940	-5 500	-2 040	-140	-3 950
---	**Total**	**-5 740**	**-1 970**	**-9 500**	**-3 580**	**-690**	**-6 470**

Source: FADN 2018 - Author's calculations.
Note: Favourable (S2a) and unfavourable (S2b) simulations. For details on S2a and S2b assumptions, see main text.

4. Farm gate demand price elasticities required to maintain unchanged conventional farms' incomes

Under S2, assuming constant prices, the average gross margin of conventional farms decreases by €5,740 per farm. The decline ranges from €2,040 (olives) to €18,760 (horticulture). In response to this reduction in production, it is likely that prices will increase in function of demand elasticities that vary between productions. Green et al. (2013) reported elasticities for nine food product categories: -0.53 for fruit and vegetables, -0.60 for meat, -0.60 for milk, - 0.43 for cereals, etc.

In the case of COP farms, the price increase needed to maintain the gross margin of COP farms is +4.6% when the production decrease is 10% (central S2). This means that the price elasticity of demand at the farm gate should range between -2.2 and 0 in order not to have a decrease in gross margin (***Table A5.2.13***). In the case of milk producers, the price increase is +10.3% meaning that the "*demand*" price elasticity should range between -1.1 and 0. This is because cost savings are proportionally much lower for dairy producers than for COP producers. However, numerous studies concluded that the milk demand was inelastic. For example, Bouamra et al. (2013) estimated that a 1% decrease in milk production translates into a price increase of about 3%.

The above-mentioned elasticities relate to consumer prices that are much higher than producer prices. The demand elasticity at the farm gate will then depend on the price formation within the food chain. Furthermore, in the case of crop products, a significant part of the production is used for animal feed and not for food. The feed demand is generally more elastic than the food demand. As a result, the price increase required to maintain the average gross margin for COP producers could be lower than +4.5%. For feed crops and fodders, the price increase could be very small because, in our simulations, the number of animals decreases and thus, so does the demand for animal feed.

On the other hand, the estimated positive impact on income of converting farms from conventional to organic farming could be lower than reported because the increase in the production of organic farming is likely to affect prices. In practice, changes in price will also depend on how the demand for the two types of products evolves. Clearly, the rough assessment that we were able to carry out with microeconomic data would need to be completed with simulations of the complex and cascading price effects: these would require the development of specific modelling approaches, given the limitations

of most models regarding the representation of the organic sector and the dynamics of changes in chemical input use (see Annex A5.1).

Table A5.2.13: Change in volume of production, price change and threshold "*demand*" elasticity per farm type required to maintain the average gross margin for conventional farms (before and after S1) in the central S2 simulation

	Change in production volume	Price increase required to maintain unchanged average gross margins	Threshold "demand" elasticity
Specialist COP	-10%	4,6%	-2.20
Specialist other field crops	-10%	6,2%	-1.61
Specialist horticulture	-10%	8,8%	-1.14
Specialist wine	-10%	8,2%	-1.22
Specialist orchards – fruits	-10%	7,1%	-1.42
Specialist olives	-10%	7,2%	-1.38
Permanent crops combined	-10%	7,5%	-1.33
Specialist milk	-8%	10,3%	-1.10
Specialist sheep and goats	-12%	14,2%	-1.07
Specialist cattle	-12%	14,7%	-1.12
Specialist granivores	-4%	4,7%	-1.13
Mixed crops	-10%	7,2%	-1.40
Mixed livestock	-10%	8,6%	-1.16
Mixed crops and livestock.	-10%	7,0%	-1.42

Source: Own elaboration.