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Compatibility of Agricultural Management Practices and Types of Farming in the EU to enhance Climate Change Mitigation and Soil Health

Policy bundles framing agricultural soil protection in EU and selected member states

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Executive summary

This deliverable analyses the relationships between the various policy packages involved in soil sustainable management, and the soil management practices they foster or restrict, at the European level and in eight Member States. Soil processes are at the interface between agricultural production and ecosystem services provision, and making sure that these processes work properly is a matter of multi-layered policies and actors, in an uncertain environment. To analyse the policy context, we have built a method that grouped together two different frameworks. Using these two frameworks together, we have designed a grid in which each relevant policy measure favours (or hampers) the adoption of each BMP, with which objectives, and whether they are implemented on a mandatory way, or with incentives, or even in a voluntary way.

Soil protection is at the interface of three major policy packages: agricultural and rural policies, where soil is considered as a production mean that needs sometimes to be preserved, environmental policies where the soil is considered as a medium towards air, water or biodiversity protection, and urban policies where forest or agricultural soils have to be preserved from urban sprawl. Since the last twenty years, soils are also a matter of policy packages related to climate change, mostly under the Kyoto protocol. The immediate consequence of soils being at the interface is the existence of a bundle of soil-related policy measures, with expected direct or indirect effects on soils: in 2008 for instance, Kutter *et al.* (2011) accounted for 410 different soil conservation measures in the European Member states, while Eurostat breakdown of agri-environmental measures (AEM) considered in 2008 that 8 % of the EU-27 agricultural area under AEM benefit from actions to conserve soils.

A proposal for a Soil Framework Directive has been initiated in 2006 with the objective of simplifying the way soils stakes are considered in policies and initiating comprehensive legislation on soil protection. This Directive was unfortunately withdrawn in May 2014[1]. Since this withdrawal, the Soil Thematic Strategy takes actions to integrate soil stakes into all relevant policies when renewed.

The main consequences on the Soil Thematic Strategy lie on the expected impacts on the region oriented approach led by the new CAP on decentralized effects which may, in turn, affect existing political and institutional relationships. There is a balance between the freedom of regions to design a variety of instruments to protect soil, directly or indirectly, and administrative burden linked to the new governance schemes where changes have to occur. Limited budgets for environmental protection in a context of economic crisis also require improving the cost-effectiveness of policy measures, which results, depending on the region and country, on putting less emphasis on soils protection objectives, or on combining measures so as to protect soils by side effects of promoted practices.

The analysis of the wide range of policy packages and their instruments implemented in the Catch-C partner countries highlights that soil stakes are embedded to different degrees in these countries. Building on this embeddedness and on the focus of each country on coherence between the various instruments they use towards soil, we have found three different strategies (see also fig below):

- Some have designed for long a comprehensive strategy towards soil protection; they consider that soil provides multiple functions, from habitats to raw material extraction through production of food and building materials. For these countries, raising concern about soil protection at EU level enforces national and regional policies, sometimes permits to design harmonized policy packages at national level (more coordination from regional initiatives). This is the case for Germany, and to a lower extent Austria. Belgium has an intermediate strategy with the next group.
- Some countries took the opportunity of implementing EU strategy to design some place-based policies to deal with local soil issues, mostly erosion (Italy, Spain and Poland).
- Last set of countries (France and The Netherlands) relies more on side-effect of already existing measures to ensure a minimum soil protection, and instead focus on other stakes like biodiversity or water protection.

[1] OJ C 163, 28.5.2014

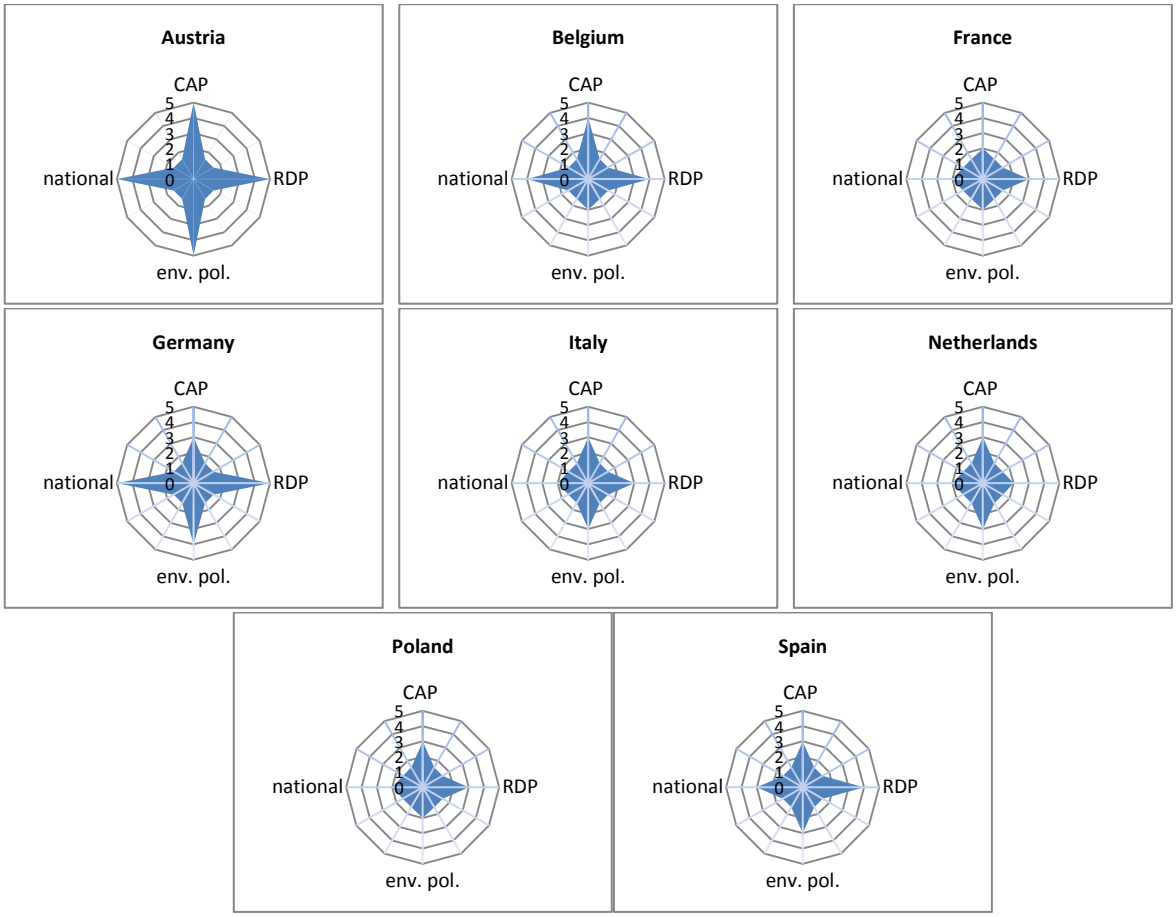


Fig ES1: Embeddedness of soil stakes into policy packages in Catch-C countries, per country. *CAP: Common Agricultural Policy (pillar I), RDP: Regional Development Programs (CAP pillar 2), national: national specific policies (not based on EU driven policy packages), env.pol.: environmental policies such as Nitrates Directive, Water Framework Directive and NEC directive*

Apart from these strategies, countries and regions usually mix mandatory measures that aim to guarantee a baseline protection, with incentives for more demanding practices, and they encourage the training of farmers. The above strategies are visible only in the relative use of the different instruments and the way countries and regions combine them. Moreover, policy packages mainly focuss on soil protection against different threats rather than towards comprehensible strategies for sustainable soil management.

Soil stakes are included in national and regional policy packages in ways compatible with the policy design tradition of each Member State. In other words, policy design uses consensus processes, consultation of stakeholders, or deeper co-design with farmer unions to varying degrees, depending on the country. We have noticed that, at all levels, more different groups of stakeholders became involved in the policy design process in the last five years. Also, we found that there may be discrepancies between the national level where objectives are set up, and the regional and local levels where policies are implemented and precise measures designed. This leaves room for more ambition towards sustainable soil management.

1 Introduction

Soil protection is at the interface of three major policy packages: agricultural and rural policies, where soil is considered as a production mean that needs sometimes to be preserved, environmental policies where the soil is considered as a medium towards air, water or biodiversity protection, and urban policies where forest or agricultural soils have to be preserved from urban sprawl. Since the last twenty years, soils are also a matter of policy packages related to climate change, mostly under the Kyoto protocol. The immediate consequence is the existence of a bundle of soil-related policy measures, with expected direct or indirect effects on soils: in 2008 for instance, Kutter *et al.* accounted for 410 different soil conservation measures in the European Member states, while Eurostat breakdown of agri-environmental measures (AEM) considered in 2008 that 8 % of the EU-27 agricultural area under AEM benefit from actions to conserve soils.

A proposal for a Soil Framework Directive has been initiated in 2006 with the objective of simplifying the way soils stakes are considered in policies and initiating comprehensive legislation on soil protection. This Directive was unfortunately withdrawn in May 2014[2]. Since this withdrawal, the Soil Thematic Strategy takes actions to integrate soil stakes into all relevant policies when renewed.

Rising concern about soil protection originates from the increasing national and European understanding of threats on soils: wind and water erosion, decline in organic matter, local and diffuse contamination, sealing, compaction, decline in biodiversity, salinisation, floods and landslides threaten non negligible areas in Europe (Jones *et al.*, 2012). These threats take root from an increasing pressure on natural resources like soil or water by industry and agriculture (see Kirchmann and Thorvaldsson, 2000 for a good overview on the later point). But there is, to the best of our knowledge, no clear assessment on how agricultural policy packages have affected, and will impact, pressure on soils. This is mostly due to two phenomena; first, all over Europe, farmers have developed a number of risk-management strategies to take into account the variability of meteorological conditions and are adapting their practices to their soils already. Moreover, the long term adjustments of farming systems and land use lead by the agricultural policy packages cannot easily be linked to soil degradation issues. So, in most assessments, soil quality is taken as given, and its long term evolution is not considered (see Berger and Troost, 2014, for a recent modelling framework that explains very well the concepts currently in use).

The objective of this Deliverable is to analyse the policy context in which soil management practices are implemented. Soil processes are at the interface between agricultural production and ecosystem services provision, and making sure that these processes work properly is a matter of multi-layered policies and actors, in an uncertain environment. To analyse the policy context, we have built a method that grouped together two different frameworks. Using these two frameworks together, we have designed a grid in which each relevant policy measure favours (or hampers) the adoption of each BMP, with which objectives, and if they are implemented on a mandatory way, or with incentives, or even in a voluntary way.

From a policy perspective, soil related Best Management Practices (BMPs) designed by WP3 are technological innovations that benefit the environment through improving soil quality. They have specific features related to innovation, environmental improvement and soil related processes that challenge policy design. Let's examine why, how and where the debates are currently.

First, it is commonly accepted that there are two pathways for firms' development: cost-cutting methods involving increased economies of scale, shedding of labour, and ignoring health, safety and environmental quality; or using more innovative and superior technologies. But, as there are often lock-in in development pathways of firms, design and implementation of accurate policy mixes can encourage willingness, opportunity and motivation to change for existing firms, and new entrants, towards the adoption of new technologies. The design challenge of such policies is how existing undesirable technologies can be removed through a combination of regulations and market incentives (Ashford and Hall, 2011).

The general definition of innovation is neutral regarding sustainability. Innovations that improve the environment have an additional feature, and are often depicted as "environmental innovations" or "eco-innovation" and defined as: "eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which:

- Develop new ideas, behaviours, products and processes, apply or introduce them, and

[2] OJ C 163, 28.5.2014

- Contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" (Rennings, 2000).

Eco-innovations differ from generic innovations in the sense that they supply a double externality: like any innovation they provide external benefits (R&D efforts leading to spill-overs), but they also develop products, processes and services that cause external benefits themselves. Because in real economies external costs are generally not internalized, classical environmental policies, or classical innovation policies, applied alone, may fail to enhance eco-innovations (van den Bergh, 2013): environmental policies fail to discriminate between eco-innovative and non-eco-innovative firms, as innovation policies may lead to unknown environmental efficiency. Moreover, it is more and more considered that the regulatory framework is a key determinant for eco-innovative behaviour of firms and those problems of design and implementation (such as stringency, flexibility, differentiation, phasing, and enforcements) shouldn't be ignored.

Soil related BMPs add a third feature: they address long term processes, impact the fixed costs at farm level and their assets. Economists agree that regulations towards sustainability can favour innovation, by spurring the development of new products, and by creating conditions under which new producers can enter the field. The dynamics of new entrants is very important: if existing firms comply with the regulation in an intelligent way, late entrants won't be able to catch-up unless at high costs, and thus there are advantages to be first and early. This is especially true for soil related BMPs: early adopters may have an important comparative advantage in the case a new regulation on soil quality arises, because non adopters of these BMPs would need years to comply with the new regulations.

This deliverable is designed as follows: Chapter 2 describes the method we have used to analyse the various policy packages and their relationships with the soil related BMPs. Chapter 3 describes the Soil Thematic Strategy. The policy packages as collected from the Catch-C partner countries have been grouped together, and their results are presented: Chapter 4 deals with agricultural policy packages (Pillar I), Chapter 5 with rural development packages, and Chapter 6 with environmental policy packages. Chapter 7 gives a short overview of national initiatives, i.e. those not directly derived from the EU policy frameworks. Last, Chapter 8 discusses the inter-linkages between these policy packages in the partner countries, and presents a concluding overview in Paragraph 8.9.

2 Method

2.1 Literature review

We have built a method that grouped together two different frameworks. The first framework mobilised is what managers call "Logic Model". Logic models are being used in evaluating policy packages for several decades: they identify the problems that the policy wants to deal with, the objective the policy sets up, both from a strategic and an operational point of view, lists the resources mobilised (the practical policy measures), as well as the expected outputs. Altogether a logic model builds a story of the policy package expected performance and is very useful to analyse internal coherence of a given policy package. This framework has been used in soil policy analysis for the 2007-2013 programming period by Louwagie *et al.* (2011). We have expanded it to the next period, and linked to a second framework, that takes root in the economic institutional literature. There is an extensive literature about the issue complexity, and institutional complexity of policy activities in the EU, related to national policy making, that is generally wrapped up into the concept of multi-level governance (Stephenson, 2013). This concept has evolved over years, and has been used differently by scholars, but in short it helps understanding complex structures in which objectives are designed at one level while implementation depends on other levels. This is typically the case for the sets of policy packages we are analysing in this report.

Using these two frameworks together, we have designed a grid in which each relevant policy measure favours (or hampers) the adoption of each BMP, with which objectives, and if they are implemented on a mandatory way, or with incentives, or even in a voluntary way.

2.1.1 Assessment of soil policy measures

At EU level, Louwagie *et al.* (2011) used intervention logic to assess the potential of existing and future EU policies to address soil degradation processes. However, they stress that not all relevant policy measures are implemented throughout the EU-27. According to the subsidiarity principle, Member States and/or regions implement policies according to the needs and specific geo-climatic and farming conditions identified within their territories. For Louwagie *et al.* (2011), the policy objectives and/or farm management requirements should be sufficiently specified and adapted to local conditions, and subsequently adopted to reach sufficient levels of soil quality. They stress the necessity to adopt the Soil Thematic strategy to improve the coordination of local/national and EU policies.

Table IV. Positively expected effects of EU policies on soil degradation processes

	Soil degradation processes					
	Water erosion	Organic carbon decline	Soil biodiversity decline	Compaction	Contamination	Salinisation/ sodification
Environmental policies						
Nitrates Directive	+		+	+	+	
Water Framework Directive	+		+		+	
Groundwater Directive			+		+	
Sewage Sludge Directive		+	+		+	
Plant Protection Products Directive[a]			+		+	
Birds Directive	+	+	+	+	+	
Habitats Directive	+	+	+	+	+	
(proposed) Soil Framework Directive[b]	+	+	+[c]	+	+	+
Common Agricultural Policy						
Cross compliance [Regulation (EC) 73/2009]						
Statutory management requirements	+	+	+	+	+	
GAEC[d] requirement	+	+	+	+		+
Rural Development Regulation [Regulation (EC) 1698/2005]						
LFA payments	+	+				
Agri-environment payments[e]	+	+	+	+	+	+

[a]This Directive has been repealed by Regulation (EC) 1107/2009. Similar effects are expected from the Directive on Biocidal Products (98/8/EC) and the Framework Directive on the Sustainable Use of Pesticides (Directive 2009/128/EC).
[b]In addition, the proposed Soil Framework Directive also explicitly addresses sealing and landslides.
[c]Positive effects on soil biodiversity are expected, even though the proposed Soil Framework Directive does not particularly target this soil degradation process.
[d]GAEC requirement: requirement to keep land in good agricultural and environmental condition.
[e]Agri-environment payments in general have the scope to address any potential soil degradation process. The actual effect of these payments depends on the national/regional implementation process.

Figure 1: Louwagie et al. (2011) Analysis of potential expected effects of EU policies on soil degradation processes

Evaluators have found the Logic Model process useful for at least twenty years (McLaughlin and Jordan, 1999). The elements of the Logic Model are resources, activities, outputs, target reached, short, intermediate and longer term outcomes, and the relevant external influences (Wholey, 1983, Wholey, 1987).

Table VII. Expected positive effects of (a) farming systems, and farming practices under (b) arable and (c) other agricultural land use on soil degradation processes and related environmental issues, indicating their link with policy measures

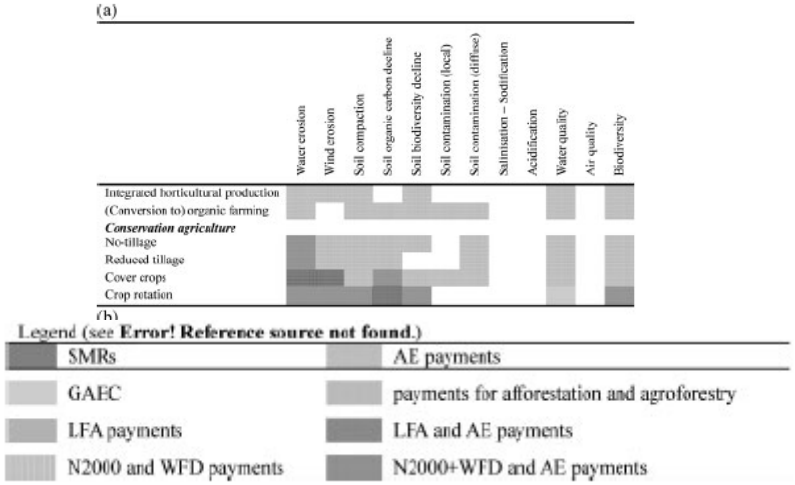


Figure 2: Kutter et al. *(2011) representation of links between practices, soil threats and policy measures*

Kutter *et al.* (2011) performed a review of policies applied for agricultural soil protection. They covered the following policies:

- the EU statutory management requirements (SMRs) (Council Regulation 1782/2003, Annex III)
- the EU requirement to keep land in good agricultural and environmental condition (GAEC) (Council Regulation 1782/2003, Annex IV) measures as part of the national or regional Rural
- development Plans (RDPs) relating to Council Regulation (EC) 1698/2005
- any national and/or regional policy of significant importance.

They highlight that soil quality is often mentioned as the main policy target of the analysed policies, that the implementation of these policies has the potential to address all soil degradation processes at EU level. However, they stress that a complete data collection that would enable detailed analysis is still missing. Last, Kutter *et al.* (2011) propose an interesting representation of potential effect of farming practices, soil threats and links with policy measures.

At the regional level, Verspecht *et al.* (2011) used comprehensive literature analysis and questionnaires with groups of actors and a very similar framework to analyse how the various policy measures complement each other in Flanders to deal with erosion problems.

2.1.2 The institutional dimension of policy assessment

Environmental policies are commonly classified into three types, following Baumol and Oates (1979) and Weersink (2002), mandatory measures, voluntary incentive-based ones and awareness-increasing measures and private initiatives. Mandatory measures involve government regulators that mandate socially desirable behaviour through law-making and then use reinforcement mechanisms, such as courts, police or fines, to ensure that people obey the law. The intention of an MM is to prevent and regulate pollution or environmental damage by declaring it illegal within a judicial system, which is designed to stop such illegal behaviour.

Voluntary incentive-based measures influence farmers' actions by providing financial incentives for pollution reduction or environment-friendly practices, or by raising the price of polluting inputs. They are often called 'economic instruments' and deliver environmental quality beyond a reference level established by measure.

Awareness-increasing measures and private initiatives are aimed at promoting environmental quality objectives and a sustainable agricultural system. The compliance is voluntary and the programmes attempt to raise the awareness of land users as to how their current practices contribute to environmental problems or how best management practices reduce these problems.

Very often, the three groups of measures are used for a given environmental problem. Important for the analysis is the scale at which the measures are designed and applied. Oates and Portney (2003) emphasize that approaches that recognize the interaction of different interest groups are the most promising for an understanding of environmental policies. One key dimension is the structure of the vertical distribution of policy-making responsibilities among the different levels of government.

Acknowledging this, Theesfeld *et al.* (2010) emphasize that if appropriate institutions increase the likelihood of actually achieving the policy objectives (i.e., they increase the likelihood of actors' compliance and (intended) change of behaviour) they also ensure that these policy objectives are achieved at reasonable costs. The authors stress that policy instruments that have proven to be very cost-effective in one specific institutional context might perform rather poorly in another, i.e., they might be not effective at all, or they might induce higher costs to become effective. On this basis, they propose a procedure to assess the institutional compatibility of policy instruments with existing institutions. The procedure is based on four steps:

- Step 1: The policy options are clustered according to a) type of intervention (regulatory, economic, and advisory, i.e. the same classification as the currently used depicted above), b) area of intervention (hierarchy/bureaucracy, market, and self-organised network), and c) possibly induced property rights changes. This classification allows identifying the generic structure of a policy option. The objective of this specification of policy types is to provide a suitable, yet formalised structure, to identify crucial institutional aspects (CIA) that are of particular importance for the policy option under scrutiny.
- Step 2: Each policy type is characterised by a specific set of CIAs (see Appendix for details). CIAs have been emphasised by Theesfeld's work group and the library is public. Within the SEAMLESS project, an extensive literature review has been carried out to identify CIAs that are typically linked with respective policy types (Schleyer et al., 2007). Appendix2 describe these CIAs.
- Step 3: Indicators help to evaluate the potential of respective CIAs to constrain or foster the implementation of a policy option. The institutional indicators are selected from existing indicator lists, perhaps modified, or new indicators are elaborated. Further, concrete assumptions on links and relationships between a CIA and the respective set of indicators are made.
- Step 4: The information provided by the institutional indicators is used for a qualitative assessment of each identified CIA.

		Area of intervention			Property rights change	
		Hierarchy/bureaucracy	Market	Self-organised network	Induced	Not-induced
Type of intervention	Regulatory		*Policies intervening at markets using regulatory (command and control) instruments* *Example: restrictions on nitrate use*			
	Economic					
	Advisory/voluntary					

Figure 3: Theesfeld et al. (2010) policy matrix

Theesfeld *et al.* method is especially appropriate to analyse *ex ante* how a limited set of policy options are liable to interfere with policies in place and existing groups of interest. The framework is

uneasy to use with large sets of policy packages that provide tens of policy measures, thus we have adapted it.

2.2 Method for policy analysis

Starting from the logic models, we have first analysed the strategic and operational objectives of each policy package, to understand how soil stakes, and which ones, are considered in each package. Regarding soils, the strategic objectives are negotiated between Member States at the EU level, with the exception of countries having soil related laws; for the latter, national laws can be stricter than EU legislation. The operational objectives are discussed at the national or regional level, depending on the governance structure of each Member State. Measures are designed, implemented, enforced (or not) and monitored at the regional (or even local) level. Thus for the same objective of soil protection, the sets of measures can be extremely different from a region to another.

We have analysed in the partner countries how the sets of measure promote (or impeded) the implementation of each BMP, how they work in synergy, or get in the way of each other. As interactions between measures are important we have used two summary tables in each country. The first one depicts which measure promotes (or impedes) each group of BMPs in a mandatory, on the basis of incentives or on a voluntary way. For the sake of communication, these tables have been called "mandatory tables". We have used colours (red for mandatory, yellow for incentives and blue for voluntary) to add a third dimension in the tables.

Table 1: frame for the "mandatory" tables

Country period	BMPs							
Policy packages	rotation	tillage	Catch-crops	Nutrient management	Plant residues management	Water management	Extensive grassland	Permanent grassland
Package1								
Package2								

The second table relates the soil stakes (as defined in the Thematic Strategy for soil Protection), the BMPs and the measures: in each cell, it depicts if the policy package targets a given stake in column, by promoting (or restricting) the adoption of a BMP in line. Colours are the same as for the mandatory tables. To avoid overlapping and facilitate reading, each cell in the table is split into four, the first for the agricultural policy packages (CAP pillar 1), the second for environmental policy packages (mostly nitrate directive and water framework directive), the third for rural development programs (CAP pillar 2), and the last one for national initiatives. We have called this table "Stake table".

Table 2: frame for the stake tables

Country	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity
MP2								
MP3								
MP4								

3 Soil Thematic Strategy

Considering that soil degradation problem in Europe is serious enough to be tackled, the commission considers that a "*comprehensive strategy for soil protection is required*". This strategy first lists the threats on soils in Europe as: wind and water erosion, decline in organic matter, local and diffuse contamination, sealing, compaction, decline in biodiversity, salinisation, floods and landslides. On the following of this report we will use this list as a guideline.

The objective of the Soil Thematic Strategy[3] is protection and sustainable use of soil, and the Strategy grounds on two strategic objectives:

- *Preventing further soil degradation and preserving its functions:*
  - *when soil is used and its functions are exploited, action has to be taken on soil use and management patterns, and*
  - *when soil acts as a sink/receptor of the effects of human activities or environmental phenomena, action has to be taken at source.*
- *Restoring degraded soils to a level of functionality consistent at least with current and intended use, thus also considering the cost implications of the restoration of soil.*

The actions proposed are built around a legislation framework (the so-called "soil directive"), integration of soil protection in the formulation and implementation of national and Community policies, closing the knowledge gap and increase public awareness of the need to protect soil. The Strategy is accompanied with an impact analysis[4].

In 2012, the Soil directive was still not accepted by Council, the main break points being the requirements of identification of polluted soils (mainly refused by the industry) and a potential change in property right (main point for the farming sector), as highlighted by stakeholders, and subsidiarity, excessive cost and administrative burden according to COM(2012)46. The Directive was withdrawn in 2014. However, the strategy has been implemented and moved forward[5]:

- Awareness raising: apart from several public events, the commission has published several soil atlases and has established a working group within the European soil Bureau Network[6].
- Research: several research projects have been funded, among which LUCAS provided a specific soil module that has also been integrated in the European Soil Data Centre[7] that "*could be a starting point for harmonised European monitoring of soil parameters for a whole range of statistical, research and policy purposes*".
- Integration: the Commission has worked on integrating soil in several revised policies, among which the Common Agricultural Policy, the Industrial Emissions Directive, Cohesion Policy and State aids for remediation of soil contamination. Let's examine the details below.

As such, the Thematic Soil Strategy indirectly favours all the BMPs we foresee, on the long run. Its impact on the adoption of theses BMPs will strongly depend on national and regional conditions.
Thus, the successful conception, development, implementation, monitoring and further improvement of soil related policies at European Union level depends greatly on the availability of robust data related to the pressures on soils and to the state of the soil, on their possible impacts and on responses that counteract any degradation. In order to ensure the provision of such data at European scale to the relevant policy makers, the European Commission's Directorate General Environment (DG ENV), the Joint Research Centre (JRC) and Eurostat (the European Commission's Statistical Services), together with the European Environment Agency (EEA), have developed the concept of "Environmental Data Centres". These centres are seen as a common system for the provision of data in critical environmental domains, like soil. The European Soil Data Centre (http://esdac.jrc.ec.europa.eu/) is hosted by JRC.

[3] COM(2006) 231
[4] COM(2006) 620
[5] COM(2012) 46
[6] http://eusoils.jrc.ec.europa.eu/esbn/Esbn_overview.html
[7] http://esdac.jrc.ec.europa.eu/

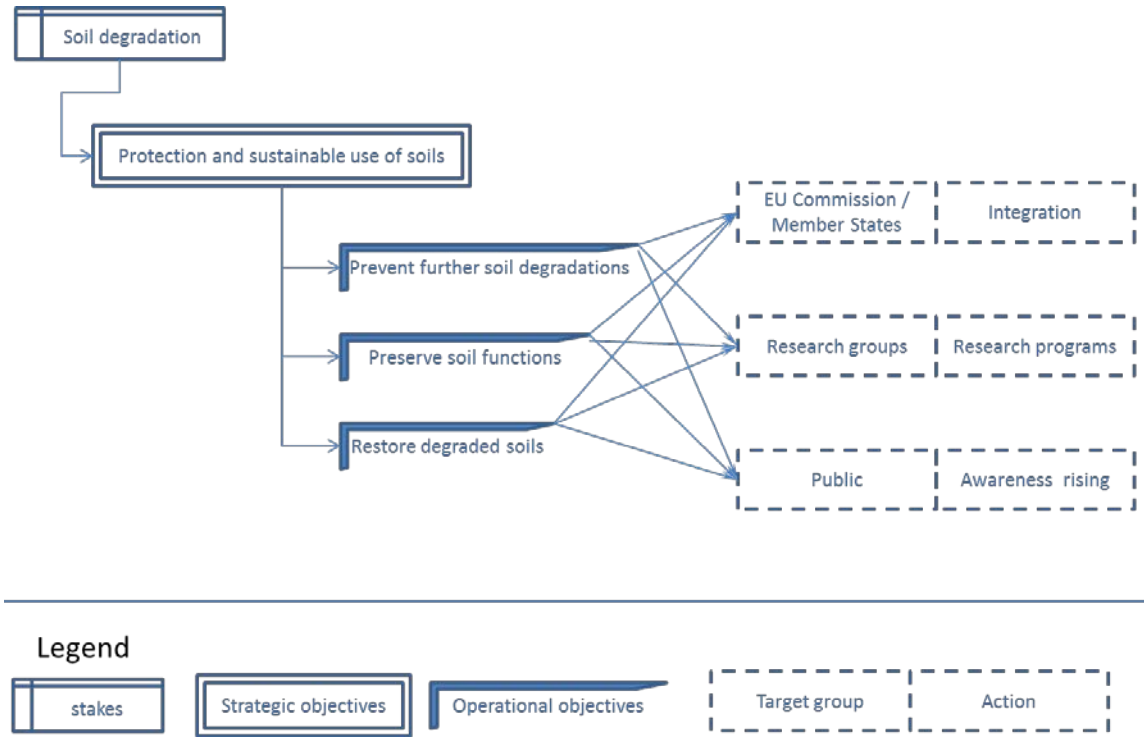


Figure 4: Logic diagram for the Thematic Soil Strategy

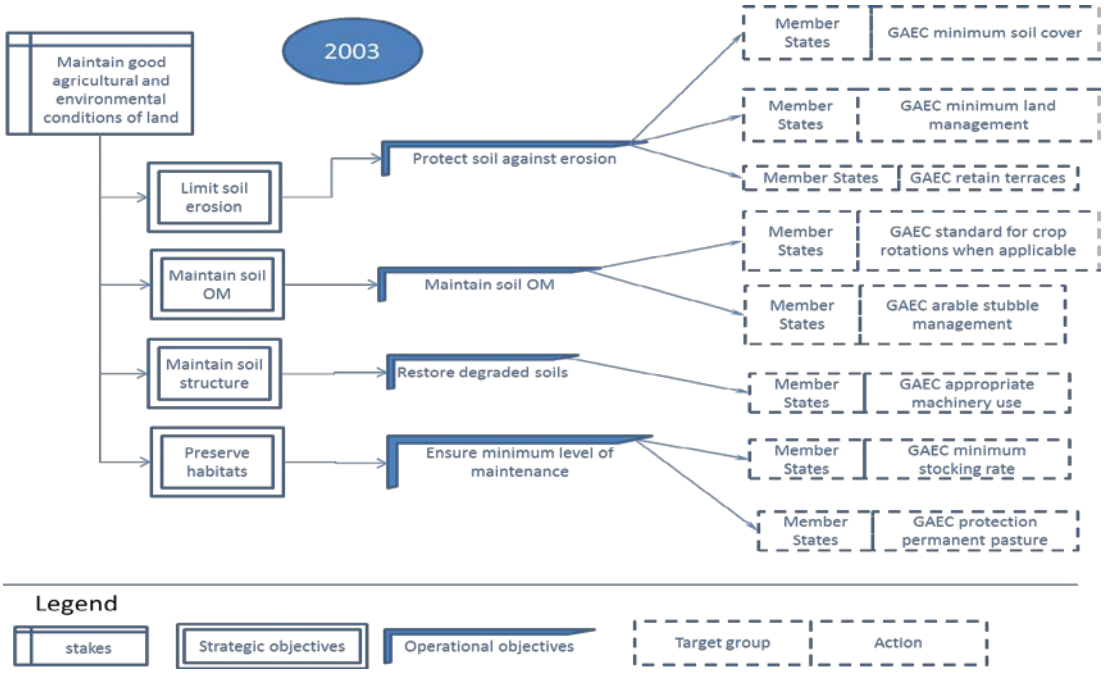
4 Common Agricultural Policy and soil protection

As stated in Council regulation 1782/2003, the main scope of CAP is to provide an income support for farmers. Since the introduction of cross-compliance[8] in 2003, soil protection is an integral part of Good Agricultural and Environmental Conditions (GAEC). Cross compliance states that a farmer who receives direct payments has to respect statutory management requirements (SMRs) and GAECs. The SMRs refer to all Directives in place (nitrate, water, birds, sludge, animal welfare etc.), and there are links between CAP package and other policies, but the Directives in place can also emphasise on more restrictive conditions that GAECs do. So we will examine here only SMRs that are designed under the CAP package, and highlight links CAP can have with other policy packages.

4.1 Policy measures

4.1.1 Good Agricultural and Environmental Conditions

Member States have a broad margin in determining national GAEC obligations as long as the European framework is respected. Regarding soil protection, emphasis has been put on limiting erosion, maintain soil organic matter levels, maintain soil structure and ensure a minimum level of maintenance in 2003[9]. Standards were put at minimal soil cover and minimal land management depending on local conditions for erosion; arable stubble management and possibly rotations standards for maintenance of soil organic matter; appropriate machinery use for soil structure. The minimum level of maintenance was to be ensured by protecting permanent pastures and minimum livestock stocking rates.



[8] COUNCIL REGULATION (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001 - Title II, Capter1, Article 3.

[9] Council Regulation (EC) 1782/2003

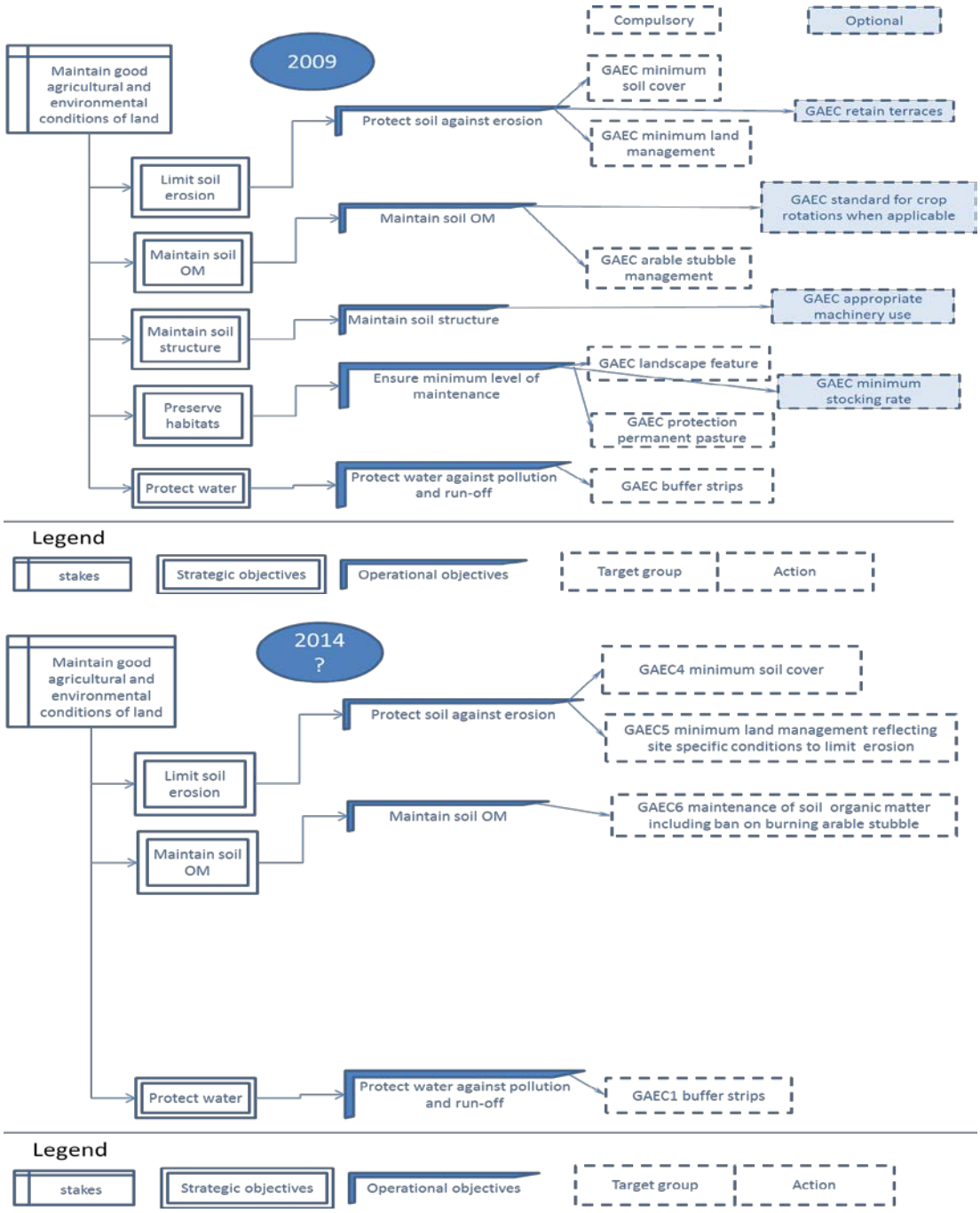


Figure 5: Logic diagrams for GAECs and evolution over time

GAECs have evolved along time. In 2009[10], standards for crop rotations, appropriate machinery use, minimum livestock stocking rate became optional (the Member States could apply them but that was not mandatory anymore). Retention of landscape features (like hedges, ditch trees) and avoiding the enrichment of unwanted vegetation were added for the minimum level of maintenance strategic objective.

In 2013 it has been proposed a new GAEC on organic matter protection that would include a ban on arable stubble burning and an obligation not to plough wetlands and carbon-rich soils. Unfortunately the latter was not retained during the CAP negotiations. The previous CAP payments schemes grounded on what we could call a "negative concepts of compliance": farmers receive payments for farming that could be discarded if they don't comply with GAECs. The new framework adopted a

[10] Council Regulation (EC)73/2009

more positive concept of payments: farmers are paid for both farming and good practices. He has a negative incentive if he supplies fewer environments, and a positive incentive linked with agri-environmental commitment if he supplies more environment. As a consequence, the requested list of GAECs has been reduced: all the optional standards, which appeared to be difficult to understand by Member States, have been suppressed ("optional" meant that the Member States could chose to apply them as mandatory for farmers, or not to apply them). 30% of the direct payments will be dedicated to the good practices and SMR. Soil is very often mentioned in the discourses: *"Income support for farmers and assistance for complying with sustainable agricultural practices: farmers receive direct payments, provided they live up to strict standards relating to food safety, environmental protection and animal health and welfare. These payments are fully financed by the EU, and account for 70% of the CAP budget. Under the June 2013 reform, 30% of direct payments will be linked to European farmers' compliance with sustainable agricultural practices which are beneficial to soil quality, biodiversity and the environment generally, such as crop diversification, the maintenance of permanent grassland or the preservation of ecological areas on farms."*

In other words, for the next CAP, farmers can receive a negative incentive if they don't comply with SMRs that can reach 30%, as it was limited to 15% before in most cases (apart for intentional repeated infractions where it could reach 100 %).

Table 3: foreseen GAECs for CAP 2014-2020 (note that GAEC7 hasn't been accepted)

Area	Main issue	Requirements and standards		
Environment, climate change, good agricultural conditions of land	Water	SMR1	Council directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375, 31.12.1991, p1)	Articles 4 and 5
		GAEC 1	Establishment of buffer strips along water courses	
		GAEC 2	Where use of water for irrigation is subject to authorisation, compliance with authorisation procedures	
		GAEC 3	Protection of groundwater against pollution: prohibition of direct discharge into groundwater and measures to prevent indirect pollution of groundwater through discharge on the ground and percolation through the soil of dangerous substances, as listed in the annex to the Directive 80/68/EEC	
	Soil and carbon stock	GAEC 4	Minimum soil cover	
		GAEC 5	Minimum land management reflecting site specific conditions to limit erosion	
		GAEC 6	Maintenance of soil organic matter level including ban on burning of arable stubble	
		(GAEC 7)	*(Protection of wetland and carbon rich soil including a ban of first ploughing)*	

SMR: statutory management requirement
GAEC: standards for good agricultural and environmental condition of land

Since 2013, the implementation of GAEC across Europe has been quite homogenous, with slight variations depending on local conditions (sloppy area for example). GAEC requirement are regularly amended and better detailed along time (Angileri *et al.*, 2011). But, as pointed out by Nowicki *et al.* (2009) there are very few impact analysis of cross-compliance on soil quality. Impact is expected on reduced levels of soil erosion, reduced levels of soil compaction and to a lesser extent, increased levels of soil organic matter. Similar assessment has been made by Louwagie *et al.* (2011) who mention also reduced soil biodiversity decline. To the best of our knowledge, no quantified assessment still exists.

According to Baumol and Oates (1979) and Weersink (2002) classification, SMRs are mandatory measures. They are command-and-control instruments (Member States have to design them according to national specificities, and enforce their application, farmers who do not comply receive less money from the CAP).

4.1.2 Greening measures

The initial objective of CAP has evolved with the 2013 development[11], towards "*the enhancement of environmental performance through a mandatory "greening" component of direct payments which will support agricultural practices beneficial for the climate and the environment applicable throughout the Union*". Member States are required to use part of the payment to grant an annual payment (on top of the basic payment) for "*compulsory practices to be followed by farmers addressing, as a priority, both climate and environment policy goals. Those practices should take the form of simple, generalised, non-contractual and annual actions that go beyond cross-compliance and that are linked to agriculture, such as crop diversification, the maintenance of permanent grassland, including traditional orchards where fruit trees are grown in low density on grassland, and the establishment of ecological focus areas*".

The Thematic Strategy for Soil Protection seeks to integrate soil protection within several revised policies. As such, among these compulsory practices, the obligation of crop diversification specifically addresses "*progress towards enhanced environmental benefit, and in particular the improvement of soil quality*". Ecological focus areas also focus on the improvement of soil quality (along with climate change mitigation).

Member States also have to make decisions on equivalent practices. These equivalent practices are covered by agri-environment-climate measures or certification schemes, are similar to greening measures and yield an equivalent or higher level of benefit for the climate and the environment. The differences lay in the diversity of local situations in terms of agricultural systems and environmental conditions within the European Union. Double funding of these equivalent measures has to be avoided.

Greening measures are mandatory as SMRs are, and also belong to the command-and-control policy type. The difference with SMRs is that farmers get subsidised (even if the application is mandatory) to comply, rather than fined for lack of compliance. The economic consequences of non-compliance for farmers are different, fines being (at least theoretically) of greater magnitude than subsidies for greening measures.

There are strong interactions between greening measures and agri-environmental schemes (AES), because the equivalent measures and avoidance of double funding: in other words, all farmers have to comply with the greening measures, and only those who volunteer to adopt more strict measures under AES will get additional subsidies.

The green direct payment represents 30 % of the direct payment envelope, for applying three groups of basic practices. It is the responsibility of Member States to delineate the equivalent measures, and to decide how the want these practices to be implemented:

- Maintenance of permanent grasslands: this measure includes bans on ploughing in designated areas, and fixes a national/regional ratio with 5% flexibility. The maintenance of permanent grassland can be accounted at the regional level (like in the Netherlands) or for each farm individually (like in France).
- Crop diversification: this practice mandates farms operating over more than 10 hectares of arable land to have at least 2 crops (for farms over 10 ha), and at least 3 crops (for farms over 30 ha of arable land). The main crop must not exceed 75 % of arable land, and the two main crops 95%. Diversification doesn't mean crop rotation.
- Maintenance of an "ecological focus area" of at least 5 % of the arable area of the farm. What Member States consider as "ecological" and conversion factors (to "convert" linear elements like hedges into surfaces for example) is at their will. Farms of less than 15 hectares of arable land are exempted. Note that this exemption is not a minor issue: the area threshold exempts at least 88% of EU farms and over 48% of farmed area (Pe'er *et al.*, 2014).

[11] REGULATION (EU) No 1307/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 december 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009.

4.1.3 How are BMPs considered in the CAP package?

Table 4 depicts the potential path towards implementation incitations for Catch-C BMPs through CAP pillar1, from a EU perspective and as described in the EU regulation 1307/2013.

Table 4: potential of adoption promotion of the BMPs by CAP pillar 1 policy package

		SMRs				Greening measures			Equivalent practices										
N°	BMP	GAEC1 buffer strips	GAEC4 minimum soil cover	GAEC5 minimum land management to limit erosion	GAEC6 maintenance of soil organic matter level	Crop diversification	Maintenance of permanent grassland	Establishment of ecological focus areas	Crop diversification (more appropriate selection of crops)	Crop rotation	Winter soil cover	Catch crops	Management of meadows or pastures	Extensive grazing systems	Ecological set aside	Buffer zones	Management of uncultivated buffer strips	Production on arable land with no use of fertilisers	Conversion of arable land into permanent grassland extensively used
Rotation BMPs (reference is monoculture)																			
MP2	Rotation with cereals					X				X									
MP3	Rotation with legume crops					X			x	X									
MP4	Rotation with tuber or root crops					X				X									
MP5	Rotation with fallow land		x			x			x	X	x								
MP6	Rotation with grassland		x			x			x	x	x								
Catch-crops, cover crops, green manures (reference is bare soil)																			
MP7	Intercropping		x								x	x							
MP8	Rotation with cover/catch crops		x								x	x							
MP9	Rotation with green manures		x								x	x							
Grassland management																			
MP11	Permanent grazing			X			X						x	x					x
MP12	Rotational grazing			x			x						x						
Reduced tillage (reference is plowing)																			
MP16	No / Zero tillage																		
MP17	Non inversion tillage/reduced tillage																		
MP18	Non inversion tillage/minimum tillage																		
MP19	Non inversion tillage																		
MP22	Contour ploughing																		

		SMRs				Greening measures			Equivalent practices										
N°	BMP	GAEC1 buffer strips	GAEC4 minimum soil cover	GAEC5 minimum land management to limit erosion	GAEC6 maintenance of soil organic matter level	Crop diversification	Maintenance of permanent grassland	Establishment of ecological focus areas	Crop diversification (more appropriate selection of crops)	Crop rotation	Winter soil cover	Catch crops	Management of meadows or pastures	Extensive grazing systems	Ecological set aside	Buffer zones	Management of uncultivated buffer strips	Production on arable land with no use of fertilisers	Conversion of arable land into permanent grassland extensively used
Application of external organic inputs (reference is mineral fertiliser)																			
MP50	Fertilization plan																	x	
	Composts (MP29, MP30, MP31)																		
	Manures (MP32, MP34)																		
	Slurries (MP33, MP35)																		
Incorporate crop residues (reference is removal or burning)																			
	Leave residue on field				Ban on burning crop residues														
MP36	Return of crop residues																		
Crop protection																			
MP41	Mechanical weeding																		
MP43	Push-pull strategies																		
MP44	Patches or stripes of natural vegetation	x												x	x	x	x		
MP45	Pheromones application																		
MP49	Soil fumigation																		
Water management (reference is low-efficiency irrigaiton)																			
MP53	Drip irrigation																		
MP55	Subsurface drainage																		
Others																			
MP23	Terrace farming																		
MP24	Controlled traffic farming																		

4.2 National implementation

In all cases, the Ministry of Agriculture is in charge of the design of the cross-compliance settings, in close cooperation with the Ministry of environment. There is a general frame at national level and often regional specifications:

- In Belgium, GAECs are designed by the Ministry of Agriculture. The Soil protection service of the Ministry of Environment is in charge of implementing the soil erosion decree which subsidises soil erosion action plans at municipality level and small scale constructions. Each policy package is designed in consultation with a large group of stakeholders, including farm organisations and people from other ministries.
- In France, standards are designed as the outcome of a negotiation between the Ministry of agriculture and farmers unions, with a consultation of ministry of environment, NGOs, experts. Standards are refined at NUT3 level, with a similar negotiation framework (local services of ministry of agriculture and local farmers unions). Control is performed at NUTS3 level by the services of Ministry of agriculture (section of farms to be controlled and control itself).
- In Germany, standards have been designed at the federal level by the Federal Ministry of Food and Agriculture, in working group with the Federal Ministry of Environment and ministries of the Länders. During the design process, NGOs have been consulted. Standards are harmonized at national level. Controlled farms are selected by the service centre for rural and agricultural support and controls performed by the general inspection at NUTS1 level by agricultural chambers or other authorities. Germany has taken the opportunity to enforce the Federal Soil Protection Act (designed in 1998) through SMRs.
- In Italy, GAECs have been framed by the Ministry of Agricultural and Forest policy and the environmental SMRs by the Ministry of the Environment and Territory Conservation. This is a national framework, approved by the State-Regions conference. As such, representatives of the regional governments, the national and regional paying agencies, the Ministry of Environment, the farmers unions and the environmental organisation have been consulted during the design of the measures. Regional (NUTS2) governments can adopt more precise standards according to local conditions. Controlled farms are chosen by the agency for agricultural payments, control being generally carried out by specialised private bodies contracted by payment agencies.
- In the Netherlands, the Ministry of Economic Affairs (now including Agriculture) prepared the proposals for implementing the CAP via an extensive stakeholder consultation proces during 2010-2014. Central to this process were the internet platform “GLB Toekomst” (Future CAP) with blogs, a lively forum section, and a corresponding linked-in group. A similar series of internet consultation was held for the ‘simplification of CAP’ aspect. Throughout 2010-2014, series of workshops and conferecnes were held, organized by the ministry as well as by farmer organizations. Several pilots were held, specifically to evaluate the potential of farmers working in ‘collectives’ aiming for regionally defined goals. Lessons learned were shared by ‘Communities of Practice’ (CoPs), expanding the process of collecting views by practitioners. Progress and outcomes precipitated into a total of 15 proposals and letters from the ministry to the Dutch parliament, over the period 2010-2014. Key actors were farmers organizations (LTO, NAJK, NAV), agro-industry (NZO, Suiker Unie; for milk and sugar, respectively), seven NGO’s, and three local public bodies: Unie van Waterschappen (water management bodies), VEWIN (extraction of drinking water), and the Interprovicial coordination platform. See also www.toekomstglb.nl (in Dutch).
- In Poland, the national implementation of CAP is a direct transposition of the EU legislation, and is under the supervision of the Ministry of Agriculture and rural Development.
- In Spain, the Ministry of Agriculture, Food and Environment elaborate the so called "Model of Implementation of the CAP in Spain", in the scope of the Agriculture Sectorial Conference that includes both Central and Regional Governments. The framework for the implementation of Rural Development Plan is developed at national level but they are regional governments that decide what measures are financed.

