Cross Compliance Assessment Tool

CROSS-COMPLIANCE ASSESSMENT TOOL

Policy-oriented research:
Scientific support to policies SSP

Specific Targeted Research Project (STREP)

Deliverables 2.1 and 2.2 : General approach to the assessment of the impacts of CC in the EU and list of indicators

Due date of deliverable: [31-04-2007]

Actual submission date: [25-07-2007]

Authors of this report and contact details

Name:	***Partner acronym***
Roel Jongeneel	*LEI*
Berien Elbersen	*Alterra*
Wim de Vries	*Alterra*
Janneke Roos Klein-Lankhorst	*Alterra*
Jörg Schramek	*IfLS*
Bettina Rudloff	*UBonn*
Thomas Heckelei	*UBonn*
Markus Kempen	*UBonn*
Dominic Annen	*UBonn*
Marijn van der Velde	*JRC*
Adrian Leip	*JRC*
Mark Redman	*CEET*
Merit Mikk	*CEET*
Juan José Oñate	*UAM*
Louis Slangen	*LEI*

Contact details editors:

Name : Roel Jongeneel
Address : Burgemeester Patijnlaan 32, Den Haag
Email: roel.jongeneel@wur.nl

Name: Berien Elbersen
Address: Droevendaalsesteeg 3, 6700 AA Wageningen
Email: Berien.elbersen@wur.nl

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Disclaimer:

“This publication has been funded under the CCAT project, EU 6th Framework Programme, Priority 8.1 (European Commission, DG RTD, contract no. 44423-CCAT). Its content does not represent the official position of the European Commission and is entirely under the responsibility of the authors.”

"The information in this document is provided as it is and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at its sole risk and liability."

Contents

Executive summary

This Deliverable provides an overview of the literature, state of play, other research projects with respect to cross-compliance (CC) and the related specific fields of regulation. It has the character of a first investigation into the research done and the available approaches and tools and as such serve as a basis for making further choices with respect to follow-up activities and tasks within the CCAT project.

As regards the literature a distinction was made according to a few fundamental disciplinary lines. More specifically it became clear that:

- Within the economic approach the behavioural understanding of the compliance decision is crucial. Factors influencing the compliance decision are costs (punishment) and benefits (lower costs, higher revenues) of non-compliance as compared to costs (higher costs, lower revenues) and benefits (no punishment or sanctions, i.e no reduction in the single farm payment) of compliance. However, also other factors such as risk aversion, moral attitude, social standing and institutional economic issues, which go beyond a costs/benefit-evaluation appear to be potentially relevant;
- Central elements in the environmental sciences approach are the analysis and understanding of the main environmental fluxes in agriculture and the impacts they have on soil, water and air quality. The analysis focuses on the linkage of various farming activities (like number of animals, fodder regimes, crop residues, manure excretion and application, fertilizer and pesticides applications, etc.).
- The ecological perspective contains a literature comprising a lot of detailed case studies on the impacts of agricultural practices on farmland habitats and biodiversity (plant species and bird and wildlife). These studies often have a qualitative character. Moreover, the results of the analyses appear to have their own scale and scope, which precludes simple generalization to other areas and cases, even if these share a number of similarities.
- As regards approaches to changes in land-use and landscape the first issue is well-explored in the literature, both from agronomic and economic sides. The landscape-issue is also addressed but here the literature is relatively weaker. But overall it is clear that changes in land use are strongly linked to changes in landscape, and if land use changes are induced by cross-compliance so will the landscape.

Within the context of the current project, with its scope to evaluate the impacts of CC at an ultimately EU-wide level, it is noted that the literature about the economic and environmental science approaches best fits in with the planned tool development. As regards ecology and landscape the literature and the current state of science is likely to create limitations in terms of developing quantitative assessment tools. This does not exclude treatment of these aspects, but the level and detail might be somewhat less then for the other fields as this project is not to be expected to go beyond the current state of the literature.

The state of play or review of other projects on, or related to CC made clear that there are a number of interesting modelling tools and indicator frameworks available,

which can be exploited for assessing the impacts of CC, in particular the economic and environmental ones (see details below). There is a lot of knowledge available from various projects where upon CCAT could built. In particular information from the Cross Compliance project, the CIFAS project, the IRENA project, and the SEAMLESS and NEU project will be used. Whereas the first three contribute mainly with respect to classifications, characteristic descriptions and indicator frameworks, the latter two projects are contributing in terms of modelling tools (CAPRI) or modelling elements (INTEGRATOR of which information will be used to develop MITERRA-Europe).

From the inventory of available indicator framework a large set of indicators resulted. In a scrutinize analysis these indicators were linked to various fields of impact. A similar exercise was done for all the SMRs and GAECs, where the regulations were decomposed into several requirements. Together this inventory and classification provide a stepping stone for further indicator selection, where the established linkages make it possible to guarantee that each aspect of the CC regulations is properly linked to indicators. Some general results found were ……

Quantitative models and their integrated application play an important role in deriving indicators for the assessment of CC measures in this project. The combination of different existing models and their partial extension aims at covering economic and environmental impacts of the policy. Integrated use of economic and biophysical models allows achieving a consistent set of indicators focussing on regional economic impacts related to agriculture and environmentally relevant emissions to air, soil, and water.

