STUDY

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European Parliament

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

ANNEXES

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

ANNEXES

Abstract

This document provides the annexes of the final report on "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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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

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	
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Costică Mihai (Ticu)	Professor of the "Alexandru Ioan Cuza" University of Iasi, Romania
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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
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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
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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.

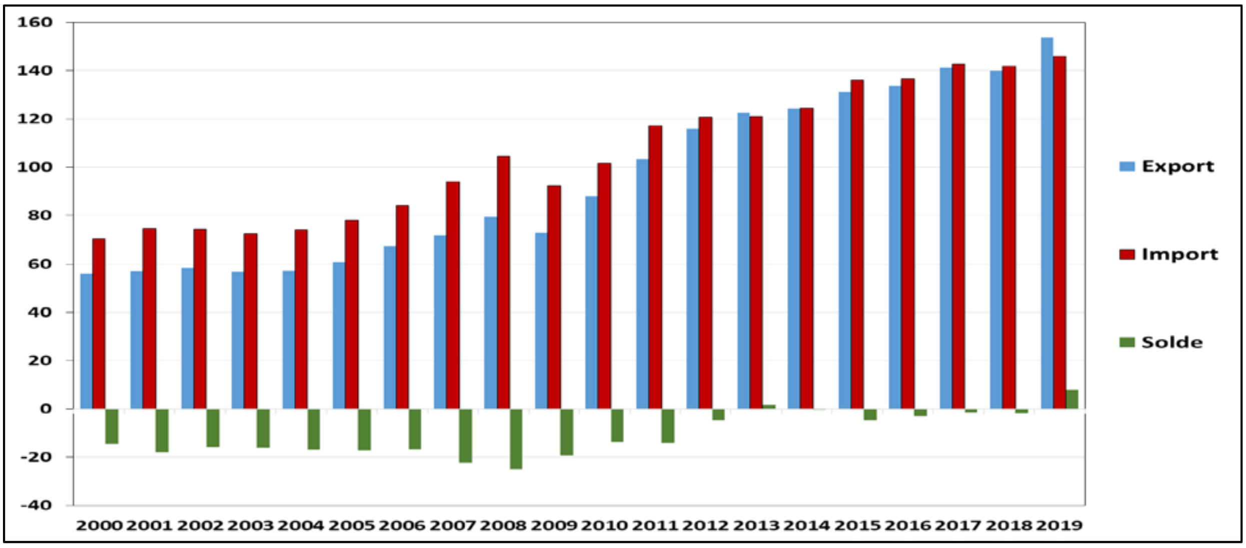
Table A3.2.4: Cost of crop protection products in 2007-2018 and 2018 in EU MS (euros and percent)

	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.[1] 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.

[1] 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 Favoured 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 Favoured 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 Favoured 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 Favoured 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 Favoured 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 Favoured 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 Favoured 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:

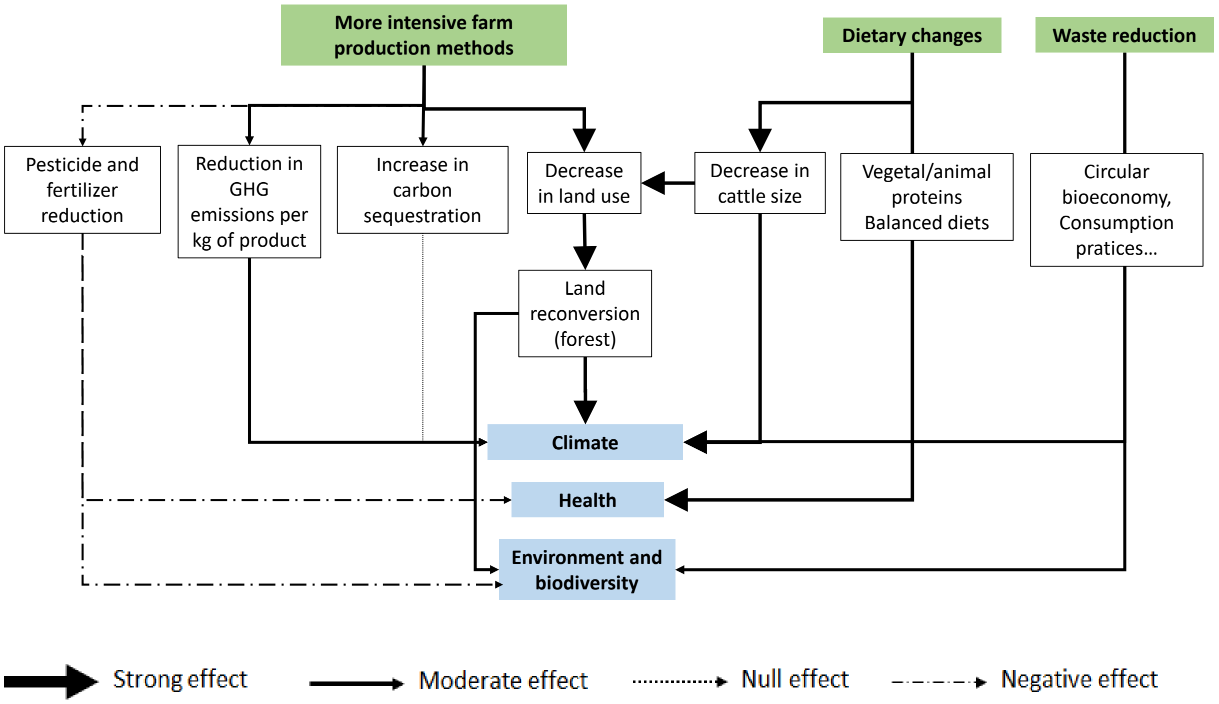
- The first strategy is based on an ***"intensification" process***, which targets yield increases worldwide and aims at closing the yield gap between regions at the global level. Scenarios considered by Springmann et al., (2018) at the global level or Lóránt and Allen (2019) at the European level fall 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