4.2.1 Austria

Austria has implemented a comprehensive set of GAECs standards, starting from national legislation. GAEC requirements are defined at the national level.

4.2.1.1 Cross-compliance 2007-2013

There have been 13 compulsory standards for soil erosion prevention:

- Minimum soil cover (compulsory): Green soil cover and cultivation of • arable land and areas destined for permanent cultures (fruit, wine).

- Minimum land management reflecting site specific conditions (compulsory): no machinery can be used on frozen, water-saturated or flooded land, or on land close to lakes (10m) or rivers (5m).
- Retain terraces (optional).
- Arable stubble management (compulsory): no burning of straw.
- Standards for crop rotation (optional): max 85 % of arable land can be used for growing cereals and corn (there was an exemption from crop rotation for farms with more than 0.5 LU/ha and less than 5 ha arable land).
- Appropriate machinery use (optional), same specification as for minimum land management.
- Retention of landscapes features (compulsory): retaining protected natural features which do not exceed a minor share of the field area
- Minimum stocking rate or/and appropriate regimes (optional): max 50% of land can be crushed as minimum cultivation standard; the rest of the land must be harvested or grazed; all alpine pastures have to be grazed (this requirement has little to do with Catch-C BMPs).
- Avoid the encroachment of unwanted vegetation on agricultural land (compulsory): prevention of bushes, trees and wasteland on agricultural land through appropriate measures (same).
- Protection of permanent pastures (compulsory): no conversion of permanent pasture into arable land. On slope greater than 15%, buffer strips along water courses: 20 m to lakes and 5 m to rivers.
- Maintenance of olive groves and wines in good condition (optional).
- Establishment of buffer strips along water courses (compulsory), according to the Austrian nitrate action programme: restricted use of pesticides, no use of machinery, no conversion from permanent pasture into arable land.
- Use of water for irrigation, compliance with authorization procedure (compulsory).

4.2.1.2 Cross-compliance 2014-20203

The INVEKOS-Umsetzungs-Verordnung states: "To maintain agricultural land in good environmental status and within the scope of cross compliance in the field of soil erosion, soil organic matter, soil structure and a minimum level of maintenance of fields, qualitative and quantitative targets are normalized in Community law. These are implemented and concretized in national federal law. These minimum requirements apply to all managers obtaining direct payments and certain payments from rural development, which nearly 90% of all agricultural land are affected in Austria. They are subject to Community control and penalties system."

As Austria already has designed a comprehensive agri-environmental program, the measures selected for greening have been chosen according to two principles: as few overlap with AEM as possible, and simple administration for farmers and authorities. Greening measures apply in ecological focus areas.

4.2.2 Belgium (Flanders)

4.2.2.1 Common Agricultural Policy (CAP) Pillar I- cross compliance

The current regulation on cross-compliance is valid until the end of 2014. Policy makers are currently working on the new regulation coming into force from January 1^{rst} 2015.

4.2.2.2 CAP Pillar I (valid up to December 2014)

Farmers who receive CAP subsidies have to fulfil requirements grouped into a cross-compliance package. This package includes standard mandatory requirements, good environmental and environmental conditions and additional requirements for those who also get funding for agri-environmental schemes.

Standard mandatory requirements

The standard mandatory requirements are a summary of all requirements the farmers must fulfil in order to receive direct payments. These requirements are based on European regulations and directives. A few of them have an impact on soil management, being:

Bird Directive (79/409/EEG) and Habitats Directive (92/43/EEG)

- **Aim: protection of birds and biological diversity by protection of habitats**
- **Includes conditions in special designated areas for permanent grasslands and other vegetation types**

Sewage sludge directive (86/278/EEG)

- Aim: protection of soil and the environment
- Strict regulation for use of sludge (from water treatment) on agricultural land

- Prohibition to use sludge from sewage sludge station

Nitrates directive (91/676/EEG)

- Aim: protection of water against contamination by nitrates from agricultural sources
- See also 2.3 Nitrates Directive

Good agricultural and environmental conditions (GAEC)

The overall aim is to keep the agricultural soils in a good agricultural and environmental condition. Some requirements are explicitly related to sustainable soil management practices studied in the Catch-C project.

Soil erosion

The Flemish Government adopted on April 25 2014 new requirements regarding to soil erosion. These new requirements are discussed in this report, although they still might be subject to change. Agricultural field plots in Flanders are divided into 4 classes according to soil erosion risk. If the carbon content is >= 1.7% and the pH in the optimal range, the erosion risk can be lowered with one class.

Obligated measures

First the measures that should be taken in 2014 are described, after which the period of 2015-2018 is discussed.
In 2014, there are some obligated measures for field parcels with a very high soil erosion risk. Depending on the crop type (susceptibility for soil erosion), there are different obligations regarding crop cover (maximum time period without any crop on the field) and 'minimum soil management'. These are the different measures to be taken to comply with 'minimum soil management'. Sometimes there is a choice for several options in this list, depending on the crop type (soil erosion susceptibility):

- Contour sowing (if contour >100m)
- Applying non-inversion tillage or being engaged in the agri-environmental scheme (AES) 'erosion control' (non-inversion tillage)
- Being engaged in AES erosion control (direct drilling)
- Being engaged in AES erosion control (grass buffer strips and grass ways ('grasgang'))
- Ensuring buffer capacity (erosion dam)

Crops on ridges, vegetables or strawberries can only be grown once in 3 years, and they should be rotated with crops with low erosion risk or maize sown with direct drilling or strip-till or crops with more than 80% cover between the rows.

For field parcels with high erosion risk there are only some obligated measures for crop cover.

The obligated measures for combatting soil erosion are gradually becoming more strict between 2015 and 2018 for the field parcels with a very high or high soil erosion risk. Depending on the erosion risk and crop type, these measures include:

- Stricter rules for crop cover (maximum period without crop in the field);
- Prohibition for conversion of permanent grassland to arable land on parcels with very high erosion risk, except for permanent grassland under AES;
- Contour sowing becomes an obligation on more parcels;
- There is a requirement for a cover between rows (e.g., grass) of e.g.., some fruit crops, ornamentals, and woody crops;
- Prohibition for crops on ridges on parcels with very high erosion risk;
- Micro dams ('*drempeltjes*') between ridges on parcels with high erosion risk;
- Non-inversion tillage;
- Prohibition for maize growth unless sown with direct drilling or strip-till on parcels with very high erosion risk;
- Prohibition for vegetables or strawberry growing unless more than 80% soil cover on parcels with very high erosion risk.

Recommended measures

On field parcels with medium and low erosion risk, farmers are strongly recommended to apply the same erosion control measures as for the field parcels with a high or very high soil erosion risk.

Soil organic matter and soil structure

The aim for the second set of measures is to optimize soil fertility and soil structure. Soil structure is considered important for root growth and optimal use of nutrients leading to a reduced fertilizer requirement. The farmers are obliged to take soil samples for pH and C analysis on arable land.

If the carbon content is too low the farmer should take one of these measures:

- Follow advice
- Applying farmyard manure
- Applying compost
- Incorporating straw
- Growing cover crops.

If the pH is too low the parcel should be limed.
Stubble and crop residues may not be burnt so that they can contribute to soil organic carbon.
Potato may only be grown once in 3 year (except for very early potatoes). This measure is what farmers already normally do for phyto-sanitary reasons (Federal regulation) and thus does not additionally stimulate crop rotation.

Conservation of permanent grassland
Permanent grassland is defined as natural or sown grasses or herbaceous fodder crops that are not rotated for at least 5 years. Conversion of these permanent grasslands is restricted.

The primary aim is EU driven, being maintaining and increasing carbon stocks in the soil, other aims are to increase biodiversity and to reduce the use of pesticides.

Additional requirements to obtain support for Agro-environmental schemes (AES)
To get money for some agri-environmental schemes, the farmer is obliged to fulfil some additional minimum requirements. Those related to soil management practices are:

- Rotation of seed potatoes (once in 4 years). This is for disease prevention and is not intended to stimulate crop rotation in function of soil quality.
- Monitoring pests and diseases in order to be able to apply suitable crop protection measures.

Specific agricultural support
In Flanders specific agricultural support is provided for cover crops, as is enabled by Article 68 of the EU regulation No73/2009. Cover crops can be sown after each main crop except for after grasslands, clover and grassclover. The cover crops should be sown before September 1 in the 'Polders' and 'Leemstreek (loamy region)' and before October 15 in other areas. Incorporation is only allowed from October 15 in the 'Polders', December 15 in the loamy region and February 1 in the other regions.

Cover crops are considered beneficial for reduction of nitrate leaching and erosion, improvement of soil structure, increase of soil organic matter content, lowered weed pressure, lower pressure of plant parasitic nematodes and release of nitrogen for the subsequent crop.

4.2.2.3 CAP Pillar I from January 2015

The first preliminary adoption by the Flemish Government occurred on April 14 2014. More details will become available over the coming months.

Greening
On all agricultural land for which the farmer receives subsidies, the farmers should comply with three greening measures (Art.35) The minister can decide that some agro-environmental or climate friendly measures or measures to comply with some environmental certificate schemes can replace one or all of these greening measures.

The greening measures are:

1. Crop diversification.
2. Maintaining permanent grasslands in ecological valuable regions and safeguarding the area of permanent grasslands at farm level.
3. Establishing ecological focus area of at least 5% (for farms larger than 15 ha). Ecological focus area can be fallow, agroforestry, landscape elements, buffer strips, coppice, catch and cover crops, leguminous crops.

Good agricultural and environmental conditions (GAEC) and additional requirements
There are only minor changes regarding the practices for GAEC and additional requirements as described above. Some of the changes concern the fact that
The only option when the soil organic carbon is too low is to follow an advice of a certified lab.

- The requirement to rotate is part of additional requirements (in framework of integrated pest management) instead of part of GAEC.

- The measure for permanent grasslands will remain in 2015 and 2016 but will be excluded afterwards as maintaining permanent grasslands is also a greening measure.

There will be no specific agricultural support for cover crops anymore.

4.2.2.4 CAP Pillar I summary

Although the main aim of the standard mandatory requirements is not on soil (except for soil contamination by sludge until 2014), some requirements for good agricultural and environmental conditions have a direct link with soils. The aim is to reduce soil erosion and to optimize soil organic matter and soil structure. Farmers need to take soil samples to get to know soil pH and carbon content so that they can adjust management practices if needed.

CAP Pillar I directly or indirectly has an impact on sustainable soil management practices. An overview is provided in Table 1. We do not consider the Nitrates directive which will be discussed in section 2.3.

Table 5: Impact of CAP-Pilar I on sustainable soil management practices (MP) considered in the Catch-C project (GAEC: good agricultural and environmental conditions, AR: additional requirement)

Management practice	Main aim	Remarks
Rotation		
MP4 rotation with tuber or root crops	Phyto-sanitary reason	Potato can only be grown once in 3 years (except for very early potato) (GAEC until 2014; AR from 2015)
	Phyto-sanitary reason	Seed potato can only be grown once in 4 years (AR)
MP6 Rotation with grasslands	Erosion control	Prohibition for conversion of permanent grassland to arable land on parcels with very high erosion risk (GAEC – from 2015)
	Soil carbon, biodiversity	Obligation for conservation of permanent grassland (GAEC until 2016)
	Biodiversity, greening	Maintaining permanent grasslands in ecological valuable regions and safeguarding permanent grassland area at farm level (greening from 2015)
MP7 intercropping	Erosion control	Requirement to have minimum crop cover between the rows of some crops (e.g. some fruit crops), e.g. by intercropping with grass (GAEC – from 2015)
MP8-9 green manures/cover crops/catch crops	Erosion control	Maximum time period defined without any crop on the field for parcels with (very) high erosion risk (GAEC – 2014 + after)
	Soil carbon and soil structure	Growing cover crops is in the list of measures to be taken if soil organic carbon content is too low (GAEC)
	Multiple aims such as erosion, soil carbon, nitrate leaching	Specific agricultural support can be provided under certain conditions for sowing and incorporation dates (until 2014).
	Ecological focus area	Might become one of the measures to establish ecological focus area from 2015
Other MPs with impact on rotation	Greening	Crop diversification (Greening from 2015)
	Erosion control	Max. 1 in 3 years crops on ridges/vegetables/strawberry/maize on parcels with very high erosion risk + rotation with crops with low erosion risk or maize with direct drilling/strip till or crops with > 80% cover between rows (GAEC-2014)
	Erosion control	Prohibition for crops on ridges on parcels with very high erosion risk from 2018 (GAEC)
	Erosion control	Prohibition for maize growth on parcels with very high erosion risk unless sown with direct drilling or strip-till (GAEC – from 2018)
	Erosion control	Prohibition for vegetables or strawberry growth on parcels with very high erosion risk unless more than 80% soil cover (GAEC – from 2018)
Tillage		
MP16 No/zero tillage	Erosion control	Option or obligation on parcels with very high erosion risk, depending on crop type (GAEC – 2014); obligation for maize growth on parcels with very high erosion risk (GAEC from 2018)
MP19 Non-inversion tillage (depth not specified)	Erosion control	Option on parcels with very high erosion risk (GAEC-2014), obligation for some crops on parcels with very high erosion risk from 2015 and with high erosion risk from 2018 (GAEC)
MP22 contour ploughing	Erosion control	Contour sowing on parcels, depending on crop type (GAEC – 2014 + after)
Other MPs	Erosion control	Obliged to have micro dams between ridges (GAEC – from 2015 for parcels with very high erosion risk and from 2016 on parcels with high erosion risk)
Nutrient management		

MP29 Plant compost application	Soil carbon, soil structure	Applying compost is in the list of measures to be taken if soil organic carbon is too low (GAEC)
MP32 Farmyard manure	Soil carbon, soil structure	Applying farmyard manure is in the list of measures to be taken if soil organic carbon is too low (GAEC)
MP 36 Return of crop residues	Soil carbon, soil structure	Straw incorporation is in the list of measures to be taken if soil organic carbon content is too low (GAEC)
MP37 Burning of crop residues	Soil carbon	Burning stubble and crop residue is prohibited (GAEC)
Other MPs	Soil contamination	Use of sludge is restricted (soil contamination) (standard mandatory requirement)

4.2.3 France

4.2.3.1 Common Agricultural policy (CAP), first pillar

The French agricultural and rural policy packages are designed according to a dialogue between the Ministry of Agriculture, Farmer unions and the agri-food industry.

The last dialogue ended up on December 17th 2013 in France and shaped the national choices about CAP implementation. The main choices do not target soils directly. The objective of contributing to the energetic transition has been added to the previous packages. Indirectly, soil quality may be enhanced by some specific measures, like subsidies for crop protein production (improved subsidies for animal farms that produce fodder proteins, and in a logic of agri-food chain, specific subsidies for crop farms supplying dry alfalfa, or lupine, horse bean, peas, or soya). In complement, France aims at favouring agro-ecologic practices, which also involve soil quality, but no precise relationship is included in the rationale for policy design.

Measures concerning greening of the CAP in France aim at favouring agro-ecologic landscape features (hedges, borders, landscape discontinuities), and upkeeping of permanent grasslands. Few features directly concern soil quality protection.

Last, as permitted by the EU, a transfer of 3 % (230 M€) is planned from the first pillar to the second pillar to enable the latter subsidise measures that have been aided by the first one (modernisation and improvement of the competitiveness of farms is included in this transfer). Unfortunately, despite the importance of soils for farms competitiveness, there is no explicit soil targeted measures included in this package.

The first pillar measures are embedded in the French rural code, regulatory part, book VI, Title 1, chapter 5 that defines the French implementation of CAP payments. Yearly modifications of the coefficients related to payments are taken by Arrêtés.

GAECs are defined by the *Arrêté du 13 juillet 2010 relatif aux règles de bonnes conditions agricoles et environnementales* (BCAE)[12]. They are included in the *Code rural et de la pêche maritime*, articles D615-45 to D615-61. Farmers benefitting from CAP payments:

- Have to implement grass strips (D615-46) along water courses, at least 5 meters wide. On these strips, fertilization or use of pesticides are forbidden.
- Cannot burn crop residues (D615-47). Local exemptions are possible for sanitary reasons.
- Guarantee a diversity of crops on the farm yard (D615-48).
- Have to monitor water abstraction (615-49).
- Have to maintain their fields in good condition (615-50), keep-up topographic singularities (615-50-1), conserve the same area in grassland as the reference level of year 2010 (615-51); and in some cases have to keep permanent grassland unploughed. Technical definitions of maintenance are designed at NUTS3 level.

For 2015 onwards GAECs definitions have evolved slightly:

- GAEC 1 :Grass strips (D615-46 hasn't been modified) are supposed to prevent erosion to run into watercourses. On grass strips, non-inversion tillage is allowed (traditional tillage is forbidden). Their width is of 5 meters. Some regions have started to try to inter-connect these grass strips within the green and blue corridors framework proposed by the French "Grenelle de l'Environment" initiative.
- GAEC 6 : The ban of burning crop residues (D615-47 is the same).

[12] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000022485129

- GAEC 4 : The GAEC dealing with the diversity of crops (D615-48 is the same) mentions that if the farmer does not satisfy to the obligation of cropping different crops on the same field, it is mandatory for him to implement a cover crop or a winter crop, so that the soil is covered from November 1rst to March 1rst.
- GAEC 5 : The minimal maintenance GAEC states that fields have to be maintained, and defines tolerance of non-maintenance at 3% of each plot (more in urbanised areas), with an interdiction to let self-propagating plants to grow enough to weed. This GAEC has no direct consequence on soil or climate change mitigation, except that it encourages farmers to use crushers on their pastures and increase their fuel consumption. D615-50 is the same, as is D615-50-1, an article (D615-50-2) has been created that bans discharge of dangerous substances and also bans storage of farm manures closer than 35 meters of wells. The GAEC upkeep of topographic specificities mostly deals with biodiversity stakes. Filed borders that are considered as topographic specificities cannot be fertilised or receive pesticides, but they can be ploughed.
- GAEC permanent grasslands : last, according to the GAEC "meadows", farmers who benefit from the CAP payments have to keep a reference area in meadows, and this area is defined from the grassland that were on the farm in 2010. Permanent pastures have to be kept as is, and temporary meadows cannot be modified by more of 50 % of the reference area. This GAEC has no direct impact on soil on the grassland fields, but at the regional level it limits drastically the ploughing of long term meadows and the associated organic matter decrease it would have induced.

Moreover, at the national level, there will be a coupled subsidy for leguminous crops from 2015 onwards.

GAECs 1, 4, 5 and meadows are mostly targeted at mitigating erosion and preventing water pollution by mandating grass strips along water courses, catch-crops, and forbidding ploughing of permanent grasslands. Moreover, GAEC6 bans burning of crop residues (but farmers do what they want with these residues, including harvesting, as long as they don't burn them), with the aim to improve soil organic carbon.

4.2.3.2 Greening of the CAP

Three main measures have been designed in France to ensure the greening of the CAP:

- Crop diversity: farmers who benefit from CAP payments must implement 3 different crops on their arable land (the largely implemented has to occupy less than 75% of the crop area). But many exemptions exist:
  - Farms having less than 10 ha of arable land have no obligation
  - Farms having more than 10 ha of arable land and on which grassland occupy more than 75 % of the UAA (and for which the remaining arable land represent less than 30 ha) have no obligations either.
  - Other farms have to implement 2 crops only (the largely implemented being less than 75% of the farm yard) if their arable land is comprised between 10 and 30 ha.
- Maintenance of permanent grasslands: the ratio permanent grassland / UAA shall not decrease by more than 5% compared with the reference year 2012 (some can be ploughed with an administrative authorization but then others have to be implemented elsewhere).
- Areas of ecological interest have to represent 5 % of the UAA (permanent grassland not included). This area includes grass strips, catch-crops and leguminous crops. Note that leguminous crops can't be accounted both for greening measures and for GAEC on crop diversity (farmers have to choose one option).

The strategic objectives of these measures features have not been explicated, albeit in a plan promoting agro-ecology (Le Foll, 2012). The agro-ecology project for France is supposed to deal with water erosion, water quality, and improve some features of soil quality, like mitigating compaction, or preventing biodiversity decline.

4.2.3.3 National regulation and initiatives

In France, farming is shaped by agricultural laws. The previous one was voted in 2006, and named law n° 2006-11 of 5 January 2006 "d'orientation agricole"[13]. The law is organised in titles, subdivided in chapters. Title IV, chapter II of this law promotes environmentally friendly practices, and more precisely it modifies the Taxation Code and the Rural Code to create environmental lease agreements. When the owner of the land is the State or a registered environmental association, the lease agreement can contain long term guarantees that the farming practices will respect some sort of minimum compatibility with the environment. In practice, these lease agreements have had very little application.

This limited application has been broadened by the 2014 version of the "Loi d'avenir pour l'agriculture, l'alimentation et la forêt"[14]. This law modifies the rural code and the environmental code. Regarding soils, the following items are of interest:

[13] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000264992
[14] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000029573022&dateTexte=&categorieLien=id

- Article L411-27 of rural code now includes the possibility to add environmental contractual clauses to lease agreements even between private individuals, in order to keep up already existing practices or infrastructures. Soil quality is quoted as one aim, and so is erosion prevention (among many other aims like biodiversity, landscapes, quality of products).
- Article L315-1 has been added to allow for GIEE (groupement d'intérêt économique et environnemental – economic and environmentally interest groups), who have to be granted at the regional (NUT2) level. These groups are composed of farmers and non-farmers, on a coherent territory, and propose actions linked to agro-ecology that aim at improving at the same time the economic, environmental and sociologic performance of the farms by favouring technical, social or governance innovations, and by encouraging experiments. The regional agricultural chambers are requested to ensure networking of the outcomes.
- It creates a regional scheme for farming, which frames the orientations of agriculture at the regional level, according to the stakes outlined by the regional plans for sustainable agriculture. The structures of authorised farms is the target of these regional schemes, the new point is that both the environmental and economic interest of each authorisation has to be taken into account.
- Article 50 of this law introduces the necessity to monitor the impact of pesticides on various targets and media, including soils.

Article L411-27 creates a real opportunity to sustain soil quality as a local good, and it embeds it into private stakes: with no public money, soil quality is seen as a feature of the fields themselves and it becomes the responsibility of owners to enforce management practices that preserve the features of their goods (seen as private). In other terms, lease agreement can internalise their own willingness to pay for long term soil quality preservation. It might be of interest in the future to survey the use of this article, because owners, who can live far from rural areas, might not be fully informed of the necessary practices and of their impacts on soils (among many other information asymmetries).
Of course, for all the ecosystem services that soils supply, biodiversity, limitation of erosion, water quality, carbon storage, etc. which apply at larger scales than on rented fields and are local (or broader) public goods, private loans cannot support all the cost of provision, and public intervention is still required.

In France, there are many expectations about awareness rising of farmers about the benefits of agro-ecology. Agricultural schools programs are to be modified to include the above-related techniques, long-life learning programs, and networking of on-farm experiments. Unfortunately, at the time of writing the report, among the 7 plans designed according to the overall plan on agro-ecology, none aimed at improving soil quality yet.

4.2.4 Germany

In Germany requirements for Cross Compliance are defined by the Direktzahlungen-Verpflichtungenverordnung (DirektZahlVerpfIV) and the Direktzahlungen-Verpflichtungengesetz (DirektZahlVerpfIG). They include specifications for *Good Agricultural and Environmental Conditions* (GAECs), guidelines for permanent grassland and *Standard Mandatory Requirements* (SMRs).

The DirektZahlVerpfIV defines requirements for several fields: *prevention of erosion, soil conservation, maintenance of agricultural land, landscape components, compliance with authorisation procedures for the use of irrigation water, groundwater conservation* and *conservation of permanent grassland*. According to this regulation e.g. soil organic matter and soil structure have to be conserved. Therefore one of the measures humus balance, analysis of humus content or crop rotation with at least three crops has to be applied.

4.2.4.1 CAP 2007-2013

Crop rotation (reference: monoculture)

CAP-x-Crop rotation

- Compliance of cultivation proportion with at least three different crops as one possibility to conserve soil organic matter

Reduced tillage (reference: plowing)

Depending on the erosion risk of the area there are special requirements on tillage operations (Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz (ML) 2014). However, in addition there can be further regulations depending on the Federal State (cf. ML 2014, Landwirtschaftskammer Nordrhein-Westfahlen (LWK NRW) 2013).

Minimum tillage (incl. shallow non-inversion tillage)

Areas with erosion risk induced by water (level 1)

- 01.12. to 15.02. no ploughing

Areas with erosion risk induced by water (level 2)

- 01.12. to 15.02. no ploughing
- before sowing row plants (row distance > 45 cm) no ploughing

Areas with erosion risk induced by wind

- before sowing row plants (row distance > 45 cm) no ploughing

No tillage (incl. direct seeding)

Areas with erosion risk induced by water (level 1)

- 01.12. to 15.02. no ploughing
- Contour ploughing allowed without restrictions

Areas with erosion risk induced by water (level 2)

- 01.12. to 15.02. no ploughing
- 16.02. to 30.11. ploughing only allowed immediately before drilling
- before sowing row plants (row distance > 45 cm) no ploughing

Areas with erosion risk induced by wind

- ploughing allowed before 01.03.
- after 01.03. ploughing only immediately before drilling
- before sowing row plants (row distance > 45 cm) no ploughing (except certain measures against erosion are applied)

Incorporate crop residues (reference: removal or burning)

leave residues on field

- **Burning of straw is not allowed**

Apply external organic inputs (reference: mineral fertiliser)

Mineral fertilizer

- No application if soil is flooded, deep frozen, saturated or more than 5 cm snow cover
- at least 3 m distance for application to open water bodies
- restriction of application on highly inclined (> 10 %) slopes in proximity to open water bodies

Farm yard manure

- No application if soil is flooded, deep frozen, saturated or more than 5 cm snow cover
- restriction of application on highly inclined (> 10 %) slopes in proximity to open water bodies
- No application from 01.11. to 31.01. for arable land
- No application from 15.11. to 31.01. for grassland
- determination of amount of total N and P
- ≤ 170 kg N/ha*y in average for all areas of one farm

Slurries

- No application if soil is flooded, deep frozen, saturated or more than 5 cm snow cover
- No application from 01.11. to 31.01. for arable land
- No application from 15.11. to 31.01. for grassland
- determination of amount of total N and P
- Application for winter crops as current fertilisation demand or compensation fertilisation (in total ≤ 80 kg/ha*y total N or ≤ 40 kg/ha*y NH_4^+)
- highly inclined (> 10 %) slopes in proximity to open water bodies, application with special distances to open water bodies
- ≤ 170 kg N/ha*y in average for all areas of one farm

Composts

- No application from 01.11. to 31.01. for arable land
- No application from 15.11. to 31.01. for grassland
- determination of amount of total N and P

Grassland

- to avoid further transformation of grassland, the regional grassland area should not fall below the amount of 2003 (reference year). A regional tolerance of 5% is allowed.

4.2.4.2 CAP 2014-2020

In order to implement the Regulation (EC) No 73/2009 into national law a draft for Direktzahlungen-Durchführungsgesetz (DirektZahlDurchfG) was published. It shall be put into force in 2015. However, at the time of writing concrete requirements beyond that draft had not been specified yet.

4.2.5 Italy

4.2.5.1 Commmon Agricultural Policy (CAP) 2007-2013, European Regulation n. 1698/2005/EC:

National implementation: D.M. 21/12/06 n. 12541

The overall intent: CAP was mentioned in the crop production to respect some standards of food safety, environmental protection, animal welfare, improved landscape management. The respect of the reference baseline was considered a necessary condition, without which any financial support was not acceptable.

Soil mentioning: CAP measures aimed to maintain soil in good agronomic and environmental conditions. These conditions are defined with respect to soil erosion, soil organic content, good soil structure, and a sufficient habitat conservation.

- Rotation:

Maximum monoculture duration was 5 years, but it could be extended if soil organic matter does not decrease (analyses must be provided).

4.2.5.2 Common Agricultural Policy (CAP) 2014-2020, European Regulation n. 1306/2013-1307/2013/UE:

National implementation: still under discussion, at this moment there are only draft versions or versions sent to Brussels for discussion

The overall intent: to enforce the application of standards about food safety, environmental protection, animal welfare and proper management of soil and landscape. Respecting these standards, without which Community aids cannot be accessed, is the base level for the proper management of the agricultural ecosystem. The new program aims to raise such "base level" through measures such as greening and integrated pest management.

Soil mentioning: soil is mentioned in many areas, such as the greening (and equivalent commitments) the rotations and soil tillage.

- Rotation:

Planned measures: crop diversification is in direct support (1307/2013/EU), single farm payment is mentioning greening. Greening is a baseline on arable crops (<10 ha there are no constraints, 10-30 ha minimum of two crops, >30 ha minimum of 3 crops). Previous rotations are not taken into account only the actual farm situation is considered.

- Cover crop, catch-crop, green manure, areas of ecological interest and permanent grassland:

Commitments equivalent to greening are to be decided by each Member State. In Italy this regulation is yet to be fully decided: soil winter coverage will be probably included, but tendency is to diverisfy other measures from greening, to avoid any overlap between greening and other policies such as the agro-environment measures.

- Grassland:

Italy aims to promote the convertion of some arable land into meadows. There are limits to application of such measure because in many areas grassland is already in place. If cut and grazed grassland is in place, greening is automatically fulfilled.

- Tillage:

On the basis of provisions contained in the Code of Good Agricultural Practice, political measures are in favour of minimum tillage and no tillage. Public officials are worried about how to control these measures, because controlling the type of tillage and the tillage depth is difficult.

- Nutrient management:

Nitrate directive as CGO (Compulsory management criteria) and BCAA (good agricultural and environmental condition) are to be respected in the Nitrate Vulnerable Zones areas, for the single payment. Regarding crop residues management (MP36), prohibition to burning straw is mentioned, with the rice crop exception.

- Integrate pest management:

The PAN (National Action Plan for pesticide management) in application of 128/2009/UE on the integrated pest management has been adopted. Ket points are: increasing knowledgeabout data monitoring, listing the BMP to be adopted. No new requirement about limits of active ingredient concentrations are set in PAN. For all that concerns voluntary action, PAN refers to the AEC..

- Buffer strips:

From 2012 the standard 5.2 should be applied. This corresponds to a buffer with permanent continuous vegetation as baseline, no planting or tillage should be performed. Above this baseline level, any supplementary action is voluntary.

4.2.6 Netherlands

4.2.6.1 Commmon Agricultural Policy (CAP) 2007-2013, European Regulation n. 1698/2005/EC, Netherlands

Crop rotation:
The obligations are given by the GAECs that say that set-aside land must be protected by cover crops, and that it must land be grazed or mowed at least once per 2 years, to avoid shrubs. Further, a specific restriction holds for the Loess district: no fruit trees are allowed on slopes >2%, unless special precautions are taken.

Grassland management:
One SMR is the fulfilment of the NiD which stipulates that grassland may be ploughed up (for renewal, or in rotation) only within a restricted period in spring. And it must be followed by a crop with high N-demand, to reduce leaching losses. Further, in the Loess district, farm land with slopes >18% must be held under grassland.

Tillage
Tillage practices are only regulated for soils in the Loess district, under GAEC-5 (minimum land mangement reflecting site specific conditions to limit erosion). The district is a small part of NL territory, in southernmost tip of Limburg province where topography is rolling and texture is silt of aeolian origin.

Regulation here consists of stipulating a set of requirements, and waivers under specific conditions. The set of requirements includes: removal of tracks after harvest, by tilling at least 15 cm depth; removal of tracks after sowing maize, onion, or sugar beet; tillage to max depth of 12 cm or application of a 'mulch system' (is plow in autumn, set cover crop, and non-inversion til in spring). This set of obligations is waived for farms that meet all of the following conditions: use only non-inversion tillage; sowing of cover crop after harvest (except when later than 15 September); use sills to stop water flow in ridge-crops (as potato); the storage capacity for runoff should be at least 100 m3/ha. The obligations are also waived for winter cereal crops sown before January 1st.

Nutrient management
The Netherlands have developed a very detailed regulation of nutrient management under the NiD. Major elements are closed periods for land application of animal manures, application standards for nitrogen and phosphorus specified per crop and soil type, and fixed fertilizer-equivalencies of organic inputs. Moreover, phosphorus application standards depend on phosphorus status of the soil. On sand and loess soils, catch crops are mandatory after maize. Grassland can be plowed up only in restricted periods: Feb.1-May 10 for sand and loess, Feb.1-Sept.15 for clay and peat soils. In all cases, N-demaning crops must be grown upon destruction of the grassland sod. There is a derogation for the use (max rate) of cattle manures on intensive dairy farms. A major condition for this derogation (during the 2007-2013 CAP period) was a minimum grassland area of at least 70% of the farm area.

Other
There is a ban on the burning of crop residues. A permit is required to irrigate crops.

4.2.6.2 Common Agricultural Policy (CAP) 2014-2020, European Regulation n. 1306/2013-1307/2013/UE, Netherlands

The package is still under negotiation. Most of the above obligations and restrictions will remain in place under the new CAP. The proposals for the new CAP (2014-2020) mainly relate to the greening requirements, and include the additions and amendments given below.

Ban on plowing – maintenance of permanent grassland
This holds in Nature 2000 areas.
The condition of maintenance of permanent grassland (decrease should not exceed 5%) is applied at national scale. Monitoring will indicate whether a stricter regime is needed, implementing the restriction at the individual farm level.

Diversification
Farms of 10-30ha must grow at least two crops, farms of more than 30 ha at least three crops. Specialised vegeable farmers (renting land, and growing often only one or two crop species, e.g. cabbage farmers) have objected early 2015; still under negotiation. No obligation to diversify if more than 75% is grassland. A request for simplification has been forwarded by NL to EC early 2015, including e.g. that catch/cover crops can be single species instead of mixtures.

Ecological focus areas (EFAs)
Currently (early 2015) 20% of NL farmers must implement EFAs. Farmers can choose from a list of legumes, cover crops, and willow coppice, or opt for a so-called 'sustainability certificate'. http://www.toekomstglb.nl/efa-duurzaamheidscertificaten-1285.html. Central to the design of lists, options, packages and equivalent measures are scores attributed to crop species, expressing their contribution to the promotion of biodiversity and environmental goals. These were revised for NL in a study commissioned by the ministry in 2014 to Wageningen-UR (Belder et al., 2014).

For the 'sustainability certificates', the standard option is (i) a package 'Akkerbouwstrokenpakket incl. vogelakkers' (strips on arable fields including bird plots). This includes managed strips on arable fields, landscape elements, ditch edges, catch crops, legume crops.

Details on http://www.toekomstglb.nl/duurzaamheidscertificaat-akkerbouwstrokenpakket-1287.html. no nutrient inputs are allowed here. Alternative options of these certificates are:
(ii) package 'Veldleeuwerik'. Similar to previous, but more flexibility for the farmer. Here, farmers must work on 100% of their land to make farming more sustainable; this intent is documented by a Veldleeuwerik 'certificate'. In return, other standards on the 5% EFA are relaxed (e.g. the minimum width of strips; the retainment of 50% strips over winter).
(iii) a package 'Biodiversity Plus'; this initiative by collectors, retailers and NGO's aims at launching of a 'Biodiversity+' label on certain farm products. Includes the over-winter retention of cereal stubble as voluntary option. This option is still under negotiation with stakeholders.

An option receiving much interest is to meet EFA requirements in collectives of max. 10 farmers. Conditoons are that the land of participants must be geographically connected (bordering), and that each participant devotes at least 2.5% of his farm to EFA.

Another form of collaborative action was recently (January 2015) proposed by the NL government to EC : facilitate the merging of actions (on the ground, i.e. in geographical sense) under greening in Pillar-I with agri-environment measures under Pillar-II, allowing the construction of corridors and larger patchworks of land with biodiversity values by collaborative actions. Connected with this initiative is the earmarking of budget (20 M€, doubles by provinces) under Pillar-I for measures to meet international water quality goals; these measures include agri-environment and climate actions.

Nitrates Directive
Changes to regulation under the SMR of NiD are as follows. Manures are accounted now with higher fertilizer equivalency coefficients, thus restricting further the use of manures under a given farm N use allowance (the latter being based on acreage, crops and soil type). On sensitive soils (sand and loess), N and P application standards (covering mineral and organic inputs) are lowered. N application standards for grassland on clay are raised. Cereals on clay soils are allowed higher N application standards, depending on registered yields. Manure use in autumn is now allowed on oilseed rape. And cattle slurry may be applied to curb wind erosion.

During this new CAP period (2014-2020) the derogation for the max use of cattle manures on intensive dairy farms was continued but restricted. Now, at least 80% of the farm area must be in grassland, mineral phosphate fertilisers are banned, and maximum application rate of N in manures is reduced to 230 kg/ha (versus standard in EU of 170 kg/ha) for sand and loess soils in five provinces. For other provinces, and for all clay and peat soils, the max rate remains at 250 kg/ha. There is a series of additional requirements on soil sampling, farm planning and adminsitration, and transports.

4.2.7 Poland

National implementation of CAP direct payments is a transposition of EU Parliament Regulation 73/2009 with Polish wording: *Rozporządzenie Rady (WE) nr 73/2009 z dnia 19 stycznia 2009 r. ustanawiającego wspólne zasady dla systemów wsparcia bezpośredniego dla rolników w ramach wspólnej polityki rolnej i ustanawiającego określone systemy wsparcia dla rolników, zmieniające rozporządzenia (WE) nr 1290/2005, (WE) nr 247/2006, (WE) nr 378/2007 oraz uchylające rozporządzenie (WE) nr 1782/2003 (Dz. Urz. UE L 30 z 1.01.2009 r.).*

Before 2007 good practice codex was the only requirement to be fulfilled by farmers to receive direct payments. Within CAP 2007-1003 Statutory Management Requirements (SMR) of Cross-compliance were implemented, however new Member States, including Poland, were obliged to implement them by 2009.

The SMRs in the priority Natural environment were the following:
SMR 1: Protection of wild birds
SMR 2: Groundwater protection
SMR 3: Sewage sludge application rules
SMR 4: Protection of water against nitrates
SMR 5: Protection of flora and fauna species

Table 6: GAECs in Poland

GAECs group/SCOPE	Norm	Way of implementation
GAEC1 Soil protection against erosion	Minimum soil cover	Soil is cropped or fallowed. Land under erosion risk is vegetated within Dec 1 and Feb 15 - at least 40% of farm area
	Minimum land management according to site specific conditions	Arable land with slope >20^{o} are not cropped with rows alongside slopes Arable land with slope >20^{o} is not used as black fallow Soil of arable land with slope >20^{o} used for permanent crops is covered with vegetation or terrace method is applied
GAEC2 Maintenance of soil organic matter	Crop rotation	Wheat, oat, rye or barley are not cropped longer than for 3 years in monoculture
	Stubble management	No burning is allowed
GAEC3 Maintenance of soil structure	Use of appropriate machinery	No heavy machinery is allowed when soil profile is water saturated
GAEC5 Water protection and management	Creation of buffer strips along water bodies (lakes, rivers, channels)	At least 20 m in case of lakes >50ha At least 5 m (mineral fertilizers) and 10 m (liquid manure) in case of lakes <50ha, rivers, channels
GAEC6 Protection of permanent grasslands	Protection of permanent grasslands	They are not converted to arable land and they are managed

Soil issues are represented in SMR3. Any farmer that applies sewage sludge to soil must possess results of sludge and soil analysis, including trace elements, and documents on sludge transfer (amounts) from sludge producer to

farmer. This protects soil against contamination since the sludge meets quality criteria and is applied at rates allowed by national regulation on sludge utilization in agriculture.

Besides direct payment scheme there was the instrument of specific payments to legumes. This type of support was beneficial to protect soil quality, especially to preserve soil organic matter level. The support referred to such plants as been, soybean, peas, lupine, clover, alfalfa.

Farmers connected to direct payment mechanism had to follow GAEC norms. Table 6 depicts the norms relative to soil protection that were applied in the polish case.

Within the new CAP perspective the following GAECs will refer to soil protection and are within interest of Ministry of Agriculture and Rural Development:

- Minimum soil cover (GAEC 4)
- Minimum land management reflecting site specific conditions to limit erosion (GAEC 5)
- Maintenance of soil organic matter level including ban on burning arable stubble (GAEC 6).

The instruments that are discussed for new CAP within pro-environmental payments will be definitely important for soil protection from Poland perspective. They include:

- Diversification of crops
- Protection of permanent grasslands
- Pro-ecological areas (EFA-ecological focus area) – besides grasslands, fallow, catch crops, terraces, permanent bioenergy crops.

4.2.8 Spain

4.2.8.1 National scale

In Spain, at the national scale, the Reglamento (CE) Nº 73/2009 del Consejo, de 19 de enero de 2009, establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers is implemented by the Real Decreto 486/2009 de 3 de Abril de 2009

In this PP, the statutory management requirements and good agricultural and environmental conditions are defined for farmers who receive direct payments under the common agricultural policy, rural development, and support programs for restructuring and conversion of vineyards. Furthermore specific orders are described based in the different climatic, soil and crop conditions to prevent the abandonment of the lands.

- Real Decreto 486/2009 de 3 de Abril de 2009. Aplicación de la Condicionalidad
  - *CAPÍTULO I Cuestiones de carácter general Artículo 2. Definiciones d), e), g), i and j)*
  - *ANEXO II Buenas Condiciones Agrarias y Medioambientales.*
    1. Normas exigibles para evitar la erosión.
    2. Normas exigibles para conservar la materia orgánica del suelo.
    3. Norma para evitar la compactación y mantener la estructura de los suelos.

For **soil erosion**, the Real Decreto 486/2009 describes some enforceable rules to prevent erosion regarding:

a) Minimum ground cover
1.º Herbaceous crops

- Inversion tillage is forbidden in function of the harvesting and pre-sown dates.in non irrigated farms, sown with winter herbaceous crops.
- However, to enhance the implementation of cover crops these dates can be adapted to local conditions.

2.º Woody crops
For olive orchards:

- Based on the slope of the farm and the irrigation system, a cover crop between the tree rows should be maintained.
- However, the cover crop can be mechanical or chemically killed (and incorporated into the soil profile) if it competes for water and nutrients with the crop.
- For determined slopes, trees must not been pulled up unless it is allowed, following the regional guidelines.

3.º Fallow and removal lands
Any of the following practices must be carried out in these kinds of lands:

- Traditional crops
- Minimum tillage
- Cover crop (spontaneous or sown)
- As a complement, every three years a maximum amount of manure or slurry is defined previous the sown of the crop.

b) Minimum landscape planning for preserving the specific site conditions
Adapted tillage based on the slope conditions
1.º Herbaceous crops.
- Inversion tillage is forbidden in function of the slope of the farm

2.º Woody crops
- Inversion tillage is forbidden in function of the size, design, slope and the productive activity of the farm.
- Applicable to vineyards, olive and nut orchards

3.º High risk erosion areas
Restrictions imposed by regional policies must be followed

c) Retention terraces
The terraces should be maintained in good conditions: drainage capacity, avoiding silting and landslides and emergence of new gullies.

- Real Decreto 202/2012, de 23 de enero, sobre la aplicación a partir del 2012 de los pagos directos a la agricultura y a la ganadería.
  - *Sección 1.º Programa Nacional para el Fomento de Rotaciones de Cultivo en Tierras de Secano, establecido en el Real Decreto 202/2012, de 23 de enero, Título V(Ayudas específicas por aplicación del artículo 68 del Reglamento (CE) n.º 73/2009 del Consejo, de 19 de enero), cap. I, sección 1ª, Art. 28 . (No está recogida en el PDR andaluz)*
  - *Sección 3.ª Programa nacional para el fomento de actividades agrícolas específicas que reporten mayores beneficios agroambientales en determinadas especies del sector de los frutos de cáscara, Artículo 42. Manejo de residuos.*

In relation to water use and management more decrees should be consider at this national scale:
- Real Decreto Legislativo 1/2001, de 20 de julio, por el que se aprueba el Texto Refundido de la Ley de Aguas.
- Real Decreto 926/1989, de 21 julio, por el que se constituye el Organismo de cuenca Confederación Hidrográfica del Guadalquivir.
- Real Decreto 927/1988, de 29 julio, que aprueba el Reglamento de la Administración Pública del Agua y de la Planificación Hidrológica.
- Real Decreto 849/1986, de 11 abril, que aprueba el Reglamento del Dominio Público Hidráulico.

4.2.8.2 Regional scale
At the regional scale of Andalusia, the national PP is regulated by the Orden de 22 de junio de 2009, modified by Orden de 22 de junio de 2011.

In this PP legal requirements of management and good agricultural conditions that farmers must implement to receive direct payments under the common agricultural policy are set. Given the changes in the control elements of compliance made by coordinating circulars from FEGA (Spanish Agricultural Guarantee Fund), after consultations with the autonomous communities and different units and MAGRAMA (Ministry of Agriculture, Food and Environment) it is necessary to update Annex II. Furthermore, more requirements are defined for GAECs support such as, the establishment of buffer strips along the riverbanks and the regulation of fertilizers and phytosanitary products in these zones.
- Orden de 22 de junio de 2011 por la que se modifica la Orden de 22 de junio de 2009 sobre la aplicación de la Condicionalidad
  - *CAPÍTULO I. Cuestiones de carácter general Artículo 2 Definiciones d), e), g), i)*
  - *CAPÍTULO II Buenas condiciones agrarias y medioambientales Artículo 4. Buenas condiciones agrarias y medioambientales. 1. Norma sobre la cobertura mínima del suelo a), b), c)*
  - *ANEXO II ELEMENTOS A CONTROLAR PARA LA VERIFICACIÓN DEL CUMPLIMIENTO DE LOS REQUISITOS LEGALES DE GESTIÓN ESPECIFICADOS EN EL ANEXO II DEL REGLAMENTO (CE) 73/2009 A) Ámbito 1: Medio ambiente Acto 3: Directiva 86/278/CEE*
- Resolución de 26/08/2011, modificación Orden de 22/09/2011, ámbito de MA

- *ANEXO II ELEMENTOS A CONTROLAR PARA LA VERIFICACIÓN DEL CUMPLIMIENTO DE LOS REQUISITOS LEGALES DE GESTIÓN ESPECIFICADOS EN EL ANEXO II DEL REGLAMENTO (CE) 73/2009 A) Ámbito 1: Medio ambiente*
  - *Acto 2, Protección de las aguas subterráneas de la contaminación causada por determinadas sustancias peligrosas*
  - *Acto 3 Directiva 86/278/CEE del Consejo de 12 de junio de 1986, relativa a la protección del medioambiente y, en particular, de los suelos, en la utilización de lodos de depuradoras en agricultura*

- Resolución de 3/08/2012 modifica el Anexo II de la Orden 22 de junio de 2009- RLG
  - *«Anexo II- Elementos a controlar para la verificación del cumplimiento de los requisitos legales de gestión especificados en el Anexo II del Reglamento (CE) Núm. 73/2009 del Consejo, de 19 de Enero de 2009». A) Ámbito 1: Medio ambiente Acto 3: Directiva 86/278/cee del consejo, de 12 de junio de 1986, relativa a la protección del medio ambiente y, en particular, de los suelos, en la utilización de lodos de depuradoras en agricultura.*
- Orden de 28 de septiembre de 2012 que modifica la Orden de 22/06/2009
  - *Artículo 4, Sección 13. Norma sobre la creación de franjas de protección en las márgenes de los cursos de agua*

Table 7: Summary of the SMRs related to soil quality at the National scale

SMRs/ SCOPE	Directives and regulations: Acts	Reference articles: Requirements	National reference standards	Regional reference standards
ENVIRONMENT	Dir. 80/68 protección de las aguas subterráneas contra la contaminación	Art. 4 y 5: Impedir la introducción de determinadas sustancias peligrosas en las aguas subterráneas	Real Decreto 849/1986, de 11 de abril, por el que se aprueba el Régimen del Dominio Público Hidráulico	Ley 9/2010, de 30 de julio, de Aguas para Andalucía
	Dir. 86/278 protección del medio ambiente y en particular de los suelos en la utilización de los lodos de depuradora en agricultura	Art. 3: Cumplimiento de la normativa nacional relativa a la utilización de lodos en agricultura.	Real Decreto 1310/1990, de 29 de octubre sobre utilización de los lodos de depuración en el sector agrario.	Orden de 22 de noviembre de 1993, por la que se desarrolla en el ámbito de la Comunidad Autónoma Andaluza sobre utilización de Lodos de Depuración en el Sector Agrario
	Dir. 91/676 protección de las aguas contra la contaminación producida por nitratos	Art. 4 y 5: Cumplimiento de las medidas establecidas en los programas de actuación, en las explotaciones agrícolas y ganaderas situadas en zonas declaradas por la Comunidad Autónoma como zonas vulnerables	Real Decreto 261/1996 de 16 de febrero, sobre protección de las aguas contra la contaminación producida por los nitratos procedentes de fuentes agrarias	Orden de 18 de noviembre de 2008, por la que se aprueba el programa de actuación aplicable en las zonas vulnerables a la contaminación por nitratos procedentes de fuentes agrarias designadas en Andalucía, modificada por la orden de 9 de marzo de 2010, y sus correcciones de 14 de enero de 2009 en BOJA nº 8 y de 27 de febrero de 2009 en el BOJA nº 40

Good Agricultural and Environmental Conditions (regional scale)

These GAECs are mainly focused in the establishment of the limitations and conditions for using fire as a tool for residues management. This requires public authorities to take measures to reduce as far as possible the situations that cause forest fire risk, particularly those that involve the use of fire or motor vehicles in agricultural and forest

areas. The measures provided in this PP prevent, with increased efficiency, the existence of a phenomenon that threatens seriously the natural heritage of Andalusia, structured in five scopes: the time of danger as well as areas where such danger exists or ends, the prevention of forest fires, the controlled burning of scrubs, use of fire in agricultural operations and solid waste landfills.