The results from the assessment of indicator frameworks were cross-checked with the indicator-output from the reviewed models. Based on this the available modelling tools the economic CAPRI-Dynaspat model (as it is and further will be developed within SEAMLESS), and the environmental MITERRA-Europe model are interesting, in particular with respect to the economic and environmental indicators. More specifically the CAPRI-MITERRA-Europe combination, with the use of the DNDC and EPIC models as complementary modules, looks promising. The MITERRA-Europe model has to be further developed in the coarse of this project. With respect to the impact fields of biodiversity, food safety and animal welfare both the number of observed operational indicators, and the power of the models to produce indicators related to these fields was found to be limited.

Although various indicator frameworks and modelling tools are available, still several challenges remain for this project. To mention a few:

- Best estimates of the degree of compliance and costs of compliance are only available for a subset of member states. Insights into the additional compliance induced by the CC enforcement mechanism is still very limited. More information on this will be crucial for a successful impact assessment;
- The integration and linking of the modelling tools will require the necessary efforts and impose challenges in terms of connecting different aggregation and scale levels;

- The linkage between tools and indicators will need further attention. Whereas a number of indicators are directly available from the modelling tools, for others linkages will have to be established;
- The reviewed studies and models appear to be relatively less developed with respect to issues of biodiversity, food safety, animal welfare and landscape. As they are part of the planned assessment tool particular attention will have to be given to these aspects. One way is to work further on creating indirect links with existing modelling tools. Another way is to use different complementary approaches, including case studies.

1 Introduction

This report describes the rough approach to assessing impacts of Cross Compliance (CC) in CCAT. Before to come to this overall approach it will first be necessary to present the state-of-play, the available information, models and tools available in this project and the possible impact indicators to be developed to assess the impacts of cross-compliance (CC) in the EU. These impacts include effects on agricultural markets, producer's income, land use, soil, water, air, climate, biodiversity and landscapes, as well as food safety, animal welfare and health. It starts with introducing cross compliance, providing some background information on its genesis, the goals it aims at, and the instruments used. This is followed by a section which introduces the project, its focus and scope. It also makes clear where and how this project is going to contribute to the evaluation of the CC policy. Finally it closes with a section describing the structure and organisation of the rest of the report (and its annexes).

1.1 Introduction

Background info on Cross Compliance

The 2003 Mid-Term Review (MTR) of the Common Agricultural Policy (CAP) introduced a number of adjustments to agricultural support. One of the most substantive changes was the introduction of a system of decoupled payments per farm (Single Farm Payment). Moreover a cross-compliance instrument was to accompany this system making the payments conditional on recipients meeting environmental, food safety, animal and plant health, animal welfare requirements as well as standards of good agricultural and environmental practice. The main objective of CC is to enhance enforcement of areas of EU legislation that were not fully complied with (or even not fully implemented) by Member States (MS) and their farmers. There is a risk that this ignorance will have adverse effects on environment, will delay reaching animal welfare standards and increase the risk of health incidents.

The primary objective of the whole policy reform of 2003 was to promote a more market-oriented and sustainable agriculture. However, it remains largely unknown how the introduction of cross-compliance affects producers' income, consumers' welfare and agricultural markets. Overall, little knowledge is available until now on the effects of CC on sustainability. This is not only because it has only recently been implemented in a selection of the EU Member States (MS) but also because of the variation across MS, in particular with respect to minimum standards for good agricultural and environmental condition (GAECs) under Annex IV. In addition, the impacts of CC may largely vary as a result of a combination of practical implementation within a specific national and regional context and farmers' decisions. Although still of a preliminary nature, some estimates are available about costs of compliance with standards included in the CC-package (see also Section 3.3 on the CC project). However, as regards the benefits of CC, viz. their contribution to a more sustainable agriculture, most of the work still has to be done. This project aims to clarify this latter aspect, therewith contributing to a more balanced picture of both benefits and costs of CC.

Policy coverage and implementation

The CC instrument has been implemented from 2005 onwards in the EU-15. It specifies that all farmers receiving direct payments are subject to compulsory cross-compliance (Council Regulation No 1782/2003 and Commission Regulation No 796/2004). In total 19 legislative acts applying directly at the farm level in the fields of environment, public, animal and plant health and animal welfare have been established and farmers are sanctioned in case of non-compliance. Some additional acts may extend this list in the future as it is currently discussed for the “Hygiene Package” on food safety. Beneficiaries are also obliged to keep land in good agricultural and environmental conditions. These Good Agricultural and Environmental conditions (GAECs) are defined by Member States, and should include standards related to soil protection, maintenance of habitats and landscape, including the protection of permanent pasture. In addition, Member States must also ensure that there is no significant decrease in their total permanent pasture area, if necessary by prohibiting its conversion to arable land. Land abandonment should lso be avoided. Such measures are aimed to ensure that the positive environmental benefits of agricultural management of the land are achieved. As a condition of receipt of the single area payment, there is more flexibility for Member States in the development of GAECs which farmers must observe, than in the compliance with the SMRs.