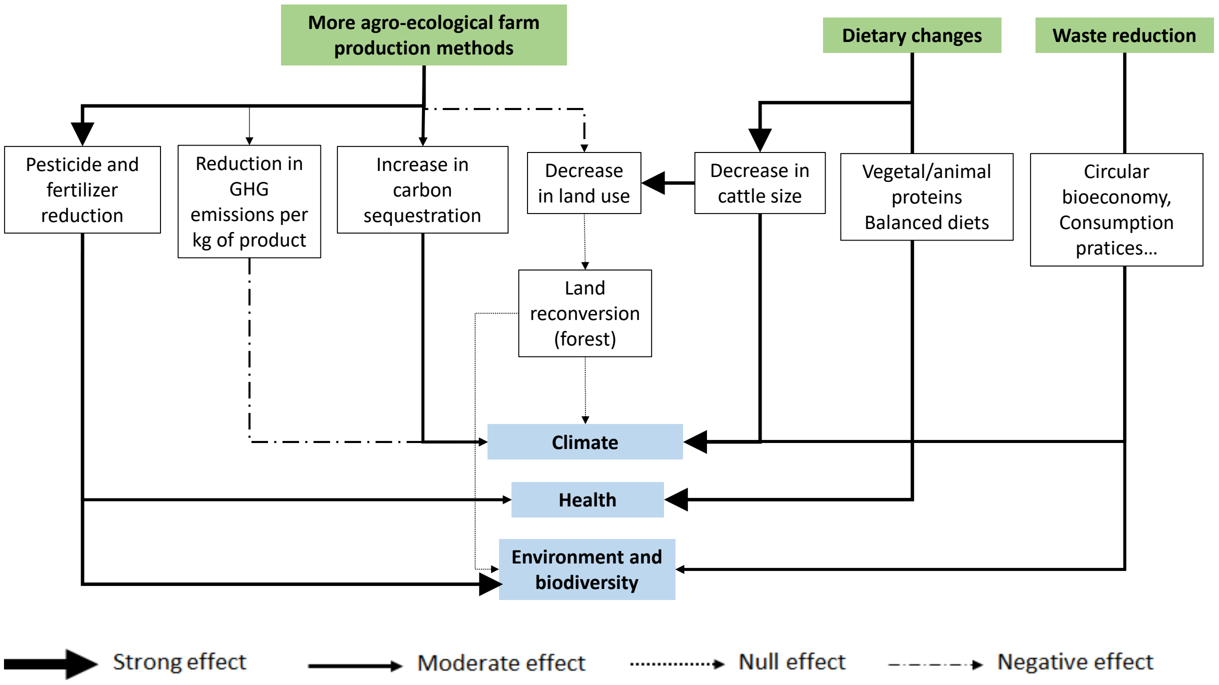


Source: Own elaboration.
Note: The scheme does not take into account changes in imports and exports, and their feedback effects (notably through price changes).

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[2]

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

[2] 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*".[3] 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).[4] 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.

[3] Quoted from EURACTIV (23 June 2020, updated 7 July 2020).

[4] 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[5], STICS[6], ORCHIDEE[7]). 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

5 *https://epicapex.tamu.edu/epic/.*
6 *https://www6.paca.inrae.fr/stics_eng/About-us/Stics-model-overview.*
7 *https://orchidee.ipsl.fr.*

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 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[8] 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.

[8] 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 4^{th} 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 4^{th} 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.

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