- Orden de 21 de mayo de 2009 de limitaciones de uso y actividades forestales
- Decreto 470/1994, de 20 de diciembre, de Prevención de Incendios Forestales

Table 8: Summary of the GAECs related to soil quality at the National scale

GAECs/SCOPE	Norm	Mandatory	Facultative
GAEC1 Soil protection against erosion	Minimum ground cover	X	
	Minimum land management according to site specific conditions	X	
	Retention terraces		X
GAEC2 Maintenance of soil organic matter	Management of crop residues, stubble and pruning	X	
GAEC3 Maintenance of soil structure	Use of appropriate machinery		X
GAEC4 Minimum maintenance for preventing environment degradation	Maintenance and protection of permanent pasture	X	
	Maintenance of structural elements	X	
	Prohibition of pulling up olive trees		X
	Control of the growing of non-wanted spontaneous vegetation	X	
	Maintenance of olive orchards and vineyards with good vegetative conditions		X
	Maintenance of habitats		X
GAEC5 Water protection and management	Compliance with authorization procedures, when the use of irrigation water requires it	X	
	Creation of buffer strips along watercourses banks	X	

Regarding water quality and therefore agricultural soil quality in irrigated areas, the Hydrological Plan of the Guadalquivir River Basin, should be considered. The Hydrological Plan of the Guadalquivir River Basin 2009-2015, whose work began in 2007, is the cornerstone on which the management of water resources is supported to achieve the objectives of the water planning: to get good and adequate protection of public water and water, meeting the demands and balance and harmonization of regional and sectorial development, increasing the availability of the resource, protecting its quality, saving their jobs and streamlining its uses in harmony with the environment and other natural resources. This Plan is also the main element of information and participation for the implementation of the Water Framework Directive in the Member States of the European Union.

4.2.8.3 New common agricultural policy

The new common agricultural policy is developed in the following European Directives, currently under discussion for their implementation at the national and regional scales:

- REGLAMENTO (UE) Nº 1305/2013 del Parlamento Europeo y el Consejo de 17 de diciembre de 2013 relativo a la ayuda al desarrollo rural a través del Fondo Europeo Agrícola de Desarrollo Rural (FEADER) y por el que se deroga el Reglamento (CE) nº 1698/2005 del Consejo
  - *Artículo 5 Prioridades de desarrollo rural de la Unión*
  - *Artículo 26 Inversiones en tecnologías forestales y en la transformación, movilización y comercialización de productos forestales*
  - *Artículo 53 Red de la Asociación Europea para la Innovación*

  ANEXO III CRITERIOS BIOFISICOS PARA LA DELIMITACION DE ZONAS CON LIMITACIONES NATURALES
- REGLAMENTO (UE) Nº 1306/2013 del Parlamento Europeo y el Consejo de 17 de diciembre de 2013 sobre la financiación, gestión y seguimiento de la Política Agrícola Común, por el que se derogan los Reglamentos (CE) nº 352/78, (CE) nº 165/94, (CE) nº 2799/98, (CE) nº 814/2000, (CE) nº 1290/2005 y (CE) nº 485/2008 del Consejo.
  - *TÍTULO IV GESTIÓN FINANCIERA DE LOS FONDOS CAPÍTULO I FEAGA Sección 1. Financiación de los gastos. Artículo 22 Seguimiento de los recursos agrarios*
  - *TÍTULO VII DISPOSICIONES COMUNES CAPÍTULO III Informe y evaluación. Artículo 110 Seguimiento y evaluación de la PAC*

- *ANEXO I INFORMACIÓN EN EL CONTEXTO DE LA MITIGACIÓN DEL CAMBIO CLIMÁTICO Y LA ADAPTACIÓN AL MISMO, LA BIODIVERSIDAD Y LA PROTECCIÓN DE LAS AGUAS ESTABLECIDA EN EL ARTÍCULO 12, APARTADO 3, LETRA D)*
- *ANEXO II NORMAS DE CONDICIONALIDAD CON ARREGLO AL ARTÍCULO 93*

- REGLAMENTO (UE) Nº 1307/2013 del Parlamento Europeo y el Consejo de 17 de diciembre de 2013 por el que se establecen normas aplicables a los pagos directos a los agricultores en virtud de los regímenes de ayuda incluidos en el marco de la Política Agrícola Común y por el que se derogan los Reglamentos (CE) nº 637/2008 y (CE) nº 73/2009 del Consejo.
  - *TÍTULO I ÁMBITO DE APLICACIÓN Y DEFINICIONES. Artículo 4 Definiciones y disposiciones conexas*
  - *CAPÍTULO 3 Pago para prácticas agrícolas beneficiosas para el clima y el medio ambiente*
    - *Artículo 43 Normas generales*
    - *Artículo 45 Pastos permanentes*
    - *Artículo 46 Superficie de interés ecológico*
  - *ANEXO IX Lista de prácticas equivalentes a las que se refiere el artículo 43, apartado 3*

Regarding to soil, this new PP will continue with the cross compliance as it is shown in the following table:

Table 9: SMRs and GAECs of cross compliance in the new Common Agricultural Policy

Area	Issue	Requirements and Norms	
Environment, climate change, good agricultural conditions of soil	Water	SRM1	Directiva 91/676/CEE del Consejo, de 12 de diciembre de 1991, concerning the protection of water against pollution caused by nitrates from agricultural sources (DO L 375 de 31.12.1991, p. 1)
		GAEC/BCAM1	Creation of buffer strips along watercourses banks
		GAEC/BCAM2	Compliance with authorization procedures, when the use of irrigation water requires it
		GAEC/BCAM3	Protection of groundwater against pollution: prohibition of direct discharges into groundwater and measures to prevent cross-contamination of groundwater by pouring on the ground and filtration through the soil of hazardous substances, as listed in Annex of Directive 80/68/EEC in the version in force on the last day of validity, to the extent that is related to agricultural activity
	Soil and Carbon reservoir	GAEC/BCAM4	Minimum ground cover
		GAEC/BCAM5	Minimum land management reflecting specific local conditions to limit erosion
		GAEC/BCAM6	Maintenance of organic matter level in the soil through appropriate practices, including the prohibition of burning stubble, except for phytosanitary reasons

Three main requirements (greening) are included in this new PP. In Spain, this new conditions are under discussion, looking for their respective equivalences:

G1 Equivalent practices to crop diversification

Crop diversification should be implemented taking into account the difficulty that small farms present combining diversification and environmental protection. Some exemptions should be established for farms when diversification is improve as much of their land in dedicated to pasture or fallow, farms specialized farms in the annual rotation of their plots , as well as farms in which geographical locations make difficult the introduction of a third crop. The Commission has the power to establish standards for the implementation of the exact calculation percentages of different crops and to adopt certain acts in relation to the recognition of other genera and species.

G2 Equivalent practices to the maintenance of permanent pasture practices

In the interests of the environmental benefits of permanent pasture, and in particular carbon sequestration, considerations should be made for the maintenance of permanent pasture. Such protection shall include the prohibition of plowing and conversion of most sensitive areas from an environmental point of view areas included in "Natura 2020" covered by Directive 92/43/EEC and Directive 2009/147 / EC and in a more general way, based on a

proportion of permanent grassland from conversion to other uses. Member States should be able to define sensitive areas from an environmental point of view not covered by these Directives. They must also decide in which territorial level must be applied that ratio to ensure the effective protection and maintenance of permanent pastures. It should be delegated to the Commission the power to adopt certain acts in order to define the framework within which Member States shall designate the permanent pasture not covered by the above Directives.

G3 Equivalent practices in ecological focus areas

In order to ensure the establishment of areas of ecological interest in an efficient and consistent manner, the specific characteristics of the Member States should be taken into account and the Commission has the power to adopt certain acts in relation to set criteria additional to the classification of surfaces as ecological focus areas, to recognize other types of ecological focus areas, to establish conversion and weighting factors for certain types of ecological focus areas, to establish rules for the implementation by the Member States, etc. When adding other types of ecological focus areas, the Commission must ensure that aspire to improve the overall environmental performance of the farm, regarding biodiversity, soil and water quality, landscape preservation and meeting the objectives of climate change mitigation and adaptation.

4.3 Discussion

Comparison of implementation of the various policy measures between the Catch-C partner countries highlights that most everywhere, the same combination of practices, already suggested from the EU level, is used in all countries: measures foster catch-crops, permanent grassland conservation and crop diversity, as stated in Table 10.

Table 10: policy packages and BMPs fostered for implementing the CAP pilar1 (red for mandatory, yellow for incentive based policy measures)

		BMPs							
Country	Policy packages	rotation	tillage	Catch-crops	Nutrient management	Plant residues management	Water management	Extensive grassland	Permanent grassland
Austria	GAECs				X X				
	greening								
Belgium (Flanders)	GAECs					X			
	greening								
France	GAECs								
	greening								
Germany	GAECs	*Not implemented in national legislation so far*							
	greening								
Italy	GAECs	*Not implemented in national legislation so far*							
	greening								
Netherlands	GAECs								
	greening								
Poland	GAECs								
	greening								
Spain	GAECs								
	greening								

Very recently, with the rising policy concern in the political sphere of ecosystem services (ES), there has been a growing literature that describes the various ways this new concept is actually embedded in the policy design process. Helming (2013) proposes to analyse how ecosystem services are mainstreamed in policy impact assessment by distinguishing between the extent to which the policy is framed around ES, and the extent to which the potential impacts of the policy are assessed (from an ES perspective). Building on that distinction, we use our per country analysis to examine how soil stakes are considered, both in the framing and the expected impacts of the policy package, and classify them on the following criteria:

- Type0: no soil or soil stakes mentioned.
- Type1: soil mentioned but not targeted at all.
- Type2: soil or soil stakes mentioned in any part of the process of policy design, but never prominent.
- Type3: soil or soil stakes mentioned in the policy objectives, but some elements are missing, measures are not explicitly targeted towards soils (or soil stakes), and the elements that are present are only weakly evaluated.

- Type4: soil or soil stakes mentioned in the policy objective, as an outcome of a knowledge based diagnosis (sometimes spatially differentiated), explicitly mentioned in the measures, but their expected impacts are not analysed beyond vague descriptions.
- Type5: soil and soil stakes fully embedded in the policy process; the policy explicitly refers to soil or soil stakes in its objectives, includes measures clearly targeted towards soil or soil stakes, and is associated with a clear assessment of direct and indirect expected impacts of these measures on soil stakes, along with trade-off and synergies with other policy packages dealing with soil.

According to this typology, embeddedness of soil in CAP pilar1 appears very different from one country to another: of course, all countries foster the adoption of GAECs and greening measures, but the reasons underpinning this promotion may not be directly related to soil stakes (Figure 6).

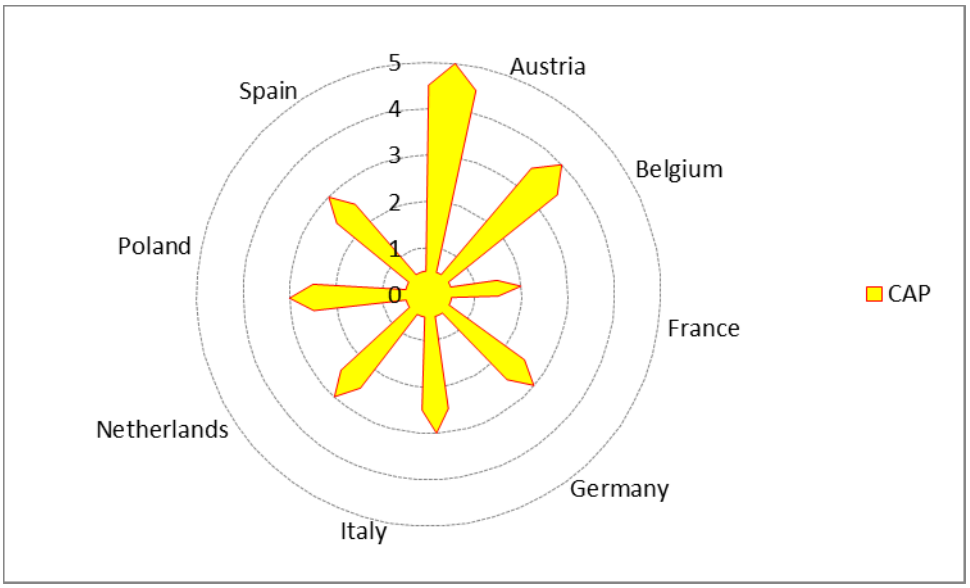


Figure 6: embeddedness of soil stakes into the design of GAECs and greening measures for Catch-C countries

5 Rural development policy packages

5.1 Policy measures

Acknowledging that increasing specialisation and intensification of agriculture may generate negative environmental externalities, the European Union introduced agri-environmental schemes firstly in 1992 (Council Regulation (EC) 2078/92). Since 1992, the application of agri-environment programmes has been compulsory for Member States in the framework of their rural development plans[15], whereas they remain optional for farmers.
The stakes addressed by this program are threefold:

- Axis1: Increasing the competitiveness of the agricultural sector through support for restructuring.
- Axis2: Enhancing the environment and countryside through support for land management.
- Axis3: Strengthening the quality of life in rural areas and promoting diversification of economic activities through measures targeting the farm sector and other rural actors.

If we focus on axis2, there are 3 three strategic objectives: participate to a balanced land use, preserve natural resources and foster of sustainable agriculture, and promote forest as a sustainable mean landscape management.

The operational objectives are first improve farming practices so as to preserve biodiversity and water resources, protect remarkable biodiversity through Natura2000 network, participate to the objectives of the water framework directive, protect soil and finally contribute to mitigate greenhouse gas emissions.
Most of these operational objectives are associated with only one measure: agri-environment payments (article 36). Agri-environment measures are established by Member States or Regions and submitted to the Commission for approval as part of their Rural Development Plans. Member States and Regions set up agri-environment programmes and these are often subdivided into different schemes. Each programme or scheme is made up of a series of measures. Programmes/schemes come in many different forms. Council Regulation (EC) No 1698/2005 mandates targeting these measures on specific areas.

The intervention logic for the agri-environmental and animal welfare measure for the 2000-2006 program has been depicted in the ex-post evaluation of rural Development Programs (Kantor MC, 2012).

The report that synthesises the mid-term evaluation of Rural Development Programs 2007-2013 (Herm, 2012) emphasises a complicated system for axis2, including facts that a given piece of land can receive several payments for different purposes, the lack of incentives to create contiguous areas that can be functional from a conservation perspective, and maybe a lack of monitoring: out of 88 programs targeting soils, Herm (2012) found only 67 displaying soil quality indicators.

[15] Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)

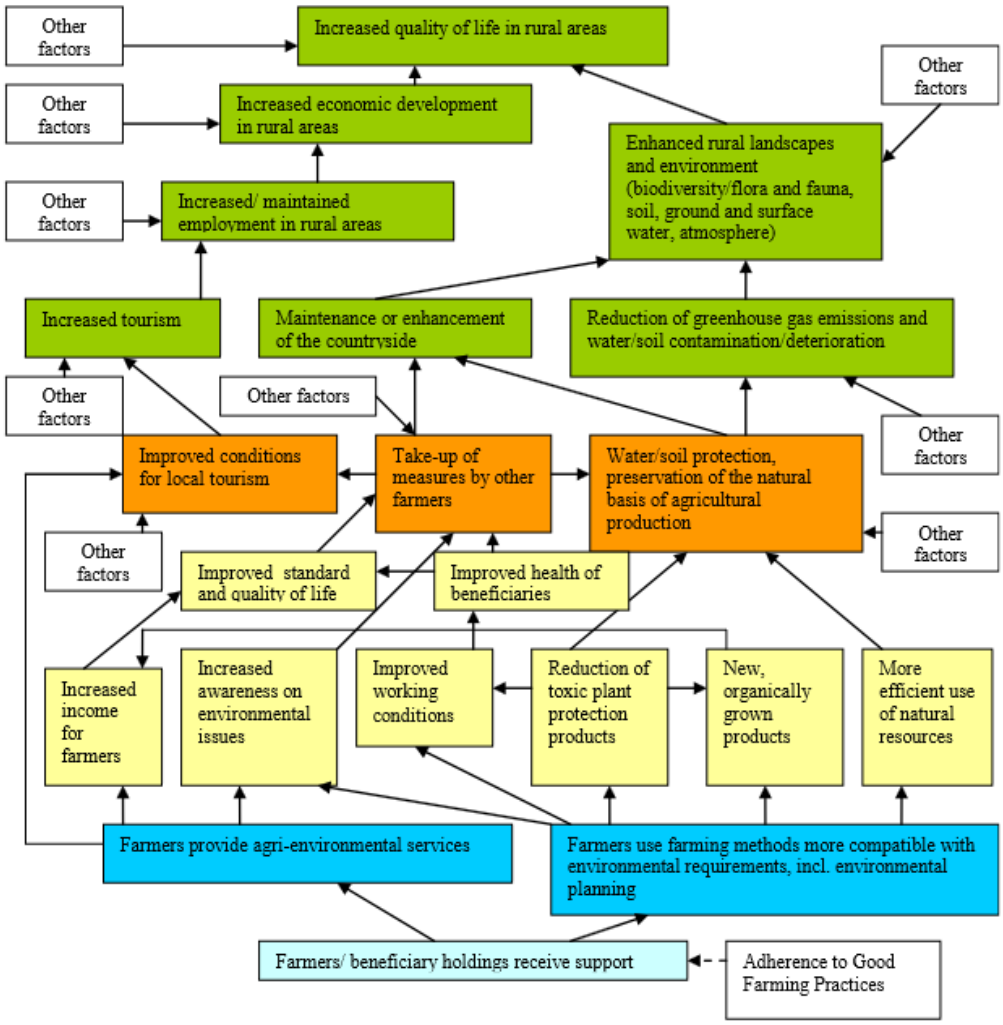


Figure 7: Intervention logic for agri-environment and animal welfare (source Kantor, 2012)

On a whole the breakdown of UAA under agri-environment measures by type of action (contracts signed from 2007 to 2009) supplied by the European Commission[16] considers that 8 % of the total area under agri-environment measures is targeted to actions to conserve soil. Agri-environmental schemes have been broadly analysed in the literature, albeit not always in detail for each program, and are expected to have positive effects on most soil threats (Louwagie *et al.*, 2011), provided they are actually implemented.

Regulation (EU) n°1305/2013[17] enlarges the scope of rural development. First of all, it frames the Union priorities, among which preventing soil erosion and improving soil management is set in good place. This is the first time soil is specifically mentioned as a priority, and this statement can be considered as a consequence of the soil thematic strategy.
The second important point lies in the obligation for Member States to include in the rural development programs two very important elements:

[16] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Agri-environmental_indicator_-_commitments
[17] REGULATION (EU) No 1305/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 december 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005

- *"a description of the strategy which demonstrates that: (i) appropriate targets are set for each of the focus areas of the Union priorities for rural development included in the programme, based on the common indicators referred to in Article 69 and, where necessary, on programme specific indicators";*
- *"an indicator plan, broken down into focus areas, comprising the targets referred to in point (i) of Article 8(1)(c) and the planned outputs and planned expenditure of each rural development measure selected in relation to a corresponding focus area".*

5.2 National implementation

There is a general frame at national level and often regional specifications:

- In Austria, the RDPs are fully included into national legislation (see chapter7) and won't be further commented here.
- In Belgium, the programs are supported by the Department of Agriculture and Fisheries and federal agencies (Flemish Land Agency for AES, for instance, or Flemish Agricultural Investment fund –VLIF, for investment). Water quality and biodiversity are clearly the main targets, and soil stakes are mostly erosion control.
- In France, beside a handful of programs and plans at national and regional levels, involving most stakeholders in their design and implementation, soil stakes are seldom highlighted in the implementation. Governance has changed, as RDPs are now designed by the regional authorities, but they pick up measures into nationally designed lists.
- In Germany, the RDPs are designed by the federal states.
- In Italy, the regional authorities have high initiative possibilities in designing the RDPs.
- In the Netherlands, the program has been designed at the national level.
- In Poland, similarly, a national design has been performed bu the ministry of Agriculture and Rural Development.
- In Spain, there is a national plan and regional programs.

5.2.1 Belgium (Flanders)

5.2.1.1 CAP Pilar II- RDPII (2007-2013)

In RDPII, there are three common policy objectives, corresponding to thematic Axes. The first two axes contain measures that are relevant for soil management. Axis 1 aims to improve the competitiveness of agriculture and forestry, and axis 2 aims to improve the environment and the countryside by supporting land management. The measures within those axes relevant for soil management are listed below.

Axis 1: Awareness campaigns on sustainable agriculture

Awareness projects are supported by the Department of Agriculture and Fisheries and PDPO means with the objective of encouraging farmers and horticulturists to apply more sustainable agricultural techniques. In the 2009-2012 period, the following subjects related to sustainable soil management were selected:

- Integrated pest management;
- Techniques for better use efficiency of nitrogen fertilizers to prevent potential leaching. Project subjects included: cover crops, fertilization in the row, KNS-fertilization system;
- Soil management in function of restricted fertilizer doses. The project selected was on organic fertilization in organic farming;
- (Bio)diversity: project on short rotation coppice.

Soil quality was thus not the primary aim of these projects but rather water quality and biodiversity.

Apart from PDPO means, the Department of Agriculture and Fisheries also supports extension on sustainable and innovative practices by organising study days, publishing digital brochures (e.g. on fertilization) and the support of extension research stations.

Axis 1: Farm advise systems ('Bedrijfsadviessystemen')

Farmers can ask for subsidised advice concerning, amongst others, 3 topics regarding cross compliance. One of these topics are good agricultural and environmental conditions.

Axis 1: Investments in agricultural businesses (VLIF support)

One of the aims for investment support is to reduce the burden on the environment. Investments which are relevant for sustainable soil management are

- Machinery for mechanical weeding
- Farm composting machinery (only for plant materials, not for manure)

- Machinery for energy tree crop growing
- Machine for manure separation
- Machinery for direct drilling to prevent soil erosion

Axis 2: Agro-environmental schemes (AES)
The AES are managed by two entities, being the department of Agriculture and Fisheries ('agromilieumaatregelen) and the Flemish Land Agency ('beheersovereenkomsten'). The ones that are important for soil management are listed below. Farmers could sign in for the AES from 2007 until 2013. The measures they signed in for can run until 2017, but not necessarily under the same conditions.

Mechanical weeding ('agromilieumaatregel')
Aim: obtaining a positive effect on soil and water quality, biodiversity on the field parcel and the wider environment.

Leguminous crops (grass-clover, alfalfa, red clover) ('agromilieumaatregel')
Aim: Being less dependent from protein crops (soy) for fodder grown elsewhere and diversification of fodder crops in the Flemish stock farming. Other advantages mentioned are: less fertilizer requirements, less need for pesticides, low susceptibility to soil erosion.

Organic farming ('agromilieumaatregel')
Aim: supporting organic farming that functions as an essential example for transition towards sustainable agriculture. Advantages of organic farming mentioned are better soil fertility, prevention of over-fertilization and positive impacts on biodiversity.

Species conservation ('beheersovereenkomsten')
Aim: protection of some bird species and hamsters
One of the proposed measures is to convert arable land to grass lands.

Reduced fertilization ('beheersovereenkomsten')
Reduced fertilization on arable land and grasslands.

Erosion control ('beheersovereenkomsten')
Erosion control can be applied by different measures of which non-inversion tillage and direct drilling are of importance for soil management.

5.2.1.2 CAP Pilar II- RDPIII (2014-2020)
The RDPIII (2014-2020) measures, most of them coming into practice from 2015, are currently in the Commission approval procedure. The measures, related to sustainable soil management, listed below are thus only preliminary.

Agro-environmental schemes (AES)
Similar to the 2007-2013 period, the AES are divided into 'agromilieumaatregelen' managed the department of Agriculture and Fisheries and 'beheersovereenkomsten' managed by the Flemish Land Agency.
The main focus areas of 'agromilieumaatregelen' are reduction of greenhouse gas emissions and ammonia (climate) and improved water quality. Improvement of soil quality is only a secondary aim. Soil carbon sequestration aims at mitigating climate change and is not mentioned as being positive for soil quality.

'Beheersovereenkomsten' are mainly aimed at biodiversity, water quality (e.g., N leaching), Natura2000 and erosion reduction. Prevention of nitrogen leaching is an important target in Flanders. In the new 'beheersovereenkomsten' crops with low risk for nitrogen leaching are stimulated if they, at the same time, also have a good potential to increase soil carbon sequestration, which is also expected to result in improved soil structure and soil biodiversity and reduced soil erosion by water. In contrast to the previous period, there are more attempts to integrate the soil protection policy with the water quality policy.

Relevant AES for sustainable soil management are:
***Leguminous crops* ('agromilieumaatregel')**
The crop choice (grass-clover, alfalfa, red clover) in comparison with the previous period has been enlarged with crops such as alfalfa-grass, beans and peas. The main focus area is reduction of greenhouse gas emissions and ammonia. Secondary effects mentioned include improved soil management and soil carbon sequestration.

***Carbon sequestration by the growth of fiber flax or fiber hemp with reduced fertilization* ('agromilieumaatregel')**
The main focus area is reduction of greenhouse gas emissions and ammonia. Secondary effect mentioned include carbon sequestration (in products such as building materials and clothing) and improved soil management (increased soil health).

***Mechanical weeding* ('agromilieumaatregel')**
Improved soil management is mentioned as a secondary effect of the practice.

Establishment and maintenance of strategically located grasslands ('beheersovereenkomsten')
The aim is to reduce erosion. Secondary effects mentioned are increased carbon sequestration.

Water quality ('beheersovereenkomsten')
Improving water quality by having a high percentage (90%) of crops with a low risk profile in the crop rotations on the farm. The risk profile is determined by nitrate leaching risk (primary aim), susceptibility to erosion and potential for soil organic carbon increase (secondary aim). The crops should be followed by cover crops (except for grain maize).
It is worth to note that a AES was proposed which directly targeted the increase of soil organic matter, but this AES was not retained, a.o., because it was difficult to check.

Several nutrient related measures in and close to Natura2000 areas ('beheersovereenkomsten')
These include measures to such as P mining and zero fertilization. Prevention of soil erosion and improvement of soil management are mentioned as secondary effects.

Online systems (e.g. DEMETER-tool) to monitor fertilization and the application of effective organic carbon are of disposal for the farmers and are provided by the Flemish Land Agency.

Other PDPOIII measures
Soils are also considered to be a focus area in measures apart from AES. It is mentioned as a theme for awareness campaigns, EIP Operational Groups and agricultural training. Soils will be a module in the Farm advise systems ('bedrijfsadviessystemen').

5.2.1.3 CAP Pillar II summary
CAP Pillar II directly or indirectly has an impact on sustainable soil management practices. An overview is provided in Table 11.

In RDPII water quality and biodiversity are main objectives, while soil is mainly directly targeted in some erosion control measures. In RDPII these included a.o. suitable tillage techniques (non-inversion tillage, direct drilling). Besides this, investment subsidies are provided for direct drilling machinery, composting and manure separation. In RDPIII reduced tillage as erosion control measure will presumably not be subsidised anymore as they are included in GAEC-requirements for field parcels with a (very) high erosion risk. In RDPIII there is an AES which is aimed at the establishment and maintenance of grasslands strategically located for erosion control. The main objectives of RDPIII are climate change, water quality and biodiversity. Erosion control remains a target. Besides this soil quality is mentioned as a secondary aim. New is the attempt to better integrate water and soil protection policies. In one AES crops with low risk for nitrogen leaching are stimulated if they at the same time also have a good potential to increase soil carbon sequestration, which is also expected to result in improved soil structure and soil biodiversity and to reduce soil erosion by water. The Flemish Land Agency is also developing a tool (DEMETER) in which both N losses and effects on soil carbon are simulated for particular soil management practices. In RDPIII soil is also mentioned as being a theme for awareness campaigns, EIP operational groups, training and farm advise systems.

Table 11: Impact of CAP-Pilar II on sustainable soil management practices considered in the Catch-C project

Management practice	Main aim	Remarks
Rotation		
MP3 rotation with legume crops	Less dependent from foreign protein crops, less fertilizer needs, less pesticides, low susceptibility to soil erosion	AES: leguminous crops (grass-clover, alfalfa, red clover) (RDPII)
	Reduction of GHG emissions, NH3, secondary: improved soil management, C sequestration in soil	AES: leguminous crops (larger crop choice than previous period) (RDPIII- preliminary)
MP6 Rotation with grasslands	Biodiversity (bird species and hamsters)	AES: species conservation. One of the measures is to convert arable land to grass lands (RDPII)
	Erosion control	AES: establishment and maintenance of strategically located grasslands (RDPIII-preliminary)
MP9 green manures	Water quality (N leaching)	Awareness campaign cover crops (RDPII)

	Unclear, multiple	Digital brochure on fertilization, including cover crops (Axis 1, but with means of the Department of Agriculture and Fisheries)
	Water quality, secondary erosion control, soil carbon	AES 'water quality': high percentage of crops (90%) with low risk profile for nitrate leaching and erosion and high potential for soil carbon increase. The crops should be followed by cover crops except for grain-maize (RDPIII-preliminary)
Other MPs with impact on rotation	Biodiversity	Awareness campaign: Short rotation coppice (RDPII)
	Unclear	Investments in agricultural businesses: Machinery for energy tree crop growing (RDPII)
	Reduction of GHG emissions, NH3, secondary: improved soil management (health)	AES: Fiber flax or fiber hemp with reduced fertilization (RDPIII-preliminary)
	Water quality, secondary erosion control, soil carbon	AES 'water quality': high percentage of crops (90%) with low risk profile for nitrate leaching and erosion and high potential for soil carbon increase (RDPIII-preliminary)
Tillage		
MP16 No/zero tillage	Erosion control	Investments in agricultural businesses: machinery for direct drilling
	Erosion control	AES: erosion control of which direct drilling is one of the options (RDPII)
MP19 Non-inversion tillage (depth not specified)	Erosion control	AES: erosion control of which non-inversion tillage is one of the options (RDPII)
Nutrient management		
MP29 Plant compost application	Unclear	Investments in agricultural businesses: Farm composting machinery (only for plant materials, not for manure)
Other MPs	Water quality (N leaching)	Awareness campaign: Fertilization in the row (RDPII)
	Water quality (N leaching)	Awareness campaign: KNS-fertilization system in horticulture (RDPII)
	Unclear, multiple	Digital brochure on fertilization, including organic fertilization (Axis 1, but with means of the Department of Agriculture and Fisheries)
	Unclear	Investments in agricultural businesses: machinery for manure separation (RDPII)
	Soil fertility, less fertilization, biodiversity	AES: organic farming (RDPII)
	Water quality	AES: reduced fertilization on arable land and grasslands (RDPII)
	Water quality, secondary soil management, erosion control	AES: several nutrient related measures in and close to Natura2000 areas (RDPIII-preliminary)
Crop protection		
Integrated weed management (post emergence)	Unclear	Investments in agricultural businesses: machinery for mechanical weeding (RDPII)
	Soil and water quality, biodiversity	AES: mechanical weeding (RDPII)
	Improved soil management (secondary effect)	AES: mechanical weeding (RDPIII-preliminary)

5.2.2 France

5.2.2.1 Regional Documents for Rural Development 2007-2013

There has been a succession of decrees shaping the application of second pillar in France. A national plan has been set up in 2007, and detailed at regional level. Each program was grounded on a diagnosis, and then explains very clearly the logic of each option. The decree n° 2007-1342 shapes the legislation around the National Program for rural Development, and the design of agri-environmental measures[18].
In the diagnosis of this program, soil quality degradation is mentioned, with a quote on the difficulty to precisely quantify the phenomenon and a need on improving the monitoring. Dealing with soil protection grounds on GAECs and cover crops in winter, but the diagnosis stresses the need to protect soils as an operational objective (among many others), related to the strategic objective of protection of natural resources.

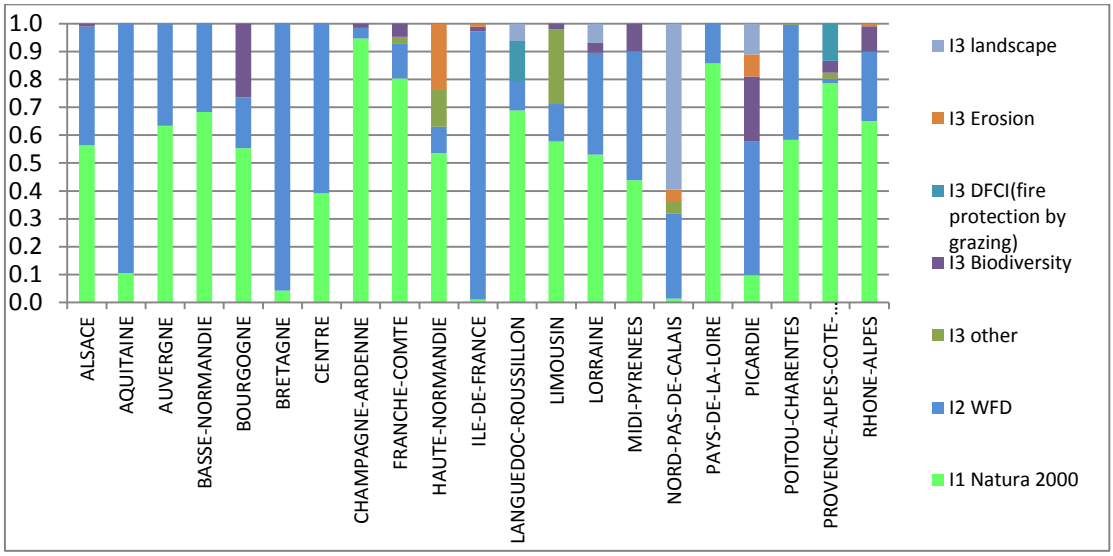


Figure 8: breakdown of the areas contracted for year 2011 in the French NUTS2 area

In France, rural developments documents have been organised into 4 axes for an expenditure of nearly 6.8 billions euros over the period:

- Axis1 fosters competitiveness (35% of the community participation)
- Axis2 is about environment protection (54 %)
- Axis3 aims at improving the quality of life in rural areas (10%)
- Axis4 is the LEADER program (5% additional).

The strategic objectives of Axis2 include preservation of natural resources and fostering of sustainable agriculture. The operational objectives do quote soil protection (of course among others). If we focus on the actions and their expected impacts, agri-environmental measures (measure 214 of the French RDP) breaks down into 2 national programs, 6 regionalised ones and a territorialised one:

- The national programs concern:
  - A: The environmental grassland premium (PHAE)
  - B: schemes to improve rotations in arable farms.
- The regionalised programs include measures defined at the national level, but the regions have the ability to design the areas of application (only farms whose buildings are located in the targeted LAU2 can apply to the scheme):
  - C: low inputs mixed farm systems
  - D and E: organic farming
  - F: protection of endangered domestic species
  - G: protection of endangered plants species
  - H: beekeeping.
- The territorialised programs have to be built on each area and concern:
  - I1: Natura 2000 stakes

[18] Décret n° 2007-1342 du 12 septembre 2007 relatif aux engagements agroenvironnementaux et modifiant le code rural http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000464203&fastPos=1&fastReqId=585426433&categorieLien=id&oldAction=rechTexte

- o I2: WFD stakes
- o I3: other environmental stakes.

Measures 214- A, B, C, D, E, I2 and I3 can foster soil protection, mostly on indirect manner, only I3 can be directly targeted on soils in some places.

Figure 8 depicts the breakdown of areas put under contract for the year 2011. We have chosen this year as being in the last part of the contracting period, so farmers have had plenty of time to understand the aims of the programs and associated measures. Natura2000 measures clearly occupy the larger part with WFD measures. Measures directly targeted against erosion (orange on the figure) represent a very minor share of the areas under AEM214 contracts. Obviously, when priorities have been sorted out, the contentious between France and the EU Commission about Nitrate directive implementation has been a major argument for prioritizing WFD measures at the expense of soil related ones.

5.2.2.2 Regional rural Development Programs, 2014-2020

Regulation (EU) n° 1305/2013 of the EU Parliament and of the Council[19] shapes the general rules governing EU support for rural development, financed by EAFDR. It also sets out the objectives to which rural development is to contribute. In France, each region has performed an ex-ante SWOT analysis and a strategic environmental analysis that identified the main stakes. From these stakes, the main areas of public intervention have been derived and has been included into a strategic programming, split into a bundle of schemes and programs (acronyms are in French): the Regional Plans for Sustainable Agriculture (PRAD), the Regional Schemes for Climate, Air and Energy (SRCAE), the Regional Schemes of Ecological Coherence (SRCE), the Regional Programs of Agricultural and Rural Development (PRDAR), the Blueprint for Water Management (SDAGE) and the Water management plans (SAGE).

The position paper launched by the Commission for France (Ares, 2012) quotes soil protection as a stake, for soils that are affected by degradation or artificialisation issues. The mentioned risks include erosion, floods, landslide, acidification, salinization, pesticide use and decrease of soil organic matter, in link with a decrease of soil fertility and organic and mineral pollutions.

As negotiations are carried out with intermediary organisations, individual members of such organisations are not legally bound by the outcomes of the negotiations: gentleman agreements are difficult to enforce by courts. Consequently, all these schemes and programs rely more on incentives and these incentives will come from EARDF and regional subsidies. In France at least 32 % of EARDF has to be targeted to environmental and climate measures.

The Regional Development Plans are not ready yet, so we have based our analysis on the national recommendations for designing these plans (MAAF, 2014), and on the documents that regional governments have sent to the Commission.
At national level, the measures highlighted to promote agro-ecologic systems are the agroenvironmental and climatic measures (art. 28), organic farming (art. 29), quality systems for farm products (art. 16), non-productive investments for environment and climate (art. 17.1.d), agroforestry (art. 23), compensatory payments for the Water framework directive and Natura 2000 (art. 30), animal welfare (art. 33). Measures with side effects should be: transfer of knowledge (art. 14), advice services (art. 15), productive investments (art.17.1a-c), cooperation (art. 35), and development of enterprises (art. 19.1.b). It is worth noting that using soil quality criteria for delineating areas facing natural constraints, as now permitted by Regulation 1305/2013, has not been considered by France.

5.2.2.3 Some regional examples

5.2.2.3.1 Bretagne

For soil stakes, the former program was grounded on a diagnosis of soil erosion and major water pollution (Préfecture Bretagne, 2009). The main objectives of the program were first an improvement of the implantation of new farmers (including those who buy farms from retiring farmers), promoting a sustainable development of agriculture with a focus on agronomy, fertilization practices, landscape planning and sustainable management of resources (soil is not quoted in these resources however), enhance the development of quality products, and last sustain rural development. Soil is not quoted in the priorities.

The 2007-2013 program is organized in 4 axis, as all programs on this period, axis2 being the protection of environment, for 25 % of the EARDF funds in Bretagne (way below the national average of 54%). The main

[19] REGULATION (EU) No 1305/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 december 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:EN:PDF

operational objective for axis2 is the improvement of water quality, as Bretagne is totally included in a vulnerable zone. The measures included in the program were 214A (extensive grassland systems), 214C low input systems, 214D and E organic farming, and MAEt214I1 and I2 (Natura2000 and WFD). No territorialized scheme for other stakes than biodiversity and water quality has been included, and non-productive investments have been discarded too.

In between the two programs, policy makers and farm representatives agreed on the idea that promoting whole farm approach and soil quality improvement would be a good way towards a more positive attitude than keeping on focusing on the negative impacts that farming can have on the environment and thus they worked on better considering soils in the new program. During the interviews, stakeholders mentioned the negative association of non-inversion tillage and use of glyphosate: in Bretagne, glyphosate was permitted to destroy pastures only if non-inversion tillage was used, and because that combination gave better results than ploughing without herbicides, it had been adopted largely. As the extensive use of glyphosate wasn't wished in the region, the local legislation has been modified.

The main limitation for including more soil related measures in the new program is reported as being a lack of knowledge on the impacts on ecosystem service provision for improved practices, and also the lack of specific governance arrangements for soils, as some already exist for water (there is no soil management plan, as there are river management plans).

The new 2014-2020 program (Préfecture Bretagne, 2014) improved the diagnosis and states that 38% of the territory suffers from sealing negative impacts and losses of biodiversity, that 18% of the soils are sensitive to erosion with a progressive decrease of organic matter. Other stakes are of importance too, and putting them together lead to 26 strategic objectives. The soils are included in the strategic objective "preserve natural resources (water, soil, biodiversity) that sustain agricultural and forestry activities". In relation to these 26 strategic objectives, 6 operational objectives, named "priorities" and three transversal themes have been designed. Only one sub-priority addresses soil stakes (priority 4C - prevent erosion and improve soil management). Associated measures include M01 (knowledge transfer, although priority 4C is not related to the operational objective regarding knowledge transfer itself), M04 (physical investments), M10 (AEC), M11 (organic farming), M12 (Natura200 and WFD payments), M13 (natural constraints payments, the definition is not given yet). The AEC measures support mostly extensive grassland systems, in continuity with the previous scheme.

Rather late in the design process, operational objectives related to climate change mitigation have been added to the scheme, but no measure has been targeted to sustainable soil management for these objectives.

5.2.2.3.2 Centre

For the Centre region, the word "soil" doesn't appear in the diagnosis in the 2007-2013 program (Préfecture Centre, 2012). The main operational objective for axis2 on environment are water quality and to "respect the EU directives" (with no detail). Despite this lack of objectives, AEM121B sustains investments in equipment to under-seed cover-crops in packages dealing with erosion prevention, and AEM125C (infrastructure) subsidizes anti-erosion gullies.

For the stakeholders interviewed, clearly mitigating water pollution is the main stake to deal with. Regarding soil, they stress that the long term effects of non-inversion tillage are not known in the region. Thus they prefer promoting actions around increasing the number of crops in the rotations, in connexion with their neighbouring regions that have developed alfalfa based industries. Preference goes to promoting practices with well-known effects rather than focussing on specific issues and trying to convince farmers to adopt new techniques with unknown impacts.

In the 2014-2020 program (Préfecture Centre, 2014), soil sealing appears as an important stake in the diagnosis. Soil quality is reported as good, and as improving due to the extensive use of non-inversion techniques. In relation with this diagnosis, the operational objective to improve soil management (priority 4C) is considered as not that important. Measures planned are sustaining investments in equipment and material for non-inversion tillage.

5.2.2.3.3 Midi-Pyrénées

As for the region Centre, soil is not quoted in the diagnosis for the 2007-2013 program in Midi-Pyrénées (Préfecture Midi-Pyrénées, 2008). Interesting to note, the diagnosis mentions changes in crop successions because of increased droughts linked with climate change. Corn, for which Midi-Pyrénées is the second productive region in France, tends to decrease because of water shortages, at the benefit of rape (cropped before summer draughts) or sunflower (can bear water shortages).

Operational objectives for axis2 include water quality first, then biodiversity. Other and of smaller importance objective relate to organics farming promotion, beekeepers, low input farms. Axis2 represents 17 % of the FEADER envelope.

Because farmers have started on their own to implement conservation techniques to prevent erosion, prevention of erosion and of soil sealing slowly become at stake, even if policy makers stress that it is still poorly considered in strategic documents. Among the 16 strategic objectives of the new program (Préfecture Midi-Pyrénées, 2014), one deals with soil protection (objective 15). Interesting to note, one objective of improving the competitiveness of the farms is also linked with the operational objective 4C (prevent erosion and improve soil management).

Measures associated with soil protection include experimentation, long-life learning, awareness rising.

5.2.3 Germany

Rural Development Plans are developed by the Federal States. Thus, AES differ between States. As examples the potential interactions of AESs with selected BMPs in Lower Saxony and Thuringia are analysed.

5.2.3.1 Lower Saxony

5.2.3.1.1 Agri-environmental schemes (CAP 2007-2013)

Lower Saxony is located in the North-West of Germany and represents the main region of FTZ ENZ4_SL1_TXT1 which is coined by arable and mixed farming on sandy soils. Previously, soil problems in this region have been identified: nitrate leaching to groundwater, high inputs of slurries and manures in spring (if accompanied with livestock), drought sensitivity (especially closer to the former German border), wind erosion on fine sands, problems with nematodes and bacterial diseases (where locally concentrated potato cropping occurs).

In the Rural Development Plan soil is mentioned as subject of protection(ML 2012). In particular, soil impairment through increasing cultivation of bioenergy crops and erosion as result of narrow crop rotation and tillage are listed as risks. (ML 2012)

The AES are divided into 3 categories. 1. Agri-environmental programme (A – Extensive arable farming, B – Extensive grassland, C – Organic farming), 2. Groundwater friendly measures and 3. Nature conservation (Bundesanstalt für Landwirtschaft und Ernährung (BLE), Deutsche Vernetzungsstelle Ländliche Räume (dvs) 2010). Beyond measures of the agri-environmental programme, measures focusing on groundwater friendly management are relevant for the adoption of the preselected BMPs.

5.2.3.1.1.1 Crop rotation (reference: monoculture)

AES-x-Crop rotation

- measure C – organic farming

5.2.3.1.1.2 Reduced tillage (reference: plowing)

AES-x-Minimum tillage (incl. shallow non-inversion tillage)

- **Extensive arable farming:** measure A2 – application of strip-till, minimum tillage and no tillage procedures
- **Extensive grassland:** measure B0 – climate friendly management of permanent grassland with no deep inversion tillage
- **Groundwater friendly measures (drinking water protection areas, target area of WFD):** measure 2e) no tillage after maize with subsequent summer crop
- measure C – organic farming -> more mechanical weed control

AES-x-No tillage (incl. direct seeding)

- **Extensive arable farming:** measure A2 – application of strip-till, minimum tillage and no tillage procedures
- **Groundwater friendly measures (drinking water protection areas, target area of WFD):** measure 2e) no tillage after maize with subsequent summer crop
- measure C – organic farming -> more mechanical weed control

5.2.3.1.1.3 Cover crops (reference: bare soil)

AES-x-Cover crops to carry N over winter

- **Extensive arable farming:** measure A7 – catch crops
- **Groundwater friendly measures (drinking water protection areas, target area of WFD):**
- measure 2d) hardy catch crop with late turn up
- measure C – organic farming
-

AES-x-green manure to improve soil fertility/ organic matter
- measure C – organic farming
- **Extensive arable farming:** measure A7 – catch crops
-

AES-x-Cover crops to reduce soil erosion
- measure C – organic farming
- **Extensive arable farming:** measure A7 – catch crops

5.2.3.1.1.4 Apply external organic inputs (reference: mineral fertiliser)

AES-x-Farm yard manure
- measure C – organic farming: mineral fertilizer not allowed
- **Groundwater friendly organic management practices (drinking water protection areas, target area of WFD)**: measure 2c) max. 80 kg total N/ha*y from organic fertilisers

AES-x-Slurries
- measure C – organic farming: mineral fertilizer not allowed
- **Groundwater friendly organic management practices (drinking water protection areas, target area of WFD)** : measure 2c) max. 80 kg total N/ha*y from organic fertilisers

AES-x-Composts
- measure C – organic farming: mineral fertilizer not allowed
- **Groundwater friendly organic management practices (drinking water protection areas, target area of WFD)**: measure 2c) max. 80 kg total N/ha*y from organic fertilisers

5.2.3.1.2 Agri-environment-climate measures (CAP 2014 - 2020)

At the time of writing only a draft was available for the new directive NiB-AUM (cf. ML et al. 2014) that will be put into force in 2015. The categories *Sustainable practices on arable land* and *operating obligations* contain AEC measures with importance for the selected BMPs.

5.2.3.1.2.1 Crop rotation (reference: monoculture)

AEC-x-Crop rotation
- **Operating obligations:** measure BV1 – organic farming

AEC-x- Crop rotation with legumes
- **Sustainable practices on arable land: measure AL1 - c**rop diversification (min. 5 main crops, min. 10% legumes, main crop on 10 – 30% of the total farm area, cereals on max. 66 % of the area)
-

5.2.3.1.2.2 Reduced tillage (reference: plowing)

AEC-x-No tillage (incl. direct seeding)
- **Sustainable practices on arable land : measure AL 4 – no tillage after rape (min. 25 % of the area or 10 ha in drinking water protection areas and target area of WFD)**
- **Sustainable practices on arable land : measure AL 5 – no tillage after maize (min. 25 % of the area or 10 ha in drinking water protection areas and target area of WFD)**

5.2.3.1.2.3 Cover crops (reference: bare soil)

AEC-x-Cover crop to carry N over winter
- Operating obligations: **measure BV1 – organic farming**
- Sustainable practices on arable land : measure AL 2.1 –cover crops on ≥ 5 % of the area
- Sustainable practices on arable land : measure AL 2.2 – hardy cover crops on ≥ 5 % of the area (min. 25 % of the area or 10 ha in drinking water protection areas and target area of WFD)

AEC-x-green manure to improve soil fertility/ organic matter
- Operating obligations: measure BV1 – organic farming
- Sustainable practices on arable land: measure AL 2.1 –cover crops on ≥ 5 % of the area
- Sustainable practices on arable land: measure AL 2.2 – hardy cover crops on ≥ 5 % of the area (min. 25 % of the area or 10 ha in drinking water protection areas and target area of WFD)

AEC-x-Cover crops to reduce soil erosion
- Operating obligations: measure BV1 – organic farming
- Sustainable practices on arable land: measure AL 2.1 –cover crops on ≥ 5 % of the area
- Sustainable practices on arable land: measure AL 2.2 – hardy cover crops on ≥ 5 % of the area (min. 25 % of the area or 10 ha in drinking water protection areas and target area of WFD)

5.2.3.1.2.4 Apply external organic inputs (reference: mineral fertiliser)

AEC-x-Farm yard manure
- **Operating obligations:** measure BV1 – organic farming

AEC-x-Slurries
- **Operating obligations:** measure BV1 – organic farming
- **Operating obligations:** measure BV2 – low-emission application of slurry

AEC-x-Composts
- **Operating obligations: measure BV1 – organic farming**

5.2.3.2 Thuringia Agri-environmental schemes (CAP 2007-2013)

Thuringia is part of the central uplands of Germany and represents FTZ ENZ6_SL2+3_TXT3 which is coined by arable farming. The area is prone to soil erosion and to nitrate leaching where soil layers are shallow. The Rural Development Plan (Thüringer Ministerium für Landwirtschaft, Forsten, Umwelt und Naturschutz (TMLFUN) 2012) mentions soil as subject of protection, as well as water erosion, loss of humus and nutrients and soil compaction as particular threats. Further, the positive impact of reduced tillage on CO_2 fixation is acknowledged. Measure focus on the multi-functionality of soil, since exclusively soil related issues are covered by Cross Compliance and other legal instruments. Soil related objectives of AE measures are: improvement of soil conservation and soil fertility, reduction of erosion and mineral fertilisers, melioration of humus accumulation in order to improve fixation of CO_2 , sorption of nutrients and water capacity.