Policy experience and reform

The planned review of the EU’s agricultural policy in 2008 (Health-check) is likely to also affect cross-compliance policy. It is expected that based on first experiences a discussion will be opened to further refine and simplify the policy. In 2005 in total 240,898 on-farm checks have been done, covering 4.92 percent of the farmers subject to the CC requirements. For 11.9 percent of the inspected farmers, the check resulted in an imposed reduction of their direct payments. Most violations of the requirements had to do with the Identification and Registration Directives, although also with respect to the Nitrate Directive and the GAECs many violations were observed. Issues which are likely to be further discussed in the Health-check are:

- the treatment of minor violations (those involving minimum payment reductions). An option could be to rely on warning only and not giving a follow up financial punishment.
- adjustments in the monitoring and inspection regime. Issues are the possibility of pre-announcing on farm checks for certain regulations, additional checks in cases where a large number of violations are detected, and lower number of checks on regulations where the degree of compliance is very high, improved timing of monitoring, improved sample selection.
- a phased introduction of the SMRs in new member states rather than full imposition in 2009.

As far as possible in this project the consequences of eventual CC-policy reforms will be taken into account, which in particular regards the outcome of the Health check.

1.2 Focus and scope of project

The main objective of this project is to develop an analytical tool that enables the integrated assessment of the impact of Cross Compliance (CC) at different geographical scales ranging e.g. the European, national, markets, regional and farm level scale. Impacts assessed by the tool should include effects on agricultural markets, producer's income, land use, soil, water, air, climate, biodiversity and landscapes, as well as food safety, animal welfare and health. The development and application of the analytical tool will be supported by an assessment of the impacts of CC since it's implementation in 2005. However, for food safety and health it is 2006 and for animal welfare it will be 2007 before the policy is implemented which will require assumptions for forecasting results.

This project will deliver:

1) a better understanding of CC as an instrument to enhance enforcement of areas of European legislation not fully implemented by MS
2) a scientific-based tool for impact assessment of cross-compliance and sustainable development of agriculture in the EU.
3) an analytical tool that will help the European Commission Directorates, particularly DGs Agriculture, Environment, Health and Consumer Protection, and national Ministries responsible for implementation and control of the Common Agricultural Policy instruments, to get a better understanding of the effectiveness and efficiency of CC under specific regional and national conditions.

The analytical tool to be developed in this project will deliver the possibility to assess all components of sustainability (i.e socio-economic and environmental impacts) of CC taking account of different implementation pathways given specific national and regional conditions. Including the regional component is crucial in this project, but also challenging, and capturing the different farmer's choices even more. It is challenging because of the complexity but also because of the limited information available. This project will therefore build as much as possible on relevant existing projects, models and will also combine own survey information with information collected in other projects. The state-of-play in relation to the assessment of Cross Compliance and existing models and tools are extensively described in this report. They provide the basis from which an analytical approach for assessing the impacts of Cross Compliance can be further elaborated.

Data and information requirements for this project are partly met by building on information and results of other projects such as CIFAS, Cross Compliance project, using existing EU data sets and collecting information through surveys and interviews. A description of the main projects this project will build on by either using the results and data provided and/or by using the knowledge and/or models produced, is given in chapter 3.

For the specification of the CC impact indicators in this project, we will use as much as possible the indicators from existing indicator frameworks which already have EU policy relevance. A selection of the indicators from the different indicator frameworks which are most useful for assessing the impacts of CC is made in Chapter 4 of this report. The development of indicators in this project should enable the measurement of these effects and make EU wide regional comparison possible. These indicators should reflect the impacts on agricultural markets, producer income, land use, soil, water, air, climate, biodiversity and landscapes, as well as food safety, animal welfare and health across the EU. The indicators will build on existing indicator frameworks for as far as possible but we will also specify new indicators if necessary. The indicators should fit well with the different themes and implementation pathways covered by CC. For this the different CC SMRs and GAECs are first systematically categorized according to fields of potential impact. This categorization will then enable to establish a link between the SMEs and GAECs and the impact indicators to be developed.

For the assessment of the impacts of CC it is clear that there is an interdependency between the economic impacts and the rest. It can be assumed that the implementation of CC may lead to changes in farming practices and/or to making certain investments to comply with certain regulations and standards. The potential effects on farmers' income are likely to (significantly) influence the farmer's final decision on how to change his/her farming practices in order to comply with the standards of CC. This in turn will have its impact on the environment and/or the way animal welfare standards are respected.

How to approach the assessment of the economic and environmental affects is discussed in the next chapter and the tools and models available to further specify the impacts indicators are discussed in chapter 5. In this chapter the models are described and their further adaptation for the purpose of this project is investigated. See the next section for a more detailed overview of the structure of this report.

1.3 Outline of the report

Outline of report

The report is divided into 6 chapters that reflect the steps outlined above:

1. *Introduction* - This chapter includes the introduction to the research project. It starts with introducing cross compliance, providing some background information on its genesis, the goals it aims at, and the instruments used. This is followed by a section which introduces the project, its focus and scope. It also makes clear where and how this project is going to contribute to the evaluation of the CC policy. Finally it closes with a section describing the structure and organisation of the report (and its annexes).

2. *General approach* – this chapter discusses the general approach that will be followed, i.e. the disciplines it relies on and the particular theories and methodologies that will be exploited. The chapter starts with an introduction which briefly sketches the evolution of agriculture, with particular focus on the differing degrees of production intensity for different farming practices. Subsequently the perspective of economics, environmental sciences and ecology (biodiversity) on assessing the impacts of regulations and standards is discussed. In a derived way also landscape formation is related to changes in farming practices and land use. This chapter does not yet discuss each regulation in detail, but will focus on a number of common themes (e.g. biodiversity, environment (water, air, climate, soil) and economics (e.g. costs, benefits). The chapter closes with providing an integral perspective, linking and ordering the role and potential contributions of the various disciplines.