5.2.3.2.1 Crop rotation (reference: monoculture)

AES-x-Crop rotation
- measure L1 – organic farming

AES-x-Crop rotation with legumes
- measure L2 – diverse crop rotation (min. 6 main crops, min. 5% legumes, main crop on 10 – 30% of the total farm area, cereals on max. 66 % of the area)

5.2.3.2.2 Reduced tillage (reference: plowing)

AES-x-Minimum tillage (incl. shallow non-inversion tillage)
- measure L1 – organic farming -> more mechanical weed control

AES-x-No tillage (incl. direct seeding)
- measure L1 – organic farming -> more mechanical weed control
- **Erosion prevention:** measure W22 – mulch or direct drilling or mulch planting in areas near water bodies with erosion risk and excess P

5.2.3.2.3 Cover crops (reference: bare soil)

AES-x-Cover crop to carry N over winter
- measure L1 – organic farming
- **Erosion prevention:** measure W21 - cultivation of cover/ catch crops in areas with excess N and in areas near water bodies with erosion risk and excess P

AES-x-green manure to improve soil fertility/ organic matter
- measure L1 – organic farming
- **Erosion prevention:** measure W21 - cultivation of cover/ catch crops in areas with excess N and in areas near water bodies with erosion risk and excess P

AES-x-Cover crops to reduce soil erosion
- measure L1 – organic farming
- measure L5 – soil friendly production of fodder (fodder grass, legumes)
- **Erosion prevention:** measure W21 - cultivation of cover/ catch crops in areas with excess N and in areas near water bodies with erosion risk and excess P

5.2.3.2.4 Apply external organic inputs (reference: mineral fertiliser)

AES-x-Farm yard manure
- measure L1 – organic farming
- **Reduction of N-leaching:** measure W1 – reduced N output in areas with excess N: N balances of ≤ 50/ 30 kg N/ha

AES-x-Slurries
- measure L1 – organic farming
- **Reduction of N-leaching:** measure W1 – reduced N output in areas with excess N: N balances of ≤ 50/ 30 kg N/ha

- measure L7 – application of slurries (ground level application on 70 % of the area, incorporation on 30 % of the area)

AES-x-Composts
- measure L1 – organic farming
- Reduction of N-leaching: measure W1 – reduced N output in areas with excess N: N balances of ≤ 50/ 30 kg N/ha

5.2.3.3 **Thuringia** Agri**-environment-climate measures (CAP 2014 - 2020)**
At the time of writing the programme was being developed by the authorities.

5.2.4 Italy

5.2.4.1 Agri-Environmental Schemes (AES) 2007-2013, European Regulation n. 1698/2005/EC
Regional implementation: the application is at the Regional scale

The overall intent: the topic is the BMPs voluntary adoption, through compensation measures, to improve sustainable management. The macro-objectives can be synthetized in: competitiveness improvement in agricultural and forestry sector, environmental improvement at rural scale, financial diversification at farm scale, reinforcement of local management and planning capacity, and valorization of endogenous territorial resources.

Soil mentioning: measures for soil protection and soil best management

- Rotation: Two crops every five years
- Cover crop, catch-crop, green manure, ecological interest areas and permanent grassland
- Nutrient management: Limitation in NP(K) doses.: - 30% rule (with respect to a baseline)
- Integrated pest management:
- Irrigation: Increase the efficiency for delivering water from irrigation consortium to the farm. Other measures aim to increase the efficiency of inter-farm distribution of irrigation water. Actions to implement irrigation systems reducing water consumption are also mentioned
- Buffers strips: Implementation of buffer strips, to protect water and agro-ecosystem biodiversity are included

5.2.4.2 Agro-Environment-Climate Measures (AEC) 2014-2020:

Regional implementation: still under discussion, at this moment there are only draft versions

The overall intent: the overall aim is to support, with compensatory norms, the voluntary adoption of BMPs, to reach sustainable management standards to a level that is greater than what imposed by cross-compliance. The macro-objectives do not change much with respect to the 2007-2013 period, but more attention is given to environmental protection and climate change mitigation.

Soil mentioning: measures aims to soil good management and protection, with a tendency to confirm previous measures.

- Rotations:

Previous AEC measures already supported the adoption of rotation. As the greening is already supporting diversification of crops, there is the risk of overlap between greening and AEC measures for rotation. However rotations will be supported, with specific measures in intensive areas applying more stringent measures than greening.

- Cover crop, catch-crop, green manure, ecological interest areas and permanent grassland:

Cover crops are supported, with specific measures in intensive areas.

- Tillage:

Actions concern sod seeding and minimum tillage, applied for a minimum of 5 years on the same surface. A monitoring problem is often cited: for example, in Lombardia, the region supplies a list of the adequate machinery to do minimum tillage, and the BMP is such if that machinery was used.

- Nutrient management:

Strong limitations to nutrient management are planned. The objective is a 30% reduction with a baseline technique, but all problems of the previous planning would be again repeated (difficulties in deciding the baseline, difficulties in reaching a sufficient quality of cereals with such high reduction). The introduction of a nutrient management plan and an enhancement of farm technical advisory assistancce could be planned instead. There is a tendency to apply simplified decision support systems (e.g. "standard dose" of the Emilia Romagna Region) to avoid the problems of applying a fix 30% reduction.
A specific measure will concern compost application (MP 32/33/29). The problem is that high quality compost is not easily available.
For manure management, specific measures will help to buy machineries for direct injection, to reduce ammonia losses.

- Integrated pest management:

Upgrade of the previous planning, in reference to 128/2009/UE and the National Action Plan is planned.

- Irrigation:

Measures are mainly for maize, because of its importance in Italy. Reference baseline for the irrigation of maize is surface irrigation. New measures aim to expand drip micro-irrigation (to be implemented at least on 80% of total farm surface). Fertigation is another possibility. However drip irrigation is criticized for the use of plastic to be removed and disposed and the problem of water filtering.
Irrigation supply should be based on a water balance.

- Buffers strips:

Buffer strips management criteria are defined in the AEC. Some financial measures support the planting of trees and shrubs (field edge control).

5.2.5 Netherlands[20]

5.2.5.1 Assessment of the NL situation

5.2.5.1.1 Environmental concerns

Nitrogen and phosphorus loading on soils and groundwater. Loading has been decreasing since peak in 80's, due to decreasing application rates. N surplus in 2008 was 188 kg/ha and P surplus 10 kg/ha.
For N in 2011, crops absorbed 60% of annual input onto agricultural land, 5-10% was lost directly to surface water, and some 30% accumulated in soil and groundwater (CBS, 2012). Accumulation was 40% in 2000. For P in 2011, accumulation in soil was 24% of the total amount brought onto soils. In 2000 this was still 40%.
POP3 states that good soil management is crucial for the production factor soil, and proper management of soil organic matter is explicitly mentioned. The top 30 cm of NL arable acreage contains 12.5 Mt organic matter. The fraction of area subject to water erosion is stated to be negligible.
Weaknesses (4.1.3):

- Too high N and P surpluses
- Exceedance of standards for ground and surface waters
- WFD ecological targets hardly achieved
- Soil quality 'under pressure'

Opportunities for water and soil management (4.1.4) : Opportunities for reducing emissions by precision agriculture, adapted conventional methods or organic farming
Threats (4.1.5): Waters too eutrophic in spite of efforts over decades

5.2.5.1.2 Assessment of needs ('behoeftenbepaling')

Priority area 4b (improving water management, including fertiliser and pesticide management)

[20] (all information from the NL draft proposal 'POP3' to EC dd. March 12, 2014)

Generic needs: *sharing knowledge on how agriculture can contribute to improvement of the quality of the water system.*
The sector can contribute to reducing emissions and improving water quality. More efficient input use, use of products with lower environmental impact, or end-of-pipe approaches (buffer strips; purifying drains). Need for knowledge transfer to farmers on improved farming practices as well as end-of-pipe methods.

Specific needs environment and climate: *promoting the use of emission-reducing measures*
There is a stagnation of earlier improvements in loading of surface water bodies with phosphate and crop protection agents. This is one of the causes (besides limited fish migration and lack of hydrological dynamics) of difficulties in reaching ecological quality targets of the WFD (PBL, 2012). There is a need for farmer incentives to promote adoption of emission-reducing measures.

Specific needs for innovation: *none.*

Priority area 4c (preventing soil erosion and improving soil management).

Generic needs: as UP 4b.
Specific needs environment and climate: *none*
Specific needs for innovation: *knowledge dissemination for sustainable soil management*
The diagnosis mentions various options for farmers to manage their soils well, namely: a fitting rotation, non-inversion tillage, and promotion of soil life. Soil quality is under pressure. Examples are damage to soil structure by heavy machinery, late harvesting, insufficient organic inputs resulting in decreasing organic matter content. Ten Berge en Postma (2010) indicate that new knowledge and dissemination are necessary to achieve a more sustainable soil management. There is a need for knowledge dissemination for sustainable soil management.

5.2.5.2 Strategy

Overall goals of the POP3 programme:

1. Competitiveness and innovation. Towards an agrosector clean and effective in 2020, in balance with man and environment
2. Sustainable use of natural resources including water; focus on the goals of EU directives - such as the Bird, Habitat, Nitrates and WF directives.
3. Good condition of rural area with quality of nature and landscape, by contributing to achieving goals on biodiversity, nature and landscape.

The NL POP3 chooses to address only a limited set of (5) priorities, covering 7 priority areas, see table below.

Direct programming (codes & descriptions as in EU-1305-2013)

Priority	Priority area	Description	Served by NL measure # (EC Article #)
2		enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and the sustainable management of forests, with a focus on the following areas:	
	2a	improving the economic performance of all farms and facilitating farm restructuring and modernisation, notably with a view to increasing market participation and orientation as well as agricultural diversification	NL_01 (EC_14) NL_04a1-2-3, _04c NL_16 (EC_35)
3		promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture, with a focus on the following areas:	
	3b	supporting farm risk prevention and management	NL_17 (EC_36)
4		restoring, preserving and enhancing ecosystems related to agriculture and forestry, with a focus on the following areas:	
	4a	restoring, preserving and enhancing biodiversity, including in Natura 2000 areas, and in areas facing natural or other specific constraints, and high nature value farming, as well as the state of European landscapes;	NL_10 + via measures for 2a
	4b	improving water management, including fertiliser and pesticide management	NL_10 + via measures for 2a
6		promoting social inclusion, poverty reduction and economic development in rural areas, with a focus on the following areas:	
	6b	fostering local development in rural areas	NL_19 (EC_42-44)

Horizontal priorities addressed by POP3

Priority	Priority area	**Description**	**NL measure # (EC Article #)**
1		fostering knowledge transfer and innovation in agriculture, forestry, and rural areas with a focus on the following areas:	
	1a	fostering innovation, cooperation, and the development of the knowledge base in rural areas;	NL_01 (EC_14) NL_16 (EC_35)
	1b	strengthening the links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance	NL_01 (EC_14) NL_16 (EC_35)

POP3 does not directly address Priority 5 (promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors), in spite of the SWOT-analysis indicating a number of needs here. This is because national policies already cover this area, and moreover the measures programmed under the other priority areas can contribute to the goals of priority 5. ('Integeral approach'.)

In short, POP3 addresses, based on the SWOT analysis, 7 areas all of which are directed at sustainability and innovation. Through direct programming for 2a,3b, 4a, 4b en 6b, the poliy package contributes to horizontal priorities 1a and 1b.

Measures NL_01 and NL_16 contribute to priority 1 (they aim to enhance knowledge for innovation, including for making the sector more sustianable). They also contribute to life-long learning. Measure NL_04a3 enables to provide risk kapital for innovative and sustainable products and systems.

Measures NL_01, NL_04a1-2-3, NL_04c and NL_16 aim to improve competitiveness and sustainability via innovation. They are programmed under priority area 2a. Thus POP3 makes the link with sustainability and innovation by addressing environment, climate, water, soil management, energy, animal welfare, biodiversity and landscape. This package (for 2a) thus contributes to priority areas 3 and 4.

No specific actions for 3(a). For 3(b), a weather insurance with broad coverage is introduced.

Priority area 4(a) is about improvement of ecosystems and conservation of biodiversity. On the one hand it is important to stop biodiversity loss in agric areas via blue-green services and ecological corridors; on the other hand 'inrichtingsmaatregelen' are needed in meadowland bird areas to make conservation more succesful. Both are covered by POP3.

Priority area 4(b) is about improvement of water quality and indirectly biodiversity by supporting low emission agriculture and optimising agric water management. Demands by the NiD and WFD are governing here.

Priority area 4(c) is not directly programmed in POP3. Measures NL_01, NL_16 and NL_10 contribute indirectly to the need for knowledge transfer for better soil management.

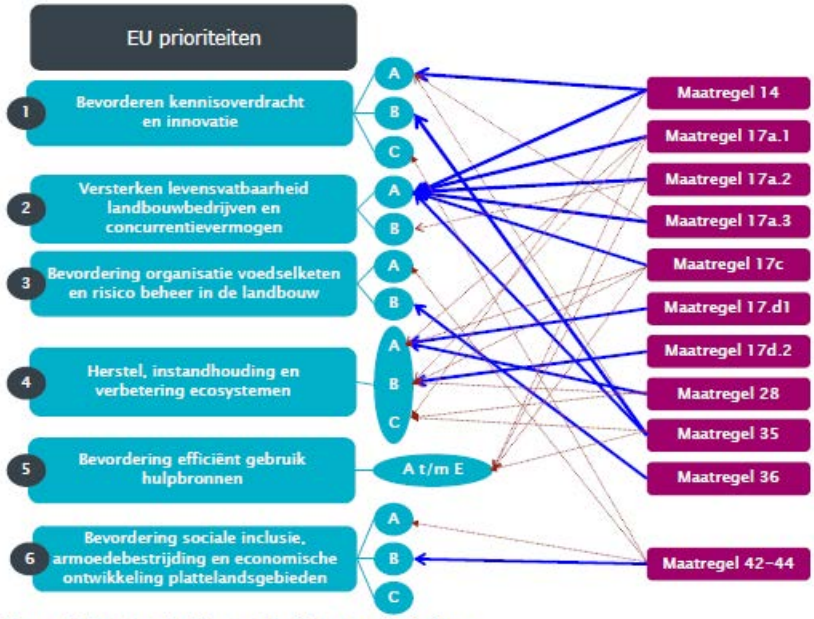
No specific measures for priority areas 5(a), (b), (c), (d) en (e). Measures for 2a contribute here.

LEADER (EC_42-44) aims to support local development and so contributes directly to priority 6. It is programmed under 6(b). LEADER requires active involvement of citizens and firms. Local Action Groups LAGs (Lokale Actie Groepen) choose mx three themes and set their strategies. These may include social innovation, economy, urban-rural relations, environment, sustainability. LEADER can contribute to horizontale themes (innovation, environment, climate).

No specific measures for 6(c).

All in all, an integrated approach is often needed to reach the goals for a region, involving many actors via many measures. Structural measures ('inrichtingsmaatregelen') can improve infrastructure for farming as well as nature. Efficient resource use is good for water quality as well as farm economy.

Figure 9: Overview of intervention logic (from NL POP3 document, chapter5)



Figuur 5.1 Overzicht van de interventielogica

5.2.5.3 Description of measures

Based on the SWOTanalysis NL chose to focus on a limited set of Priorities and measures. Its emphasis is on stimulating innovation, and increasing sustainability of the NL agrosector. The proposed measures in POP3 contribute to innovation, environment, climate adaptation and mitigation.

5.2.5.3.1 Measure NL_01 (Article EC_14) Knowledge sharing and dissemination

Knowledge transfer to large numbers of farmers is the motor for innovation. Exchanges with farmers, knowledge institutions, advisers and other actors in agriculture and food industry and rural areas.

This measure is to support innovation and modernisation on the following themes:

- Cost reduction, new market concepts ...
- Risk reduction, adressing market failure, strengthening position of primary producer
- higher input efficiency, and better farm management, reduction of resource use, closed cycles, lower emissions to soil, air and water (GHG, ammonia, nutrients, biocides) and less exhaustion of resources (water, phosphate, soil fertility).
- Climate mitigation: knowledge transfer actions will target the application of on-farm measures and innovations that promote higher energy efficiency, transition to renewable energy and reduction of fossil fuel, resulting in lower GHG emissions
- Climate adaptation: reducing (effects of) water shortage and excess, and salinisation
- Improvement of animal welfare and reduced risks to public health
- Conservation and promotion of biodiversity and environmental quality

Submeasures:

- Training courses, workshops and coaching of entrepreneurs (01.1.0);
- Demonstration activities (01.2.0).

This measure contributes to horizontal goals of innovation, environment, and climate.

Environment

An importnat component of knowledge transfer will be directed to innovative farming practices that reduce input and resource use and close cycles, resulting in lower emissions to soil, air and water (CO2, ammonia, nutrients, biocides) and less consumption of resources (e.g., water, phosphate, soil fertility).

Climate

Actions of knowledge transfer to stimulate application of farm practices with lower energy consumption, transition to renewable energy, and reduction of fossil fuels. Resulting in lower emission of GHG.

The measure NL_01 aims at exchange of practical information to large groups of farmers. NL_16, on the other hand, is directed at deloping and validating knowledge with small groups of fore-runner farmers. Both can be combined into single projects, also with NL_04 and NL_10. This measure NL_01 enables to connect with EFRO- and Interreg-programmes.

5.2.5.3.2 Measure NL_04 (Article EC_17) Investments in material activa

This measure is to support innovation and modernisation on the following themes:

- Cost reduction, new market concepts ...
- Risk reduction, adressing market failure, strengthening position of primary producer
- higher input efficiency, and better farm management, reduction of resource use, closed cycles, lower emissions to soil, air and water (GHG, ammonia, nutrients, biocides) and less exhaustion of resources (water, phosphate, soil fertility).
- Climate mitigation: knowledge transfer actions will target the application of on-farm measures and innovations that promote higher energy efficiency, transition to renewable energy and reduction of fossil fuel, resulting in lower GHG emissions
- Climate adaptation: reducing (effects of) water shortage and excess, and salinisation
- Improvement of animal welfare and reduced risks to public health
- Conservation and promotion of biodiversity and environmental quality

Measure NL_04 includes submeasures:

- Physical investments for developing, testing and demonstrating innovations and wide outreach (04.1.01)
- Physical investments to make farms of young farmers more sustainable (04.1.02);
- Guarantee funds for introduction of high-risk innovations (04.1.03);
- Investments in infrastructure (04.3.01).

and non-productive investments for water, biodiversity and landscape:

- non-productive investments for water, biodiversity and landscape and hydrological measures PAS (Programmatische Aanpak Stikstof) (04.4.01);
- non-productive investments for water (04.4.02).

Innovation

Investments are primarily meant to promote innovation in the primary sector. Not for the execution of regular activities.

Environment

Large component of physical investments will go to innovative on-farm measures that lead to lower use of resources, resulting in lower emissions of pollutants (ammonia, nutrients, biocides) to air, water and soil, and in less exhaustion of stocks (water, soil).

Investments:

- 04.01: investments in innovation and modernisation to make agriculture and horticulture more sustainable
- 04.03 investments in infrastructure
- 04.04 non-productive investments for water, biodiversity and landscape.

The submeasures 04.01 and 04.03 aim to reinforce competitiveness and sustainability by investment in innovation. This is, according to POP3, the only way to make agriculture future-proof. These measures contribute directly to priority area 2a, the reinforcement of farm viability and competitiveness in all regions and promoting innovative farm technologies. Thus, the NL makes a direct link with sustainability and innovation by working on environment, climate, water, soil management, energy, animal health and welfare, biodiversity and landscape. Thus, via its response to priority area 2a, NL contributes also to priority areas 3, 4, 5.

Support actions will often relate to innovations that contribute to various priority areas. Examples are the processing of manures, which contributes to priority area 4a (improvement of ecosystems due to lower ammonia emissions), 4b (quality of water systems, Nitrates directive, WFD targets), and 5d (reduction of GHG). For these reasons, physical investments in innovation are focussed on priority area 2a.

Submeasure 04.4.2 contributes to priority area 4(b), improvement of water management, including the management of soil and fertilisers and biocides. Contributions to NiD and WFD through non-productive investments including measures that mitigate the negative impact of agriculture on ecological functioning of waters, and vice versa. Loading of ground and surface waters with pollutants.

Submeasure (04.1.01). Physical investments for developing, testing and demonstrating innovations and wide outreach. This enables support for broad dissemination of innovations. In addition, also support for developing and testing innovations via pilots or experiments in farmer fields. This is testing of prototypes in practice.

Submeasure (04.3.1). This submeasure aims at investmenst in rural areas that contribute to better access to farms and fields, improvements in soil and hydrology, and re-location of farms.

Submeasures (04.4.1 and 04.4.2) Non-productive investments for water, biodiversity and landscape. These aims at non-productive investments in rural areas relating to re-structuring and transformation and management of the water system for agricultural, water and climate goals. Examples are investments for better water quality and quantity for WFD and Nitrates Directive, sustainable optimisation of hydrology and measures to prevent water shortage or excess, salinisation, and subsidence, including the water holding capacity of agricultural land.

Submeasure 04.4.1. (Non-productive investments for biodiversity, nature, landscape and hydrology (PAS=Programmatic Approach to Nitrogen)) Contributes to priority area 4a. This is achieved by structural measures (inrichtingsmaatregelen) that contribute to increasing biodiversity and conservation of specific landscapes. Examples are hydrology measures PAS, restauration of landscape elements, ecological measures in the landscape or for 'key areas' of meadow birds.

Submeasure 04.4.2. (Non-productive investments for water) Contributes to priority area 4b. This is achieved by non-productive investments that optimize the hydrology by investments in construction measures or hydrological measures in or near water courses, measures that mitigate the negative effects of agriculture on ecologoical functioning of surface and groundwater, and vice versa. Examples are reduction of loading of nutrients and biocides on surface and groundwater. Also they contribute to cliamte adaptation and mitigation with respect to water sortage and excess and salinisation in rural areas. Emissions relevant to NiD and WFD can also be achieved via physical investments under priority area 2a.

5.2.5.3.3 Measure NL_10 (Article EC_28). Agri-environment and climate

Demarcation from Article 17d

For demarcation from 17d, (agro-envir and climate support by non-productive investments) it is relevant whether the measure is for layout ('inrichting', only once), or for a 6-8 year management support ('beheersvergoeding') (Article 28).

General description of the measure

AEC (agri- environment and climate) support plays an important role in NL in sustainable development and public services. This measure promotes production methods with favorable effects on environment (incl. water), landscape, natural resources, soil, and biodiversity. The measure focuses on maintaining biodiversity on agricultural land and adjacent land. It enables resitution of extra cost or lost income, resulting from the agreements. The agreements extend beyond the standard legal requirements. Only open to agreements not leading to double financing. For correct implementation, agricultural collectives – through regional coördinators – can participate in knowledge exchange and education to acquire the necessary skills.

Contribution to priority areas

Within priority 4, this measure specifically targets priority area 4a (restoring and preservation of biodiversity) and 4b (improvement of water management). Environmental pressure is high due to intensive character of NL agriculture. This impact negatively on biodiversity (e.g. farm land bird and meadow birds) and deterioration of water and soil quality. Moreover, agriculture has undesirable effects on landscape and society. Agricultural nature management is important for a balanced rural environment – specifically for biodiversity and water quality - but the effectiveness of this instrument must be reinforced. The SWOT analysis recommends that agricultural nature management should be made less fragmented and more integral.

Horizontal: by reinforcing sustainability of farms this measure also contributes to environment, climate and water management.

Agreements are established to reinforce nature and water quality on and near agricultural land. Run-time 6 years. Priorities are governed by:
1) relevant species; (Bird and Habitat dirs.)
2) meeting thresholds (numbers / densities of species)
3) activities to be adpated (mowing, grazing, 'further than standard' reduction of manures and fertilisers) and biocides.

NL choose not to formulate general obligations, but to tailor measures to local situtation in relevant high-value areas. If needed, this measure (NL_10) can be connected (added to) the greening requirements of pillar 1.

Submeasures:
- Meadow birds
- Fauna connected with arable land (incl. farmland birds and hamsters)
- Botanical conservation
- Landscape conservation

In each of these submeasures, there are long lists of requirements. They include restrictions on timing or form of field operations such as tillage, manuring, cutting, residue management, weed control, water management; and on previous land use (rotations). Also, a collective plan is needed (farmers in region operate as one, represented by regional coordinator). So here there is a very strong impact on (scope for) BMPs. (There is a lot of detail on hamsters, but these occur on only a few ha in the very south of the country.)

Within botanical conservation, subcategories are made: grassland (grazed; cutting; borders; source areas), arable land with botanical value, 'arable land free of chemicals' (requirements on cereal component in rotation), and biodiverse buffer zones (strips along arable land; only sandy soil). Landscape conservation is about hedges, ponds, ditches, shrubs, trees. No obvious connection with soil management.

The measure NL_10 responds to priority areas 4a and 4b. In the case of botanical conservation, also 4c. is explicitised.

5.2.5.3.4 Measure NL_16 (Article EC_35) - Cooperation

Innovation processes increasingly depend on cooperation between various partners, and on involvement of users in developing new products and services. Peering 'over the fence' results in better views on innovative ideas, this is especially so for the agro sector where primary production is mostly in the hands of family-run farms. This measure (NL_16) contributes to open innovation in networks. This responds to trends towards increasingly complex products and services, with increasing mutual dependencies of parties; and to changes in the market ('experience economy'), convergence of technologies (bio- and ICT technologies), the changing position of the knowledge system with stronger focus on valorisation, and the increasing role of private R&D firms in the knowledge landscape.

Collaboration for open innovation relates to all aspects of the innovation process: research (new knowledge), proto-typing, validation, production, market introduction, implementation and revision of the business model. Although companies are well able to find their partners and develop collaboration, government can contribute to flourishing networks, clusters and EIP "operationele groepen" - from local to European level - that boost innovation.

Environment
Collaboration contributes to innovations enabling more efficient use of resources and inputs, resulting in lower emissions (ammonia, nutriënts, biocides) en a reduced spedning of finite resources (water, phosphate, soil fertility). This can contribute to the protection or use of biodiversity as an ecosystem service. Collaboration in the production chain can also contribute to reducing market failure and spill-overs, by searching methods to make consumers pay for 'above mandatory' ('bovenwettelijk') environmental measures.

Climate adaptation and mitigation
Collaboration is used for farm measures and innovations that reduce energy consumption, transition to renewable energy and reduction of fossil energy, thus lowering greenhouse gas emissions.

Submeasures:
- Pilot projects (artikel 35 lid 2(a)) and development of new products, practices, processes, techniques in agric and food industry. (16.2)
- Set up of operational groups under EIP for productivity and sustainability (16.1)

Measure NL_16 is directed at development and validation of practical knowledge and technology for a limited group of 'fore-runners'. Measure NL_01 (knowledge transfer) is directed at exchange of directly applicable knowledge/technology to large groups of farmers. Both can be combined into one project, and possibly combined also with NL_04 (investments) and NL_10 (agri-environment and climate).

Synergy with other funds ESI is encouraged, innovation strategies (RIS3) of EFRO-programs, Interreg programs, and Horizon2020 (science) for regionally strong sectors and crossovers between them.

5.2.5.3.5 Measure NL_17 (Article EC_36)

Subsidy to insurance against weather extremes.
No direct relevant to soils / BMPs.

5.2.5.3.6 Measure NL_19 (EC_42-44)

LEADER – for local socio-economic development. No direct relevant to soils / BMPs.

5.2.6 Poland

5.2.6.1 Agri-environmental schemes in Rural Development Plan 2007-2013

There were two major national documents implementing RDP 2007 – 2013:
National strategic plan for RD (*Krajowy Plan Strategiczny Rozwoju Obszarów Wiejskich*) and Rural Developement Plan for 2007-2013 (*Program Rozwoju Obszarów Wiejskich na lata 2007–2013. Ministerstwo Rolnictwa i Rozwoju Wsi, Warszawa*). Both documents issued by Ministry of Agriculture and Rural Development.

RDP for 2007–2013 contained 4 main priorities:

- Economic (improving competitiveness of agricultural and forest sectors)
- Environmental (improving quality of natural environment within rural areas)
- Social (improving life quality in rural areas)
- Leader (supporting local initiatives)

Agro-environmental schemes constitute major instrument under the environmental priority. AES were implemented in Poland through the following decree of Ministry of Agriculture and Rural Development:
Rozporządzenia Ministra Rolnictwa i Rozwoju Wsi z dnia 26 luty 2009 r. w sprawie szczegółowych warunków i trybu przyznawania pomocy finansowej w ramachdziałania „Program rolnośrodowiskowy" objętego PROW na lata 2007–2013 (Dz. U. Nr 33, poz. 262, z późn. zm.).

Main objectives of AES program were:

- Promoting sustainable agricultural production
- Recovery or protection of ecological value of rural areas and protection of biodiversity
- Protection of water and sustainable use of soil
- Protection of local genetic resources for livestock and crops.

The following policy packages refer to soil protection within AES:

1. Sustainable agriculture
2. Ecological farming
3. Extensive permanent grasslands
8. Protection of soils and water.

1. Sustainable agriculture
1.1. Sustainable production system
Crop selection and rotation, at least 3 crops, fertilization plan, requirement for soil analysis including liming needs, maintenance of permanent grassland area

2. Ecological farming
Many variants with principle of cropping according to best knowledge and agricultural practice, protection of soil, protection of grasslands, composting of residues.

3. Extensive use of permanent grasslands
   3.3.1. Extensive management of meadows and pastures
   3.3.2. Extensive management of meadows and pastures within Natura 2002.
Ban of ploughing between April and September, proper management through harvesting, thresholds for livestock density, etc.

8. Protection of soils and water
Several variants including catch crops between main crops and over winter, intercropping.

5.2.6.2 RDP 2014-2020

New RDP 2014-2020 covers 2 main Policy Packages referring to soil protection:

- Agro-environmental and climatic action
- Ecological farming.

Agro-environmental and climatic action
Package 1. Sustainable agriculture
Management based on soil analyses and fertilization plan, sustainable crop rotation. The objective is to sustain soil organic matter level.

Package 2. Protection of soils and water
Practices protecting soils against erosion, organic matter decline and groundwater contamination. The mandatory practices are catch crops, intercropping and grassland buffers on erodible slopes.

Ecological farming
Package 1. Conversion of conventional farming into ecological
Package 2. Sustaining ecological farming.

5.2.6.3 5.Less Favored Areas (LFA) support

The areas supported in Poland under LFA payment in 2007-2016 were delineated based on land valorization system and low population issues. It is difficult to assess impact of LFA on sustaining soil quality. It can be assumed that this type of support protected some areas against abandonment and, therefore, helped to protect soil against erosion in mountainous and sub-mountainous zones.
New LFA areas will be delineated based on soil texture criteria. There is also a discussion on setting soil pH as one of criteria. Sandy soils are usually acidic and susceptible to further degradation so this policy instrument in certain extend will support protection of these soils (liming, vegetation cover, crop residues).

All policy issues, especially new RDP 2014-2020 were discussed with stakeholders representing Ministry of Agriculture and Rural Development, Department of Stategy, Analysis and Development and Department of Direct Payments.

5.2.7 Spain

5.2.7.1 Agri-environmental schemes in the rural development plans

5.2.7.1.1 National and regional scale

Both, the National Strategic Plan for Rural Development 2007-2013 (NSP) and the Regional Rural Development Programs (RDP) have three main objectives (Axes): the competitiveness of agriculture, environment and quality of life in rural areas. The distribution of European Regional Development Fund (ERDF) between axes indicates the weight given to them by Spanish administrations. In Andalusia, as in the National Strategic Plan, there is a greater supply for axis 1 (52.84% of the total RDP), followed by axis 2 (35.85%) and axis 3 (10.81%). Technical assistance has a weight of 0.51% of the total.

In improving the competitiveness of the agricultural sector, one of the objectives is addressed to water resources management, by reducing losses and saving water, keeping in line with compliance with the Water Framework Directive (Measure 125 of axis 1)

The goal of improving the environment is achieved through the promotion of farming practices that respect the natural environment. Special attention is paid to the Natura 2000 network, in the agricultural land and forest, with the objective to protect these areas of high environmental value. Another objective is the conservation and support for certain traditional agricultural landscapes of great value as the “Dehesa”.

With regard to soil quality, both the NSP and the Andalusia-RDP recognize soil erosion as one of the environmental and economic problems of major significance in the area. They make special reference to soil and erosion risks due to both the irregular and low rainfall as from forest fires.
At the same time both establish the requirement of building up management practices contributing to sustainable development. In this way aids for farmers who implement certain measures to prevent soil loss, improve organic matter content, improve soil structure and reduce pollution are articulated through axis 2 (Measure 214- Agro-environmental).

All objectives and measures are collected in:

- Plan Estratégico Nacional de Desarrollo Rural 2007-2013
- Marco Nacional de Desarrollo Rural 2007-2013
- Programas de Desarrollo Rural Regionales 2007-2013
- Programa de la Red Rural Nacional 2007-2013

Table 12: Summary of the National and Andalusian RDP objectives related to soil quality

Specific objectives. Axis 2 Agro-environmental	Operational objectives
1. Saving and improvement of water quality	- To reduce water pollution by agricultural and / or forestry practices. - To recover biological flows (water savings).
2. Soil protection, soil conservation and erosion control	- To prevent erosion soil loss - Sustainable management of forest ecosystems - To reduce forest fires - To reduce soil contamination - To improve soil through practices and structures reducing erosion
3. Conservation and enhancement of biodiversity	- Conservation of the natural environment, especially the "Natura 2000" network in the agricultural and forestry environment - Sustainable management of forest ecosystems - Reduction of forest fires
5. Maintaining the agricultural landscape and combat Desertification	- To maintain agricultural and livestock activity in disadvantaged areas - To reduce forest fires

Table 13: Relationship between National Plan Specific objectives and RDP measures in Andalusia

Objectives NSP Axis 2	Measures RDP Andalusia										
	211	212	214	215	216	221	222	223	225	226	227
Water											
Reduction of water pollution by nitrogen fertilizess and other agrochemicals			X								
Soil											
Mitigation of soil loss by erosion			X			X	X	X	X		
Improvement of both organic matter and soil structure			X			X	X	X	X		
Reduction of soil contamination			X						X		
Improvement and maintenance of soil conservation structures					X						X
Biodiversity and Natura 2000											
Maintenance and Recovery of biodiversity			X						X	X	
Protection and improvement of the Community affected hábitats, specially the Natura Network 2000 in agrarian and forest areas as well as the High natural value Zones											
Caracterization, conservation and sustainable use of the genetical patrimony of agriculture and husbandry			X	X							
Potentiate the biological diversity and the sutainable management of forest ecosystems, to reduce or to avoid desertification processes provked by the removal of forest cover after wildfires and natural disasters						X	X	X	X	X	
Reduction of the wildfire number									X	X	
Enhancement of a rational management in Agriculture and Forestry to ensure the conservation and restoration of the original characteristics which propitiate the Natura 2000 network membership			X						X		
Climate change and renewable resources											
Reduction og greenhouse gases emission and control of climate change effects			X								
Development of renewable energies from raw agricultural and forest materials											
Energetic evaluation of residue and by-products of cattle management											
Adoption of more energy-efficient technics											
Enhancement of the sink potential of agrarian ecosystems			X				X				
Incorporation of energy-efficient practices in agriculture, husbandry and agro industries											
Others											
Maintenance of the rural population and articulation of the territory	X	X									
Maintenance of agrarian activity compensating natural constraints	X	X									

The Andalusian agri-environmental scheme, in axis 2, includes Measure 214: Ayudas agroambientales. This Measure includes sub-measures whit special relevance to combat soil erosion and affecting soil quality. These measures are based on the philosophy of conservation tillage that can increase the uptake capacity of the soil and prevent soil loss.

- 214-03 Agricultura ecológica

- 214-05, 214-06, 214-07, 214-13 y 214-16: Producción integrada en arroz, algodón, olivar en cuencas vertientes a embalses de abastecimiento de agua para consumo humano o en zonas Natura 2000, alfalfa, y de remolacha de siembra otoñal.
- 214-08: Gestión sostenible de dehesa, *Not included in the open call*.
- 214-12: Agricultura de conservación en cultivos herbáceos en pendiente
- 214-14: Agricultura de conservación en viñedo en pendientes pronunciadas

The RDP-Andalusia also includes measures to mitigate desertification in forest areas by preventing forest fires, aid to the forest environment and non-productive investments in "Natura 2000" in forest areas.

- 225: Ayudas a favor del medio forestal
- 226: Recuperación del potencial forestal e implantación de medidas preventivas

Regularly an open call for farmers to apply for such aid is opened, although not all measures or sub-measures are included in it. For example the open call for 2014 is:

- Resolución de 11 de febrero de 2014, de la Dirección General de Fondos Agrarios, por la que se convocan para el año 2014 ayudas al amparo del Real Decreto 202/2012, de 23 de enero, y de la Orden de 7 de marzo de 2011, que se citan, y por la que se establecen las particularidades de la campaña 2014 y se actualiza el Anexo III de la mencionada Orden de 7 de marzo de 2011.

5.2.7.2 General normative

- Reglamento (CE) Nº 2078/1992 del Consejo de 30 de junio de 1992, sobre métodos de producción agraria compatibles con las exigencias de la protección del medio ambiente y la conservación del espacio natural.
  - *1. Objetivos del régimen de ayudas*
- Reglamento (CE) Nª 1698/2005 del Consejo, de 20 de septiembre de 2005, relativo a la ayuda al desarrollo rural a través del Fondo Europeo Agrícola de Desarrollo Rural (FEADER). Disposición derogada, válido hasta 31/12/2013.

- Reglamento (CE) Nº 1974/2006 de la Comisión de 15 de diciembre de 2006 por el que se establecen disposiciones de aplicación del Reglamento (CE) nº 1698/2005 del Consejo relativo a la ayuda al desarrollo rural a través del Fondo Europeo Agrícola de Desarrollo Rural.
  - *Anexo II contenido de un programa de Desarrollo Rural*
  - *Anexo VIII Indicadores*

The regulation of programs implementation is given in:

- Real Decreto 202/2012, de 23 de enero, sobre la aplicación a partir del 2012 de los pagos directos a la agricultura y a la ganadería.
  - *Sección 1.º Programa Nacional para el Fomento de Rotaciones de Cultivo en Tierras de Secano. establecido en el Real Decreto 202/2012, de 23 de enero, Título V (Ayudas específicas por aplicación del artículo 68 del Reglamento (CE) n.º 73/2009 del Consejo, de 19 de enero), cap. I, sección 1ª, Art. 28 . (No está recogida en el PDR andaluz)*
  - *Sección 3.ª Programa nacional para el fomento de actividades agrícolas específicas que reporten mayores beneficios agroambientales en* determinadas especies del sector de los frutos de cáscara, Artículo 42. Manejo de residuos.
- Resolución de 1 de Septiembre de 2009, de la Dirección General de Desarrollo sostenible del Medio Rural, por la que se dispone la publicación del Acuerdo de las autoridades de gestión de las Comunidades Autónomas de los programas de desarrollo rural cofinanciados con el Fondo Europeo Agrícola de Desarrollo Rural
- Real Decreto 1852/2009, de 4 de diciembre, por el que se establecen los criterios para subvencionar los gastos en el marco de los Programas de Desarrollo rural cofinanciados por el Fondo europeo Agrícola de Desarrollo Rural (FEADER)

5.2.7.3 Specific normative

- Directiva 2000/60/CE por la que se establece un marco comunitario de actuación en el ámbito de la política de aguas (WFD) entró en vigor el 22 de diciembre del 2000.
  - *Artículo 2. Definiciones*
  - *Anexo II. 1.4. identificación de las presiones en aguas superficiales. 2.1.y 2.2 Caracterización inicial y adicional de aguas subterráneas 2.3 Incidencia de la actividad humana en las aguas subterráneas.*
  - *Anexo VII A. 2. Planes hidrológicos de cuenca.*

- DIRECTIVA 2006/118/CE DEL PARLAMENTO EUROPEO Y DEL CONSEJO de 12 de diciembre de 2006 relativa a la protección de las aguas subterráneas contra la contaminación y el deterioro.
- Directiva 91/676/CEE del Consejo, de 12 de diciembre de 1991, relativa a la protección de las aguas contra la contaminación producida por nitratos utilizados en la agricultura.
- LEY 7/2010, de 14 de julio, para la Dehesa (BOJA núm. 144)
  - *Artículo 18. Medidas específicas de Investigación, Desarrollo y Formación (I+D+F).*
- DECRETO 245/2003, de 2 de septiembre, por el que se regula la producción integrada y su indicación en productos agrarios y sus transformados. *(*Boja nº 174 de 10.09.03).
  - *Regula el funcionamiento de la Producción integrada en Andalucía, adecuando la norma básica del RD 1201/2002*
  - *Capítulo I artículo 3: Establece el manejo del suelo como uno de los aspectos a desarrollar en los reglamentos específicos de cada producto*
- DECRETO 7/2008, de 15 de enero, de modificación del Decreto 245/2003, de 2 de septiembre, por el que se regula la producción integrada y su indicación en productos agrarios y sus transformados. (Boja nº 13 de 18.01.08)
  - *En su capítulo único, punto 3, modifica los apartados que al menos deben tener los reglamentos específicos de producción integrada de cada producto.*
- ORDEN de 15 de abril de 2008, por la que se aprueba el Reglamento Específico de Producción Integrada de Olivar. (Boja nº 83 de 25.04.08)
  - *Aspectos propios del cultivo: Prácticas agrícolas obligatorias, prohibidas y recomendadas*
- ORDEN de 4 de enero de 2006, por la que se aprueba el Reglamento Específico de Producción Integrada de Alfalfa. (Boja nº 32 de 16.02.06)
  - *Prácticas agrícolas obligatorias, prohibidas y recomendadas*
- ORDEN de 27 de noviembre de 2002, por la que se aprueba el Reglamento Específico de Producción Integrada de Algodón. Boja nº 146 de 12.12.02
  - *Prácticas agrícolas obligatorias, prohibidas y recomendadas*
- ORDEN de 18 de abril de 2000, por la que se aprueba el Reglamento Específico de Producción Integrada de Arroz.
  - *Prácticas agrícolas obligatorias, prohibidas y recomendadas*
- ORDEN de 22 de julio de 2005, por la que se aprueba el Reglamento Específico de Producción Integrada de Remolacha Azucarera para siembra otoñal.
  - *Prácticas agrícolas obligatorias, prohibidas y recomendadas*

5.3 Discussion

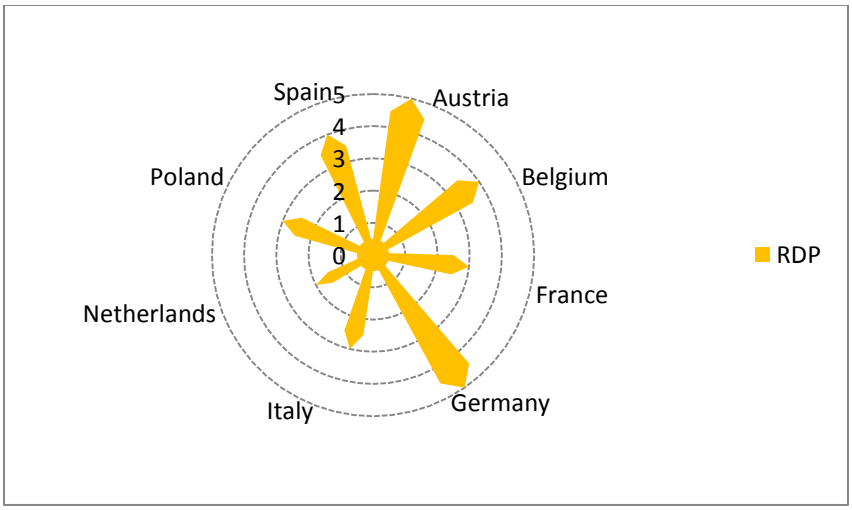


Figure 10: embeddedness of soil stakes into the design of RDPs for Catch-C countries

Similarly to CAP pilar1, we assess the degree of embedness of soil and soil stakes within the national and/or regional rural development programs (RDPs). Even though soil stakes are always quoted in the strategic and operational objectives, yet in many cases other stakes are prioritised in the policy packages. Only Austria and

Germany have totally embedded soils in their programs. Spain happens to have developed some specific measures to prevent erosion. So does Belgium, with a strong emphasis on other stakes for rural development (water and biodiversity). This is also the case, to a lower extent, in some regions in Italy. The other countries do not specifically embed soil stakes in their RDPs.

6 Environmental policy packages

6.1 Policy packages

6.1.1 Resource Efficiency Roadmap[21]

This roadmap aims at managing in a sustainable way all resources, including soil. The Roadmap provides a framework explaining how policies interrelate and build on each other in which future actions can be designed and implemented coherently. The roadmap is addressed to Member States with precise operational objectives: "*The EU and its Member States should strive to remove barriers that hold back resource efficiency and so create the right set of incentives for production and consumption decisions. This will require:*
– Addressing markets and prices, taxes and subsidies that do not reflect the real costs of resource use and lock the economy into an unsustainable path;
– Encouraging more long-term innovative thinking in business, finance and politics that leads to the uptake of new sustainable practices and stimulates breakthroughs in innovation, and develops forward thinking, cost effective regulation;
– Carrying out the research to fill the gaps in our knowledge and skills and provide the right information and training;
– Dealing with international competitiveness concerns, and seeking to get a consensus with international partners to move in a similar direction."

The roadmap specifically addresses soil as natural capital and focuses on precise operational objectives, both at commission and Member States levels:
"*The Commission will:*
- *Further develop the scientific knowledge-base on biotic material, land-use effects and trends, and spatial planning, including impacts at global level and effects on trading partners, and highlight best practices in the Member States, leading to a Communication on land use (in 2014);*
- *Address the indirect land use change resulting notably from the renewable energy policy (continuous);*
- *Publish guidelines on best practice to limit, mitigate or compensate soil sealing (in 2012);*
- *Include broader resource efficiency considerations in the review of the Environmental Impact Assessment (EIA) Directive (in 2012).*
- *Propose a candidate European Innovation Partnership (in 2011) on agricultural productivity and sustainability aiming, inter alia, at securing soil functionality at a satisfactory level (by 2020).*

Member States should:
- *Better integrate direct and indirect land-use and its environmental impacts in their decision making and limit land take and soil sealing to the extent possible (continuous);*
- *Implement the actions needed for reducing erosion and increasing soil organic matter (continuous);*
- *Set up an inventory of contaminated sites, and a schedule for remedial work (by 2015)."*

Considering that the inventory of contaminated sites was a breaking point for the adoption of the Soil Directive, let's examine how this inventory can be accepted in a roadmap and not in a Directive. EU directives lay down certain end results that must be achieved in every Member State. National authorities have to adapt their laws to meet these goals, but are free to decide how to do so. Directives may concern one or more Member States, or all of them. Each directive specifies the date by which the national laws must be adapted - giving national authorities the room for manoeuvre within the deadlines necessary to take account of differing national situations. Directives are used to bring different national laws into line with each other, and are particularly common in matters affecting the operation of the single market (e.g. product safety standards).
A roadmap is a more flexible tool that aims at bringing together stakeholders and policy makers in order to design a coherent action framework that cuts across different policy areas and sectors. Its objective is to provide a stable perspective for transforming the economy. The Commission will prepare policy and legislative proposals to implement this Roadmap.

[21] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Roadmap to a Resource Efficient Europe /* COM/2011/0571 final */

6.1.2 European innovation partnership "agricultural productivity and sustainability"

The agricultural European Innovation Partnership (EIP-AGRI) [22] works to foster competitive and sustainable farming and forestry that 'achieves more and better from less'. The innovation model under the EIP-AGRI goes beyond speeding up the transfer from laboratory to practice (referred to as the "linear innovation model"). The EIP-AGRI adheres to the "interactive innovation model" which focuses on forming partnerships - using bottom-up approaches and linking farmers, advisors, researchers, businesses, and other actors in Operational Groups. Operational Groups bring together farmers, researchers, advisors, businesses, NGOs and other actors to implement innovative projects pursuing the objectives of the EIP-AGRI.
The aims of the EIP-AGRI and the functions of Operational Groups are described in Art 61 – 63 of the proposal for a Rural Development Regulation for the programming period 2014-2020 (COM (2011) 627-3).
The EIP aims to foster a competitive and sustainable agriculture and forestry that 'achieves more from less' and works in harmony with the environment. The EIP will help building a competitive primary sector that secures global food availability, diversified products and production, long-term supply of various raw-materials for food and non-food uses, as well as a better allocation of added value across the food chain.
Given these objectives, two headline targets have been identified for the EIP:
• As an indicator for promoting productivity and efficiency of the agricultural sector, the EIP aims to reverse the recent trend of diminishing productivity gains by 2020.
• As an indicator for the sustainability of agriculture, the EIP aims to secure soil functionality (including reversing the trend of losing soil organic matter, appropriate farming practices on agricultural land susceptible to erosion) in Europe at a satisfactory level by 2020. Soil functionality encompasses the productive capacity of soils and its key roles in climate change mitigation and adaptation and eco-system stability capacity of soils and it key roles in climate change mitigation and adaptation and ecosystem stability.
In order to transpose innovation into agricultural practice, the EIP will make use of a range of existing policies, in particular CAP Rural Development Policy and Union Research and Innovation Policy, to fund concrete innovative actions. Whilst Rural Development Programs normally act within the boundaries of program regions, mostly at local, regional, or national level, innovative actions at cross-regional, cross-border, or Union-level need to be co-funded by Union Research and Innovation Policy. Synergies should be sought with opportunities provided by Cohesion Policy, in particular via regional innovation strategies and transnational and interregional cooperation programs.

6.1.3 Nitrate directive

The Nitrates Directive[23] (1991) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures.
The Nitrate Directive proposes the following actions, which have to be implemented by Member States:

1. Identification of water polluted, or at risk of pollution[24],
2. Design as "Nitrate Vulnerable Zones"(NVZs) of Eutrophic river areas of land which drain into polluted waters or waters at risk of pollution and which contribute to nitrate pollution (or apply measures on the whole territory);
3. Establish Codes of Good Agricultural Practice to be implemented by farmers on a voluntary basis. Codes *should* include:
   - measures limiting the periods when nitrogen fertilizers can be applied on land in order to target application to periods when crops require nitrogen and prevent nutrient losses to waters;
   - measures limiting the conditions for fertilizer application (on steeply sloping ground, frozen or snow covered ground, near water courses, etc.) to prevent nitrate losses from leaching and run-off;

[22] COM(2012) 79 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on the European Innovation Partnership 'Agricultural Productivity and Sustainability'
[23] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources
[24] Such water are

- surface freshwaters, in particular those used or intended for the abstraction of drinking water, containing or that could contain (if no action is taken to reverse the trend) a concentration of more than 50 mg/l of nitrates;
- groundwater containing or that could contain (if no action is taken to reverse the trend) more than 50 mg/l of nitrates;
- freshwater bodies, estuaries, coastal waters and marine waters, found to be eutrophic or that could become eutrophic (if no action is taken to reverse the trend).

- requirement for a minimum storage capacity for livestock manure; and
- crop rotations, soil winter cover, and catch crops to prevent nitrate leaching and run-off during wet seasons.

4. Establish action programmes to be implemented by farmers within NVZs on a compulsory basis. These programmes *must* include:
   - Slurry spreading with trailing shoe system measures already included in Codes of Good Agricultural Practice, which become mandatory in NVZs; and
   - other measures, such as limitation of fertilizer application (mineral and organic), taking into account crop needs, all nitrogen inputs and soil nitrogen supply, maximum amount of livestock manure to be applied (corresponding to 170 kg nitrogen /hectare/year).
5. Report every four years on nitrate concentration in surface and ground waters (monitoring), eutrophication of surface waters. Member States also have to assess the impact of the action programs on water quality, revise NVZs and action programs and estimate future trends of water quality.

6.1.4 Water Framework Directive[25]

The main objective of the policy is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
- promotes sustainable water use based on a long-term protection of available water resources;
- aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and
- contributes to mitigating the effects of floods and droughts.

Strategic objectives include ensuring the appropriate administrative arrangements to apply the rules of this Directive, identifying the individual river basins, assessing ecological status, establishing a program of measures (including basic and supplementary measures), producing river management plans, monitoring and reporting.

According to Hering *et al.* (2010), One of the most innovative aspects of the WFD is to base management decisions on the ecological effects of pollution (or other stressors) rather than the pollution itself, acknowledging that sensitivity and resilience to pollution varies substantially across ecosystems. In places where water quality has been improved, focus is nowadays put on restoring habitats (Lyche-Solheim *et al.*, 2010).

6.1.5 Groundwater Directive

The Groundwater directive[26] is build up on the same framework as the WFD. It aims at establishing measures envisioned in the WFD to prevent and control groundwater pollution. It establishes groundwater quality standards and a procedure for Member States to establish thresholds.
As the measures taken by Member States are included in the river management plans foreseen by the WFD, we will group the analysis of those last two.

6.1.6 Proposal[27] for an amended EIA Directive

Directive 2011/92/EU1 contains a legal requirement to carry out an environmental impact assessment (EIA) of public or private projects likely to have significant effects on the environment, prior to their authorisation. There is consensus that the main objective of the Directive has been achieved; the principles of environmental assessment have been harmonised throughout the EU by the introduction of minimum requirements concerning the type of projects subject to assessment, the main developer's obligations, the content of the assessment and the participation of the competent authorities and the public. In parallel, as part of the development consent process, the EIA is a tool to assess the environmental costs and benefits of specific projects with the aim of ensuring their

[25] DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy
[26] DIRECTIVE 2006/118/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the protection of groundwater against pollution and deterioration
[27] COM(2012) 628 final Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment

sustainability. Hence, the Directive has become a key instrument of environmental integration and has also brought environmental and socio-economic benefits.
The general objective of the proposal is to adjust the provisions of the codified EIA Directive, so as to correct shortcomings, reflect on-going environmental and socio-economic changes and challenges, and align with the principles of smart regulation.

Regarding soils, the proposal considers that the environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on soil (among several factors).

6.2 National implementation

6.2.1 Austria

6.2.1.1 Contractual Commitments (Vertragliche Verpflichtungen (ÖPUL))

Summary of the Austrian ÖPUL- Program 2015-2020
The aim of the Austrian program for funding of a compatible environment, extensive and natural habitat protected agriculture (ÖPUL) is to support sustainable management in agricultural cropland and grassland by improving the soil quality. Main tasks include the protection of soil, biodiversity and cultural landscape, water and climate conditions. The program tries to get a comprehensive national wide acceptance by farmers. The results-based agricultural management measures include restrictions of the crop rotation, reduction of erosion by different cultivation methods (mulch and direct tillage), the greening of agricultural areas by catch/cover crops or the sowing of perennial seed mixtures, the technique of "Immergrün" (permanent greening of at least 85% of the arable land for the whole year), the renunciation of yield-increasing operational material (mineral fertilizers and pesticides), soil-conserving production in arable farming, further for wine, fruit and vegetable, the permanent grassland conservation and preventive conservation of water (ground and surface waters). The biological farming allows the combination of certain ÖPUL agri-environmental measures with standards and guidelines of the BIO AUSTRIA. The participation of farmers in the ÖPUL program was very high in the recent years, although the interest for the individual ÖPUL agri-environmental measures could vary in a wide range.

The process of the ÖPUL funding takes place under the supervision of the agricultural market Austria association (AMA, www.ama.at). The chamber of agriculture was responsible for the submission of the farmer`s applications and the communication between the farmer and the AMA in the past. With the year 2015, it is possible for farmers to be directly in contact with the AMA by their own internet service portal (eAMA, www.eama.at) to handle farmer`s requests and messages electronically. The AMA has to decide about the disbursement of the funding, controls the compliance of rules and decides about individual sanctions in case of infringements.

Table 14: Summary of the Austrian ÖPUL program 2015-2020

	ÖPUL funding	Description of the ÖPUL funding
1	Environment and biodiversity management	Preparation of biodiversity areas on arable fields and grassland (incl. bee areas), conservation of the landscape and orchards, advanced training, guidelines for the crop rotation, permanent grassland
2	Restriction of the use of yield-increased operating resources	Renunciation of the use of pesticides and mineral fertilizers on grassland, arable and permanent cropland
3	Renunciation of the use of fungicides and growth regulators in cereals	Renunciation of the use of fungicides and growth regulators in cereals
4	Cultivation of rare arable crops	Cultivation of rare arable crops
5	Conservation of endangered livestock breeds	Breeding of endangered breeds
6	Cover crops: Catch crops	Greening of arable land between main crops
7	Cover crops: Permanent green cover	Greening of at least 85% of the arable land for the whole year
8	Mulch seeding and direct drilling (incl. strip till)	Use of erosion-reducing methods of cultivation
9	Ground-based slurry application	Spreading of liquid manures on arable cropland and grassland only with equipment that apply the manure directly on or directly into the soil
10	Erosion protection of permanent crops (fruit/wine/hops)	Greening of alleyway in fruit/wine and other permanent crops

11	Renunciation of the use of agricultural pesticides (wine/hops)	Renunciation of the use of insecticides and/or herbicides in hop and viticulture
12	Renunciation of the use of silage	Renunciation of the use of silage preparation on grassland
13	Mowing of steep slopes	Mowing of steep slopes ≥ 35%
14	Mowing of gradient meadows	A least mowing every second year and removing of the grass
15	Alpine grazing and herder management	A least grazing for 60 days/year on alpine pastures by sheeps, goats, horses and cattles
16	Preventive protection of the groundwater	Groundwater compatible management (e.g. agricultural advice, reduction of nitrogen fertilization, reduction of fertilizer application periods, etc.) for arable cropland, grassland and areas with polluted groundwater
17	Cultivation of endangered leaching arable areas	Sowing of perennial greening (e.g. in areas with endangered N-leaching, the closure of arable cropland with low crop yields by greening, etc.)
18	Preventive protection of surface water on arable land	Sowing of perennial greening (e.g. the closure of arable cropland by greening along of high polluted waters, etc.)
19	Nature conservation	Special management conditions for the conservation or increase of biodiversity on valuable agricultural cropland
20	Organic farming	Funding of the organic farming (e.g. renunciation of the use of pesticides and mineral fertilizers, a soil health improving crop rotation, agricultural recycling on the farm, etc.)

6.2.2 Belgium (Flanders)

6.2.2.1 Nitrates Directive (91/676/EEG, December 12 1991)

The Nitrates Directive in Flanders is regulated through the Manure Decree ('Mestdecreet') that first came into force in 1991. The Manure Decree aims at protecting the environment from water contamination caused by nitrates and phosphorus from agricultural soils. Since 2007, Flanders is entirely appointed as Nitrate Vulnerable Zone. Every four years a new Action Programme (so called Manure Action Plan (MAP) in Flanders) is negotiated with the European Commission. In this report the 4th Action Programme for the period of 2011-2014 (MAP4) is discussed. The aim of MAP4 is to substantially reduce the percentage of measuring points in the surface water MAP-monitoring network that exceed the threshold value of 50 mg NO_3^-/l. The target in 2014 is 84% of the MAP-measuring points not exceeding the threshold. Also for groundwater, further reductions in nitrate concentrations are aimed at. The ortho-phosphorus concentrations in water bodies should also further reduce significantly as is required by the Water Framework Directive. It is to be noted that the region of Flanders was one of the few regions to include a P policy from the start of the implementation of the Nitrates Directive, although that was not explicitly required by the Nitrates Directive. Phosphorus was only indirectly targeted in the Nitrates Directive by mentioning that eutrophication of water bodies should be prevented.

The measures in the Manure Decree that have an impact on soil management practices are discussed below:

Restricted (organic) fertilizer use and application of exogenous organic matter

Depending on soil (sandy soils vs other soils; P-saturated areas or not) and crop type, maximum yearly N and P application rates are enforced. This limits the possibilities for applying exogenous organic matter.

For N, there are different thresholds for mineral fertilizers, animal manures and other organic fertilizers. In previous action programmes maximum N application rates were based on total N inputs, making slow N-releasing organic fertilizers, which usually have a high and stabile organic carbon content, less attractive, although exemptions were possible. To stimulate good fertilization practices and make these slow releasing fertilisers with high carbon content more attractive, in MAP4 the farmer can choose for maximum fertilization doses based on effective N instead of doses based on total N. The maximum total N-input for animal manures remains 170 kg N/ha (in some specific cases it is lower or higher).

Maximum P application rates are always based on total contents. Moreover, the P-thresholds further decrease in time, even below equilibrium fertilization, to allow P mining. Therefore, P will become more frequently the limiting factor for applying exogenous organic matter and maintaining or increasing soil organic carbon levels.

In some areas important for nature values or drinking water, fertilization is even more restricted.

In some cases it is possible to apply more organic fertilizers, increasing the possibilities to apply more exogenous organic matter.

- ***Derogation measures***

In some cases farmers are allowed to apply more animal manures. The crops that are eligible for derogation include grasslands, maize (only when preceded by a grass or rye cut), winter cereals and triticale (only when followed by a non-legumous cover crop).

- ***Exemptions for slow N-releasing organic fertilizers***
  In some cases the Flemish government can decide that the maximum yearly dose of slow N-releasing organic fertilizers can be increased. However, over a period of maximum three years, no more total N and P can be applied than three times the maximum yearly N and P application rates. This exemption still exists in MAP4, but is not used in practice anymore since more compost can already be applied when using the system of effective N fertilization norms.
- ***Exemption for certified compost applications***
  To be able to maintain and increase soil organic carbon contents, (which is considered to be beneficial for nutrient use efficiency, erosion prevention and soil fertility), only half of the P-content in certified compost has to be accounted for.
- ***Cover crops after cereals***
  More nitrogen fertilization and more animal manure (170 kg N/ha vs 100 kg N/ha) is allowed on parcels with cereals if cover crops are grown after cereals.
- ***Maize preceded by a grass or rye cut***
  The maximum N and P fertilizer application rates are higher if maize is preceded by a grass or rye cut. However, the maximum dose of total N applied with animal manure remains 170 kg N/ha.
- ***Organic fertilizer use in legume crops***
  Legume crops cannot be N-fertilized with mineral fertilizers (except for peas and beans), but organic fertilizers are allowed. This is to avoid that legumes can no longer be grown in organic farming (where mineral fertilization with P and K is not allowed), although this measure also applies for conventional farming.
- ***Control of P fertilization norms at the farm scale***
  Although N and P fertilization norms are set at the field plot scale, control whether these norms are strictly observed is only at the farm scale for P. This allows to make better use of organic fertilisers. It allows for instance to use more farmyard manure on one field plot than is strictly allowed when P is the limiting factor, and to compensate this by applying less P on another field parcel. The control on N fertilisation norms is still conducted at field parcel scale (eg by taking soil samples for measuring nitrate residue) on conventional farms, but on organic farms also for N the control is at the farm scale so that organic farmers can make optimal use of organic fertilisers.

Apart from strict N and P fertilization levels, other rules apply for the storage, transport and application of (organic) fertilizers, which might hamper the use.

- ***Fertilizer application rules***
  Animal manures and other organic fertilizers should be applied with low emission techniques, which means injection or fast incorporation. Slurry can be injected, but other organic fertilizers such as farmyard manure and mushroom compost need to be incorporated, which is in conflict with no-tillage techniques. Fertilizers that are in some cases excluded from low-emission application include composts and effluents and also for mineral fertilizers no application rules to avoid emissions exist.
  Mineral and other fertilizers should also be immediately incorporated on bare steep slopes. On slopes of more than 15%, fertilization, apart from grazing, is prohibited.
  Furthermore there are strict rules for fertilization close to surface waters and for wet, frozen or with snow-covered field parcels.
- ***Fertilization restrictions after the main crop***
  It is prohibited to apply liquid animal manure, mineral fertilizer or other fertilizers (except for slow N-releasing organic fertilizers) after harvest of the main crop except when 1) a vegetable crop is grown afterwards, 2) another crop is sown before July 31, 3) a cover crop is sown in August. Organic fertilizer (except for slow N-releasing) should be applied before September 1. Vegetables can still be fertilised with mineral fertilizer before November 15. Before a cover crop the maximum allowed dose is 30 kg N/ha for mineral fertilizers and effluents from manure processing and 60 kg N/ha for other fertilizers except for slow N-releasing organic fertilizers. During the MAP4 period, research is being conducted to investigate if 60 kg N/ha before a cover crop and after cereals does not increase N leaching risks.
  In the Polder area, liquid animal manure, mineral fertilizer or other fertilizers (except for slow N-releasing organic fertilizers) can only be used after the main crop (until October 14) if a (cover) crop is sown 15 days after manure application. Without (cover) crop, fertilization is prohibited after the main crop.
  For all areas, farmyard manure and mushroom compost can be applied until November 14 and from January 16 onwards and other slow N-releasing fertilizers such as compost can be applied year-round.
- ***Storage restrictions for animal manure***

Farmers should have a minimum storage capacity for animal manures: at least 9 months for animals in stables, at least 6 months for animals that are also outdoors and at least 3 months for farmyard manures. Some exceptions apply, e.g. when manure can be treated in a timely manner.
Solid animal manure is farmyard manure, mushroom compost, the solid fraction after manure separation and any animal manure with a dry matter content of at least 20 %. Solid animal manure can not be stored on field parcels between November 15 and January 15. During the rest of the year it should not be stored on the field parcel for more than one month and some additional rules for storage on the field parcel apply such as concerning the distance to surface waters and the amount to be stored. Longer-term storage is subject to some environmental requirements in order to avoid leakage and to be able to capture fluids in a manure tank.

- ***Inspection of manure transport***
  Transport of organic manures is subject to strict control and paper work. In some cases the transport should be equipped with an automated data registration system and GPS.
- ***Advised based fertilization of vegetables***
  As regions with a large share of vegetables are characterized with too high nitrate concentration in surface waters, since 2013 the fertilization of vegetables is prohibited unless the farmer follows a certified fertilization advise. This advise is based on soil samples.
- ***The use of sewage sludge on agricultural land is prohibited***

One of the measures to control effective implementation of the fertilizer norms is measuring nitrate-N residue in autumn (October 1- November 15; 0-90 cm). Farmers may not exceed a certain threshold level. One of the sanctions if thresholds are exceeded is to take more soil samples for soil mineral N in spring in order to be able to follow fertilization advise. Too high N residue levels can also lead to thorough audits of the farm and advise regarding environmentally friendly management practices that needs to be followed. Another measure can be the obligation to grow a crop after the main crop. Ultimately, very high nitrate-N residues may lead to reduced fertilizer norms or even a fertilizer prohibition.

Cover crops

MAP4 encourages the growing of cover crops as it is considered to be a good agricultural practice to prevent nitrate leaching during autumn and winter. It is also recognized, as a secondary effect, that these crops help to maintain soil organic carbon levels. In summary, MAP4 encourages cover crops through making them a prerequisite for:

- Derogation on cereals and triticale;
- Applying more fertilizers (including more animal manure) on cereals;
- Applying fertilizers after the main crops.

One of the sanctions that can be taken for farmers that exceed nitrate-N levels in autumn is to make cover crops obligatory.

Sometimes, it is believed that the requirement to take soil samples in autumn to control if nitrate-N residues are not too high, discourage cover crops growing. This is because seedbed preparation stimulates mineralization and increases the risk for higher nitrate-N levels. This is especially important when cover crops are sown shortly before the sampling campaign and cover crops were not be able for considerable N uptake yet.

No-tillage techniques

The Manure Decree hampers the combination of no-tillage techniques and the application of some organic fertilizers such as farmyard manure and mushroom compost as they have to be incorporated. Apart from obligations enforced by the Manure Decree, there is a flanking policy to help farmers to reach the water quality objectives set by the Nitrates Directive. These initiatives include:

- Establishment of the Coordination centre for extension services for sustainable fertilization (CVBB). CVBB aims at awareness raising and coordinates water quality groups. These groups consist of several farmers that try to improve water quality in their area. CVBB also provides subsidies for individual farm advise and monitors a network of reference parcels.
- Establishment of the Research and Extension Advisory Board on Sustainable Fertilization. This advisory board consists of representatives of several universities, agricultural (applied) research centres and administration. The aim is to advise policy makers on research needs, gather knowledge and expertise, promote an optimal transition from research to extension and to monitor research projects in preparation of new Manure Action Programmes to be negotiated with the European commission.
- The Flemish Land Agency (VLM) is in charge of policy making and implementation and control of the Manure Decree and provides an extension service to farmers regarding implementation of the Manure Decree.

The objectives of the Nitrates Directive are also reached through other legislation channels such as the agro-environmental schemes (AES).

Summary
The main aim of the implementation of the Nitrates Directive is to **improve water quality**. This goal is mainly being reached by **regulation**. The obligatory soil sampling is not only introduced to control if farmers are following regulation but also for **awareness raising purposes.** It is the hope that this provides the farmers with more insights to fertilize their crops sustainably. Awareness raising is also being accomplished by the flanking policy. The impact of the Manure Decree on soil management practices is summarized in Table 3. The Manure Decree limits the amount of **exogenous organic matter** that can be applied on agricultural soils. Strict rules e.g. on manure transport and storage might potentially hamper the use of animal manures on arable farms. However, through some exemptions the policy makers recognize the importance for applying more exogenous organic matter to maintain organic carbon levels. Especially for slow N-releasing organic fertilizers, possibilities for application are created through e.g., fertilizer norms based on effective N (instead of total N), only half of the P in composts that needs to be taken into account, year-round application possibilities and the control at the farm level for P. **Cover crops** are stimulated through making them obligatory in exchange for less strict fertilizer rules, although soil samples for measuring nitrate-N levels in autumn might potentially hamper adoption. **No-tillage techniques** can not be combined with some organic fertilizers as they need to be incorporated.

Table 3: Impact of the implementation of the Nitrates Directive on sustainable soil management practices considered in the Catch-C project

Management practice	Main aim	Remarks
Rotation		
MP8-9 catch crops	Water quality	Derogation winter cereals and triticale is only possible when a cover crop is grown.
	Water quality	170 kg N/ha by animal manure can be applied if cover crops are grown after cereals. If cover crops are not grown, this is only 100 kg N/ha by animal manures.
	Water quality	Applying fertilizers after the main crop is only possible if a cover crop can be sown before a given date.
	Water quality	Cover crops can be obliged for a farmer if nitrate-N residues in autumn are too high.
	Water quality	The requirement to take soil samples in autumn to control if nitrate-N residues are not too high can discourage cover crops growing. Farmers might fear that sowing just before sampling can enhance mineralisation and lead to higher nitrate-N residues.
Tillage		
MP16 No/zero tillage	NH_3 emission reduction	Organic fertilizers such as farmyard manure and mushroom compost need to be incorporated, which is in conflict with no tillage techniques.
Nutrient management		
MP all fertilizer types	Water quality	Maximum yearly N and P application rates. This limits the possibilities for applying exogenous organic matter. Different N norms for mineral fertilizers, animal manures and other organic fertilizers. Different N and P norms for different soils and crop types.
	Water quality	Applying fertilizers after the main crop is only possible under certain conditions.
	Water quality	Fertilization of vegetables is prohibited unless the farmer follows certified fertilization advice.
MP all animal manures	Water quality	If no cover crop is grown after cereals, maximum animal manure application is only 100 kg N/ha instead of 170 kg N/ha
	Water quality	Farmers need sufficient storage capacity for animal manures, except for e.g. when manure can be treated in a timely manner.
MP all organic fertilizers		Legume crops cannot be N-fertilized with mineral fertilizers (except for peas and beans), but organic fertilizers are allowed. This is to avoid that legumes can no longer be grown in organic farming,

	Support organic farming	although this measure also applies for conventional farming
		Control of P fertilization norms at the farm scale instead of at the field plot scale (as for N).
	Better use of organic fertilizers, soil organic carbon	Obligation to apply with low emission techniques such as injection or fast incorporation.
	NH3 emission reduction	Transport of organic manures is subject to strict control and paper work.
	Water quality	
MP29 Plant compost application	Water quality, soil organic carbon	Choice between maximum N application rates based on total N or based on effective N. Effective N provides more possibilities to apply more stabile slow N releasing organic fertilizers. Effective N is lower for certified compost than for farm compost, which is a disadvantage for farm compost.
		Only half of the P-content in certified compost has to be accounted for. This is not valid for farm compost (if one or more materials from outside the farm are used).
	Water quality, soil organic carbon	Compost is excluded from the need to apply organic fertilizers with low emission techniques.
	NH_3 emission reduction	In contrast for other fertilizers, having stricture rules for timing of application, slow N releasing fertilizers can be applied year-round.
	Water quality	
		Farm compost made on the farm and from own materials does not have to comply with the manure decree if no animal manure is used.
	Not applicable	Choice between maximum N application rates based on total N or based on effective N. Effective N provides more possibilities to apply more stabile slow N releasing organic fertilizers.
MP32 Farmyard manure (FYM)	Water quality, soil organic carbon	Derogation: exemption for applying more animal manures (only cattle manure and some others, not for pig manure for instance) Obligation to incorporate farmyard manure
	Better possibilities for farmers to use animal manure on their land NH3 emission reduction	In contrast for other fertilizers, having stricture rules for timing of application, farmyard manure can be applied until November 14 and from January 16 onwards.
	Water quality	Solid animal manure can not be stored on field parcels between November 15 and January 15. During the rest of the year, it can not be stored on a field parcel for more than 1 month. Longer-term storage is subject to additional some environmental requirements.
	Water quality	Derogation: exemption for applying more animal manures (only cattle manure and some others, not for pig manure for instance)
MP33 Cattle slurry	Better possibilities for farmers to use animal manure on their land	
Other MPs	Soil contamination	The use of sewage sludge on agricultural land is prohibited

6.2.2.2 Water Framework Directive (200/60/EG) and Groundwater Directive

The European Water Framework Directive, Ground water Directive and Floods Directive are implemented through the Flemish Decree on Integrated Water Policy, which was officially approved in July 2003 (Belgium Law Gazette 14/11/2003). Objectives of the Decree include the protection and the amelioration of the status of surface and groundwater bodies towards a good chemical and ecological status for surface water and a good chemical and quantitative status for groundwater bodies. The Coordination Committee on Integrated Water Policy (CIW) is responsible for the coordination of the integrated water policy on the level of the Flemish Region.
Important for agriculture is the fact that the Decree on Integrated Water Policy regulates the application of fertilizers and pesticides and herbicides in riparian zones (Section 2, Art. 9-10). The minimum requirements are a prohibition to fertilize in the 5 m zone next to the upper end of an embankment. This zone is extended to 10 m in the areas of the Flemish Ecological Network (VEN) or when a slope is next to the water body. This prohibition does not apply for grazing. The application of pesticides and tillage operations are prohibited within the 1 m zone next to the upper end of an embankment. In some situations, e.g. in areas important for biodiversity or drink water provision, the area where the application of fertilizers or pesticides is prohibited can be enlarged.
For each river basin and sub-basin (which is part of a river basin), respectively, a river basin management plan and a sub-basin management plan is made, which includes environmental objectives and a program of measures. The latter defines how the objectives will be reached. The first sub-basin management plans were approved in 2009 and the first river basin management plans were approved in October 2010. They are revised every six years. In the second generation river basin management plans, to be approved by the Flemish Government by end 2015 for the period of 2016 - 2021, the river basin management plans and the 11 sub-basin management plans are prepared simultaneously. The environmental objectives for surface and groundwater are included as water quality standards in VLAREMII and include quality standards for nitrogen and phosporus. Some water-body specific standards are defined in the river basin management plans.

The **program of measures** contains 3 scenarios. The **basic scenario** consists of measures that are already included in other legislation, e.g., the implementation of the Manure Decree, application of the Federal Reduction programme for Pesticides, application of measures included in the rural development program 2007 – 2013 (RDPII) and the implementation of the Erosion policy in Flanders. The maximum scenario contains measures that need to be taken if the objectives are to be reached in 2015. The intermediate scenario consists of measures that aim at reaching the objectives by 2027 the latest.

Measures in the **intermediate scenario** with an impact on soil management include a code of good practice to avoid contamination by pesticides in drink water areas, following fertilization advise, reduce point contaminations of pesticides, sowing 6m wide grass buffer strips along water bodies via agri-environment schemes, optimizing the sowing of cover crops (as catch crops and to prevent erosion), sowing drift reducing catch crops for pesticides, and financial support for buying machinery for non-inversion tillage (via Agricultural Investment Fund for Flanders). It is important to note that the measures in the intermediate scenario are approved but the implementation is dependent on the available budget. Some agricultural measures are implemented through other legislation. For example, 'optimizing the sowing of cover crops' is accomplished through e.g. measures of the Manure Decree and CAP Pillar I. Most of the agricultural measures additional to other legislation are on a voluntary basis. Sowing 6m wide grass buffer strips along water bodies, for instance, can be funded through the agri-envrionment schemes. The administration has tried to convince as many farmers as possible to apply for such scheme in certain target zones but even in these zones the implementation was voluntary. These grass buffer strips are considered to be effective measures to avoid direct spill of nutrients into the water body, to limit sediment deposition in the water bodies in hilly areas, which is important to reduce contamination of P and crop protection products, and to buffer N and P that are leached to the water body via the ground water.

In the **maximum scenario**, the Flemish Government assessed the effect of more stringent measures, which are measures to be taken if a much quicker improvement in the condition of the water bodies needs to be reached. These are potential measures, but they are not approved in the plan and are thus not enforced. They include the exclusion of derogation as a possibility to apply more manure, decreasing the fertilization rate of animal manure to 140 kg N/ha (instead of 170 kg N/ha), applying non-inversion tillage techniques to decrease soil erosion, optimizing application times for organic fertilizers and removing and composting of crop residues of vegetable crops.

In summary, the consequences for the agricultural sector of the Water Framework Directive beyond the existing regulations such as the Manure Decree, are not very stringent and are mainly implemented on a voluntary basis, e.g., through voluntary schemes, for the moment. However, the Flemish Integrated Water Decree and the accompanying program of measures have assessed the possibilities to put additional restrictions on farming practices e.g., through further reducing fertilizer norms, enlarging grass buffer zones along water bodies and removing crop residues of vegetable crops.

6.2.2.3 National Emission Ceilings Directive (NEC) (2001/81/EC)

The last Belgian NEC reduction programme was submitted to the European Commission in 2006. Belgian emission ceilings have been split up into 4 sub ceilings: a national figure for emissions from non-stationary sources and three ceilings for the other sources of each of the regions. In this report the relevant figures and measures for Flemish agricultural soil management are discussed.

Emission ceilings have been defined for SO_2, NOx, VOC and NH_3. The emission ceilings for NH_3 are only regionally defined and set at 45 ktonnes for Flanders. As the farming sector accounts for the bulk of NH_3 emissions in Flanders, measures taken to reduce NH_3 emissions in Flanders rely entirely on the agricultural and livestock breeding sector. The reduction programme applies to five key targets: livestock reduction, low-emission use of manure, feed-related measures, low-emission stables and manure processing. The NH_3 reduction policy is **integrated** in the general **manure policy** (Manure Decree; see Nitrates Directive).

The low emission use of manure is compulsory as is stated in the Manure Action Plan (Manure Decree). Since 2000, precautions have to be taken to minimize emissions due to the application of manure. In 2003, legislation became even more stringent: raining in and spreading of manure are forbidden when the weather is rainy and manure has to be worked in within 2 hours after spreading.

Furthermore, the Decree also implies that no more than 170 kg N/ha from animal manure can be applied (if no derogation applies). This further limits NH3 emissions during manure application. Apart from animal manure, also other fertilizers such as mineral fertilizers containing ammonium can emit NH3 during or after application. So far, no measures are being taken for low-emission applications of mineral fertilizers although lower N fertilizers norms as imposed by the Manure Decree further decreases NH3 emissions by mineral fertilizers as well.

The measures that were already decided or agreed upon in 2006 should be sufficient to not exceed the ceilings as in the period of 1990-2005 NH3 emissions already dropped from 98 ktonnes to 47.5 ktonnes.

In summary, apart from low emission use of animal manures that is already included in the Manure Decree, NEC does not have any additional implications for sustainable soil management practices.

6.2.2.4 Waste Framework Directive (2008/98/EC)

The European Waste Framework Directive is implemented in Flanders by the Decree on sustainable management of material cycles and waste materials ("Materialendecreet"). It came into force in June 2012 but was preceded by the Waste Decree of 1981. The implementing decree is VLAREMA.

VLAREMA contains a list of waste materials that can be used as fertilizer or soil improver. This list includes vegetable, fruit and garden waste compost, green waste compost and mushroom compost. These materials must meet some quality standards, such as an acceptable content of heavy metals in order to prevent contamination of (agricultural) soils. Other waste materials can be used as well after obtaining a raw material declaration ('grondstoffenverklaring'), that proofs the same quality standards as mentioned above. Moreover, when traded (also when for free) these products should comply with the Federal legislation on the trade of fertilizers.
Farmers can thus be sure that the fertilizers and soil improvers they are purchasing are safe for use.

To close material cycles locally, farm composting is an option. Using farm compost made on the own farm and with own materials, is exempted from the VLAREMA regulation and from environmental permits. Moreover, the manure legislation only applies if animal manure is included in the compost. From the moment that materials from outside the farm are used or the compost is used on parcels of other farmers, environmental permits for production and the VLAREMA regulation apply. If compost is traded, whether or not for free, a Federal exemption ('ontheffing') is needed. Moreover, not all exemptions in the manure legislation that apply for certified compost also apply for farm compost. This all makes it less attractive and more expensive to close cycles locally and to use locally produced compost, except if the cycle can completely be closed on the own farm.

In summary, the implementation of the waste framework directive can hamper the use of waste derived materials such as compost. The administration involved might be a burden, especially for those working small scale, such as for farm composting. Also other legislation might hamper farm composting and the use of farm compost.

Table 4: Impact of the implementation of the waste framework directive on sustainable soil management practices considered in the Catch-C project

Management practice	Main aim	Remarks

Nutrient management

MP29 Plant compost application + other waste materials to be applied to soil	Prevention of soil contamination	Waste materials that can be used as fertilizer or soil improver should meet some quality standards. If not on a standard list these materials should obtain a raw material declaration.
	Not applicable	Farm compost made on the own farm and with own materials is exempted from the VLAREMA regulation. If other materials are used or the compost is used by another farmer, the VLAREMA regulation applies.

6.2.3 France

6.2.3.1 General framework in France

In 2007, a national consultative process called *Grenelle de l'environnement* was launched to update the French environmental policy packages. Outcomes of this consultation process are translated into laws, embedded into the French *Code de l'Environnement*, and in seven plans (none of them dealing with soil protection), plus a bundle of regional plans (see 2.2.2 for details). France has also embedded in its regulation all the EU environmental directives; among which the Nitrate Directive, the water framework directive). Moreover, national initiatives have emerged, on environmental certification for farms, and on climate change mitigation.

6.2.3.2 Nitrate Directive

There have been two judgments passed recently against France for poor implementation of the Nitrate Directive: one in June 2013[28] and another on in September 2014[29]. During the trials, an important work has been performed at all level to improve the delineation of vulnerable zones and coordinate actions programs on these zones. As a consequence, the number of texts associated with the implementation of the Nitrate Directive in France has increased since 2010:

- Articles R211-75 à R211-84 of the *Code de l'Environnement* frame the legal basis for organic nutrients storage and spreading in all possible situations, along with the delineation of vulnerable zones, the use of fertilisation plans.
- A national text specifies the minimal content of action programs (Arrêté interministériel du 19 décembre 2011 relatif au programme d'actions national à mettre en œuvre dans les zones vulnérables afin de réduire la pollution des eaux par les nitrates d'origine agricole).
- These action programs are designed at the NUTS3 level (Arrêtés préfectoraux relatifs au 4ème programme d'actions nitrates départemental).
- A national text specifies precisely how water sampling and analysis has to be perforemd to assess water quality (Circulaire du 19 avril 2010 relative aux modalités de mise en œuvre de la cinquième campagne de surveillance de la teneur en nitrates dans les eaux douces au titre de la directive n° 91/676/CEE du 12 décembre 1991, concernant la protection des eaux contre la pollution par les nitrates à partir de sources agricoles, dite directive nitrates).
- And a last national text gives precisions to a new delineation of vulnerable zones (Circulaire du 22 décembre 2011 relative au réexamen de la liste des zones vulnérables au titre de la directive 91/676/CEE du 12 décembre 1991 concernant la protection des eaux contre la pollution par les nitrates à partir de sources agricoles dite directive « nitrates »).

In vulnerable zones, catch-crops are mandatory, and farmers have to record their fertilisers use (with a very precise description of what is allowed to spread and at what time depending on the fertiliser type). They also have to have enough storage capacity for spreading during appropriate periods. The new law for agriculture also enables regions to record inorganic fertilisers sales directly from the suppliers to check accuracy of fertilisation plans on territories.

[28] Arrêt de la Cour (septième chambre) du 13 juin 2013. Commission européenne contre République française. Manquement d'État - Directive 91/676/CEE - Protection des eaux contre la pollution par les nitrates à partir de sources agricoles - Désignation des zones vulnérables - Teneur en nitrates excessive - Eutrophisation - Obligation de révision quadriennale. Affaire C-193/12.

[29] JUDGMENT OF THE COURT (Second Chamber), 4 September 2014 (*), (Failure of a Member State to fulfil obligations — Directive 91/676/EEC — Article 5(4) — Annex II.A, points 1 to 3 and 5 — Annex III.1, points 1 to 3, and Annex III.2 — Protection of waters against pollution caused by nitrates from agricultural sources — Periods for land application — Capacity of storage vessels for livestock manure — Limitation of land application — Prohibition on land application on steeply sloping ground or on snow-covered or frozen ground — Non-compliance of national legislation)

6.2.3.3 Environmental certification

The main aims of environmental certification are biodiversity, pesticides use, management of fertilisers, water management (soil is not directly targeted). There are three levels of certification, shaped by décrets and arrêtés[30,31,32,33,34,35,36]. Side effects on soil could occur by raising the awareness of farmers and extension services about the value of supplying ecosystems services, but the relationship to soils is still a bit vague.
The first and lower level of certification requires the farmer to prove he respects the environmental requirements of cross-compliance, and has engaged his farm into an assessment process regarding level2 or 3 indicators.

The second level[37] is a contract on means: it requires a protection of the most important areas for biodiversity protection on the farm area, to engage into strategic pest management techniques, to optimise fertiliser management, and to optimise water use in irrigation.

The third level is associated with the denomination "high environmental quality" and is a contract on outcomes. At this level, the farmers have to reach a certain level of achievements, given by a scoring of 16 different indicators on the same topic mentioned above.

6.2.3.4 Mitigation of climate change

In France, some recent prospective analysis regarding GHG emissions highlight that agriculture represents 18 % of the French direct emissions (agriculture emits directly 90 millions of carbon equivalent tons). These emissions can be split down into 45 % from soils, 28 % from enteric fermentation and 15 % from livestock manure, and 11 % from energy consumption (Delgoulet, *et al.*, 2014).

Despite the relative high share of emissions from soils, most scenarios rely on livestock and manure management to reduce emissions form farming. Soil management is seldom mentioned as a lever towards emissions reduction, in only one of the reports published during the last two years. Pellerin *et al.* (2013) advice for limiting ploughing one year over 5 with the potential of decreasing emissions by 3.77 carbon equivalent Mt, accompanied by catch crops in arable land for a reduction potential of 1.08 Mt. This reduction shows potential below methanisation process (5.78 Mtce) or cover of manure storages (3.40 Mtce). Other prospective studies consider that strong emission reductions request changing people diet (less animal proteins) and a reorganization of livestock breeding and totally let soil management aside. The expert advice from this report to the government about mitigating GHG emissions from agriculture highlights the importance of further experiments and research about the exact emission levels of some soil management practices (Madignier *et al.,* 2014), but at the moment, very little focus is put on soil management itself.

6.2.4 Germany

6.2.4.1 Nitrate Directive (NiD)

In Germany the NiD is implemented into national law by the Düngeverordnung (DüV). The DüV regulates the use of fertilisers, soil additives, growing mediums and plant additives according to the principles of *good agricultural practice (gfp).* The objective of the DüV is the reduction of the N– balance surplus and the reduction of NH_3 and N_2O emissions. Further, it contributes to the objective of the Water Framework Directive (WFD) to reduce N and P inputs from agriculture to water bodies (Osterburg, Techen 2012).

[30] Décret n° 2011-694 du 20 juin 2011 relatif à la certification environnementale des exploitations agricoles
[31] Arrêté du 20 juin 2011 portant application de l'article D. 617-3 du code rural et de la pêche maritime et arrêtant le référentiel relatif à la certification environnementale des exploitations agricoles - niveau 2

[32] Arrêté du 20 juin 2011 portant application de l'article D. 617-4 du code rural et de la pêche maritime et arrêtant les seuils de performance environnementale relatifs à la certification environnementale des exploitations agricoles et les indicateurs les mesurant - niveau3
[33] Arrêté du 20 juin 2011 portant application de l'article D. 617-4 du code rural : rectificatif
[34] Décret n° 2011-897 du 27 juillet 2011 relatif aux pouvoirs du ministre chargé de l'agriculture en matière d'agrément des organismes chargés de la certification environnementale des exploitations agricoles
[35] Arrêté du 16 septembre 2011 portant nomination à la commission nationale de la certification environnementale du Conseil supérieur d'orientation et de coordination de l'économie agricole et alimentaire
[36] Décret no 2011-1914 du 20 décembre 2011 relatif à la mention valorisante « issus d'une exploitation de haute valeur environnementale »
[37] Arrêté du 20 juin 2011 portant application de l'article D. 617-3 du code rural et de la pêche maritime et arrêtant le référentiel relatif à la certification environnementale des exploitations agricoles - niveau 2

Apply external organic inputs (reference: mineral fertiliser)
Farm yard manure

- determination of nutrients in soil before application of > 50 kg N/ha*y
- determination of nutrients in soil before application of > 30 kg P_2O_5 /ha*y
- determination of nutrient requirements, nutrient balances
- restriction of application time (arable land 1st November – 31st January, grassland 15th November – 31st January)
- no fertilisation of water saturated, frozen or snow covered soils
- technical requirements for application
- limitation of amount (170 kg total N/ha*y for grassland, 230 kg total N/ha*y for grassland under certain conditions
- determination of N and P in substrates
- 3 year average of excess N limited to 60 kg/ha*y
- 3 year average of excess P limited to 20 kg/ha*y

Slurries

- determination of nutrients in soil before application of > 50 kg N/ha*y
- determination of nutrients in soil before application of > 30 kg P_2O_5 /ha*y
- determination of nutrient requirements, nutrient balances
- restriction of application time (arable land 1st November – 31st January, grassland 15th November – 31st January)
- no fertilisation of water saturated, frozen or snow covered soils
- technical requirements for application
- limitation of amount (170 kg total N/ha*y for grassland, 230 kg total N/ha*y for grassland under certain conditions
- determination of N and P in substrates
- 3 year average of excess N limited to 60 kg/ha*y
- 3 year average of excess P limited to 20 kg/ha*y

Composts

- determination of nutrients in soil before application of > 50 kg N/ha*y
- determination of nutrients in soil before application of > 30 kg P_2O_5 /ha*y
- determination of nutrient requirements, nutrient balances
- restriction of application time (arable land 1st November – 31st January, grassland 15th November – 31st January)
- no fertilisation of water saturated, frozen or snow covered soils
- 3 year average of excess N limited to 60 kg/ha*y
- 3 year average of excess P limited to 20 kg/ha*y

6.2.4.2 Water Framework Directive (WFD)

In Germany the WFD is implemented into national law by the Wasserhaushaltsgesetz (WHG) and the according laws of the 16 federal states (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) 2004). In order to reach the objective of the WFD, nutrient inputs from agriculture into water bodies have to be reduced. Thus, specific extension services were established. Further, there are several agri-environmental measures that aim to contribute to the reduction of diffuse nutrient inputs (BMU 2013). The particular programmes are organized in catchment areas. However, more general country-wide descriptions of measures according to BMU 2013 (p. 21f) are listed below.

6.2.4.2.1 Crop rotation (reference: monoculture)

Crop rotation : Facilitation of organic farming

6.2.4.2.2 Reduced tillage (reference: plowing)

Minimum tillage (incl. shallow non-inversion tillage) Soil conserving tillage practices
WDF-x-No tillage (incl. direct seeding): Soil conserving tillage practices

6.2.4.2.3 Cover crops (reference: bare soil)

Cover crops to carry N over winter

- Increase of soil cover
- Facilitation of organic farming

Green manure to improve soil fertility/ organic matter

- Increase of soil cover
- Facilitation of organic farming

Cover crops to reduce soil erosion

- Increase of soil cover
- Facilitation of organic farming

6.2.4.2.4 Apply external organic inputs (reference: mineral fertiliser)

Farm yard manure: Facilitation of organic farming: mineral fertilizer not allowed
Slurries:

- Facilitation of organic farming: mineral fertilizer not allowed
- **Water friendly application e.g. by improved application techniques, assignment of protection areas, temporal limitations, increase of storage capacities**

Composts: Facilitation of organic farming: min fertilizer not allowed

6.2.4.3 Groundwater Directive (GWD)

The GWD is implemented into national law by the WHG (see section 6.2.4.2) and the Grundwasserverordnung (GrwV). Though, the latter only mentions soil as possible cause for harmful effects on groundwater quality (GrwV). If such changes were dangerous for human health, public water supply or the environment countermeasures would be necessary.

6.2.4.4 National Emissions Ceiling Directive (NECD)

In order to comply with the and the a common national programme was developed to reduce ozone concentration and to comply with the emission limits of the (Nationales Programm zur Verminderung der Ozonkonzentration und zur Einhaltung der Emissionshöchstmengen, Programm gemäß § 8 der 33. BImSchV; Nationales Programm zur Verminderung der Ozonkonzentration und zur Einhaltung der Emissionshöchstmengen, Programm gemäß § 8 der 33. BImSchV). Amongst others it describes a programme to reduce NH_3 emissions from agriculture. This includes some measures with impacts on soil management such as the (see section 6.2.4.1), organic farming and several agri-environmental measures concerning environmentally friendly application of slurry and organic farming.

6.2.5 Italy

6.2.5.1 Water Framework Directive (WFD), Directive 2000/60/EC

National implementation: D.Lgs. n. 152/2006 (Codice Ambiente), that includes the adoption of the Nitrate Directive and the Groundwater Framework Directive, as well as the definition of the need for river district and basin plans.

The overall intent: to describe the Strategic Environmental Evaluation (VAS), Environmental Impact Valuation (VIA) and Integrate Environmental Authorization (IPPC); main aims are to promote soil protection and to combat desertification, to protect and promote water, air and environmental resources. This directive confirmed the action of previous directives (e.g. Nitrate directive), and produced other subsidiary directives (e.g. Ground water directives). District plans correspond to basin plans, that are management tools deriving from WFD and regional directives (10R, ZVF,…) in each Region.

Soil mentioning: soil and subsoil protection and reclamation, hydrologic reclamation and desertification combat in water basin.

- Nutrient management:

Recent agronomic researches tend to promote the planning of fertilization, giving priority to the calculation of crop requirements (and nutrient balance), crop quality. More attention to phosphorous and heavy metals is requested.

6.2.5.2 Nitrate Directive (676/1991/UE)

National implementation: D.Lgs. 152/2006 is the actual reference for the Italian normative (it abrogates the previews D.Lgs. 152/1999). The Nitrate Directive has produced the Good Management Practices Code (DM 19/4/1999), adopted for the whole Italy and all Nitrate Directive regional regulations.

The overall intent: the main topic is water protection against agricultural nitrate losses.
D.Lgs. 152/2006 defines Nitrate Vulnerable Zones, farm manure management code, nitrogen fertilization plans. The district plan of Po river refers to this directive for everything that concerns nitrate pollution.

- Nutrient management:

At national level the reference is D.Lgs. 152/2006 and the related DM 7/4/2006 (Effluent decree). This is the decree that defines the difference between a) livestock manure, that can be applied for fertilization and amendment of soil, and b) the other wastes, which use is strongly limited in agriculture. Another important aspect is the definition of the Maximum Application Standard (MAS), which sets the maximum possible Nitrogen application for every crop in any condition.

- Buffers strips:

A limitation is set to the minimum distance to rivers for manure application.

6.2.5.3 Groundwater directive

National implementation: D.Lgs. 152/2006 and D.Lgs. 30/2009,.

The overall intent: specific measures to prevent and control pollution and deterioration of groundwater are included (D.Lgs. 30/2009). In D.Lgs. 152/2006 there are some legislations regarding soil protection, combat against desertification and protectin of good water status.

6.2.5.4 Sewage sludge application (86/278/CEE)

National implementation: Regional regulation 22/1979, D.Lgs. 99/1992, basin plan of Po River

The overall intent: water reclamation plan, soil and environment protection to avoid negative effects of sewage sludge applications in agriculture. Main objectives are the prevention of harmful effects of sewage sludge use on soil, vegetation, humans, at local and regional scale (supporting a correct utilization in the basin plan of Po River).

Soil mentioning: Regional regulation 22/1979 mention sewage sludge for agronomic application in some Regions (e.g. yes in Lombardia, no in Piemonte). This regulation does not describe any specific aspects concerning soil, but heavy metal analysis must be provided.

D.Lgs. 99/1992 regards only the sewage sludge application phase, while collection, transport and conditioning phases are subjected to specific regulation of special waste (D.Lgs. 152/2006). Sewage sludge can be utilized in agriculture only if some conditions are respected: sludge has to be stabilized, its fertilizing value is to be proved, soil conditioning and corrective effect are to be proved. It should not contain toxic substances harmful to the soil, crops, biota and to the environment. Sewage sludge cannot be used continuously on the same fields.

6.2.5.5 Emission Directive

National implementation: D.Lgs. 155/2010 adopts European directive 2008/50/EC (that includes all regulations related to air quality); other parts of the legislation are reported in the 5th part of D.Lgs. 152/2006.

The overall intent: pollutants monitoring (ammonia is the most important, followed by methane), modeling tools, A national emissions inventory procedure is also implemented. With this decree, the inventory of adopted abatement measures becomes mandatory.

Soil mentioning: the decree defines what measure are to be adopted to prevent or limit the emissions produced during agricultural activities, livestock husbandry, fertilizers and livestock effluent spreading.

- Rotation:

Rotation is mentioned only in the case of rice with respect to methane emission.

- Nutrient management:

The problem is related to organic and mineral nitrogen fertilization, both for ammonia emission. A particular attention regards urea, which is a serious problem from this point of view.

- Irrigation:

Fertigation is considered a way to reduce ammonia emissions from spreading fertilizer and slurry.