3. *State of play* – this chapter provides an overview of the existing studies which are available and which will be used as stepping stones for the CCAT project. The following six projects are reviewed: Cross Compliance, CIFAS, IEEP CC-Evaluation, SEAMLESS, IRENA, and NEU. For each project the following issues are dealt with: focus and scope, approaches and methods used, main results obtained, as far as currently available, relevance for CCAT project. The relevance and potential contribution of the projects will be preferably indicated by adding one or more tables summarizing key information for this project (for example on degrees of compliance, costs, indicators, etc.)

4. *Regulations, standards and potential impacts* – The first part of this chapter discusses the objectives and intervention logic of the EU's cross-compliance policy. Discussion of this is crucial for later development of indicators, since these should not stand on their own, but be connected to the policy maker's interests. Moreover, understanding the intervention logic in helpful in gaining further insight into the policy evaluation process and the issues associated with that. The second part of the chapter provides a detailed overview of the statutory management standards (SMRs) and requirements of good agricultural and environmental practices (GAECs) and assesses the potential impacts on distinguished fields. An overview of the available indicator frameworks is provided and discussed. Subsequently a section follows which explicitly links the CC standards to indicators. The final result of the latter section is a set of tables which combine the regulations and requirements with the following fields of impact: environment (water, air & climate, soil), economic (revenues and several cost types), animal welfare and health, human health (food safety, consumer trust), biodiversity (habitat quality, biota: birds, invertebrates, vegetations, mammals), farm practices, and landscape (characteristic and diversity). Finally, a first linkage will be made to a general set of indicators. This is the subject of the closing part of this chapter. A detailed account of this is saved for the appendices.

5. *Tools and models* – this chapter provides the main tools and models that will be used as inputs for the project. Key information from these models will end up in the final evaluation tool that will be developed for this project. The chapter starts with an introduction, which provides an overview of the tools and models that will be used. Since the emphasize is on the integration and linkage between the various tools the introduction provides an integrated modelling framework. In the subsequent sections the various tools and models will be further discussed. Particular attention is paid to the CAPRI and MITERRA models, which are considered to be the backbone of the project. Complementary tools and models are discussed in a more brief way. These include the Implementation-impact framework (for environment and biodiversity; see powerpoint Wim de Vries), INITIATOR, INTEGRATOR, DynaSpat, RAINS, EPIC, and DNDC. Besides a description of the aims, characteristics, structure and basic assumptions of the models, for each model a table describing the models key input variables and output variables is produced. These input-output tables will be useful in order to better understand the data requirements, links to indicators (both at input and output side), and model linkages.

6. *Conclusion* – this concluding chapter summarizes the report and includes a first evaluation of strengths, weaknesses, opportunities and threats. Issues that are paid attention to are measurement of (additional) compliance, its associated costs and reference level choice, the regionalization of different effects, data limitations and modelling tools that are going to be used. Subsequently, a first selection of indicators is presented, which will be the starting point for follow-up work (measurement, operationalisation, linkage to models, etc.). With respect to the economic and environmental indicators already a clear selection could be made. As regards to land use, biodiversity and landscape, public health and animal welfare, , a definite choice could not yet be made. However, a set of criteria is formulated to further guide the selection of indicators in these fields, and where possible optional indicators are suggested, taking into account all the limitations discussed before.

2 General approach

2.1 Introduction

For the assessment of the impacts of CC it is clear that there is an interdependency between the economic impacts and the rest. It can be assumed that the implementation of CC may lead to changes in farming practices and or to making certain investments to comply with certain regulations and standards if the farmer accepts the financial consequences of this. The potential effects on farmers income will therefore strongly influence the farmers final decision on how to change his/her farming practices in order to comply with the standards of CC and this again may impact on land use, the environment, landscape, biodiversity and/or the way animal welfare standards are respected. In this chapter different disciplinary approaches are discussed to assessing and modelling impacts of agricultural policy.

First the main changes in policy are discussed and how Cross Compliance policy was introduced in the EU. In Section 2 the economic approaches to assessing the effects of policy interventions are discussed which results in key elements to be taken into account when modelling income effects and effects on markets. In the third section a general description is given of the types of environmental impacts agriculture is responsible for and a selection is made of the environmental fields of impact to focus on in this project. In the fourth section the way farming impacts on biodiversity is discussed and which assessment approaches candidate for assessing the impacts of CC on biodiversity. In the fifth section the relationship between farming land use and landscape is discussed. The last section provides conclusions on the main fields of impact this study should focus and provides a first idea on how to assess such impacts. These approaches and fields of impacts will be worked out further in next chapters.

2.2 Evolution of agricultural production

In the 19th and 20th century prevailing traditional farming practices changed into modern farming practices, driven by rapid changes in technology and rising labour costs. The agrarian societies with more than 50% of the population working in agriculture in early 19th century were transformed into industrialized urban societies. Currently, only 5% of the population is working in agriculture in EU-15 and 13% in the new member states (Eurostat, 2003).