- Residues management:

Italian legislation focuses also on crop residues burning. In Italy, combustion effects for durum wheat and rice straw are not negligible. The legal definition of crop residues might put them in the category of wastes if they are burnt. The new decree is tightening penalties for farmers, which aroused some controversies. Each region has its own definitions that must not be contradictory to the waste directive. Burning of residues for phyto-sanitary purposes can be allowed.

6.2.5.6 Directive 2009/128/CE (Sustainable Use of Pesticides):

National implementation: D.Lgs. 150 of 14/08/2012; National Action Plan

The overall intent: measures for a sustainable use of pesticides to reduce risks and impacts of pesticides on human health, environment and biodiversity. Promoting sustainable agriculture through the application of integrated pest management and integrated farming techniques. National Action Plan provides the application of techniques for prevention, containment and fight of biological pests. It defines what protection products are presenting a minor risk to humans and environment. Current European rules and most recent local policies tend to decrease the quantity of pests distributed.

Soil mentioning:
In the Directive and in national legislations the general principles of integrated pest management often includes some agronomic practices that might prevent the pest's attack: crop rotation, conservative tillage, choice of selected cultivars, well balanced fertilization and irrigation.

In national legislation a distinction between mandatory and optional integrated pest is described.

6.2.6 Netherlands

6.2.6.1 Nitrates Directive

Animal manures

- Land application periods are restricted (depending on manure type and soil type).
- No period restriction for solid manures on arable land on clay and peat soils
- Amounts are restricted by N and P application standards.
- N application standards restrict the use of manures via the so-called 'equivalency factor'. This expresses the fertiliser value of manure relative to mineral fertiliser. For example, a crop with N application standard of 70 kg N/ha may receive 100 kg manure_N if the equivalency factor of the manure is 70%. (in this example, the allowed N quota is fully filled by manure, no room is left for additional fertiliser).
- Land application only by low-emission techniques (injection / immediate coverage)
- P application standards: 100% of all P in manure is accounted for
- Amounts are also restricted by the application standard for animal manures (170 kg N/ha). See also derogation.
- All standards have to be complied with simultaneously.

Sewage sludge

- application periods are restricted (depending on sludge type and soil type).
- No period restriction for solid sewage sludge on arable land on clay and peat soils
- N equivalency coefficient is 40%; phosphate is accounted for by 100%;
- Amounts are limited by N and P app standards;
- Amounts are not restricted by the application standard for animal manures (170 kg N/ha)
- Liquid sludge: max 1 t ds/ha/yr on grassland and 2 t ds/ha/yr on arable land.
- Solid sludge: max 2 t ds/ha/2yrs on grassland and 4 t ds/ha/2yrs on arable land.
- All cases: soil must be sampled prior to application, and must show below critical values of (8) heavy metal contents. Critical values are function of clay% and humus%.
- Sludge must be incorporated ('low-emission')

Compost and 'other organic manures' (OOM)

- all year but not on un-used land >7%, not on land with gullies >7%, not on water-saturated land, not on arable land>18%.
- No need to incorporate into soil
- Amounts are limited by P application standards; higher standards can be requested depending on P-status of soil (see under 'phosphate', below)
- Only 50% of P in compost is accounted for (full accounting beyond 3.5 g P2O5 per kg drymatter). [this 50% rule applies only to compost, not to OOM or manures]

Inorganic nitrogen fertilisers.

- application periods are restricted (depending on manure type and soil type).
- Excepted are field vegetables (all year round); and urea in fruit trees.

- Amounts are limited by N application standards. These depend on soil type (clay/peat/sand&loess) and crop.

Phosphate (Inorganic fertilisers and manures).
- Amounts are limited by P application standards. These depend on soil type (clay/peat/sand&loess) and crop.
- Higher standards for fields with low P status (to be documented, analysis by certified lab)
- Higher standards for P-fixing soils (to be documented, analysis by certified lab)
- No fertiliser-P for low soil-P repair on derogation farms (only manure-P)
- Excess application (max 20 kg P2O5/ha; arable) may be carried over to next year's accounting.

Derogation of the general limit to animal manures
- Farms can exceed the general limit (170 kg N/ha) under a series of conditions including
- At least 80% of the farm land is grassland (5th Action Programme; earlier limit was 70%)
- only manure from ruminants
- the upper limit is 230 kg N/ha (sand and loess soils in certain provinces)
- or 250 kg N/ha (elsewhere). (during 4th Action Programme, the limit was 250 kg N/ha for all soils)

Derogation of the obligation for low-emission application of animal manures
There is a series of requirements including:
- >85% grass area,
- only own-farm manure,
- low fertiliser use (<100 kg N/ha),
- low milk urea content,
- low milk production/ha,

Obligation to grow a catch crop after maize.
On sand and loess soils, a catch crop after maize must be sown, directly after the maize harvest. It must remain until at least 1 feb of next year.

Restriction on the killing (plowing up; spraying) of grassland
Grassland may be plowed up in restricted periods only. After grassland destruction, a nitrogen-demanding crop species must be sown (listed). Closed periods differ between soil types (clay/peat/sand&loess). Closed periods are longest for sand&loess, given nitrate problems in sand districts.

6.2.6.2 Water Framework Directive.

The Water Act (2010) was developed by the Ministry of Transport, Public works and Water management. The implementation of the WFD via River Basin Management Plans (Stroomgebiedbeheersplannen) is regulated under this act.

The purpose of the Act is to:
a. prevent and, where necessary, limit flooding, swamping and water shortage; while simultaneously
b. protect and improve the chemical and ecological status of water systems; and allowing water systems to fulfil societal functions; and
c. allow water systems to fulfil societal functions.

Text fragments taken from the Summary of the ('Management Plans for Catchment Areas') Stroomgebied beheersplan
Basic and supplementary measures
Every programme of measures contains basic measures and, where necessary, supplementary measures. Basic measures are all measures ensuing from European obligations and national generically applicable policy. Supplementary regional measures are all measures taken for specific water bodies with a view to achieving the wfd objectives.

Basic measures
The set of measures as a whole mainly comprises measures based on existing generic policy developed for the implementation of European directives other than the WFD. Some measures are still in the implementation stage. There are thirteen directives of direct relevance to water quality, including the Nitrates Directive, the Urban Waste Water Directive, the Plant Protection Products Directive, the Habitat Directive and the Drinking Water Directive. There are also measures that are based on national policy and adopted as generic measures. These are

sometimes concretised for specific areas, such as in relation to licensing by provinces and water boards, measures for improving water quality under the National Water Plan, and measures to prevent flooding and waterlogging for Water Management in the 21st Century. This has already resulted in a comprehensive set of hydromorphological recovery measures. Other examples of measures based on national policy concern regulation of the abstraction of surface water and groundwater, metering and pricing drinking water, levying groundwater tax and measures to promote sustainable and efficient water use and realise cost recovery of water services. Managing the abstraction of surface freshwater and groundwater and the artificial replenishment of groundwater bodies are also part of this.

Figure 8 Percentage of water bodies per river basin to reach biological parameter objectives in 2015

Figure 11: goals to be reached for WFD in the Netherlands. Depicted are the 2015 goals for Ems (left upper), Meuse (right upper), Rhine (left lower), and Scheldt (right, lower) catchments. Bars cover range from 0 to 100%. Green is the target. Bar numbers 5 and 6 (from top) in each graph refer to total P and total N concentration in water bodies, respectively.

Supplementary measures
Water quality will greatly improve once all basic measures have been implemented. However, for many water bodies the objectives for groundwater and surface water are still not expected to be achieved. This requires supplementary measures. These are mainly regional and site-specific measures such as the hydromorphological restoration, the construction of ecological corridors, and designing weirs, locks and pumping stations so that they allow fish to pass through. Moreover, substance discharges and emissions will be reduced by modifying wastewater treatment plants, decontaminating discharges in areas without sewer systems and tackling sewage overflows. The supplementary measures also include the restoration of existing water-rich areas and projects in the areas of research, development and demonstration.

Limited areas, largely on voluntary basis: setting up manure- and fertiliser- free zones along water courses; adjusted (ground) water levels. Partly Within frame of subsidy programmes. Voluntary acquisition, hence part of the action is postponed to next planning period (2016-2021).

See also Par. 7.5.3.

6.2.6.3 NEC Directive (2001/81/EG)

Implementation is under the responsability of the Ministry for Infrastructure and Environment, and is within the general frame of the Environment Act ('Wet Milieubeheer'). The EC proposal of 18 December 2013 takes the 2020 ceilings for ammonia and other NEC agents from the Gotenborg Protocol (GP). They have no legal status for the Netherlands, as this country did not yet ratify the proptocol. At the moment, only the emission target for ammonia have legal status. Nevertheless, the ceilings will achieve this status soon. The current (2010) NEC ceiling for the Netherlands is 128 kton/y, the new ceiling according to the GP for 2020 would be 123 kton/y, and this seems feasible. The reduction of NH3 emission from agriculture is a much debated dossier. Stringent measures have been and are being enforced to reduce emissions from stables and storage, and from land application of manures. All manures and slurries must be injected into the soil or immediately covered.
Besides requirements on covered manure storage capacity, air washing in stables, and closed periods for land application of manures, a key parameter linking NECD with regulations under the Nitrates Directive is the 'fertiliser-equivalency coefficient' assigned to different manure categories. By assigning higher values to this coefficient, a larger fraction of applied N in manures is accounted as 'equivalent nitrogen' and then occupies a larger fraction of the total allowed farm N quotum. This leaves less room for fertiliser-N. Under the 5th Action Programme, the equivalency coefficient of pig slurry has now been raised to 0.80 kg fertiliser-N per kg manure-N. This measure is supposed to be effective for achieving NEC targets as well as NiD targets. See also Paragraph 6.2.6.1 on the Nitrates Directive.

6.2.6.4 Organic farming

Between 2000 and 2010, the organic consumer market in the Netherlands doubled to roughly 750 M€ in 2010. This growth was supported by an active government policy. Since 2012, such active policy no longer exists. The current view is that the organic farming chain can be integrated into the various policy dossiers for agriculture in general.

6.2.6.5 Waste Directive (2008/98/EC) and Sewage Sludge Directive (86/278/CEE)

The Waste Directive (Kaderrichtlijn Afvalstoffen) is implemented by the Ministry for Infrastructure and Environment. It incorporates regulation on the use of sewage sludge on soils. Since 2008, the regulation of sewage sludge use in agriculture has been integrated into legislation on the use of manures and fertilisers (see NiD). Sludge application to soils is limited based on heavy metal levels in soil, and permitted application techniques have to comply with those for animal manures.

6.2.6.6 Phytosanitary regulations

Some fungi and plant-parasitic nematodes are classified as quarantine organisms (EPPO list of quarantine organisms) because of their devastating impact on crop production and lack of control measures. For the Potato Cyst Nematodes (PCN), a specific control directive has been installed many years ago and recently updated (Council directive 2007/33/EC). Losses associated with nematode damage are spread over the whole production chain, starting with farmers and breeders up to the processing industry. Governments implement expensive statutory regulations targeted at preventing the spread of these organisms. As a consequence, for example, the frequency of potato cultivation on a field parcel is limited to once in every three years, and in the case of infestations farmers have to take measures and are no longer free in choosing their crops and cultivars.

6.2.6.7 National Soil Quality Monitoring Network (Landelijk Meetnet Bodemkwaliteit, LMB)

NL is maintaining a limited network of 200 sites that are monitored for soil quality, with sites mostly on farmland but also on forest soils. Every year 40 sites are sampled, so in five years all sites are sampled. Observed parameters are chemical and biological indicators. Sampling and evaluation is connected with the groundwater quality monitoring network. So far, outcomes have no direct impact on agricultural practices.

6.2.7 Spain

6.2.7.1 National level

This PP consider the hydrological cycle as a unitary resource, subordinated to the general interest, which is part of the public domain of the state. Measures for preventing and correcting inland and coastal water caused by an excessive and inappropriate application of nitrogen fertilizers are described.

This package aims to reach qualitative objectives that seek to ensure the proper management of sewage sludge from urban waste water, from its origin to its final destination, protecting the environment and especially the soil. These qualitative objectives include the improvement of the information systems on sludge management and improve the control of the applications, guaranteeing a proper agricultural use of sewage sludge in soils. This law establishes a new legal regime that promotes transparency in production and waste management and ensures

traceability. In addition, it defines the information to be provided by wastewater treatment plants managers, treating plants of sewage sludge, operators who perform the application in soils with treated sludge, and the information that must accompany all transport sludge intended for agricultural activities. It is therefore necessary to establish a regulatory framework to combine the production of sewage sludge and agricultural uses in Spain with an effective protection of the physical and biotic factors affected by the agricultural production processes.

This PP contains as well the orders for executing trials and research and development experiments using phytosanitary products when they required to be emptied into the environment, a list of allowed active substances, their sanitary risks and the regulation for their commercialization. It presents the essential orders for recording the use of phytosanitary products and also for adapting, improving and simplifying the existing records, such as pesticide establishments and services and the official book movement of hazardous pesticides. These are support tools necessary to implement the policies and achieve sustainability of official control in the use of plant protection products.

Environment:

- Real Decreto 261/1996, de 16 de febrero, sobre protección de las aguas
  - *CAPÍTULO I Cuestiones de carácter general Artículo 2. Definiciones f)*
  - *ANEJO 1 Códigos de buenas prácticas agrarias B. 2)*
  - *ANEJO 2.Medidas a incorporar en los programas de actuación c) 1, 2*
  - *ANEJO 3. 2)*
- Real Decreto 1310/1990, de 29 de octubre, por el que se regula la utilización de los lodos de depuración en el sector agrario
  - *Artículo 1), 3) and 5)*
  - *ANEXO I A Valor límite de concentración de metales pesados en los suelos*
  - *ANEXO I B Valor límite de concentración de metales pesados en los lodos destinados a su utilización agraria*
  - *ANEXO I C Valores límites para las cantidades anuales de metales pesados que se podrán introducir en los suelos basándose en una media de diez años*
  - *ANEXO II B Análisis de los suelos*
  - *ANEXO II C Métodos de muestreo y de análisis*
- Orden AAA/1072/2013, de 7 de junio sobre utilización de lodos
  - *Artículo 4. Información sobre la aplicación de los lodos de depuración en el suelo con fines agrarios*
  - *Artículo 5. Obligaciones de información*
    - *CAPÍTULO XI Disposiciones específicas para el uso de los productos fitosanitarios en ámbitos distintos de la producción agraria Artículo 50. Condicionamientos específicos para los ámbitos no agrarios, 4 b)*
    - *CAPÍTULO XII Régimen sancionador Artículo 53. Infracciones y sanciones*
    - *ANEXO I Principios generales de la gestión integrada de plagas1 d)*
    - *ANEXO IV Materias de Formación Parte C. Fumigador: 1 a)*
    - *ANEXO IV Materias de Formación Parte D: Piloto Aplicador: 11)*
- Real Decreto 849/1986, de 11 de abril, por el que se aprueba el Régimen del Dominio Público Hidráulico
  - *CAPITULO II De los cauces, riberas y márgenes arts. 6 b), 9, 87.2*
  - *TITULO III De la protección del dominio público hidráulico y de la calidad de las aguas continentales CAPITULO PRIMERO. Normas generales, apeo y deslinde del dominio público y zonas de protección*
    - *Sección 1.ª Normas generales Artículo 232 b)*
    - *Sección 3.ª Zonas de protección Artículo 243 1)*
  - *CAPITULO II De los vertidos Sección 1.ª Autorizaciones de vertido Artículo 245 1)*

Public Health. Use of phytosanitary products:

- Real Decreto 1311/2012 uso sostenible de los Productos Fitosanitarios

6.2.7.2 Regional level (Andalucia)

Vulnerable areas to nitrate pollution from agricultural resources according to existing data are defined in this PP. Other measures such as, sampling programs and monitoring of water quality, are included in order to have enough data to modify vulnerable areas and to test the effectiveness of the action programs. The action plan have been revised rules and constraints in agricultural practices, establishing different levels of performance depending on the intensity of agricultural activity and the level of risk associated with it.

Environment:

- Decreto 261/1998, de 15 de diciembre de declaración de zonas vulnerables en su ámbito territorial
- Resolución de 18 de junio de 2007, de la Dirección General de la Producción Agrícola y Ganadera, sobre la llevanza por los agricultores de los datos relativos a la información sobre el uso de productos fito-sanitarios.
- Decreto 36/2008, de 5 de febrero por el que se designan las zonas vulnerables.
- Orden de 18 de Noviembre de 2008. Zonas vulnerables a nitratos.
  - *ANEXO I OBLIGACIONES Y RECOMENDACIONES RELACIONADAS CON LAS PRÁCTICAS AGRÍCOLAS EN LAS ZONAS DESIGNADAS COMO VULNERABLES A LA CONTAMINACIÓN POR NITRATOS PROCEDENTES DE FUENTES AGRARIAS*
    - *1. Obligaciones relacionadas con la época de aplicación al terreno de fertilizantes nitrogenados.*
    - *2. Obligaciones y recomendaciones relacionadas con la aplicación de fertilizantes nitrogenados al suelo.*
- Segunda corrección de la Orden de 18 de Noviembre de 2008. Zonas vulnerables a nitratos
  - *ANEXO I OBLIGACIONES Y RECOMENDACIONES RELACIONADAS CON LAS PRÁCTICAS AGRÍCOLAS EN LAS ZONAS DESIGNADAS COMO VULNERABLES A LA CONTAMINACIÓN POR NITRATOS PROCEDENTES DE FUENTES AGRARIAS 2. Obligaciones y recomendaciones relacionadas con la aplicación de fertilizantes nitrogenados al suelo. 2.1. Obligaciones y recomendaciones de carácter general para todas las zonas vulnerables.*
- Orden de 7 de julio de 2009. Modificación de las zonas vulnerables (Decreto 36/2008, de 5 de febrero).
- Orden de 22 de noviembre de 1993, por la que se desarrolla en el ámbito de la Comunidad Autónoma Andaluza el Real Decreto 1310/90 y Orden de 26 de octubre de 1993, del MAPA sobre utilización de Lodos de Depuración en el Sector Agrario.
- Ley 9/2010, de 30 de julio, de Aguas para Andalucía
  - *TÍTULO PRELIMINAR DISPOSICIONES GENERALES Artículo 1. Objeto y finalidad. Artículo 4. Definiciones*
  - *TÍTULO VI Dominio Público Hidráulico Artículo 43. Cartografía.*
  - *TÍTULO VII Prevención de efectos por fenómenos extremos CAPÍTULO I Instrumentos de prevención del riesgo de inundación.*
    - *Artículo 58. Evaluación preliminar del riesgo de inundación.*
    - *Artículo 60. Planes de gestión del riesgo de inundación.*
- *CAPÍTULO III Canon de regulación y tarifa de utilización del agua y canon de servicios generales Sección 2.ª Canon de servicios generales.*
  - *Disposición adicional cuarta. Comisión Interadministrativa del Estuario del Guadalquivir.*
  - *Disposición final segunda. Modificación del Anexo de la Ley 1/1994, de 11 de enero, de Ordenación del Territorio de Andalucía.*

6.3 Discussion

Austria apart, environmental policy packages are focussed on other stakes, like water or biodiversity and they don't embed soil stakes properly. First of all, the transposition of the EU legislation does not permit Member States to include directly national stakes, like acidification in Poland, or soil-related landscape degradation, water consumption or pesticide use in Italy. Second, the implementation of some EU Directives takes so much energy at national level that Member States are tempted to implement measures that are believed to have some side effect on soil rather than designing soil-specific measures. Overall, Figure 10 suggest that, even if in Austria and Germany soil stakes are of importance in the environmental policy packages, somes improvements could be found for the other countries.

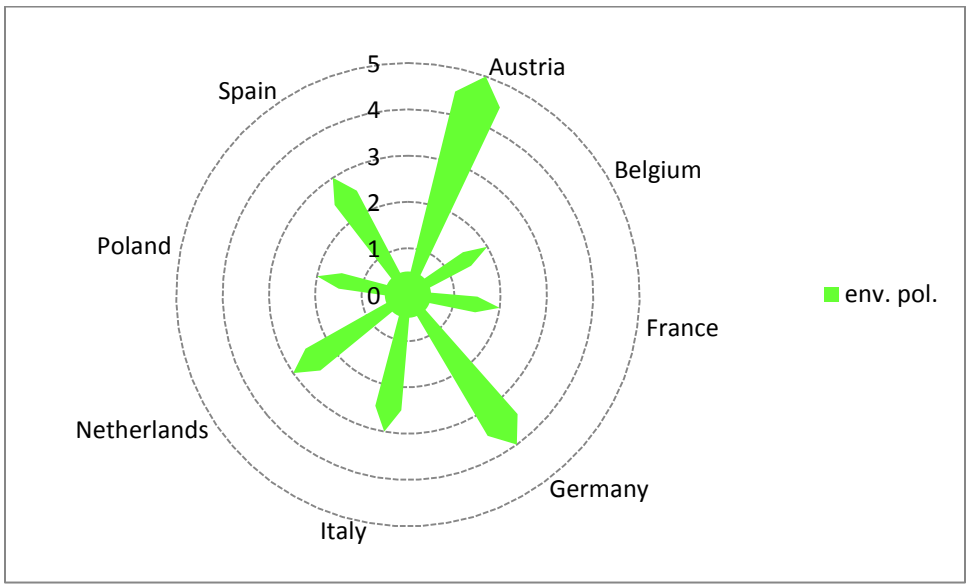


Figure 12: embeddedness of soil stakes into the design of environmental policy packages for Catch-C countries

7 National initiatives

7.1 Austria

It is maybe in Austria that soil is the most considered as a non-renewable resource due to the long periods of formation and development. It considered as part of a comprehensive system in a biological environment and has to meet many different soil functions. On the one hand it has to fulfill different ecological and biological tasks, on the other hand it is part of various technical-industrial assignments. The following soil functions are distinguished:

- Function for the agricultural production to supply humans and animals with food and feed products;
- Function as a filter and buffer (storage) as well as the procedure of degradation, transformation and growth during the process of mineralization of organic matter;
- Function as a natural habitat for various species (humans, animals, plants, ...);
- Function as a location for economic and public development (settlement, transport, ...);
- Function for the extraction of raw materials (construction industry, fertilizer industry, ...);
- Function as an archive of natural and cultural history (preservation, ...).

In 2006 the European Commission published a thematic strategy for soil protection and a proposal for a directive to establish a framework for the protection of the soil (EU Soil Framework Directive), which involved the preservation and restoration of soil quality. The diverse soil functions and characteristics have been illustrated and described for the first time and the main threats to soil were identified. The initiative for soil protection based on the desire to create a common European soil protection policy and one goal was to show the possible risk of high future costs for the society through the soil degradation. That approach by the European Commission was also used as a motivation for the member states to address the protection and sustainable use of soil in their own country.

The national law is a heterogeneous field in Austria and was established by contract in the competence of the provinces. That was explained by the Federal Constitutional Law (BGBl. Nr. 491/1984) under Article 15 of the Federal Constitution, which ascribed the law for soil protection to the provinces. The provinces Burgenland, Lower Austria, Upper Austria, Salzburg and Styria established five different laws for soil protection which set a framework for a sustainable use of soil. Other relevant rules for soil protection can be separated in “legal standards of the provinces for pollutants” and “legal standards of the provinces for soil consumption”. These rules include on the one hand schemes, such as the sewage sludge and compost waste regulations, the compost ordinance, the waste management act, the manure regulation, etc., on the other hand spatial and regional planning laws. Neither the federal government nor the provinces have an overall competence in the field of soil protection.

New national approaches for an overall federal soil protection act were initiated with the initiative of the EU soil framework directive by the European Commission. The different transnational European cooperation and initiatives, such as the definition of limits for heavy metals in soil or the conservation of natural resources in the EU conduce as an argument and competence for a national federal soil protection act.

Agricultural soils are affected in different ways by the management practices of farmers. These management practices range from conventional tillage with plough to the non-inversion tillage or no tillage (direct drilling), show differences between the mineral fertilization and the use of organic fertilizers or distinguish between monoculture and crop rotation with/without the use of cover/catch crops or green manure, etc. The management practices differ in type and variety on the farms and the effects can be described with a huge number of important soil indicators such as the increase of organic carbon contents and stocks with reduced tillage or with the use of organic fertilizers.

A comprehensive characterisation of the soil is only possible by the investigation of standardized soil indicators with soil analyses. It enables an objective description of the soil conditions and enables advisors to give farmers correct fertilizer recommendations for the next season. The soil analysis guarantees a sustainable nutrient supply and balance, which is an important factor in the maintenance of soil fertility and is mentioned as a so-called good professional agricultural practice.
Basically, farmers are ambitious to maintain or improve soil fertility with sustainable land management practices. The operational management aims to enhance the efficiency by a better workload of the mechanical equipment, cost-efficient measures and modern production techniques. In this matter conflicts in management usually lead to contradictions: renunciation of the use of cover/catch crops and green manure due to increased costs for the equipment can cause erosion or the use of heavy equipment to increase the effectiveness lead to compaction.

Finally, especially farmers are asked to maintain or increase the biological, chemical and physical properties to conserve the soil fertility and the economic efficiency of their farm in future.

7.1.1 Fertiliser Act and Fertiliser Regulation[38]

The Fertilisers Act and its Fertiliser Regulation guarantee an extensive protection from the risks of impairment of soil fertility. The competence of the "Regelung des geschäftlichen Verkehrs mit Saat- und Pflanzgut, Futter-, Dünge- und Pflanzenschutzmitteln sowie mit Pflanzenschutzgeräten - regulation of commercial transactions of seeds and plants, animal feed, fertilizers and plant protection products and plant protection equipment" in Article 10, Section Z 12 B-VG enables fertilizers to be part of the agricultural operational equipment and its marketing. Regulations about the use of fertilizer (i.e. amount (kg or t)/ha) are in the competence of the Austrian provinces. The regulation by the Fertiliser Act 1994 (DMG) and the Fertiliser Regulation 2004 (DMVO), based on the fertilizer legislation, include the marketing of fertilisers, soil improvers, growing media and plant additives. The Austrian provinces meet the requirements mostly in form of individual soil protection legislations. The controlling and surveillance of the fertilizer regulations is an official task in responsibility of the Federal Office for Food Safety.

7.1.2 Compost Ordinance[39]

The Compost Ordinance is based on §5 und 23 Abs 2 Abfallwirtschaftsgesetz 2002 (Waste Management Act 2002) and standardizes the quality requirements for compost produced by waste, the nature and origin of the raw materials, labeling and marketing as well as the end-of-waste characteristics (§1 Abs 1 KompostVO). Regulations about the use of compost (i.e. amount (kg or t)/ha) are in the competence of the Austrian provinces. The Ordinance specifies numerous technical requirements how composts have to be produced by wastes, further it defines the use of compost for the manufacturers own needs or the commercial marketing (§2 KompostVO).

7.1.3 Forestry Act[40]

The term "forest" is based according to §1a Abs 1 und 3 ForstG to the size of the area and includes forest stands and forest soils. The aim of the Forstgesetz 1975 (Forestry Act 1975) is the conservation of the forest soils and the productivity of the soil (§1 Abs 2 ForstG). In the context of the forest land use planning, the protective effect of forest soil conservation against soil erosion and -drift, scree and landslide formation will be facilitated (§ 6 Abs2 lit ForstG b). Reforestations have a very high effect on soil protection from the perspective of soil erosion (§ 13 ForstG). The Forestry Act at the federal level includes both qualitative and quantitative soil protection.

7.1.4 Waste Management Act[41]

The Waste Management Act 2002 (AWG 2002) contributes to a regulated waste recycling for soil conservation. It aims to avoid harmful and detrimental effects on human health and environment caused by waste.

7.1.5 Act on the Remediation of Contaminated Sites[42]

The Act on the Remediation of Contaminated Sites (AlSAG) effects localized soil protection by the regulation of financing and remediation of contaminated sites. (§2 Abs 1 AlSAG).

7.1.6 Water Rights Act[43]

The Water Act contains mainly indirect soil protection by targeting various fertilization restrictions for the filter and puffer function of the soil. It effects the Action Program nitrate and its requirements regarding the nitrogen fertilization as well as the greening to reduce the nitrogen leaching into the ground water. The Water Rights Act (WRG) provides specific management and restrictive arrangements for localized areas to improve groundwater quality and water protection areas (protection and conservation areas).

[38] Düngemittelgesetz und Düngemittelverordnung
[39] Kompostverordnung
[40] Forstgesetz
[41] Abfallwirtschaftsgesetz
[42] Altlastensanierungsgesetz
[43] Wasserrechtsgesetz

7.2 Belgium (Flanders)

7.2.1 Regional Environmental policy plan (MINA)

Every 5 years an environmental policy plan (MINA) is being developed in Flanders. We are currently in the 4th period (MINA4) covering 2011 until 2015. There are 7 priority themes identified in MINA4, including environmentally sound production and consumption, climate (mitigation and adaptation), air quality (see also 2.5 NEC), water (see 2.4 water framework directive), soil and biodiversity. The focus for soil is on soil contamination and remediation, decrease of **soil organic matter**, **soil erosion** and soil degradation in urban areas. The environmental policy plan contains two soil protection indicators for short term objectives. They are both related to soil erosion. Soil organic carbon and erosion risks are the soil protection related indicators defined for long term challenges.

7.2.2 Regional soil protection policy

In Flanders there is a specific Soil decree, being the Decree of October 27 2006 concerning soil remediation and soil protection. The part on soil protection is very limited and only specifies that measures can be taken and subsidies and support can be provided for soil protection. Implementing decrees are VLAREBO (14/12/2007) which focuses on soil contamination and the soil erosion implementing decree (8/5/2009). Soil remediation is the responsibility of the OVAM (Public Waste Agency of Flanders), while soil protection is the responsibility of the land and soil protection service (ALBON) of the Ministry of Environment, Nature and Energy (LNE).

The land and soil protection service (ALBON) focuses on protecting soils against degradation by erosion, land slides, organic matter loss, compaction and loss of basic soil functions. Regarding soil protection there are only limited international obligations but ALBON tries to link up with the European thematic strategy on soil protection, including the draft European soil framework directive and Rio+20. Rio+20 is the United Nations Conference on Sustainable Development that has 'land degradation neutral world' as one of its objectives. The initiatives taken by ALBON concerning major soil degradation issues are listed below.

Soil erosion by water

Regarding soil erosion by water, there is a stepwise policy.

1. Obligated measures to be taken on field parcels with a (very) high erosion risk, defined under GAEC (see 2.1CAP-Pillar I). These measures mainly target on-site soil erosion, e.g., by non-inversion tillage and minimum soil coverage.
2. AES (see 2.2 CAP-Pillar II). AES mainly support measures taken at the field parcel borders in order to avoid off-site effects. The newly proposed AES include grass buffer strips, strategically located grasslands and straw dam constructions.
3. Constructions to prevent off-site effects that can be subsidised by the Agricultural Investment Fund of Flanders (VLIF-CAP Pillar I) and are to be executed by farmers, such as dams made of plant materials. These constructions are suitable for small catchments (up to 5 ha).
4. The erosion decree subsidises soil erosion action plans at the municipality level, erosion-coordinators who facilitate the implementation of the action plans and small scale constructions combating off-site effects of water erosion (i.e. constructions that catch run-off water and sediments).

Furthermore, the soil erosion policy is focusing on awareness raising and extension, e.g., through the erosion coordinators, farm advisors, brochures, practical guide on soil erosion, study afternoons and machine demonstrations organised e.g. by farmers' unions, the Flemish Rural Network, Interreg projects and the agricultural administration. ALBON is providing expertise for several of these initiatives.

Soil organic carbon

The policy for soil organic carbon is mainly based on awareness raising. ALBON made brochures and ordered a C-simulating tool that is available for farmers so that they can simulate the effects of soil management practices on long term evolutions of carbon in their soils. Soil organic carbon is also a long term indicator for the environmental policy plan of Flanders (MINA) (see 2.7).

Soil compaction

Currently, the policy on soil compaction is focused on awareness raising. Some projects were financed by ALBON to map susceptibility risks for soil compaction and to develop a practical guide for farmers for soil compaction prevention and remediation.
ALBON wishes to include large volume tires and automatic tire inflation systems in the scheme of the Agricultural Investment Fund for Flanders (VLIF-CAP Pillar I).

Soil biodiversity
The policy on soil biodiversity is focused on awareness raising only, e.g., through Interreg projects, brochures and the ALBON calendar. It is assumed that more soil organic carbon is beneficial for soil life, so that soil biodiversity also benefits from the stimulating policies for soil organic carbon. Policy makers do not have any information on the status of soil biodiversity and the evolution.

Soil erosion by wind
ALBON has ordered a study to map the erosion risk by wind in Flanders. This was in preparation of the negotiated European Soil Framework Directive (that was finally not approved).

Land slides
Land slides are mapped and sensitization activities being conducted.

Soil sealing
Preventing soil sealing is an important objective for the Land and Soil protection service in accordance to international objectives for zero net land take, the negotiated but never approved EU Soil Framework Directive and the Land Directive which is currently under negotiation. The aim is to conserve ecosystem services provided by soils such as prevention of waterlogging. Soil sealing is, however, not a priority for politicians yet.

Summary
Specific soil protection policies mainly try to reach their goals through awareness raising and sensitization. Regulation is focused on soil erosion through the erosion decree and cross-compliance (GAEC). GAEC contains some obligatory measures and the soil erosion implementing decree reaches its targets by providing subsidies. Farmers can also get subsidies for combating soil erosion through AES. Erosion and soil organic carbon are indicators included in the environmental policy plan of Flanders (MINA).

7.2.3 Flemish climate policy action programme (2013-2020)

The Flemish climate action programme consists of a mitigation programme and an adaptation programme. Consequences for soil management practices are listed below.

The Flemish climate mitigation action programme lists measures to reduce N_2O emissions from agricultural soils. This can be achieved by 1) fertilisation in function of crop needs, soil analysis and analysis of animal manure and digestates, 2) reducing the use of mineral fertilizers by grass-clover, the use of deep rooting catch crops in the rotation, slow releasing fertilizers, fertilizer fractionation, slurry injection and row fertilization. Best available techniques and soil improvers (farmyard manure and compost) will be stimulated via extension, advise and potentially financial incentives.

The climate mitigation action programme furthermore recognises that climate change can be mitigated by increased carbon sequestration in soils but no specific stimulating measures are yet specified. Perhaps that might become the case in future action programmes when there is a European system to include carbon sequestration in carbon accounting.

The Flemish adaptation action programme suggests that reduced soil tillage (with conservation of crop residues at the surface) and growing cover crops help to adapt to larger periods of drought, waterlogging and erosion. Crop diversification and a wider crop rotation (including cover crops) are regarded to be good practices to spread risks of climate change.
In the programme of measures this is translated into the following actions related to soil management:

- Further developing a policy on soil organic matter;
- Sensitization regarding the importance of healthy soils, focusing on reduced soil tillage (potentially with subsidy support);
- Research on the impact of climate change on the nitrogen cycle and soil organic carbon;
- Research on growing other cultivars or species in agriculture or adapting sowing and harvest dates.

Summary
Although the role of soils and soil management practices for climate change mitigation and adaptation is recognized in the Flemish climate action programme, clear policies and actions regarding soils and soil

management practices are not developed. The policy focuses on sensitization and research, hoping to stimulate practices such as reduced tillage, crop diversification and the use of compost and farmyard manure.

7.2.4 Flemish action plan on alternative protein sources

The action plan on alternative protein sources is an engagement between of the Flemish government and the Belgian compound feed industry association (BEMEFA) and is signed February 2010. One of the goals is to reduce the dependency on non-EU protein sources. In 2013, a research project on soy growing was started funded by the agency for innovation by science and technology (IWT) and soy breeding research was started at the institute for agricultural and fisheries research (ILVO). If soy growing succeeds in Flanders, this might have a large impact on crop diversification and wider crop rotations.

Table 15: Impact of the implementation of the Flemish action plan on alternative protein sources on sustainable soil management practices considered in the Catch-C project

Management practice	Main aim	Remarks
Rotation		
MP3 Rotation with legume crops	Reduce dependency on non-EU protein sources	Specific actions include a research project on soy growing and research on soy breeding by the Flemish Institute for agricultural and Fisheries Research (ILVO)

7.3 France

In france, there is a bundle of schemes and programs (acronyms are in French) at national and regional levels: the Regional Plans for Sustainable Agriculture (PRAD), the Regional Schemes for Climate, Air and Energy (SRCAE), the Regional Schemes of Ecological Coherence (SRCE), the Regional Programs of Agricultural and Rural Development (PRDAR), the Blueprint for Water Management (SDAGE) and the Water management plans (SAGE). Since 2012, the French Ministry of Agriculture has launched a very large plan on agroecology, with the ambitious objectives of fostering France as the leader of agroecology worldwide. The plan is underpinned by ten principles, better long-life formation, favour collective initiatives and new governance dynamics, reduce pesticides use, favour biocontrol of plant pests, decrease antibiotic use, foster sustainable development of beekeeping, improve the use of farm manures, encourage organic farming, select better adapted seeds and favour tree-crops associations. So far, the general plan is implemented through 7 plans:

- Écophyto, that aims at reducing pesticides use,
- Écoantibio, that aims at mitigating antibiotics use,
- EMAA: energy, methanisation, autonomy, nitrogen, that aims at fostering the farms autonomy in energy and mitigate nitrogen loads in waters,
- A sustainable development plan for beekeepers,
- A national program to foster organic farming,
- A plan to improve seeds selection,
- A plan to favour on-farm production of plant proteins.

Despite soil is often quoted in the different plans and program, soil stakes are never the core of any of them. The concepts are slowly evolving, and very recently the potential of carbon storage in soil has been mentioned, but with absolutely no reference to any science based information, or any clear clue towards concrete implementation.

7.4 Germany : Bundesbodenschutzgesetz (BBodSchG)

The objective of the Federal Soil Protection Act (BBodSchG) is the protection of soil from harmful alterations and the prevention of negative effects (disturbance of soil functions). For the sustainable conservation of soil fertility and soil performance § 17 defines the principles of *good agricultural practice (gfp).* The basic principles are:

- weather and location adapted tillage
- conservation or improvement of soil structure
- prevention of soil compaction
- prevention of erosion by land use that is adapted to location especially to slope, water and wind conditions and land cover
- conservation of structures in the agricultural landscape that are necessary for soil protection, especially hedges, hedgerows, baulks and field terraces

- conservation or facilitation of soil biological activity via crop rotation
- conservation of typical humus content, especially through sufficient input of organic matter or through reduction of tillage intensity

7.4.1 Crop rotation (reference: monoculture)

Crop rotation

- prevention of erosion by land use adapted to location, especially to slope, water and wind conditions and land cover
- conservation or facilitation of soil biological activity via crop rotation

7.4.2 Reduced tillage (reference: plowing)

Minimum tillage (incl. shallow non-inversion tillage)

- weather and location adapted tillage
- prevention of erosion by land use adapted to location especially to slope, water and wind conditions and land cover
- conservation of typical humus content, especially through sufficient input of organic matter or through reduction of tillage intensity
- conservation or improvement of soil structure
- prevention of soil compaction

No tillage (incl. direct seeding)

- weather and location adapted tillage
- prevention of erosion by land use adapted to location especially to slope, water and wind conditions and land cover
- conservation of typical humus content, especially through sufficient input of organic matter or through reduction of tillage intensity
- conservation or improvement of soil structure
- prevention of soil compaction

7.4.3 Cover crops (reference: bare soil)

Green manure to improve soil fertility/ organic matter

- conservation or facilitation of soil biological activity via crop rotation

Cover crops to reduce soil erosion

- prevention of erosion by land use adapted to location especially to slope, water and wind conditions and land cover

7.4.4 Apply external organic inputs (reference: mineral fertiliser)

Farm yard manure

- conservation of typical humus content, especially through sufficient input of organic matter or through reduction of tillage intensity

Slurries

- conservation of typical humus content, especially through sufficient input of organic matter or through reduction of tillage intensity

Composts

- conservation of typical humus content, especially through sufficient input of organic matter or through reduction of tillage intensity

7.5 Netherlands

7.5.1 Act for the Protection of Soil ("Wet bodembescherming")

- Introduced 1986 in response to severe cases of industrial soil pollution.
- The relevance of soil protection is to prevent, limit or undo changes (in the state of soil) that imply a reduction of or threat to functional properties of soil for man, plant or animal.
- Regulates also remediation
- The Act defines a Technical Committee on Soils; this is a council to the minister on technical issues re soil protection.
- About rules on applying materials to soil that can pollute of affect soils (quality, structure) including fertilisers

- Regulates also deep tillage; and drainage works,
- Includes actions that may cause compaction, erosion, salinisation
- Includes addition of soil or dredging slurry onto soils
- Fertilisers are allowed only based on waiver of general regulations, after consultation of TC
- Regulations within the frame of this act that relate to soil productivity are proposed by the ministery of Economic Affairs (previously 'Agriculture, Nature and Food quality')
- Regarding activities regulated under the 'Act on crop protection and biocides', the Act for the Protection of Soil is partly overruled by that Act (on crop protection…)
- See Nitrates Directive for application of sewage sludge

7.5.2 European Innovation Partnership

This will be implemented in NL via the POP3 program for rural development. This will provide support – from January 2015 onward - to start up operational groups. Whether 'soil' will rank among the topics addressed by operation groups will depend on the current consultation process (bottom up). Currently, existent is only one 'pilot operational group' on coping with nitrate regulation in dairy farming. Further, NL supports the 'multi-actor approach' calls in H2020.

7.5.3 Resource Efficient Europe Roadmap

No new policies are initiated in the Netherlands in response to the Roadmap. Rather, the roadmap seems to confirm the existing 'Covenant for clean and efficient agro-sectors' agreed 2008 between the NL agro-sectors and the government (short name 'Agro-covenant'). It focuses on energy and climate change mitigation. The data below are taken from the Agro-covenant itself (2008), and from the progress report on the covenant (up to late 2013).

Goals:

- reduction of at least 3.5 Mton CO2-emission / yr relative to 1990; (ambition up to 4.5 Mton);
- Reduction of other GHG by 4.0 to 6.0 Mt by agro sector
- generating 200 PJ renewable energy from biomass in 2020
- Doubling wind energy from the agrosector (6 PJ now to 12 PJ in 2020)

The agreement is on voluntary basis, and relates to energy saving, renewable energy sources, and reduction of greenhouse gas emissions. Innovations can be risky and have long pay-back horizon. Government, therefore, intervenes by supporting R&D (subsidies; brokerage), and via the subsidy program for renewable energy investments (SDE+). The agro sector is involved in / takes up 70% of the national budget available in SDE+ (apart from windparks at sea), and produces 60% of the agreed production of renewable energy.

The covenant contributes to the European goals of 20% CO2-reduction and 14% renewable energy in 2020. It lists a number of measures that can be taken to achieve these targets. These include many measures of no direct relevance to soil management (solar panels, wind turbines, greenhouse heating, heat-power coupling, …). However, a number of measures is relevant to soil management. These include:

- anaerobic digestion of manures, mostly for 'green electricity';
- production/recycling of biomass for energy
- precision agriculture (application of N fertilisers and biocides)
- reduction of methane from ruminants through adapted feeding
- adjusting tire pressure of tractors
- (following comment taken from progress report:) 'Moreover, arable farmers can take important measures such as non-inversion tillage and measures to increase organic matter content of soils. There is, however, no monitoring of these practices.' (the covenant nor progress report documents how the covenant supports these practices.

Most of the targets were achieved or approximated in 2012, except renewable energy from biomass and renewable energy from greenhouses, both of which were not met by a very large margin. See tables below (in Dutch).

The target was 400 digestors in 2020, for 1500 m3 gas. By late 2013, 99 digestors were realised, they produced 5,5 PJ in biogas. In 2011, about 1.4% of all manures was digested. Current digestors are running below capacity. Valuable biomass prices are rising due to increased demand. This caused frequent changes in the nature of input substrates in (co-) digestion. This has led to cases of malfunctioning of reactors.

7.6 Poland

The major national regulation related to soil and agricultural protection is the law on agricultural and forest land protection (Ustawa z dnia 3 lutego 1995 r. o ochronie gruntów rolnych i leśnych). Protection against conversion of agricultural soils into non-agricultural purposes is represented in this act by the following instrument: Transformation of agricultural land of high quality (classes I-III) into other uses requires decision of Ministry of Agriculture and Rural Environment if the area of interest exceeds 0.5 hectare. Conversion of organic soils (peat soils) into non-agricultural use requires administrative approval (of lower level) regardless class of soil (these are mainly permanent grasslands).

The same legal act specifies the fees for exclusion of land from agricultural production. The fee level is dependent on soil quality – the higher quality the higher fee is collected. This measure refers to best classes I-III of mineral soils and all classes of organic soils). The collected fees are directed to budgets of regional governments (voivodeships) and shall be spent e.g. for soil remediation and reclamation, soil protection against erosion, protection of small retention, sometimes subsidies to soil liming. It is worth to note that since 2008 the fees for change of land use within administrative borders has been abolished.

According to the same Act there is obligation to reuse the topsoil of the consumed agricultural land for improvement of land quality in the vicinity. This instrument refers to good quality mineral soils (classes I – IV of VI) and peat soils. If such obligation is not executed, the owner converting the land is charged for improper use of the organic soil layer. The value of the fee depends on a class of soil.

Another article (Art. 15) the same regulation (The law on agricultural and forest land protection) emphasizes soil protection needs against degradation. Any land owner is obliged to protect soil against degradation, especially soil erosion and landslides are meant here. Local administration might force the land owner to implement measures against soil erosion – afforestation, conversion to permanent grassland. The cost of implementation of measures is reimbursed from regional government budget.

7.7 Discussion

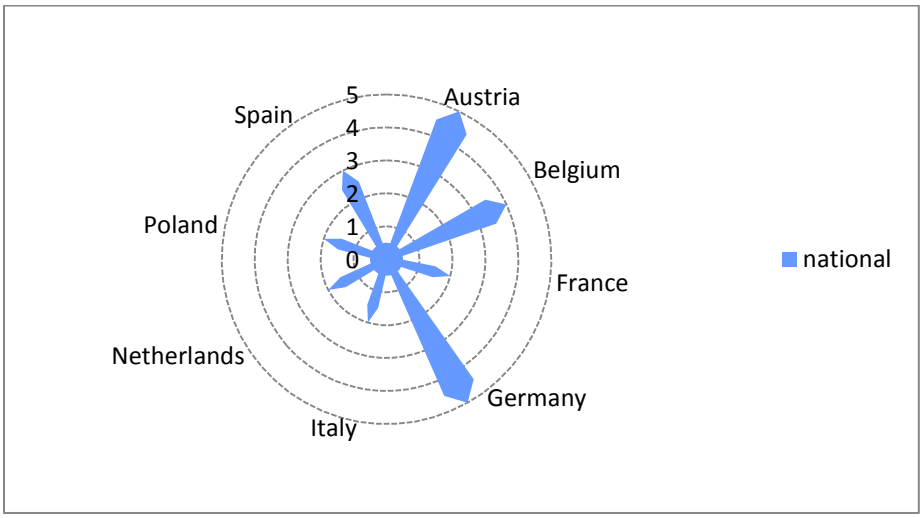


Figure 13: embeddedness of soil stakes into the design of environmental policy packages for Catch-C countries

Germany, Austria and Belgium have strong national (sometimes regional) legislation about soil protection. The other Member States pay less attention to soil stakes in the implementation of national legislation regarding agricultural soil use (Figure 13): sometimes they duly quote soils stakes, but seldom embed them in the policy packages up to *ex-ante* impact assessment of the proposed policy measures.

8 Discussion and conclusion

8.1 Conclusions for Austria

Table 14 gives a short description of the national policy packages. Table 17 shows the national policy packages in relation with soil, classified according to Theesfeld *et al* (2010). Overall, Austria has designed a comprehensive set of instruments to deal with soil protection in which soil stakes are fully embedded at all stages (Table 29).

Table 16: Description of the policy packages classified in Table 17

Policy package	BMP (Best management practice)	Description (contents of the policy packages)
Water Rights Act (Wasserrechtsgesetz)	MP26-MP35	- Temporal spreading restrictions on N-containing fertilizer, manure, liquid manure, sewage sludge, compost and manure; - 100kg N / ha are only applied in parts on slopes with 10% tendency to the surface waters. For crops with an late development in spring further regulations are important (sowing of horizontal stripes, cultivation diagonally to the slope); - Spreading restrictions of N-containing fertilizer on water-saturated, flooded, frozen or snow-covered soils; - Fertilizer restrictions near waters; - Capacity and construction of storage vessels for livestock manure; - Process of N-fertilizer application or an appropriate fertilization; - Limitation of the application of N-containing fertilizers.
Fertilizer Act and Fertilizer Regulation (Düngemittelgesetz und Düngemittelverordnung)	MP26-MP36	- Federal regulations on the commercial transactions with fertilizers: It affects the operating material (fertilizer) and its placing on the fertilizer market; - Provinces are responsible for the appropriate fertilization regulations.
Compost Ordinance (Kompostverordnung)	MP29-MP32	- Comprises the quality requirements for compost produced by waste, nature and origin of the raw materials, labelling and placing on the market as well as the end of waste character; - Provinces are responsible for the appropriate fertilization with composts (same as for the fertilizer act).
Forestry Act (Forstgesetz)		Concludes the conservation of the forest soil and ensures a forest management to obtain the production capacity of the soil.
Waste Management Act (Abfallwirtschaftsgesetz)		Regulates waste recycling for soil conservation.
Act on the Remediation of Contaminated Sites (Altlastensanierungsgesetz)		Management of the financing and implementation of environmental remediation for soil conservation.
INVEKOS-implementation-regulation (INVEKOS-Umsetzungs-Verordnung)		For the preservation of agricultural land in good environmental condition within the scope of cross compliance qualitative and quantitative targets are standardized in the community law in the field of soil erosion, soil organic matter, soil structure and a minimum level of maintenance of fields. The qualitative and quantitative targets are implemented and concretized in national federal law. These minimum requirements are for all the farmers that obtain direct payments and certain payments from the program of rural development. It includes about 90% of all agricultural land in Austria. They are subject of the common control and penalties system.
Contractual commitments (Vertragliche Verpflichtungen (ÖPUL))		The Austrian ÖPUL program 1 Environment and biodiversity management 2 Restriction of the use of yield-increased operating resources 3 Renunciation of the use of fungicides and growth regulators in cereals 4 Cultivation of rare arable crops 5 Conservation of endangered livestock breeds 6 Cover crops: Catch crops 7 Cover crops: Permanent green cover 8 Mulch seeding and direct drilling (incl. strip till) 9 Ground-based slurry application 10 Erosion protection of permanent crops (fruit/wine/hops) 11 Renunciation of the use of agricultural pesticides (wine/hops) 12 Renunciation of the use of silage 13 Mowing of steep slopes 14 Mowing of gradient meadows 15 Alpine grazing and herder management 16 Preventive protection of the groundwater 17 Cultivation of endangered leaching arable areas 18 Preventive protection of surface water on arable land 19 Nature conservation 20 Organic farming

The policy packages "good agro-environmental conditions (GAECs)" and the "statutory mandatory requirements (SMRs)" have the most impact onto the different BMPs. They are based on incentives for the farmers or mandatory guidelines by authorities. These policy packages could include favor as well as restricts or limits for the adoption of best management practices.