With two World Wars, a serious economic crisis and regular food shortages in mind, there were strong feelings and incentives in Europe to stimulate the economy and to boost industrial and agricultural productivity. The establishment of the EEC in 1957 was a result. At that time, Western Europe was a net importer of food, and understandably, the Common Agricultural Policy (CAP) of the EU was strongly focused on stimulating agricultural production and stabilizing markets. The original objectives of the CAP were:

- to increase agricultural productivity
- to ensure a fair standard of living for the agricultural community;
- to stabilize markets;
- to ensure stability of supplies;
- to ensure that supplies reach the consumers at reasonable prices.

This policy has been successful. Within a couple of decades the CAP indeed changed the EU from a net importer to a net exporter of food. It lead to productivity increase, regional and on-farm specialisation and rationalisation, a decline of agricultural labour, a decrease in the number of farms, shifts in land use types but also abandonment of (lower productive) farmland. This was accompanied by drastic adaptations to land and landscapes. Land re-allotment, which so far had only been carried out on a limited scale, increased tremendously (Slangen et al., 1996: 390). Plots were enlarged, ditches filled, lines of trees cleared, wet soils drained, soil profiles agronomically improved and farm buildings modernised and relocated. Low-nutrient ecosystems dominated by semi-natural vegetation were either transformed into nutrient rich farmland if possible, or were abandoned. With the intensification of the land use, more and more areas were manured and drained. Specialisation at farm level resulted in a large decrease in mixed farms and a scaling-up of farming in general. Farm enlargement became apparent from the rise in the numbers of livestock per farm, an increasing acreage of crops per farm, as well as from increased plot and farm size. Another factor was the increased use of non-factor or intermediary inputs. The intensification of land use involved an increased use of inputs like concentrates, (artificial) fertilizer and pesticides.

It all created an increased pressure on the environment, biodiversity loss and landscape degradation. The impacts on environment, biodiversity and landscape that accompanied these changes have been well documented (e.g. Buckwell & Armstrong-Brown 2004; Wadsworth *et al.* 2003; Hofmann, 2001; Boatman et al., 1999; EAA, 1999; MAFF, 1998; Pretty, 1998; EPA, 1999; Campbell and Cooke, 1997; Baldock, et al. 1996) and they are almost entirely negative.

This was also the main reason why integration of environmental policy with agricultural policy has become a major item on the EU policy agenda from the end of the 1980s onwards. The world summit in Rio de Janeiro in 1992 emphasized the need of environmental sustainability, and has furthered the process of integration. The McSharry reforms of the Common Agricultural Policy (CAP) in 1992 led to the implementation of the first Agri-environmental Regulation (EEC 2078/92). Also codes of 'Good Farming Practices (GFP)', i.e. agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside are being promoted though the Common Agricultural Policy (CAP). The Nitrates Directive 91/676/EC, approved in 1991, requires Member States to identify, specify and encourage farmers to apply so-called 'Good Agricultural Practices (GAP)' for animal manure and fertilizer. The prospect of EU enlargement to the Central and Eastern European countries and the continuing pressure for trade liberalisation stimulated a further reform of the CAP and an integration of environmental considerations into EU policy. It resulted in the 1996 Cork Declaration which placed sustainable rural development at the top of the EU agenda. The ideas of the Cork declaration formed the basis for the Agenda 2000 reforms and the implementation of these into regulations such as the Rural

Development Regulation (RDR) (1750/99), the so-called second pillar measures, and the Mid-Term Review proposal (Commission of the European Community, 2002).

Cross-compliance was introduced in the EU by the Agenda 2000 CAP reform. From then on member states were allowed to link environmental conditions to direct payments to farmers, independent of their production level. In June 2003 cross-compliance has become an obligatory element of CAP.

In the following Sections of this Chapter an overview will be given of the economic, environmental and ecological scientific perspectives and their relevance in assessing the impacts and consequences of CC[1].

2.3 Economic science perspective

2.3.1 Introduction

As was denoted in the previous subsection agriculture underwent dynamic changes increasing its productivity and the intensity of production. From an economic point of view in particular the use of non-factor inputs (like fertilizer, plant protection products, feedstuffs, etc.) strongly increased. The increased factor inputs together with the increased capital input played a role as a substitute for labour. Added to this was a long and steady process of technical and genetic progress in agriculture as well as its downstream and upstream industries. As a result of these developments total factor productivity increased substantially and partial productivity indicators like labour productivity and land productivity increased even more. Correlated to this is the increased pressure on the environment, landscape and animal welfare.

Not only the supply side, but also the demands on agriculture changed. The increase in real per capital, not only stimulated the demand for food and traditional agricultural production, but in a later phase also increased the 'demand' or willingness to pay for other non-traditional agricultural outputs wildlife and landscape, demand for leisure and outdoor recreation, more food safety, better quality of soil, water and air.

Summarizing, during the time when the supply of these environmental goods decreased and food safety issues became more complex (increased complexity of production chains, more concentrated animal stocks), the demand for them actually increased. Changes in demand co-determine changes in the institutional and policy environment. For example, ownership or property rights with respect to the environment which were traditionally part of agriculture are now contested. Farmers have to adapt themselves not only to changed price signals, but also to a new institutional arrangement giving agriculture its proper place in society. The

[1] No effort was done to include ethology and its perspective on animal welfare because this discipline seems less established and important than the other ones. The relevant outcomes of the animal welfare analysis will be discussed later.

introduction of Directives and Regulations on the environment, health, food safety, biodiversity, sustainable agricultural practices in the EU, the introduction of cross-compliance as an additional enforcement system, and also voluntary agri-environmental schemes (AES) with associated cost offsets are notable examples.