Table 17: Mandatory table: Classification of Austrian policies dealing with soil according to the typology of Theesfeld et al (2010). For further details regarding acronym and description of the policy packages seeTable 16.

Austria 2007-2013			BMP (Best management practice)							
	Policy packages		Rotation	Tillage	Catch/Cover crops	Nutrient management	Crop residues management	Water management	Extensive grassland	Permanent grassland
CAP	GAECs					X X		X		
	SMRs		Y							
Nitrate Directive	SMRs	Action plans in VZ				X		X		
		others								
	recommendations									
WFD	SMRs					X		X		

Legend:
X: Restricts use of organic/mineral N-fertilizers

Type of policy	Favors the BMP adoption
Mandatory (M)	
Incentives to farmers (IF)	
Incentives to market(IM)	
Voluntary (V)	

Y: RIS - Landesgesetzblatt - LGBl. Nr. 32/2012 Stück 12: Regulation on the western corn rootworm, the rotation for the cultivation of maize in Styria (only)

	Acronym	Policy package
1	GAECs	Good Agro-Environmental Conditions
2	SMRs	Statutory Mandatory Requirements
3	CAP	Cross-compliance
4	AESs	Agro-Environmental Schemes
5	Nitrate Directive	Nitrate Directive
6	WFD	Water Framework Directive (for all aspects not included in the Nitrate directive)

8.2 Conclusions for Flanders

The main environmental aims in Flanders are those with clear European policy targets. Water quality, biodiversity, air quality and climate change are therefore higher on the political agenda than soil quality. However, regarding soils, there are two major policies, i.e. on soil erosion by water and soil contamination. Soil erosion is mainly regulated through GAEC and financial support to farmers is provided through agro-environmental schemes. Through the erosion decree, financial support is also provided for e.g. the development of local erosion action plans and small off-site constructions. The soil decree has a strong focus on soil contamination.
CAP-Pillar I with a.o. GAEC, CAP-Pillar II with a.o. agro-environmental schemes (AES) and the Nitrates Directive have the largest impact on management practices through regulatory measures (obligations) and financial support. Other policy packages aim more at sensitization or try to reach their targets through these earlier mentioned policy packages.
Table 18 provides a summary of the relationship between the described policy packages, the management practices considered in the Catch-C project and soil degradation and other environmental stakes. In the first line the main

aims of each policy package are described. It can be seen that water quality, water erosion and soil organic carbon (SOC) are embedded in several policy packages (Table 30). Except for areas prone to high erosion risk, regulated through GAEC, there are not so many restrictions or obligations on crop choice or rotation. Cover crops, grassland and legumes are mainly stimulated by AES, specific agricultural support and the Nitrates Directive, with the aim of a better water quality, more SOC, higher biodiversity or less erosion. Policy tries to have an impact on tillage practices, i.e. non-inversion or no-tillage, for water erosion reduction on-site, both through obligations (GAEC) and financial support. The Nitrates Directive, aiming at a better water quality, strongly impacts nutrient management. The manure legislation has provided some possibilities to increase soil organic carbon content although it remains also barrier. GAEC requires farmers to take measures to increase soil organic carbon content if too low, with the use of farmyard manures, compost or incorporation of straw as some of the options.

Table 18 : Relationship between policy packages, management practices (MPs) considered in the Catch-C project and environmental stakes.

	Water erosion	**Wind erosion**	**Soil compac-tion**	**SOC decline**	**(Soil)bio-diversity**	**Soil contaminati on**	**Water quality**	**Air quality**	**Climate change**	**Other**
Main aims of policy packages	GAEC RDPII/III MINA RSP	RSP	RSP	GAEC RDPIII MINA RSP CP	RDPII/III RSP	WFD	RDPII/III ND WFD	NEC	RDPIII CP	Not consider ed
Rotation										
MP3 Legumes	AESII			AESIII				AESIII	AESIII	AESII APS
MP4 Tuber/ root crops										GAEC AR
MP6 Grassland	GAEC from '15 AESIII			GAEC til'16	GAEC til'16 greening AESII					
MP7 Inter-cropping	GAEC from '15									
MP8-9 Cover/ catch crops	GAEC SAS til'14 AESIII			GAEC SAS til'14 AESIII	GAEC from '15		SAS til'14 AESII-III RDPII ND			
Diversification					greening from '15					
Other	GAEC AESIII			AESIII	AESII RDPII		AESIII	AESIII	AESIII	
Tillage										
MP16 No/zero tillage	GAEC VLIF AESII							ND		
MP17 Non inversion	GAEC AESII									
MP22 Contour ploughing	GAEC									
Other	GAEC from '15									
Nutrient management										
Fertilizers general							ND			
Animal manures							ND			
Organic fertilizers				ND			RDPII ND	ND		ND
MP29 Plant compost				GAEC ND		WFD	ND	ND		VLIF
MP32 Farmyard manure				GAEC ND			ND	ND		ND
MP33 Cattle slurry										ND
MP36 Return of crop residues				GAEC						
MP37 Burning of crop residues				GAEC						
Other						SMR ND	RDPII AESII-III			RDPII
Crop protection – mechanical weeding					AESII-III		AESII-III			VLIF

CAP: common agricultural policy; **SMR** (CAP-Pillar I): standard mandatory requirements; **GAEC** (CAP-PillarI): good agricultural and environmental conditions; **AR** (CAP-Pillar I): additional requirements; **SAS** (CAP-Pillar I): specific agricultural support; **RDP**: rural development programme; **AESII-AESIII** (CAP-PillarII): agro-environmental schemes under RDP II or III, respectively – measures for RDPIII are preliminary; **VLIF** (CAP-Pillar II): investments in agricultural businesses; **ND:** nitrates directive; **WTFD:** water framework directive; **WFD**: waste framework directive; **CP**: climate policy action programme; **MINA**: regional environmental policy plan; **RSP**: regional soil protection policy; **APS**: Flemish action plan on alternative protein sources.

8.3 Conclusions for France

Table 19 is a summary of all the policy measures described in the previous section, according to Theesfeld *et al.* (2010) policy matrix. The EU soil and biodiversity strategies, the water framework directive, the EIA directive mandates national and regional policy makers to shape plans and design schemes to deal with EU targets. Greening of the CAP and GAEC are mandatory measures addressed to farmers, and their regional design changes market rules and competitiveness of farms depending on their region. So does Nitrate Directive, with more pressure put on vulnerable zones. The negative effects of NiD on farm revenue can be compensated.

Table 19: Theesfeld's policy tablefor France

		Area of intervention		
		bureaucracy	market	Self organised networks
Type of intervention	Regulatory	Water framework directive EU Soil Strategy EU Biodiversity strategy Environmental Impact Assessment directive	GAEC1, 4, 5, 6 Greening NiD	
	Economic		AES AEC Compensation for NiD and WFD constraints Lease agreements	Leader Support of research and training projects
	Advisory/voluntary		Awareness raising through the soil thematic strategy	

Overall, GAEC and greening measures favour catch-crops. The greening measure about crop diversity won't apply to the whole arable area because of exemptions, and, as it is assessed at the farm and not the field level, it is expected to widely enhance soil quality.
Agrienvironmental schemes, agrienvironmental and climate measures, subsidies to physical and non-physical investments, provide incentives to farmers to adopt soil conservation practices. Because of more stringent stakes in many regions, public funds directly devoted to soils represent so far a very small share of the envelopes. As a complement, most regions have designed local research schemes and training projects, to raise awareness on the benefits of soil conservation.

Despite apparently complementary measures, because there is no specific scheme dealing with soil protection in the regions, policy makers have stressed the existence of important institutional aspects that may hamper the diffusion of sustainable soil management practices. Most of these aspects are also described as important in Theesfeld's typology:

- Contradictory policy instruments and rules (joint production) : this is very clear when regions rely on side-effects of other policies to improve soil quality ("this can't be bad for soils"). Contradiction of instruments could be diminished by writing down soil strategy schemes, which do not exist at the moment.
- Redundant policy instruments rules: this aspect is less important than ranking of stakes; because water quality is so important, most measures are targeted to mitigating water pollution, and only small shares of envelopes can be devoted to other objectives, like soils.
- No experiences with measures: several policy makers have highlighted that because they have no idea of the long term impact of some management practices, they don't wish to promote them. More effort on soil research and networking of field experiences could improve the knowledge base of policy makers.
- Insufficient information on policy: France re-organises the responsibility of measures designs from governmental agencies to regions, and learning takes some time.
- Target group not (fully) eligible: because soil quality hasn't been a stake for a long time, policy makers do not rely on erosion risk maps to design target areas for example. As a consequence, measures can reach other farmers than the initially targeted group. Another important aspect is that most farmer associations in France stress that most farmers should have the possibility to receive incentives in the current schemes. Targeted and zoned measures are not popular.

Even if the current policy packages do not appear to strongly encourage farmers to adopt sustainable soil management techniques in France, they already do adopt some of them, on their own initiative (Figure 14).

Reasons for adoption are very diverse (Turpin, *et al.*, 2014), and they are not directly connected to areas suffering from the higher soil threats (Perret, *et al.,* 2014).

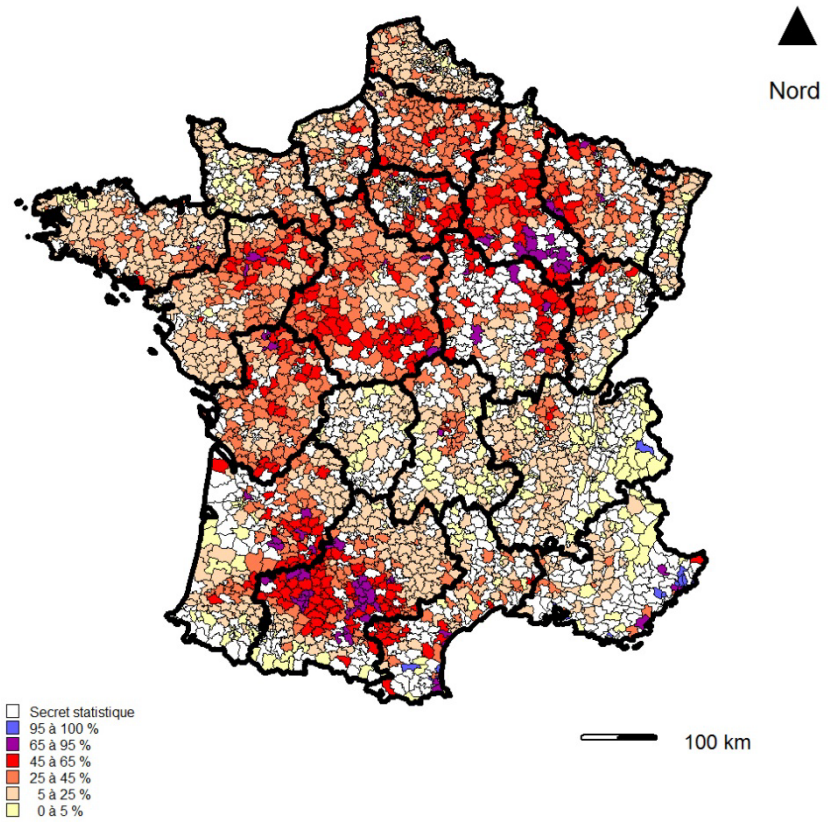


Figure 14: share of non-inversion tillage and no-till on total ploughed areas at LAU1 level in France in 2010

To better understand the interactions between policy packages, we have designed a new table, that we called "mandatory table". It represents the main CATCH-C BMP groups in columns, and describes in each cell if the BMP is promoted in a mandatory way, or sustained by incentives, or even proposed to adoption on a voluntary way, and by which policy package (Table 20). From 2007-2013 to 2014-2020, the packages have evolved from just encouraging catch-crops and organic fertilisers management to much complex packages that have the potential to foster soil sustainable management, if the regions have the willingness to implement them. However, because there is no soil quality related scheme at the moment and regions have more urgent stakes to deal with, it is expected that little effort will be put to soil sustainable management.

Last, the stake table (see Table 31) highlights the relationships that exist between soil ecosystem services provisions, soil sustainable management practices, and the policy packages that encourage their adoption or limit their use. This table has been designed for international comparisons, and it confirms the previous analysis: France focusses on water quality issues, which are dealt with using a mixture of mandatory measures and incentives that encourage sustainable fertiliser management and catch-crops (mostly in vulnerable zones). Erosion is of importance too and the related policy packages encourage crop diversity and catch-crop with a mixt of mandatory measures (GAECs, greening and NiD). The other stakes are handled by training, and various combinations of incentives, but only represents a small share of the total efforts.

Table 20: policy packages and BMPs in France, 2007-2013

France 2007-2013			BMPs							
	Policy packages		rotation	tillage	Catch-crops	Nutrient management	Plant residues management	Water management	Extensive grassland	Permanent grassland
CAP-PI	GAECs	Code rural, D615-45 toD615-61	Crop diversity					Monitoring water withdrawal		
NiD	SMRs	Vulnerable zones Code env. R211-80 R211-81 Regional specifications				X				
		Structural excess zones Code env. R211-82 Regional specificaitons				X				
		Protection of drinking water abstraction Code env. R211-83 Regional specifications				X				
	Recommendations	Outside vulnerable zones								
WFD	SMRs	Code env. R211-80 to R211-85				X				
CAP-PII	RDP	Code rural, D341-7 to D341-20 for the payment schemes NUT3 texts for specifications	AES214-B	AES214-I3		AES214-C		AES214-I2	AES214-A AES214-C	AES214-A
National		Code de bonnes pratiques agricoles								

Notes:
X : Restricts use of organic fertilisers
AES214-A and B are national measures, the others are defined at NUTS2 level
AES214-A: Agrienvironmental subsidy to grassland (prime herbagère agro-environnementale) – objective of soil protection against erosion
AES214-B : rotation (diversity of crops)
AES214-C: polycrop polybreed system with low inputs
AES214-I: territorialized agri-environmental schemes, I1 WFD, I2 Natura2000 and biodiversity, I3 other aspects

8.4 Conclusions for Germany

Table 22 shows national policy packages with relation to soil, classified according to Theesfeld et al. 2010. Since the policy packages inferred here are not related to specific BMPs, additional instruments are considered that are not included in previous sections. Thus Table 21: gives a short description of these instruments.

Table 21: Description of the policy packages classified in Table 22.

Policy Package	Short Description	Type of Intervention
Bundes-Bodenschutzgesetz (BBodSchG)	Federal Soil Protection Act: Law for the protection against harmful changes in soil and for the remediation of contaminated soils to maintain soil functions	Precepts Precautionary duty Fine for infringement
Düngeverordnung (DüV)	Fertilising Regulation: Regulation for the use of fertilisers, soil additives, growing mediums and plant additives according to the principles of good agricultural practice (gfp) to reduce nutrient discharges in ecosystems. Investigation of fertiliser demand.	Precepts Prohibitions Fine for infringement
Düngegesetz (DüngG)	Fertiliser Act: Law for the sale of fertilizers and placing on the market; Description of fertiliser types	Precepts Prohibitions Fine for infringement
Düngemittelverordnung (DüMV)	Regulation for fertilizer approval and labeling; placing on the market of fertilisers, soil additives, growing mediums and plant additives	Precepts Prohibitions
Cross Compliance and direct payments	Baseline for maintaining the land in a good agricultural and ecological condition (minimum requirements) Regulations concerning soil erosion, organic matter, soil structure	Direct premium payments or their reduction
Nitrate Directive (NiD)	Directive for the protection of waters against contamination with nitrate from agricultural sources. Water protection in Europe.	Rules for good agricultural practice Control measures Action plan
Plant Protection Act	Law for the protection of cultivated plants, protection against dangers from the use of pesticides; placing pesticides on the market, their proper handling and application	Precepts and prohibitions Action plan Fine or imprisonment for infringement
Pflanzenschutzmittelverordnung (PflSchMV)	Plant Protection Regulation: Regulation for the implementation of the plant protection act; registration of pesticides and requirement for application equipment	Requirements
Bundes-Immissionsschutzgesetz (BImSchG)	Federal Pollution Control Act : Law for the protection against harmful environmental impacts through air pollution, noises, concussions.	Legal limitations, permits, compensations, expropriation, fees, duty of disclosure
Baugesetzbuch (BauGB)	Building Code: Law that defines the most important urban planning instruments; regulates land use and development	Precepts Prohibitions
Klärschlammverordnung (AbfKlärV)	Sewage Sludge Regulation: Regulations for the protection of soil when using sludge in agriculture, limits for toxins	Limits for pollutants and applied quantity
Bundesnaturschutzgesetz (BNatSchG)	Federal Nature Conservation Act: Law about nature protection and landscape conservation, nature reserves and compatible agricultural methods	Precepts Prohibitions

*Table 22: Classification of German policies dealing with soil according to the typology of **Theesfeld et al. 2010**. For descriptions of the policy packages see Table 21.*

		Area of intervention		
		Hierarchy/Bureaucracy	Market	Self-organized Network
Type of intervention	Regulatory	Düngeverordnung (DüV) Pflanzenschutzgesetz (PflSchG) Pflanzenschutzmittelverordnung (PflSchSachkV; PflSchMV) Klärschlammverordnung (AbfKlärV)	Düngegesetz (DüngG) Düngemittelverordnung (DüMV) Bundesimmissionsschutzgesetz (BImSchG)	
	Economic		CAP (CC, DirektZahlVerpflV)	Leader
	Advisory/voluntary	Bundesbodenschutzgesetz (BBodSchG) (Plant Protection Act, Action plan) Baugesetzbuch (BauGB) Bundesnaturschutzgesetz (BNatSchG)		Farm advisory service (CAP)

Table 22 shows the inferred policy packages and the environmental stakes they aim to address in relation to BMPs according to Kutter *et al.* (2011) and Spiegel *et al.* (2014). Overall, the embededness of soil stakes into policy packages is high in Germany for rural development, environmental and national policy packages, with a good connexion between these packages, and a bit lower for the agricultural policy package (Table 32). This statement is also valid at the regional levels (see Table 33 and Table 34).

8.5 Conclusion for Italy

The main environmental aims of agricultural policy in Italy is to support, with compensatory norms, the adoption of BMPs. Environment has to reach sustainable management standards. The macro-objectives do not change much during the periods, but in the 2014-2020 more attention is given to environmental protection and climate change mitigation. In fact, all the measures aim to soil good management and protection, with a tendency to confirm previous measures. However, regarding soils, there is a great attention to soil erosion, nitrate leaching, pesticides leaching and runoff.

The following table reports the main CATCH-C BMP groups in columns, and describes in each cell if the BMP is promoted in a mandatory way, or sustained by incentives (to farmers or to market), or even proposed for adoption on a voluntary way. Finally, it shows which policy package is most relevant. Table 23 gives a summary and a short description on national policy measures, referred to 2007-2013.

Table 23: Relationships between BMPs and policy packages in Italy

Policy packages 2007-2013			MP 2 – 3 – 4 – 5 – 6 Rotation	MP 8 – 9 Green manure / cover crop	MP11 Grassland (extensive / permanent)	MP 16 – 17 – 18 – 21 Tillage	MP 26 – 27 – 28 – 50 Mineral fertilization / plan	MP 29 – 30 – 31 – 32 – 33 – 34 – 35 Manure and organic fertilisation	MP 36 – 37 – 38 Plant residues	MP 53 – 54 Water management	MP 44 Buffer strips
CAP-PI	GAECs		IF	IF	IF	IF			IF	IF	IF
	SMRs							IF			
CAP-PII	RDP	AESs	IF	IF	IF	**IF**	**IF**	IF	**IF**	IF	IF
NiD	SMRs	Action plan in VZ					M	M			
		others									
	Recommendation										
WFD	SMRs						M	M			

Legend Table 23 *M = mandatory, IF = incentives to farmers, IM = incentives to market and V = voluntary. The distinction about the size of "**IF**" vs. "IF" shows that the first one is when regulation is adopted in large number of Regions, the second in few. All these type of policy restricts or limits the BMP adoption*

The policy packages referred to 2014-2020 are not defined, but they are very similar to previous period. The new measure called 'Greening' regards the rotation and grassland BMPs, and these type of policy package are described by 'Incentives to farmers'.
Soil degradation problems and other environmental stakes are described in the next table (Table 24). In this table all BMPs included in the Catch-C project are combined with main environmental stakes. Policy packages that take into account these aims are in the cells. More or less all measures include a direct or indirect effect on sustainable management of soil.
The object of reducing SOC decline, erosion of enhancing water quality and biodiversity are embedded in several policy packages (Table 35). Nutrient, plant residues and water management are mainly stimulated by AES, specific agricultural support and the Nitrates Directive. For cover crops there are regulations for all the stakes, through obligations (GAEC) and AESs.

8.6 Conclusions for The Netherlands

In the Netherlands, the Act for the Protection of Soil was the first national initiative towards dealing with soil stakes and threats in Europe. However, even with its installation of a Technical Committee for Soils, this Act is implemented into only a limited number of mandatory requirements relevant to farming. Similarly, in The Netherlands, most of the environmental stakes considered are EU driven, and agricultural soils seem to receive only low priority, after water quality, biodiversity, and climate change. Apart from restrictions and obligations for farmers in the southern Loess district, there is no clear policy towards sustainable soil management; rather, soil management is addressed mostly indirectly via policy measures designed for other stakes, such as water quality.

In the Netherlands, the Act for the Protection of Soil was the first national initiative towards dealing with soil stakes and threats in Europe. However, even with the design of a Technical Committee of Soils, this Act is implemented into a limited number of mandatory requirements. Similarly, in The Netherlands, most of the considered environmental stakes are EU driven, and soils are dealt with, after water quality, biodiversity, climate change. There is no clear policy towards soil sustainable management; rather, soil management is concerned by policy measures designed for other stakes. Table 25 depicts all the measures that target soil stakes. Mandatory measures are precisely designed, but incentives rely on side effect of practices on soil. Similarly, Table 36 highlights a strong emphasis on water stakes, and less on the other possible soil stakes.

Table 24: Relationship between policy packages, management practices (MPs) considered in the Catch-C project and environmental stakes.

	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality decline	Air quality decline	Biodiversity decline	Water consumption	Pesticide use	Landscape degradation
Rotation BMPs (reference is monoculture)											
MP2 Rotation with cereals		AESs		GAEC; AESs	GAEC; AESs		AESs	GAEC; AESs	AESs	AESs	AESs
MP3 Rotation with legume crops				GAEC	GAEC			GAEC			
MP4 Rotation with tuber or root crops											
MP5 Rotation with fallow land											
MP6 Rotation with grassland		AESs		GAEC; AESs			AESs	AESs; GAEC	AESs		AESs
MP7 intercropping				GAEC							
Permanent grassland	SMRs; GAEC	AESs	SMRs; GAEC	SMRs; GAEC; AESs	SMRs; GAEC; AESs		AESs	SMRs; GAEC; AESs	AESs	AESs	SMRs; GAEC; AESs
Reduced tillage (reference is plowing)											
MP16 No / Zero tillage	GAEC	AESs	GAEC	GAEC; AESs	AESs		AESs	AESs	AESs	AESs	GAEC
MP17 Non inversion tillage/reduced tillage											
MP18 Non inversion tillage/minimum tillage		AESs									
MP19 non inversion tillage											
MP20 deep ploughing				GAEC							
MP 22 Contour ploughing/seeding											
Catch-crops, cover crops, green manures (reference is bare soil)											
MP8 rotation with cover/catch crops	GAEC	GAEC; AESs	GAEC	GAEC; AESs	GAEC; AESs	GAEC	AESs	GAEC; AESs	AESs	AESs	GAEC; AESs
MP9 rotation with green manures											
Nutrient management											
MP26 Mineral N application						SMRs; NiD; AESs					
MP27 Mineral P application											
MP28 Mineral K application											
MP29 Plant compost application		AESs		AESs	AESs	SMRs; NiD; AESs			AESs	AESs	
MP30 Bio-waste compost application											
MP31 Sludge compost application											
MP32 Farm yard manure (FYM) application				AESs	AESs		AESs		AESs	AESs	AESs
MP33 Cattle slurry application							AESs	AESs			
MP34 Poultry manure application		AESs									AESs
MP35 Pig slurry application											
MP50 Fertilization plan				AESs			AESs	AESs	AESs		
Plant residue management											
MP36 Return of crop residues		AESs		AESs	AESs		AESs	AESs	AESs		
MP37 Burning of crop residues											
MP38 Harvesting of crop residues											
Water management											
MP53 Drip irrigation				AESs	AESs		AESs	AESs	AESs	AESs	
MP54 Sprinkler irrigation											
MP55 Subsurface drainage											

Table 25: combination of policy measures affecting soil management in the Netherlands (note that most of these measures are not designed primarily for soil protection)

Netherlands 2014-2020			BMPs							
	Policy packages		rotation	tillage	Catch-crops	Nutrient management	Plant residues management	Water management	Extensive grassland	Permanent grassland
CAP-PI	GAECs	GLB Inkomenssteun[5] Specific rules in loess district[6]	Cover-crop on set-aside[a] Management to avoid shrubs[b] No fruit trees on slopes[c]	Loess district[d]			Ban burining crop residues[5]	Ban on irrigation without a permit[5]		Management[b] In loess district only[6] grassland on slopes >18%
	Greening		Crop diversification						If >75% temporary grass, then no obligation to diversify	-Ban on plowing in Natura2000 areas ; -national area monitoring ; possible ban plowing
	Ecological focus areas		choose from list Legumes, CC, and willow coppice or sustainab.certificate, options : - arable biodiverse strips With legumes or CC ; Or Collective EFA action		choose from list Legumes, CC, and willow coppice or sustainab.certificate, options : - arable biodiverse strips With legumes or CC ; Or Collective EFA action	No nutrient inputs on arable biodiverse strips in EFA				
NiD/NEC	SMRs	Action plans in VZ	Derogation for more slurry in dairy requires grassland on > 80% of farm area	Ban on grass plowing after May 1st	Obligations on sand and loess soils[e]	Fertilisers and manures management rules[f] Obligation for low air emissions application of slurries				
WFD	SMRs					Buffer strips without manures/fertilisers along selected water courses		Regional measures for hydromorphic restoration ; adjusted groundwater levels		
CAP-PII	RDP					Ban on use of any phosphate-containing products[2]				
National		Soil act		Deep plowing regulated		Sludge application regulated		Drainage works regulated		

a- Obligatio to use cover crop on set-aside land
b- Obligation at least once/2years must land be grazed or mowed- to avoid shrubs
c- only in loess district: on Slopes >2% no fruit trees are allowed except with set of precautions
d- GAECs[5] only for arable in the Loess District[6] of Limburg province:
After harvest remove tracks by tilling at least 15cm
Remove tracks after sowing maize, onion, or sugar beet
Obligation to till to max 12 cm depth or to apply 'mulch system' (is plow in autumn, set cover crop, and non-inversion til in spring)
The above obligations are waived if all following conditions are met:
Farm uses only non-inversion tillage
Cover crop after harvest except >15 September
In ridge-grown crops (as potato) use sills to stop water flow
Storage capacity for runoff >100 m3/ha
Obligation are also waived for winter cereal crops sown<January 1st
e- Obligation[1] use catch crops after maize on sand and loess soils (phacelia, legumes, 'crucifers-no-colsa', tagetes, solanum sisym.) and ban to destroy these <1 February.
f- The following apply to fertilisers and manures management, and sludge products:
-No application[1]
On frozen/water-saturated/ snow covered soils
Outside given periods
On slope >7% with gullies
On slope >7% without crop cover
On slope >18% in any arable crop
On bufferstrips along watercourses[3]
-Only low-emission land application methods[1] are allowed for manures to avoid ammonia loss
-Ban on all fertilisers and manures unless within so-called Application Standards for N and P (tables with numerical values per crop)[2,4]
-86/278/CEE sewage sludge application:
Quality criteria for sludge[1]
Obligation to maintain same land use after sludge application, for specified period1
-new in 2014:
higher manure N equivalency to further reduce manure doses;
lower N and P application standards on sensitive soils
higher N application standards for grassland on clay soils
higher N application standards for high yields in cereals
autumn manure allowed in winterrape
cattle slurry allowed in excess of application standards, to curb wind erosion (in restricted areas with fine sand)

legislation:

1. Besluit gebruik meststoffen (BGM)
2. Meststoffenwet
3. Activiteitenbesluit milieubeheer
4. Note: the Application Standards for N and P are differentiated to crop, soil texture, and soil-P status (Application Standards for P)
5. GLB Inkomenssteun 2006
6. Verordening PA Erosiebestrijding Zuid Limbur 2008; and Verordening PT Bestrijding Erosie Zuid-Limburg 2009; (these GAECs marked [6] apply to a very small part of NL territory, in southernmost tip of Limburg province where topography is rolling and soil texture is silt of aeolian origin).

8.7 Conclusions for Poland

8.7.1 Threats to consider

The major threats to soil that should be addressed by policies in Poland are soil erosion, low organic matter, soil sealing and acidification. Sealing seems to be out of CATCh-C project scope since it refers to areas under direct urbanization pressure.

Share of soils with extremely low SOM content (<1%) is 6% whereas share of other SOM content group is the following: 50%, 33% and 11% for 1-2%, 2-3.5% and >3.5% contents, respectively. Totally SOM content in 89% of soils is below the level of 3.5% (approx. 2% C) treated in Europe as low content. Several percent of agricultural land is located on organic soils (mainly peatlands). Their protection is also a major issue since they play many environmental functions – water retention, biodiversity, carbon storage.

According to water erosion modeling results 96.7% of land in Poland is characterized by low erosion. The highest share of soils under high erosion risk is present in Malopolskie and Podkarpackie regions (7.4 and 5.1% of area, respectively) in the southern Poland.

Soil acidification has not been listed by EU commission among major threats, however soil acidity is a major factor affecting crop production in Poland. Over 50% of agricultural soils is classified as acidic (pH in KCl <5.5). Spatial distribution of acidic soils is driven by soil texture (light soils with low buffering system) and abundance of soils developed from acidic igneous rocks in southern parts of the country (Figure 15).

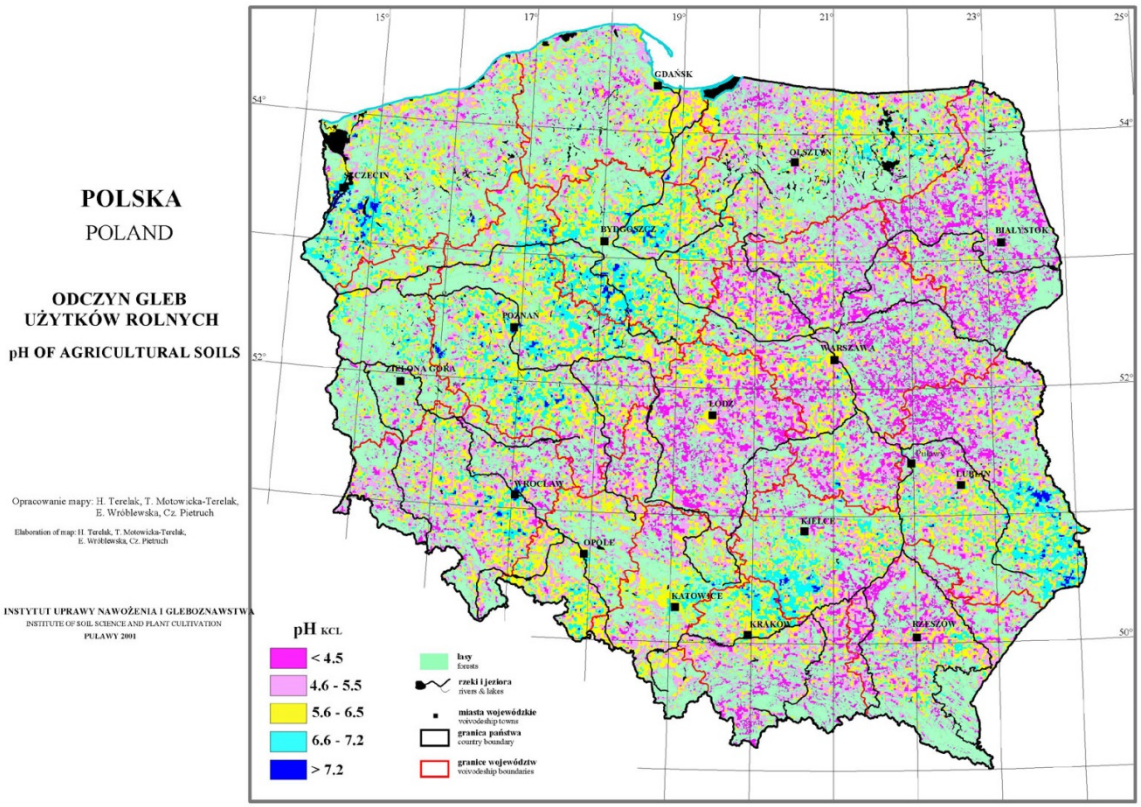


Figure 15: Soil pH map of Poland

Literature: Stuczynski et al., 2007. Przyrodnicze uwarunkowania produkcji rolniczej w Polsce (Natural conditions of agricultural production in Poland). Studia i Raporty IUNG-PIB, 7: 77-116 (in Polish).

8.7.2 Analysis

Table 26: area and types of intervention of policy packages intervening on soils in Poland

	Area of intervention (structures on which the policy option impacts)					
		Hierarchy/Bureaucracy	**Hierarchy/Bureaucracy +Market**	**Market**	**Market+ Self organised networks**	**Self organised networks**
Type of intervention	**Regulatory**	CAP - SMR 3: Sewage sludge application rules GAEC1 Soil protection against erosion GAEC2 Maintenance of soil organic matter GAEC3 Maintenance of soil structure GAEC5 Water protection and management GAEC6 Protection of permanent grasslands New CAP – GAECs 4-6 New CAP - Diversification of crops New CAP - Protection of permanent grasslands				
	Regulatory+ Economic	CAP- specific payments to legumes	The law on agricultural and forest land protection New CAP – EFA AES-Extensive permanent grasslands AES-Protection of soils and water New RDP-Agro-environmental and climatic action	AES-Sustainable agriculture		
	Economic		Current LFA New LFA		AES-Ecological farming New RDP-Ecological farming	
	Economic+Advisory Voluntary					
	Advisory Voluntary					

As in many countries, Poland mixes mandatory instruments with incentives to promote sets of management practices linked with sustainable soil management (Table 37). However, soil stakes still show a relatively low embededness into these policy packages.

8.8 Conclusion for Spain

In line with Mediterranean soil stakes, a strong focus is put in Spain on losses of organic matter (in relation with productivity) and soil erosion threats. In Spain, environmental issues are dealt in an interrelated manner, water quality issues (eutrophication, pollution, water availability and silting) come immediately after erosion, and then the focus is on biodiversity, droughts and desertification, then wildfires.

There are different regional situations. For example, soil erosion is one of the main issues concerning to the Andalusian government. In this region more than 70% of the cultivated area is located on slopes greater than 8%, with much of the area devoted to olive trees.

Table 27: ***Theesfeld policy matrix for soil and water quality at the national and regional scales.*** *Color codes: red (cross compliance at national scale), pink (other normative regarding soil/water at the national scale), green (new CAP: greening), blue (cross compliance at the regional scale), orange (other normative regarding soil/water at the regional scale),and black (AES at the regional scale).*

	Area of intervention (structures on which the policy option impacts)					
		Hierarchy/Bureaucracy	Hierarchy/Bureaucracy+Market	Market	Market+ Self organised networks	Self organised networks
Type of intervention	**Regulatory**	GWD: Real Decreto 849/1986 SS: Real Decreto 1310/1990 W: Real Decreto 1/2001 Real Decreto 926/1989 Real Decreto 927/1988 Real Decreto 849/1986 GAEC1 CONTROL EROSION GAEC2 SOIL ORGANIC MATTER GAEC3 COMPACTION AND SOIL STRUCTURE GAEC/BCAM 3 GROUND WATER QUALITY GAEC/BCAM4 MINIMUM GROUND COVER GAEC/BCAM 5 CONTROL EROSION GAEC/BCAM 6 SOIL ORGANIC MATTER SS: Orden de 22 de noviembre de 1993	GAEC4 MAINTENANCE OF HABITATS GAEC/BCAM 4 BUFFER STRIPS GAECs: Orden de 21 de mayo de 2009 Decreto 470/1994		GW+W: Ley 9/2010	GAEC5 WATER MANAGEMENT GAEC/BCAM 2 IRRIGATION WATER
	Regulatory+ Economic		NID: Real Decreto 261/1996		G1 CROP DIVERSIFICATION G2 MAINTENANCE OF PERMANENT PASTURE G3 ECOLOGICAL FOCUS AREAS NI: Orden de 18 de noviembre de 2008	Plan Hidrológico de la CHG (2009-2015)
	Economic					
	Economic+Advisory Voluntary				AES 214-03 AES 214-04 AES 214-05 AES 214-06 AES 214-07 AES 214-13 AES 214-16	AES 214-12 AES 214-14
	Advisory Voluntary				AES 125	AES 214-08 AES 214-10

Soil stakes are very clearly embedded into CAP and rural policy packages, which ground on a combination of very precise mandatory measures (see also Table 38). Measures are designed by consultation between the national level (Ministry of Agriculture), the autonomous communities and local stakeholders. Policy makers mention sometimes difficulties in enforcing these measures and there is a strong lack for extension services: the Constituency Office has done significant work through IFAPA. Universities and professional organizations also do consulting, but do not get subsidy for it. The former PAC promotes the extension, but only reaches 2% of farmers. Associations of farmers have submitted proposals to the Government for subsiding technical advice. They have had no response. Management technicians do not advise they only inspect if CAP requirements are fulfilled.

The implementation of BMPs that control erosion are also encouraged by agro-environmental measures that are more ambitious that the mandatory measures. AEM also deal with the conservation of cultural high value agricultural landscapes (like Dehesa), keep up terraces and prevent soil losses, improve SOC and soil structure. Still, commitment should increase if there were extension services to help spread out knowledge.

Water stakes are of particular magnitude in Spain. They are linked to the willingness of mitigating water pollution and improve water use in stringent environmental conditions. These stakes are of prime importance for environmental policy packages, with only little references to soil stakes at this level.

For the future development, policy makers put much emphasis on improving the knowledge base of farmers about the importance of sustainable soil management.

8.9 Overall discussion

In this report, we refer to 'soil stakes' as public and/or private stakes concerned with the conservation of agricultural soils, notably of their integrity and quality for use in agriculture as well as for supplying other ecosystem services. Defined this way, we can distinguish stakes related to the preservation of soil itself ("soil stakes *sensu stricto*") versus a broader set of soil stakes. Soil erosion, compaction, and the declines of SOC content and of soil biodiversity all affect the quality of the soil itself (being physical, biological or chemical) and soil functioning, and affect directly associated local public goods (like the regulation of hydrology and prevention of landslides, siltation of dams and water ways). Alternatively, a *broader set* of soil stakes is linked to the provision of landscape-based ecosystem services such as water quality, air quality, and biodiversity in more general sense, all of which have a mostly public value with far wider (than local) outreach. These services are more determined by soil management practices that do not necessarily affect or degrade the soil itself, nor its capacity to function. Both types of stakes are listed in Table 28.

Soil quality as the foundation of agricultural production is generally considered in the economic literature as a private good and capitalized into rental prices (Kilian, *et al.*, 2003) and sale prices (Feichtinger and Salhoger, 2013). It is generally agreed in the political sphere that public effort is better targeted at public goods: equity between firms generally prevents policy makers to design policies that directly subsidise private goods.

Relations between private and public goods supplied by soils are not always straightforward. For example, in Michigan, Ma and Swinton (2011) showed no effect of soil quality and erosion on the provision of land-based ecosystem services. Nevertheless, the legislation we analysed and most of policy makers we have met support - in line with literature - the general idea that it is worthwhile to promote soil management towards the supply of land-based ecosystem services, besides protecting the soils themselves for private concerns.

Different Catch-C countries focus on different sets of soil related stakes. All countries are concerned by water quality, biodiversity preservation and water erosion, but they also consider, to a various extent, the other existing soil stakes. The set of stakes that a country includes into policy objectives

Table 28: soil stakes as included in policy packages by Catch-C countries (details of the information in Tables 29 to 38)

	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	biodiversity (general)	others
Austria	x	0	0	0	x	x	0	x	0
Belgium	x	0	X	x	0	x	x	x	X
France	x	0	X	x	x	x	0	x	0
Germany	x	x	X	x	x	x	x	x	0
Italy	x	x	X	x	x	x	x	x	Water consumption Pesticide use Landscape degradation
Netherlands	x	x	X	x	x	x	x	x	0
Poland	x	0	X	x	x	x	0	x	acidification
Spain	x	0	0	x	x	x	0	x	0

reflects the national state of soils and perceived soils threats, but also the national habit of complying with the EU requirements in policy framing, along with the national traditions of perceiving the agricultural soils. Some countries choose a small set of stakes and strongly embody them into policies, others can use a wider set but with little emphasis in policies.
For the soil stakes *sensu stricto* as defined above, we assessed their "embeddedness" in the various policy packages of the respective partner countries. From the policy objectives to implementation, the soil stakes have to pass through various levels of subnational policies. We have chosen to describe these paths by the concept of embeddedness in the successive stages of policy design, and developed the following scale for this purpose:

- Level 0: no soil or soil stakes mentioned.
- Level 1: soil mentioned but not targeted at all.
- Level 2: soil or soil stakes mentioned in any part of the process of policy design, but never prominent.
- Level 3: soil or soil stakes mentioned in the policy objectives, but some elements are missing, measures are not explicitly targeted towards soils (or soil stakes), and the elements that are present are only weakly evaluated.
- Level 4: soil or soil stakes mentioned in the policy objective, as an outcome of a knowledge based diagnosis (sometimes spatially differentiated), explicitly mentioned in the measures, but their expected impacts are not analysed beyond vague descriptions.
- Level 5: soil and soil stakes fully embedded in the policy process; the policy explicitly refers to soil or soil stakes in its objectives, includes measures clearly targeted towards soil or soil stakes, and is associated with a clear assessment of direct and indirect expected impacts of these measures on soil stakes, along with trade-off and synergies with other policy packages dealing with soil.

For the sake of simplicity we did not take into account possible *ex-post* monitoring as a criterion.

By grouping together the various policy packages into agricultural packages (CAP pillar1), rural development packages (CAP pillar2), environmental and national policies, we can express embeddedness as shown in Figure 16.

From Figure 16, it appears clearly that Catch-C countries do not focus on soils the same way in the different policy packages. Austria, Germany and - to a lower extent - Belgium have designed a comprehensive strategy towards soil protection. They have different ways of combining the different policy packages to reach their objective. Germany underpins its policies by national legislation, and builds on it to include soils in EU driven policy packages. Austria has provincial laws about soil protection with different levels of soil protection effort. The Netherlands has its national Soil Act, but impacts on agricultural soil management are limited apart from its formal connection with elaborate legislation on nutrient management.

Italy, Spain and to a lower extent Poland take the opportunity of implementing the EU strategy to design some place-based policies to deal with local soil issues. These issues are mostly erosion in Spain, belong to a wide range in Italy, while Poland reports to miss an explicit EU concern about acidification, an issue relevant in Poland.

The embeddedness of soil stakes is less explicit in the Netherlands and France. Despite a large bundle of general frameworks and commissions in these countries, very little is detectable towards measures that clearly target soil stakes in agriculture or towards any ex-ante analyses of the impacts that such measures might have. These countries rely on side effects of farming practices that are promoted for other reasons than soil stakes, without assessment of impacts on soil.

Glæsner *et al.* (2014) consider that there should be a more integrated policy in Europe to deal with soil stakes, because the current policies do not address all stakes, especially not compaction, salinization or soil sealing. However, in our analysis, compaction appears clearly in the stakes for some countries, while others mention policies that aim at preventing sealing: these stakes can be dealt with in the current policy framework (including urban policies for preventing agricultural soils sealing in some countries) without implementing additional specific policies (which would increase the tome of policies dealing with soils, and the current administrative burden). In this report, we didn't analyse industrial or urban policies, as they do not address agricultural soils directly. Sealing might be the more tricky threat to handle, because agricultural and urban policies are usually well

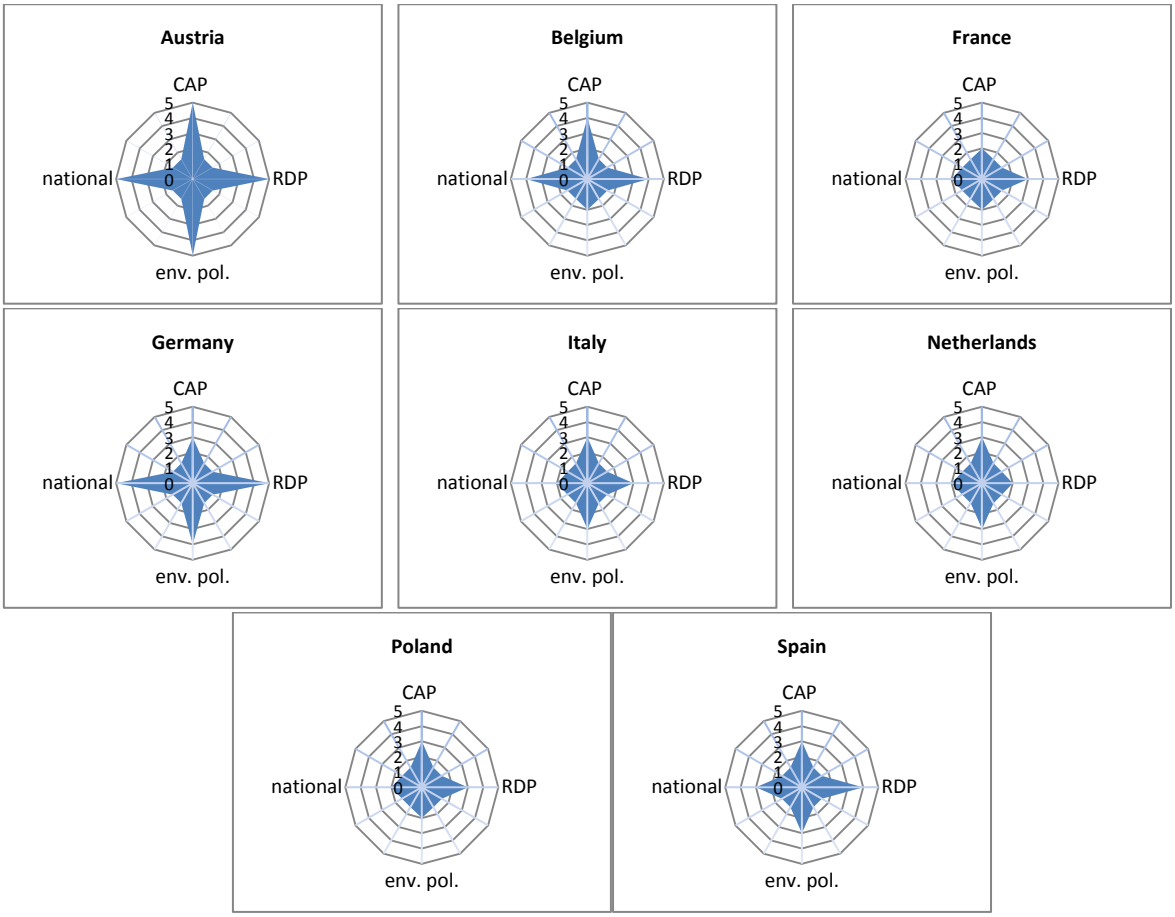


Figure 16: Embeddedness of soil stakes into policy packages in Catch-C countries, per country. *CAP: Common Agricultural Policy (pillar I), RDP: Regional Development Programs (CAP pillar 2), national: national specific policies (not based on EU driven policy packages), env.pol.: environmental policies such as Nitrates Directive, Water Framework Directive and NEC directive*

separated; their objectives could be reconciled into regional development strategic objectives, even if the differences of prices between urbanised and cropped land remains a strong incentive to sell their fields by farmers wherever the demand exists.

Similarly, other issues that are not covered yet by European policy packages, like salinization, acidification, and urban sprawl, can be integrated in the existing policy frame, just widening the scope of the current policies (some few countries have already arranged this in their national policies).

We also found that the ecosystem services provided by agricultural soils are partly promoted by thematic policies (regarding water, air and biodiversity protection) and partly through the greening of CAP or (albeit only on relatively small surfaces in many countries) RDP/AEC. The ways these policies are mixed, and how they incorporate soils, determine their efficiency in dealing with soil stakes. The coherence of agricultural, agri-environmental and environmental policies has improved over the past decades. Payments have however been mainly focussed on paying for the implementation of specific farming practices rather than for measureable environmental outcomes. Most countries seem to have strategic objectives covering a wide range of stakes related to soil, but, from this study, it appears clearly that the embeddedness of soil stakes in the existing policy packages is not at the same level all over Europe.