Elements that need to be addressed in an economic analysis regard the costs and benefits of regulations. A full evaluation and measurement of these costs and benefits (welfare impact assessment) involves great difficulties in practice and is beyond the scope of the current research (Gardner, 1997, 735). In the following the focus will be first on an impact assessment taking into account the farmer's behaviour (adjustments in input and output mix to mitigate the impacts of the regulation), including his decision to comply or non-comply with the imposed standards. Changes at farm level will translate into impacts at market level, both internally (changes in supply, prices and demand in home market) and externally (changes in trade and competitiveness).

2.3.2 Reasons for intervention

In economic theory the market economy is usually taken as a starting point to indicate the reasons for government intervention. If all conditions for perfect competition have been fulfilled, the operation of such an economy is efficient or Pareto-optimal[2] without government intervention. In practice, however, there are all sorts of imperfections, which results in market failure. A main reason is the negative and positive externalities created by agriculture. These externalities are side effects of agricultural production, which are not taken into account in the production decisions of farmers, but create negative or positive effects (costs/benefits) elsewhere in the economy or in society. Examples are the loss in biodiversity due to agricultural activity, environmental externalities, impact on animal welfare, surface water contamination due to soil run-off (erosion) or overuse of fertilizers and/or organic manure (eutrophication), etc. In other cases, like food safety, they might in principle be taken into account by the market, but still there consumer trust is a collective good, where 'free rider'-behaviour of some farmers (maybe leading to a food scandal) can have large negative effects for many others. Some collective action, therefore, also here applies.

The existence of market failure implies that there are some opportunities for mutual gains that are not being exploited. This means that there are other feasible allocations in which everyone can be better off that are not attained. Market failure can be a reason for 'corrective' government intervention. There are various types of market failure (DEFRA, 2005, 11-13):

- the presence of externalities –where a market transaction has a negative (or positive) impact on third parties who are not party to the transaction (e.g. pollution, landscape). As a consequence the full costs and benefits of actions involving externalities are not reflected in market prices;
- public goods –good which owing to their nature are not typically provided by the private sector (e.g. access to clean air and water, guarantee of food safety). As a

[2] Pareto optimal implies that an equilibrium allocation results which has the property that no one's situation can be improved without at the same time worsening the situation of someone else.

consequence of the non-rivalry and non-excludability of public goods the market will either fail to provide or underprovide these goods;
- informational failures –problems with the amount of information or imbalances (asymmetric information) in its availability to different parties to a transaction (e.g information about the health status of animals). This will in general lead to inefficient outcomes;
- failure of competition –imbalances in market power across the supply chain. Farmers often buy and sell into markets that are considerably more concentrated that farming itself, which can lead to unfair competition.

Besides market imperfections the government can also act to achieve goals that are not usually met by the market mechanism. Together these two reasons constitute the basis of government intervention from the viewpoint of economic theory. However, from an economic perspective, market failure is a necessary but not sufficient condition for justifying government interference. Not only markets but also governments can fail. The same factors that lead to the persistence of market failure (transaction costs, monitoring and enforcement costs) can adversely affect government intervention (DEFRA, 2005, 14). When screening government policies, those in agriculture not excluded, one often finds inconsistencies, unforeseen adverse consequences of interventions (e.g. price support and environmental sustainability under the CAP), policies failing to achieve the stated objectives, and even policies without clear objectives (non-SMART policies). Although policies are repeatedly ‘reformed’ the aforementioned problems are often rather persistent.

2.3.3 Policy tools

The government can use numerous policy instruments to influence behavior and alter incentives. Each of these instruments has its advantages and disadvantages, strengths and weaknesses. It is beyond the scope of this study to provide a detailed evaluation. A short summary will suffice to see the alternatives and put the cross-compliance *cum* regulation-approach into a wider policy perspective. Available policy instruments are:

- direct regulation – a command and control approach using obligatory standards and licenses that require people to change their behavior and punishes them if they are detected to be non-compliant;
- economic instruments – includes all instruments changing price incentives (taxes, subsidies, tariffs), but also quantity constraints ((tradable) quota, tariff rate quota), and charges. Instruments give people incentives to voluntary (e.g. based on their own rational cost-benefit calculations) change their behavior;
- voluntary approaches – could be codes of good practice, self-regulation and other industry-led initiatives. Financial incentive schemes could be part of these instruments. These approaches typically encourage rather than force people or businesses to show the desired behavior;
- information and advice sharing systems – policies aimed at raising the awareness and facilitating changes in behavior;
- market-based signalling approaches – labelling, traceability, voluntary certification schemes and farm assurance schemes. These approaches are often related to

informational problems (lack of information about product quality and food safety) hindering the proper functioning of markets.

Cross-compliance policies, which were initially developed and applied in the US, aim to make farmer participation in certain government farm programs contingent upon the farmers attainment of certain standards (the “red ticket approach”). Alternatively, cross-compliance could also imply that the benefit of farm assistance programs increase if farmers met or exceeded certain standards (the “green ticket approach”) (Batie and Sappington, 1986). Cross-compliance as currently applied in the EU, affects farmers eligible for direct payments under the common agricultural policy (CAP, Pillar I single farm payments), by deducting part of the these payments in case they are detected to violate one of the 19 statutory management requirement (SMRs) Regulations and Directives, or of the 11 requirements of good agricultural and environmental (GAECs) practices. Whereas the SMRs consisted all of pre-existing legislation, only the GAEC requirements included some new standards. As such the EU’s cross-compliance policy operates mainly as an additional enforcement mechanism for existing legislation. Cross-compliance is an instrument to reduce conflicts between farm support policies and environmental and conservation policies (Stonehouse, 1996).

2.3.4 Method & framework of analysis

The first step of an economic analysis of the impacts of government policies and regulations will be an assessment of the impacts they have at farm level. Subsequently, derived impacts on markets and trade are discussed. The neoclassical theory of producer behavior (profit maximization) is a natural starting point. However, when one would like to take into account a broader range of factors than only financial incentives (such as prices, direct payments, subsidies, etc.), like for example risk aversion, an expected utility maximization framework is more appropriate to explain producer behavior. Alongside the neoclassical economic theory, concepts and insights from (new) institutional economics (like transaction costs, property rights, reputation, hidden information, hidden action, social capital, and trust) seem relevant to exploit.

In the following a brief description of the potential contribution of both approaches is described. Whereas the economic theories of regulation cover also other issues like regulation design, the rationale for regulation to improve social welfare, the political causes of regulatory policies, and the anatomy of a disaggregated contractual and organizational framework of public governance, these will be non dealt with as these elements are beyond the scope of the current research (see Hägg (1997) for a rather complete overview).

2.3.5 Neo-classical economics approach to producer behaviour

According to the standard neo-classical model, farmers maximize their profits subject to a production technology constraint. The standard outcome of this optimization problem is a (short-run) system of variable input demand and variable output supply relationships, which are a function of input and output prices, quasi-fixed factors (capital, land, family labour), and dynamic shifters like technological change and genetic progress. If some inputs or outputs are restricted (e.g. the milk quota) than these restricted variables are also included in the set of explanatory variables. The outcome of the optimization reflects the farmers decisions regarding input and output mix, where increasing costs of production (input price increases) lead generally to a decline in input demand as well as output supply. Increasing output prices, in contrast, show a reversed effect: they lead to an increased output supply as well as increasing demand for variable inputs. Technological change increases factor productivity (same output mix can be produced with less inputs; or with same inputs more output can be produced) and can have a neutral or a biased character (e.g. labor saving, land saving, etc.). For land-based agricultural productions technical change usually implies over time shifts of the supply relationships therewith increasing supply. In the intermediate or long-run also the quasi-fixed factors (capital, lands, …) are likely to adjust, making supply and demands more responsive to prices than is the case in the short-run.

Understanding the impact of regulation within the neoclassical economic framework can be obtained in three steps:

Firstly, one could include regulation as further constraints on production possibilities, and therewith as factors affecting the production technology (Sutinen, 1988). Since imposed regulations reduce the production possibility set (excluding possibilities that were allowed without the regulations being imposed) in general they are expected to negatively affect production or to increase the costs of production. Defining output supply vectors as q(.) and input demand as x(.) a typical solution to this problem would be

$$Max\,\{pq - wx \mid f(q,x;t,\bar{r})\} \quad \Rightarrow \quad q(p,w;t,\bar{r}), \quad x(p,w;t,\bar{r}) \qquad (1)$$

where *p, w, t, r* represent respectively a vector of output prices, input prices, technical change, and a vector of regulatory constraints r, with the bar indicating that they are assumed to be binding (i.e. restricting the farmer's behavior). Substituting the supply and demand relationships into the profit condition would yield the dual (optimum value) profit function $\pi(p,w;t,\bar{r}),$ which gives the profits associated with the regulatory regime. As denoted before the profits including the regulatory constraint impact will be lower than without the regulation, i.e. $\pi(p,w;t,\bar{r}) \leq \pi(p,w;t).$ The drawback of this first approach is that it is implicitly assumed that the regulatory constraints are fully integrated in the farmer's behavior. In other words, regulations are fully respected and there will be full compliance to them.

Secondly, one could allow for the possibility that farmers might violate the regulations or show non-compliant behavior. Rather than respecting the regulation the farmer could choose a level $r\,(>\bar{r})$ rather than the restricted level $\bar{r}$. For example, the farmer may decide to choose an organic manure application on grassland which goes beyond the regulated level of 170kg N/ha. In this case the difference $(r-\bar{r}),$ i.e. the amount of manure application exceeding the imposed standard is illegal. If the farmer violates the regulation there are in principle two possibilities. His violation is detected and then a punishment follows, or his violation is non-detected. If detected a penalty fee is imposed on the farm in an amount given by g, which will usually be a function of the degree of violation, i.e. $g = g(r - \bar{r})$. So if detected

$$g > 0, if\ \ r > \bar{r};\ \ g = 0\ otherwise$$

and

$$\frac{\partial g}{\partial r} \geq 0, \quad \frac{\partial^2 g}{\partial r^2} \geq 0 \quad \forall r > \bar{r}$$

where it is implicitly assumed that g(.) is a continuous function and differentiable for all $r > \bar{r}$.