We believe that our agricultural soils are Europe's most important asset in agricultural production in a worldwide context. Simultaneously, soils are of first relevance for the provision of many other ecosystem services that directly impact the quality of human life. Given this setting, we cannot but conclude that policy packages to protect the degradation of soils (i.e. loss of their productive potential) and to foster the supply of soil-based ecosystem services, are rather limited in most countries, and we found no clear long-term strategies to this end. Austria and Germany apart, most

countries and regions seem to protect soils where there is imminent danger or nuisance, but surprisingly few countries have a general effective protection against total disappearance of productive land (soil sealing by urban and roads sprawl) or against gradual decline (organic matter, compaction, soil biodiversity, soil pathogens).

The current policy packages can be widened to include the threats so far uncovered, but this is likely not enough to make policies effective for the protection of soils. What is needed in addition is to assure better embedding of the soils stakes in those packages, and mutual inter-connection of the packages so that the measures don't contradict each other, but rather act in synergy. A coherent policy framework, with clear and shared objectives, explicit R&D priorities, policy measures that are targeted and implemented at the appropriate level, and that monitors progress using relevant indicators, would be essential to establish a comprehensive strategy for sustainable soil management in agriculture all over Europe. In deliverable (D542) of Catch-C Work Package 5 we discuss the opportunities for future policies to enhance soil stakes.

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Appendix1 BMP codes from WP3 database

N°	BMP	Description
MP1	Monoculture	The growing of a single arable crop species on a field year after year, for at least 9 to 10 years.
MP2	Rotation with cereals	The growing of different species of crops in a crop rotation with >50% coverage with cereals.
MP3	Rotation with legume crops	The growing of different species of crops in a crop rotation with >25% coverage with legume crops.
MP4	Rotation with tuber or root crops	The growing of different species of crops in a crop rotation with >25% coverage with tuber or root crops.
MP5	Rotation with fallow land	The growing of different species of crops in a crop rotation with >25% fallow.
MP6	Rotation with grassland	The growing of different species of crops in a crop rotation with >50% grassland.
MP7	Intercropping	The growing of two or more different arable crops simultaneously in different rows in the same field.
MP8	Rotation with cover/catch crops	The growing of different species of crops in a crop rotation with >25% coverage with cover/catch crops. Double cropping (two different crops grown on the same area in one growing season) is here included. Cover/catch crops are harvested.
MP9	Rotation with green manures	The growing of different species of crops in a crop rotation with >25% coverage with green manure crops. Green manure crops are incorporated into the soil.
MP11	Permanent grazing	Continuous feeding on standing vegetation by livestock.
MP12	Rotational grazing	Rotational feeding (i.e. changing the grazed parcels) on standing vegetation by livestock.
MP13	Zero grazing	No grazing but only mowing to harvest grass.
MP15	Conventional tillage	The conventional tillage consists of ploughing the soil (e.g. Â± 30 cm), which causes turning, loosening, crumbling and aeration of the topsoil. This should result in a clean field surface.
MP16	No / Zero tillage	No tillage. Sod-seeding or Direct drilling are included
MP17	Non inversion tillage/reduced tillage	Tillage without inversion, at a reduced depth (e.g. 5-15 cm), with specific equipment (e.g. grubber/cultivator) more than once a year. About 30% of soil cover after seeding or the incorporation of organic matter >1120 kg/ha.
MP18	Non inversion tillage/minimum tillage	Tillage without inversion, at a reduced depth (e.g. 5-10 cm), with specific equipment (e.g. rotovator) only once a year. About 30% of soil cover after seeding or the incorporation of organic matter >1120 kg/ha.
MP19	Non inversion tillage.	Tillage at a reduced depth (about 30% crop residues remaining on the field surface), often with specific machines (e.g. rotovator).
MP20	Deep ploughing	The deep ploughing describes the use of the plough, where the soil is ploughed > 35 cm. It causes a turn, loosening, crumbling and aeration of the topsoil and parts of the subsoil. Furthermore, deep ploughing is used as a measure for agricultural land imp
MP22	Contour ploughing	Parallel ploughing to the contours of hill slopes.
MP23	Terrace farming	The term describes the use of graded terrace steps of sloped land, used to farm on hills and mountainous area.
MP24	Controlled traffic farming	Controlled traffic farming means using similar traffic lanes for different application within one year and the same traffic lanes between years , often applying a navigation system.
MP26	Mineral N application	Applications of nitrogen in inorganic fertilisers.
MP27	Mineral P application	Applications of phosphorus in inorganic fertilisers.
MP28	Mineral K application	Applications of potassium in inorganic fertilisers.
MP29	Plant compost application	Application of plant compost which results from biodecomposition of plant material in the presence of air.
MP30	Bio-waste compost application	Application of bio-waste which results from biodecomposition of organic material, such as animal wastes, plant residues, etc. in the presence of air.
MP31	Sludge compost application	Application of sludge which consists of suspended particles settling out of the water and sediment on the bottom in the presence of air including mechanical mixing and aerating. The term "compost" describes the additional mixinng of sludge with structura
MP32	Farm yard manure (FYM) application	Application of manure from livestock which is a mixture of excrements (faeces and urine) of animals with a binding medium such as usually straw.
MP33	Cattle slurry application	(Cattle slurry application) Application of slurry from livestock which is mainly a mixture of faeces and urine.
MP34	Poultry manure application	(Poultry manure application) Application of manure from livestock which is mainly a mixture of faeces and urine.
MP35	Pig slurry application	(Pig slurry application) Application of slurry from livestock which is mainly a mixture of faeces and urine.
MP36	Return of crop residues	Crop residues (e.g. stubble and roots) that remain after harvesting and are ploughed in.

MP37	Burning of crop residues	Straws are left on the soil and set to fire after harvesting
MP38	Harvesting of crop residues	Crop residues are harvested and removed for different purposes (e.g. biogas, livestock feeding, …)
MP41	Mechanical weeding	The mechanical weeding uses technical tools to bury, cut or uproot the existing weeds. For this mechanical method, straight-row planting is essential.
MP42	Herbicide application	The application of herbicides to combat weeds and protecting crops.
MP43	Push-pull strategies	Push-pull technology is a method of biological pest control. Within cultures, crops are cultivated with repellent effects and outside the cultures crops are grown with attractive effects. This makes it possible to pull or to push the insects from the crop
MP44	Patches or stripes of natural vegetation	Patches or stripes of natural vegetation are included in the field. They serve as a refuge for beneficial insects for biological pest control, for promotion of soil-field weeds, and to avoid erosion and prevent leaching of nutrients.
MP45	Pheromones application	The application of pheromones to influence plant growth.
MP46	Insecticide application	The application of insecticides to protect crops.
MP47	Fungicide application	The application of fungicides to protect crops.
MP48	Nematode application	The application of nematodes to protect crops.
MP49	Soil fumigation	After covering the soil the application of gaseous pesticides by specialized devices are used to control pests inside the soil.
MP50	Soil solarization	Covering the soil to trap solar energy and heat the soil to control pests.
MP50	Fertilization plan	Different methods and procedures to determine biological, physical and chemical soil parameters, e.g. supply with nutrients. Development and adoption of fertilisation plans (for mineral and organic fertilisers).
MP52	Surface irrigation	Application of water to the field by surface irrigation.
MP53	Drip irrigation	Application of water under low pressure through a piped network in a pre-determined pattern, applied as a small discharge to each plant or adjacent to it and adjustable by irrigation nozzles.
MP54	Sprinkler irrigation	Application of water to the field by sprinkler irrigation.
MP55	Subsurface drainage	Artificial systems of furrows, ditches, pipes, etc. to improve drainage of excess water from the sub-soil.

Appendix2 Crucial Institutional Aspects that can be encountered for different policy types (Schleyer *et al.*, 2007)

		Area of intervention			Property rights change	
		Hierarchy/Bureaucracy	Market	Self-organized Network	For farmers	For non farming land-owners
Type of intervention	Regulatory	Political and administrative inertia Administrative public transaction costs Bargaining power State versus farmers' organizations Unclear distribution of responsibilities between administrative levels (Problems of interplay) Contradictory policy instruments & rules (joint production) Redundant policy instruments & rules Not matching financial means and capacities for administrative restructuring Adverse, but historically deep rooted institutions Heterogeneity of actors' interests Problems of (institutional) fit	Ambiguous property rights (more pronounced for New Member States) Information asymmetry state vs. firm Contradictory policy instruments & rules (joint production) Redundant policy instruments & rules High level of opportunism Monopoly power Lack of trust between economic actors High administrative public and/or private Transaction Costs Weak consumer preferences Strong consumer preferences together with high level of social capital High level of corruption		Endowment effect Ambiguous property rights (more pronounced for New Member States) Information asymmetry state vs. firms High level of opportunism	Weak/Strong consumer preferences High level of opportunism
	Economic		Contradictory policy instruments & rules (joint production) • Redundant policy instruments & rules) • High level of opportunism • More pronounced in New Member States: • No experiences with measures • Insufficient information on policy • Not matching farmers' competencies & capabilities • Target group not (fully) eligible	Strong bargaining power of farmers' organisations • Lack of social capital (among local actors, state vs. local, between levels)) • High public and private (administrative) Transaction Costs • High level of redistribution of decision making power • Resistance to pluralisation of decision making	Endowment effect More pronounced in New Member States: • No experiences with measures • Insufficient information on policy • Not matching farmers' competencies and capabilities • Target group not (fully) eligible	
	Advisory/voluntary			Contradictory policy instruments & rules (joint production) • Low incentives to resolve a problem • High private opportunity costs • High private Transaction Costs • Dispersion/fragmentation of property rights • High number of actors • Environmental problem is not easy to identify in space and time	Dispersion/fragmentation of property rights • High number of actors • Environmental problem is not easy to identify in space and time	

Appendix3: stakes tables

The Tables in this appendix read as follows: in each cell, the policy package aims at the stake (strategic or operational objective) in column and favors the BMP in line (BMP included in the measures).

Table 29: Combination of soil stakes, policy packages and management practices in Austria

Austria BMPs	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Soil contamination (local)	Soil contamination (diffuse)	Salinisation - Sodification	Acidification	Water quality	Air quality	Biodiversity
Rotation:												
MP2 Rotation with cereals												
MP3 Rotation with legume crops	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
MP4 Rotation with tuber or root crops												
MP6 Rotation with grassland	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
MP8 Rotation with cover/catch crops	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
MP9 Rotation with green manures	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
Grassland management:												
MP11 Permanent grazing												
MP12 Rotational grazing												
Tillage:												
MP16 No / Zero tillage / Direct drilling	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
MP17 Non inversion tillage/reduced tillage	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
MP18 Non inversion tillage/minimum tillage	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
MP22 Contour ploughing/contour tillage												
Nutrient management:												
MP26 Mineral N application										Water Rights Act		
MP27 Mineral P application												
MP28 Mineral K application												
MP29 Plant compost application										Water Rights Act		
MP30 Bio-waste compost application										Water Rights Act		
MP31 Sludge compost application										Water Rights Act		
MP32 Farm yard manure (FYM) application										Water Rights Act		
MP33 Cattle slurry application	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL), Water Rights Act		Contractual commitments (ÖPUL)
MP34 Poultry manure application												
MP35 Pig slurry application	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL), Water Rights Act		Contractual commitments (ÖPUL)
MP36 Return of crop residues												
NEW Soil analysis (Development and adoption of fertilisation plans)												
NEW Application of digestate (from biogas plants												
Crop protection:												
MP41 Mechanical weeding												
MP44 Patches or stripes of natural vegetation	Contractual commitments (ÖPUL)				Contractual commitments (ÖPUL)					Contractual commitments (ÖPUL)		Contractual commitments (ÖPUL)
Integrated weed management (only post-emergence)												
Water management:												
MP53 Drip irrigation												
MP54 Sprinkler irrigation												
Others:												
NEW Reducing soil compaction												
NEW Buffer strips (=MP44 Patches or stripes of natural vegetation)												
NEW Soil conservation practices (other than mentioned, e.g. dams for gully control)												

Table 30: Combination of soil stakes, policy packages and management practices in Flanders

Flanders	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity	Others
Rotation BMPs (reference is monoculture)									
MP2 Rotation with cereals									
MP3 Rotation with legume crops				MAEC			MAEC	Greening[30] MAEC	FCPAP[26] FAPAPS[28]
MP4 Rotation with tuber or root crops									GAEC+AR*
MP5 Rotation with fallow land								Greening[30]	
MP6 Rotation with grassland						NID[14, 17]			
MP7 intercropping	GAEC (from '15)*								
Permanent grassland	GAEC (from '15)* MAEC			GAEC (til '16)				GAEC (til '16) Greening	
Other	GAEC*[1] MAEC[10]		RDPIII-VLIF-art.17[29]	MAEC (fiber flax and hemp), MAEC[10]		MAEC[10]	MAEC (fiber flax and hemp)	Greening[30] AES (arable land to grassland) RDPII-art14* (short rotation coppice)	FCPAP[27] (wider crop rotations)
Tillage (reference is inversion tillage)									
MP16 No / Zero tillage	GAEC* RDPII/III-VLIF-art.17[8], AES						NID-X[18]		FCPAP[27]
MP17 Non inversion tillage/reduced tillage	GAEC* RDPIII-VLIF-art.17[8], AES								FCPAP[27]
MP18 Non inversion tillage/minimum tillage									
MP19 non inversion tillage									
MP20 deep ploughing									
MP 22 Contour ploughing/seeding	GAEC*								
Other	GAEC (from '15)* RDPIII-VLIF-art.17[8]								RDPII-VLIF-art.17[8]
Catch-crops, cover crops (reference is bare soil)									
MP8 rotation with cover/catch crops	GAEC* SAS (til '14), MAEC[10]			GAEC[3] SAS (til '14), MAEC[10]		NID[14, 16, 19, 23] SAS (til '14), MAEC[10] RDPII-art14*		Greening[30]	FCPAP[26, 27]
MP9 rotation with green manures									
Nutrient management									
MP26 Mineral N application						Nid-X			
MP27 Mineral P application						Nid-X			
MP28 Mineral K application									
MP29 Plant compost application			GAEC[3] NID[13,15] RDPII/III-VLIF-art.17[7]			Nid-X NID[20] RDPII-art14[5]			WasteFD-X[25] FCPAP[26]
MP30 Bio-waste compost application									
MP31 Sludge compost application									
MP32 Farm yard manure (FYM) application			GAEC[3] NID[13]			NID-X, NID-X[21] NID[20] RDPII-art14[5]	NID-X[18]		FCPAP[26]
MP33 Cattle slurry application						NID-X, NID-X[21]	NID-X[18]		
MP34 Poultry manure application						NID-X			
MP35 Pig slurry application						NID-X, NID-X[21]	Nid-X[18]		
MP50 Fertilization plan						NID[22] RDPII-art14[5] (KNS system for horticulture)			
Other				AES-MAEC (organic farming) RP – tool[12]		NID[24] RDPII-VLIF-art.17[8] AES (organic farming)– AES (reduced fertilization)-AEC[11] RDPII-art14[5] (row fertlization) RP (fertilization guide) RP – tool[12]		AES (organic farming) AEC[11]	FCPAP[26]
Plant residue management (reference is burning of crop residues)									
MP36 Return of crop residues				GAEC[3] (straw incorporation)					
MP37 burning of crop residues				GAEC-X					
MP38 Harvesting of crop residues									
Irrigation (reference is low efficiency irrigation)									
MP53 Drip irrigation									
MP54 Sprinkler irrigation									
MP55 Subsurface drainage									

Notes:
AR : additional requirements withing CAP-Pillar I to get support for AES

SAS : specific agricultural support within CAP-Pillar I (art. 68 of EU regulation No73/2009). This is provided for sowing cover crops under specific conditions, e.g. timing of sowing, which is dependent on the region, and incorporation.
AEC : preliminary list
NiD : the whole region of Flanders is Nitrate Vulnerable zone
Greening : the measures for the ecologcial focus areas still have to be decided and are therefore not included in the table.
RDPII-VLIF : rural development programme : investment support
RP : regional programme. Regional initiatives.
Water framework directive (WFD): implemented through other policy packages
National Emission Ceilings Directive (NEC): implemented through other policy packages
FCPAP : Flemish climate policy action programme (2013-2020)
FAPAPS : Flemish action plan on alternative protein sources
* : applies only to field parcels with high or very high soil erosion risk and are dependent on the crop type grown. Sometimes farmers can choose between several options. Every field parcel in Flanders is classified according to the soil erosion risk based on a model taking a.o. soil texture and topography into account. GAEC measures to prevent erosion gradually becomes more strict between 2014 and 2018. Regarding cover crops : this is not directly obligated but there are maximum periods, depending on erosion risk and crop type, in which soil can be bare.
X : limits the adoption of the practice
1 : Crops on ridges, vegetables or strawberries can only be grown once in 3 years, and they should be rotated with crops with low erosion risk or maize sown with direct drilling or strip-till or crops with more than 80% cover between the rows + prohibition for crops on ridges on parcels with very high erosion risk + prohibition for maize growth unless sown with direct drilling or strip-till on parcels with very high erosion risk + prohibition for vegetables or strawberry growing unless more than 80% soil cover on parcels with very high erosion risk
2 : Micro dams should be established on ridges on parcels with high erosion risk + Prohibition for maize growth unless sown with direct drilling or strip-till on parcels with very high erosion risk
3 : farmers can choose between a list of options if the organic carbon content is too low (based on obligated soil sampling)
4 : potatoes can only be grown once in 3 or 4 years for phytosanitary reasons
5 : Awareness and demonstration projects. In recent years, they included projects on cover crops, row fertilization, organic fertilization and short rotation coppice.
6 : Machinery for direct drilling, strip-till, strip rotary cultivation, decompaction, non-inversion tillage to prevent soil erosion
7 : Farm composting machinery (only for plant materials, not for manure)
8 : Machinery for manure separation
9 : Machinery for energy tree crop growing
10 : AEC 'water quality' supports rotations with high % of crops (90%) with low risk profile determined by 1) nitrate leaching risk (primary aim), 2) susceptibility to erosion and 3) potential for soil organic carbon increase. The crops should be followed by cover crops except for grain-maize. It is worth to note that a AES was proposed which directly targeted the increase of soil organic matter, but this AES was not retained, a.o., because it was difficult to check.
11 : AEC with nutrient related measures such as P mining and zero fertilization in and close to Natura2000 areas
12 : A tool is developed to simulate effects of crop rotations and fertilization on soil carbon and N-uptake/P-export (C-simulator/DEMETER tool), which is of disposal for farmers
13 : Instead of fertilizer norms based on total N, farmes can also opt for fertlizer norms based on effective N, which is more favourable for slow releasing organic fertilizers such as compost or farmyard manure. If P norms are met is controlled at farm level and not at field parcel level (in contrast to N), which also provides the farmer more flexibility to apply slow releasing organic fertilizers
14 : Derogation (applying more organic N) is only possible for maize when preceded by a grass or rye cut and only possible for winter cereals and triticale when followed by a non-legumous cover crop
15 : only half of the P-content in certified compost has to be accounted for to be able to increase carbon levels in the soil. This does not apply for farm compost
16 : if cover crops are grown after cereals more animal manure (170 kg N/ha vs 100 kg N/ha) is allowed
17 : The maximum N and P fertilizer application rates are higher if maize is preceded by a grass or rye cut. However, the maximum dose of total N applied with animal manure remains 170 kg N/ha
18 : Animal manures and other organic fertilizers such as slurry and farmyard manures should be applied with low emission techniques. This does not apply to composts or mineral fertilizers. Farmyard manure cannot be injected so the application is in conflict with no-tillage techniques.
19 : fertilization after the main crop is prohibited except a.o. if a cover crop is sown in August. In the Polder area fertilizers can only be used after the main crops (until October 14) if a (cover) crop is sown 15 days after manure application.
20 : Regarding application period, there are less strict rules for farmyard manure and compost.
21 : Sufficient storage capacity on the farm is needed for animal manures. The rules regarding storage of farmyard manure on the field parcels and on the farm became stricter. Transport of organic manures is also subject to strict control and paper work. In some cases transport should be equipped with an automated data registration system and GPS
22 : Since 2013 fertilization of vegetables is prohibited unless the farmer follows a certified fertilization advise based on soil samples. Soil nitrate residue measurements in autumn are a measure to assess N leaching risks during winter. If a certain threshold has been reached farmers might be obliged to take more soil samples for mineral N in spring to follow a fertilizatoin advise.
23 : one of the measures that can be obliged for farms when nitrate residues are too high in autumn is to grow a crop after the main crop.
24 :The coordination centre for extension services for sustainbel fertilization (CVBB) aims at awareness raising and coordinates water quality groups consisting of several farmers that try to improve water quality in their area.CVBB also provides subsidies for individual farm advise
25: the waste framework directive can hamper the use of waste derived materials such as compost. The administration involved might be a burden, especially for those working small scale, such as for farm composting. Also other legislation might hamper farm composting and the use of farm compost.
26: suggested actions to reduce N2O emissions
27 : suggested measures that should make crops more resilient against drought periods
28 : the main aim of the Flemish action plan on alternative protein sources is to reduce dependency on non-EU protein sources and involves a.o. soy growing and breeding
29 : Low pressure tyres and central tyre inflation system to reduce soil compaction
30 : Proposed options for the ecological focus area include fallow, agroforestry, coppice, catch and cover crops and leguminous crops

Table 31: Combination of soil stakes, policy packages and management practices in France

France	Water erosion				Wind erosion				Soil compaction				SOC decline				Soil biodiversity decline				Water quality				Air quality				Biodiversity			
Rotation BMPs (reference is monoculture)																																
MP2 Rotation with cereals	Greening[4]																													Training[14]		
MP3 Rotation with legume crops[8]	Greening[4]		MAEC[10]						Greening[4]								Greening[4]		MAEC[10]													
MP4 Rotation with tuber or root crops	Greening[4]																															
MP5 Rotation with fallow land	GAEC[19]			GIEE					Greening[4]												Greening[4]											
MP6 Rotation with grassland	Greening[4]		MAEC[10] NC[17]	GIEE					Greening[4]		Training[14]										Greening[4]		Training[14]								NC[17]	
MP7 intercropping	GAEC[3]	NID[9]	MAEC[10]	GIEE							Training[14]										GAEC[3]											
Permanent grassland	GAEC[19] Greening	NID[9]	MAEC[10]										Greening[4]		Training[14]		Greening[4]		Training[14]		Greening[4]								GAEC[19] greening			NC[17]
Tillage (reference is inversion tillage)																																
MP16 No / Zero tillage			PI[13]												Training[14]																	
MP17 Non inversion tillage/reduced tillage			PI[13]																													
MP18 Non inversion tillage/minimum tillage			PI[13]																													
MP19 non inversion tillage			PI[13]																													
MP20 deep ploughing																																
MP 22 Contour ploughing/seeding																																
Catch-crops, cover crops (reference is bare soil)																																
MP8 rotation with cover/catch crops	GAEC[1]	NID[9]																			GAEC[1]	NID[7]							Greening[5]			
MP9 rotation with green manures	GAEC[1]	NID[9]																			GAEC[1]	NID[7]							Greening[5]			
Nutrient management																																
MP26 Mineral N application																						NID-X[7,12]	C[11]									
MP27 Mineral P application																																
MP28 Mineral K application																																
MP29 Plant compost application															Nat				OF[15]			NID-X[7]	OF[15]	LA[18]						PI[16]	LA[18]	
MP30 Bio-waste compost application															Nat							NID-X[7]	OF[15]	LA[18]							LA[18]	
MP31 Sludge compost application															Nat							NID-X[7]		LA[18]							LA[18]	
MP32 Farm yard manure (FYM) application																			OF[15]			NID-X[7]	OF[15]									
MP33 Cattle slurry application																						NID-X[7]	OF[15]									
MP34 Poultry manure application																						NID-X[7]	OF[15]									
MP35 Pig slurry application																						NID-X[7]	OF[15]									
MP50 Fertilization plan																						NID-X[7]	C[11]	Training[14]						PI[16]		
Plant residue management (reference is burning of crop residues)																																
MP36 Return of crop residues																																
MP37 burning of crop residues													GAEC-X[19]																			
MP38 Harvesting of crop residues																																
Irrigation (reference is low efficiency irrigation)																																
MP53 Drip irrigation																							PI[16]									
MP54 Sprinkler irrigation																							PI[16]									
MP55 Subsurface drainage																							PI[16]									

Notes:
1 : GAEC1, Grass strips along water courses
2 : GAEC meadows, This GAEC mandates the up-keep of a minimum area with grassland (can be permanent or temporary grassland)
3 : GAEC4, When farmers do not have a sufficient diversity of crops on their arable land, they have to implement catch-crops or to crush the crop residues and let them on the soil surdace
4 : farms having less than 10 ha of arable land are totally exempted, farms cropping between 10 and 30 ha of arable land have to implement 2 different crops (unless their grassland area represents more than 75 % of their UAA, in which case they are exempted), others have to implement at least 3 different crops (the main one being less than 75 % of the arable land).
5 : GAEC4, in France, catch-crop, cover-crops and fallow are comprised into the ecological interest areas
6 : ban of burning of crop residues
7 : restrictions on fertilisers use are designed locally and more and more stringent along the gradation vulnerable zones, structural excess zones.
8 : France implements a coupled subsidy for leguminous crops from 2015 onwards (no environmental aim has been targeted as an objective).
9 : implementation of catch-crops is mandatory in watershed upstream a water abstraction plant. Up-keep of permanent grasslands too.
10 : in Bretagne, the main objectives regarding soil are to prevent erosion and improve soil management. Two MAEC are foreseen, “herbagère” (systems based on grassland) and “polyculture-élevage” (linking animal and crop productions).
11 : in Bretagne, compensation for additional constraints due to NiD and WFD are foreseen
12 : in vulnerable zones, a declaration of mineral nitrogen flows is now mandatory (also for retailers).
13 : some regions in France foresee including material for non-inversion tillage and direct seeding in the list of eligible physical investments within RDP.
14 : most regions in France aim at developing life-long training to permit a soft transition to agro-ecological farms.
15 : OF = promotion of organic farming.
16 : in Centre and Midi-Pyrénées regions, physical investments aiming at improving biodiversity or water quality are expected to have indirect effects on soil management.
17 : in Midi-Pyrénées, payments to areas facing natural or other specific constraints (art 31) are extended to extensive breeding farms outside of mountain areas.
18 : environmental lease agreements is a French specificity; they are expected mostly for biodiversity and water quality purposes, but can apply for any other stake.
19 : GAEC6, ban of burning crop residues

Table 32: Combination of soil stakes, policy packages and management practices in Germany

Germany	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity	Comments
Rotation BMPs (reference is monoculture)									
Crop rotation	AEC TH AES TH BBodSchG	AEC TH AES TH BBodSchG	AES TH	GAEC 2009 AES TH	BBodSchG	AEC NI		AES TH	**Greening** measure for crop diversification without specifically mentioning any stake
MP2 Rotation with cereals								AES TH	
MP3 Rotation with legume crops[8]	AES TH	AES TH	AEC NI	AEC NI		AES TH		AEC NI	**AEC TH**: the draft RDP includes a measure for crop rotation with legumes without specifically mentioning any stake / **Greening** measure for ecological focus areas without specifically mentioning any stake
MP4 Rotation with tuber or root crops									
MP5 Rotation with fallow land									
MP6 Rotation with grassland	AES TH	AES TH				AES TH			
MP7 intercropping									
Permanent grassland								GAEC 2009 Greening / AEC TH AES TH AES NI AEC NI	
Tillage (reference is inversion tillage)									
MP16 No / Zero tillage	GAEC 2009 / AES NI AEC NI BBodSchG	GAEC 2009 / AES NI AEC NI BBodSchG	BBodSchG	BBodSchG		WFD / AES NI AEC NI			**AEC NI:** no till after maize and rape
MP17 Non inversion tillage/reduced tillage	GAEC 2009 / AEC TH BBodSchG	GAEC 2009 / AEC TH BBodSchG	BBodSchG	BBodSchG		WFD			
MP18 Non inversion tillage/minimum tillage	GAEC 2009 / AEC TH BBodSchG	GAEC 2009 / AEC TH BBodSchG	BBodSchG	BBodSchG		WFD			
MP19 non inversion tillage	GAEC 2009 / AEC TH BBodSchG	GAEC 2009 / AEC TH BBodSchG	BBodSchG	BBodSchG		WFD			
MP20 deep ploughing									
MP 22 Contour ploughing/seeding	BBodSchG	BBodSchG							
Catch-crops, cover crops (reference is bare soil)									
MP8 rotation with cover/catch crops	AEC TH AES NI AEC NI BBodSchG	AEC TH AES NI AEC NI BBodSchG			AEC NI	WFD / AES NI AEC NI		AEC NI	**Greening** measure EFAn without specifically mentioning any stake
MP9 rotation with green manures				BBodSchG					
Nutrient management									
MP26 Mineral N application						NiD			
MP27 Mineral P application						NiD			
MP28 Mineral K application						NiD			
MP29 Plant compost application				BBodSchG		NiD			
MP30 Bio-waste compost application				BBodSchG		NiD			
MP31 Sludge compost application				BBodSchG					
MP32 Farm yard manure (FYM) application				BBodSchG		NiD	AES NI		
MP33 Cattle slurry application				BBodSchG		NiD	AES TH AEC NI WFD / AES NI		
MP34 Poultry manure application				BBodSchG		NiD	AES NI		**AES NI**: Groundwater-friendly application of organic fertilisers limits application to 80 kg total N/ha*y
MP35 Pig slurry application				BBodSchG		NiD	AES TH AEC NI WFD / AES NI		
MP50 Fertilization plan									**AEC TH:** includes measure for fertilization plan without specifically mentioning a stake
Plant residue management (reference is burning of crop residues)									
MP36 Return of crop residues				BBodSchG					
MP37 Burning of crop residues				GAEC 2009 X					Burning is not allowed
MP38 Harvesting of crop residues									
Irrigation (reference is low efficiency irrigation)									
MP53 Drip irrigation									
MP54 Sprinkler irrigation									
MP55 Subsurface drainage									

AEC TH : Agri-environmental and climate measures Thuringia (2014-2020)
AES TH : Agri-environmental schemes Thuringia (2007-2013)
AEC NI : Agri-environmental and climate measures Lower-Saxony (2014-2020)
AES NI : Agri-environmental schemes Lower Saxony (2007-2013)

BBodSchG : Federal Soil protectio Act

Notes :
Organic farming which includes some mentioned MPs is supported by

- AEC TH: no aim mentioned in draft RDP
- AES TH: conservation of soil, water and air
- AEC NI: water quality
- AES NI: water quality
- WFD

Table 33: Combination of soil stakes, policy packages and management practices in Thuringia

Germany: Thuringia	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity	Comments
Rotation BMPs (reference is monoculture)									
Crop rotation	AEC TH AES TH; BBodSchG	AEC TH AES TH; BBodSchG	AES TH	GAEC 2009; AES TH	BBodSchG			AES TH	**Greening** measure for crop diversification without specifically mentioning any stake
MP2 Rotation with cereals								AES TH	
MP3 Rotation with legume crops[8]	AES TH	AES TH				AES TH			**AEC TH**: the draft RDP includes a measure for crop rotation with legumes without specifically mentioning any stake / **Greening** measure for ecological focus areas without specifically mentioning any stake
MP4 Rotation with tuber or root crops									
MP5 Rotation with fallow land									
MP6 Rotation with grassland	AES TH	AES TH				AES TH			
MP7 intercropping									
Permanent grassland								GAEC 2009 Greening; AEC TH AES TH	
Tillage (reference is inversion tillage)									
MP16 No / Zero tillage	GAEC 2009; BBodSchG	GAEC 2009; BBodSchG	BBodSchG	BBodSchG		WFD			
MP17 Non inversion tillage/reduced tillage	GAEC 2009; AEC TH; BBodSchG	GAEC 2009; AEC TH; BBodSchG	BBodSchG	BBodSchG		WFD			
MP18 Non inversion tillage/minimum tillage	GAEC 2009; AEC TH; BBodSchG	GAEC 2009; AEC TH; BBodSchG	BBodSchG	BBodSchG		WFD			
MP19 non inversion tillage	GAEC 2009; AEC TH; BBodSchG	GAEC 2009; AEC TH; BBodSchG	BBodSchG	BBodSchG		WFD			
MP20 deep ploughing									
MP 22 Contour ploughing/seeding	BBodSchG	BBodSchG							
Catch-crops, cover crops (reference is bare soil)									
MP8 rotation with cover/catch crops	AEC TH; BBodSchG	AEC TH; BBodSchG				WFD			**Greening** measure EFAn without specifically mentioning any stake
MP9 rotation with green manures					BBodSchG				
Nutrient management									
MP26 Mineral N application						NID			
MP27 Mineral P application						NID			
MP28 Mineral K application						NID			
MP29 Plant compost application					BBodSchG	NID			
MP30 Bio-waste compost application					BBodSchG	NID			
MP31 Sludge compost application					BBodSchG				
MP32 Farm yard manure (FYM) application					BBodSchG	NID			
MP33 Cattle slurry application					BBodSchG	NID	AES TH WFD		
MP34 Poultry manure application					BBodSchG	NID			
MP35 Pig slurry application					BBodSchG	NID	AES TH WFD		
MP50 Fertilization plan									**AEC TH:** includes measure for fertilization plan without specifically mentioning a stake
Plant residue management (reference is burning of crop residues)									
MP36 Return of crop residues					BBodSchG				
MP37 Burning of crop residues				GAEC 2009 X					Burning is not allowed
MP38 Harvesting of crop residues									
Irrigation (reference is low efficiency irrigation)									
MP53 Drip irrigation									
MP54 Sprinkler irrigation									
MP55 Subsurface drainage									

Table 34: Combination of soil stakes, policy packages and management practices in Lower Saxony

Germany: Lower Saxony	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity	Comments
Rotation BMPs (reference is monoculture)									
Crop rotation	BBodSchG	BBodSchG		GAEC 2009	BBodSchG	AEC NI			**Greening** measure for crop diversification without specifically mentioning any stake
MP2 Rotation with cereals									
MP3 Rotation with legume crops[8]			AEC NI	AEC NI				AEC NI	**Greening** measure for ecological focus areas without specifically mentioning any stake
MP4 Rotation with tuber or root crops									
MP5 Rotation with fallow land									
MP6 Rotation with grassland									
MP7 intercropping									
Permanent grassland								GAEC 2009 Greening; AES NI AEC NI	
Tillage (reference is inversion tillage)									
MP16 No / Zero tillage	GAEC 2009; AES NI AEC NI; BBodSchG	GAEC 2009; AES NI AEC NI; BBodSchG	BBodSchG	BBodSchG		WFD; AES NI AEC NI			**AEC NI:** no till after maize and rape
MP17 Non inversion tillage/reduced tillage	GAEC 2009; BBodSchG	GAEC 2009; BBodSchG	BBodSchG	BBodSchG		WFD			
MP18 Non inversion tillage/minimum tillage	GAEC 2009; BBodSchG	GAEC 2009; BBodSchG	BBodSchG	BBodSchG		WFD			
MP19 non inversion tillage	GAEC 2009; BBodSchG	GAEC 2009; BBodSchG	BBodSchG	BBodSchG		WFD			
MP20 deep ploughing									
MP 22 Contour ploughing/seeding	BBodSchG	BBodSchG							
Catch-crops, cover crops (reference is bare soil)									
MP8 rotation with cover/catch crops	AES NI AEC NI; BBodSchG	AES NI AEC NI; BBodSchG			AEC NI	WFD; AES NI AEC NI		AEC NI	**Greening** measure EFAn without specifically mentioning any stake
MP9 rotation with green manures				BBodSchG					
Nutrient management									
MP26 Mineral N application						NID			
MP27 Mineral P application						NID			
MP28 Mineral K application						NID			
MP29 Plant compost application				BBodSchG		NID			
MP30 Bio-waste compost application				BBodSchG		NID			
MP31 Sludge compost application				BBodSchG					
MP32 Farm yard manure (FYM) application				BBodSchG		NID	AES NI		
MP33 Cattle slurry application				BBodSchG		NID; AEC NI WFD	AES NI		
MP34 Poultry manure application				BBodSchG		NID	AES NI		**AES NI**: Groundwater-friendly application of organic fertilisers limits application to 80 kg total N/ha*y
MP35 Pig slurry application				BBodSchG		NID; AEC NI WFD	AES NI		
MP50 Fertilization plan									
Plant residue management (reference is burning of crop residues)									
MP36 Return of crop residues				BBodSchG					
MP37 Burning of crop residues				GAEC 2009 X					Burning is not allowed
MP38 Harvesting of crop residues									
Irrigation (reference is low efficiency irrigation)									
MP53 Drip irrigation									
MP54 Sprinkler irrigation									
MP55 Subsurface drainage									

Table 35: Combination of soil stakes, policy packages and management practices in Italy

Italy	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity	Water consumption	Pesticide use	Landscape degradation
Rotation BMPs (reference is monoculture)											
MP2 Rotation with cereals		AES		GAEC AES	GAEC AES		AES	GAEC AES	AES	AES	AES
MP3 Rotation with legume crop				GAEC	GAEC			GAEC			
MP4 Rotation with tuber or root crops											
MP5 Rotation with fallow land											
MP6 Rotation with grassland		AES		GAEC AES			AES	GAEC AES	AES		AES
MP7 intercropping				GAEC							
Permanent grassland	GAEC SMRs	AES	GAEC SMRs	GAEC SMRs AES	GAEC SMRs AES		AES	GAEC SMRs AES	AES	AES	GAEC SMRs AES
Tillage (reference is inversion tillage)											
MP16 No / Zero tillage	GAEC	AES	GAEC	GAEC AES	AES		AES	AES	AES	AES	GAEC
MP17 Non inversion tillage/reduced tillage				AES	AES		AES	AES	AES	AES	
MP18 Non inversion tillage/minimum tillage		AES		AES	AES		AES	AES	AES	AES	
MP19 non inversion tillage				AES	AES		AES	AES	AES	AES	
MP20 deep ploughing											
MP 22 Contour ploughing/seeding											
Catch-crops, cover crops (reference is bare soil)											
MP8 rotation with cover/catch crops	GAEC	GAEC AES	GAEC	GAEC AES	GAEC AES	GAEC	AES	GAEC AES	AES	AES	GAEC AES
MP9 rotation with green manures	GAEC	GAEC AES	GAEC	GAEC AES	GAEC AES	GAEC	AES	GAEC AES	AES	AES	GAEC AES
Nutrient management											
MP26 Mineral N application						NID-X AES					
MP27 Mineral P application						NID-X AES					
MP28 Mineral K application						NID-X AES					
MP29 Plant compost application		AES		AES	AES	NID AES			AES	AES	
MP30 Bio-waste compost application		AES		AES	AES	NID AES			AES	AES	
MP31 Sludge compost application		AES				NID AES					
MP32 Farm yard manure (FYM) application		AES		AES	AES	NID-X AES	AES		AES	AES	AES
MP33 Cattle slurry application				AES	AES	NID-X AES	AES	AES	AES	AES	
MP34 Poultry manure application		AES			AES	NID-X AES				AES	AES
MP35 Pig slurry application		AES			AES	NID-X AES				AES	AES
MP50 Fertilization plan		AES		AES	AES	NID AES	AES	AES	AES	AES	
Plant residue management (reference is burning of crop residues)											
MP36 Return of crop residues		AES		AES	AES		AES	AES	AES		
MP37 Burning of crop residues											
MP38 Harvesting of crop residues											
Irrigation (reference is low efficiency irrigation)											
MP53 Drip irrigation				AES	AES		AES	AES	AES	AES	
MP54 Sprinkler irrigation											
MP55 Subsurface drainage											

Table 36: Combination of soil stakes, policy packages and management practices in Netherlands

Netherlands	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity
						AEC (Art.28) in NL focuses on improving water management and/or restoring biodiversity		**AEC** (Art.28) in NL focuses on improving water management and/or restoring biodiversity
						WFD: largely voluntary measures as part of 'management plans for catchment areas'		
Rotation BMPs (reference is monoculture)								
MP2 Rotation with cereals	GAEC[1]				Greening[2]			Greening[2]
MP3 Rotation with legume crops[8]					Greening[3]			Greening[4]
MP4 Rotation with tuber or root crops					Greening[3]			Greening[3]
MP5 Rotation with fallow land					Greening[3]			Greening[5]
MP6 Rotation with grassland					Greening[3]	NiD[7]		Greening[2]
MP7 intercropping					Greening[6]			Greening[4]
Permanent grassland	GAEC[8]			Greening[9]				
Tillage (reference is inversion tillage)								
MP16 No / Zero tillage								
MP17 Non inversion tillage/reduced tillage	GAEC[10]							
MP18 Non inversion tillage/minimum tillage	GAEC[10]							
MP19 non inversion tillage	GAEC[10]							
MP20 deep ploughing			SPA[11]					
MP 22 Contour ploughing/seeding								
Catch-crops, cover crops (reference is bare soil)								
MP8 rotation with cover/catch crops	GAEC[12]				Greening[3]	NiD[13]		
MP9 rotation with green manures					Greening[3]			
Nutrient management								
MP26 Mineral N application						Greening[14]	NiD[15] / WFD[16]	
MP27 Mineral P application						Greening[14]	NiD[15] / WFD[16]	AES, AEC[17]
MP28 Mineral K application						Greening[14]	WFD[16]	
MP29 Plant compost application				NiD[18]		Greening[14]	NiD[13]	AES, AEC[17]
MP30 Bio-waste compost application					NiD[19] SPA[19]	Greening[14]	NiD[13] / WFD[16]	AES, AEC[17] NiD[20]
MP31 Sludge compost application						Greening[14]	NiD[13] / WFD[16]	AES, AEC[17] NiD[20]
MP32 Farm yard manure (FYM) application						Greening[14]	NiD[13] / WFD[16]	AES, AEC[17]
MP33 Cattle slurry application		NiD[21]				Greening[14]	NiD[13] / WFD[16]	AES, AEC[17] NiD[20]
MP34 Poultry manure application						Greening[14]	NiD[13] / WFD[16]	AES, AEC[17]
MP35 Pig slurry application						Greening[14]	NiD[13] / WFD[16]	AES, AEC[17] NiD[20]
MP50 Fertilization plan								
Plant residue management (reference is burning of crop residues)								
MP36 Return of crop residues								
MP37 Burn of crop residues				GAEC[22]				
MP38 Harvesting of crop residues								
Irrigation (reference is low efficiency irrigation)								
MP53 Drip irrigation						GAEC[23]		
MP54 Sprinkler irrigation						GAEC[23]		
MP55 Subsurface drainage						GAEC[23]		SPA[24]

Notes:
EFA : ecological focus areas
1 : GAEC loess soils: Tillage constraints are waived for winter cereals sown<1st January
2 : Greening promotes diversification
3 : Greening promotes legumes on EFA
4 : Greening promotes diversification; and legumes on EFA
5 : Greening promotes diversification; And fallow EFA
6 : CAP-PI-Greening promotes intercrop with legumes on EFA
7 : NiD restricts period of year when grassland can be plowed/ renewed
8 : GAEC Mandatory grassland on slopes >18%
9 : CAP-PI-Greening -restricts grass plowing at MS level; restriction at farm level may come later - ban plowing Natura2000 areas
10 : GAEC promotes NIT on loess soils by waiving other obligations if NIT is applied; GAEC on loess : Ban on till >12cm
11 : Soil Protection Act regulates deep plowing
12 : GAEC on all set aside land: cover crop mandatory; GAEC loess soils mandatory: cover crop OR till <12cm OR NIT (non inversion till)
13 : NiD mandatory catch crop after maize on light soils (sand, loess)
14 : Greening: no nutrients on biodiverse strips EFA
15 : NiD restricts amount and timing of all N or P containing fertz+manures
16 : WFD: (largely voluntary) fertiliser/manure free zones along water courses
17 : (AES+AEC): ban on P containing products
18 : NiD allows double P rates if applied as Plant compost
19 : NiD and Soil Prot. Act - Applic only if heavy metal contents in soil below threshold

20 : NiD mandatory to incorporate immediately/Inject
21 : NiD allows extra cattle slurry to combat wind erosion
22 : GAEC all soils Ban on burning crop residues
23 : GAEC Ban on irrigation without permit
24 : Soil Protection Act regulates drainage measures

Table 37: Combination of soil stakes, policy packages and management practices in Poland

Poland	Water erosion			Wind erosion	Soil compaction		SOC decline			Soil biodiversity decline	Water quality		Air quality	Biodiversity
Rotation BMPs (reference is monoculture)														
MP2 Rotation with cereals							GAEC[7] Greening[2]	AES, AEC[3]						
MP3 Rotation with legume crops[8]														
MP4 Rotation with tuber or root crops														
MP5 Rotation with fallow land							Greening[4]							Greening[4]
MP6 Rotation with grassland														
MP7 intercropping		AES, AEC[5]						AES, AEC[5]				AES, AEC[5]		
Permanent grassland	GAEC[6] Greening[7]	AES[4]	N[4]		GAEC[6] Greening[7]	AES[4]	GAEC[6] Greening[7]	AES[4]	N[4]					
Tillage (reference is inversion tillage)														
MP16 No / Zero tillage														
MP17 Non inversion tillage/reduced tillage														
MP18 Non inversion tillage/minimum tillage														
MP19 non inversion tillage														
MP20 deep ploughing														
MP 22 Contour ploughing/seeding														
Catch-crops, cover crops (reference is bare soil)														
MP8 rotation with cover/catch crops		AES, AEC[5]				AES, AEC[5]						AES, AEC[5]		
MP9 rotation with green manures						AES, RDP[9]		AES, RDP[9]						
Nutrient management														
MP26 Mineral N application											NiD			
MP27 Mineral P application											NiD			
MP28 Mineral K application														
MP29 Plant compost application						AES, RDP[9]		AES, RDP[9]						
MP30 Bio-waste compost application						AES, RDP[9]		AES, RDP[9]						
MP31 Sludge compost application											NiD			
MP32 Farm yard manure (FYM) application						AES, RDP[9]		AES, RDP[9]						
MP33 Cattle slurry application						AES, RDP[9]		AES, RDP[9]			NiD			
MP34 Poultry manure application											NiD			
MP35 Pig slurry application						AES, RDP[9]		AES, RDP[9]			NiD			
MP50 Fertilization plan												AES, AEC[5]		
Plant residue management (reference is burning of crop residues)														
MP36 Return of crop residues						AES, RDP[9]		AES, RDP[9]						
MP37 Burning of crop residues					GAEC[1,6]					GAEC[1,6]				GAEC[1,6]
MP38 Harvesting of crop residues														
Irrigation (reference is low efficiency irrigation)														
MP53 Drip irrigation														
MP54 Sprinkler irrigation														
MP55 Subsurface drainage														

Notes:
PI: pillar 1
1 : CAP PI - GAEC2 Maintenance of soil organic matter
2 : New CAP PI - greening Diversification of crops
3 : AES, AEC sustainable agriculture
4 : New CAP PI - Greening – proeco areas
5 : AES, AEC Protection of soils and water
6 : CAP PI - GAEC6 Protection of permanent grasslands
7 : New CAP PI – greening -Protection of permanent grasslands
8 : National - The law on agricultural and forest land protection
9 : new RDP Ecological farming (different from AEC)

Table 38: Combination of soil stakes, policy packages and management practices in Spain

Spain	Water erosion	Wind erosion	Soil compaction	SOC decline	Soil biodiversity decline	Water quality	Air quality	Biodiversity
Rotation BMPs (reference is monoculture)								
MP2 Rotation with cereals	Greening[1]				Greening[1] AES 214-03			AES 214-03 AES 214-04 AES 214-07
MP3 Rotation with legume crops[8]	Greening[1]				Greening[1] AES 214-03			AES 214-03 AES 214-04 AES 214-07
MP4 Rotation with tuber or root crops	Greening[1]				Greening[1] AES 214-03			AES 214-03 AES 214-04 AES 214-07
MP5 Rotation with fallow land	Greening[1]				Greening[1] AES 214-03			AES 214-03 AES 214-04 AES 214-07
MP6 Rotation with grassland	Greening[1]				Greening[1] AES 214-03			AES 214-03 AES 214-04 AES 214-07
MP7 intercropping								
Permanent grassland								
Tillage (reference is inversion tillage)								
MP16 No / Zero tillage	GAEC1 GAEC/BCAM5 AES 214-12			AES 214-12		AES 214-12		
MP17 Non inversion tillage/reduced tillage	GAEC1 GAEC/BCAM5 AES 214-03 AES 214-07 AES 214-13			AES 214-12		AES 214-12		
MP18 Non inversion tillage/minimum tillage	GAEC1 GAEC/BCAM5 AES 214-03 AES 214-07 AES 214-13			AES 214-12		AES 214-12		
MP19 non inversion tillage	GAEC1 GAEC/BCAM5 AES 214-03 AES 214-07 AES 214-13			AES 214-12		AES 214-12		
MP20 deep ploughing								
MP 22 Contour ploughing/seeding								
Catch-crops, cover crops (reference is bare soil)								
MP8 rotation with cover/catch crops	Greening AES 214-03			AES 214-03	GAEC/BCAM4 Greening	AES 214-03		
MP9 rotation with green manures								
Nutrient management								
MP26 Mineral N application						GAEC/BCAM3 NID WFD AES 214-05 AES214-06 AES 214-07		
MP27 Mineral P application								
MP28 Mineral K application								
MP29 Plant compost application								
MP30 Bio-waste compost application								
MP31 Sludge compost application								
MP32 Farm yard manure (FYM) application				AES 214-03 AES 214-04	AES 214-03 AES 214-04			AES 214-03 AES 214-04
MP33 Cattle slurry application						AES 214-06 AES 214-13		
MP34 Poultry manure application								
MP35 Pig slurry application								
MP50 Fertilization plan				AES 214-03 AES 214-04	AES 214-03 AES 214-04			AES 214-03 AES 214-04
Plant residue management (reference is burning of crop residues)								
MP36 Return of crop residues				GAEC/BCAM6	Greening			
MP37 Burning of crop residues				GAEC/BCAM6	Greening			
MP38 Harvesting of crop residues								
Irrigation (reference is low efficiency irrigation)								
MP53 Drip irrigation						AES 214-05 AES 214-06 AES 214-07 AES 214-13 AES 121 AES 125		
MP54 Sprinkler irrigation						AES 214-05 AES 214-06 AES 214-07 AES 214-13 AES 121 AES 125		
MP55 Subsurface drainage								