Let $\pi(p, w, r; t)$ be the (dual) profit function, where r denotes the level of the regulated activity the farmer would choose in case not restrictions are imposed (i.e. the level corresponding to $\partial\pi/\partial r = 0,$ or with a zero impact on marginal profits). More generally the impact of a change in or restriction on *r* on profits could be derived from impacts on revenues (e.g. yield reduction) and/or costs (including costs due to adjustment to a more expensive input mix, additional labor input, expenses for paper work and record-keeping activities, licenses, charges, etc.). Figure 2.1 provides a graphical presentation of the firm’s revenues, supply (e.g. the marginal costs curve), and its variable average and variable fixed costs. Since in principle variable costs (and consequently also marginal costs and thus supply) are a function of the regulatory constraint, imposing a binding regulation is likely to lead to an upward shift of the cost curves. Given an unchanged product price level output supply will decline with *dq*. So, as soon as *r* becomes a regulated factor it will impact on profits and a relaxation of the constraint would create a positive impact on marginal profits, i.e. $\partial\pi/\partial r > 0$.

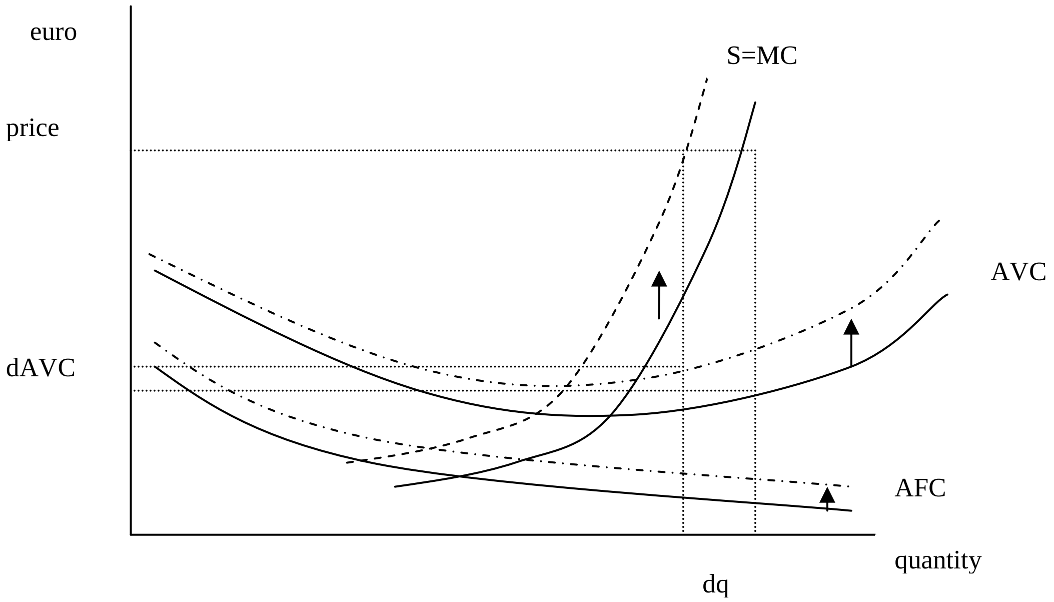


Figure 2.1 Regulation and the firm's revenues, costs and profits

In an imperfect law enforcement system not every violator is detected. Let the probability of detection be given by θ. If detected a punishment follows and the farmer's profits will be equal to his profits without taking into account the regulatory constraint $\pi(p,w,r;t)$ less the punishment fee $g(r-\bar{r})$, or equal to $\pi(p,w,r;t)-g(r-\bar{r})$. If not detected the farmer's profits are $\pi(p,w;t)$. Although r is not included as a specific argument of $\pi(p,w,r;t)$. Accounting for the probability of detection, the expected profits are

$$\theta\left[\pi(p,w,r;t)-g(r-\bar{r})\right]+(1-\theta)\pi(p,w,r;t) \qquad (2)$$

Assuming farmers maximize expected profits, the first order condition for the optimal *r* level is

$$\frac{\partial\pi(p,w,r;t)}{\partial r}\geq\theta\frac{\partial g(r-\bar{r})}{\partial r} \qquad (3)$$

where he inequality is due to the discontinuity allowed for in the punishment function for the case $r=\bar{r}$. The optimality condition presented in (3) shows that the farmer will evaluate the marginal profits of violating the regulation against the expected marginal penalty. In general he will choose a level of *r* for which the marginal profits are equal to the expected marginal punishment penalty.

Figure 2.2 provides a graphical representation of the solution as obtained in equation 3. The downward sloping curve is the marginal profit line (see left hand side of 3), whereas the upward sloping curve reflects the expected marginal penalty. If there would be no penalty $(g=0)$ or enforcement of the legislation (no chance to be detected as a violator; $\theta=0$) the farmer would choose level r_{free}. If the expected marginal profit lies above the expected marginal penalty the farmer chooses to be non-compliant with the regulation $(r^* > \bar{r})$. The range $r^* - \bar{r}$ where the marginal benefits of violation exceed marginal costs (penalty), is the range where it is 'efficient' for expected profit maximizing farmers to act illegally and violate the regulation. Note that $r^* < r_{free}$. The degree of violation is determined by the intersection of the curves, i.e. the point where marginal profits equal the expected marginal penalty.

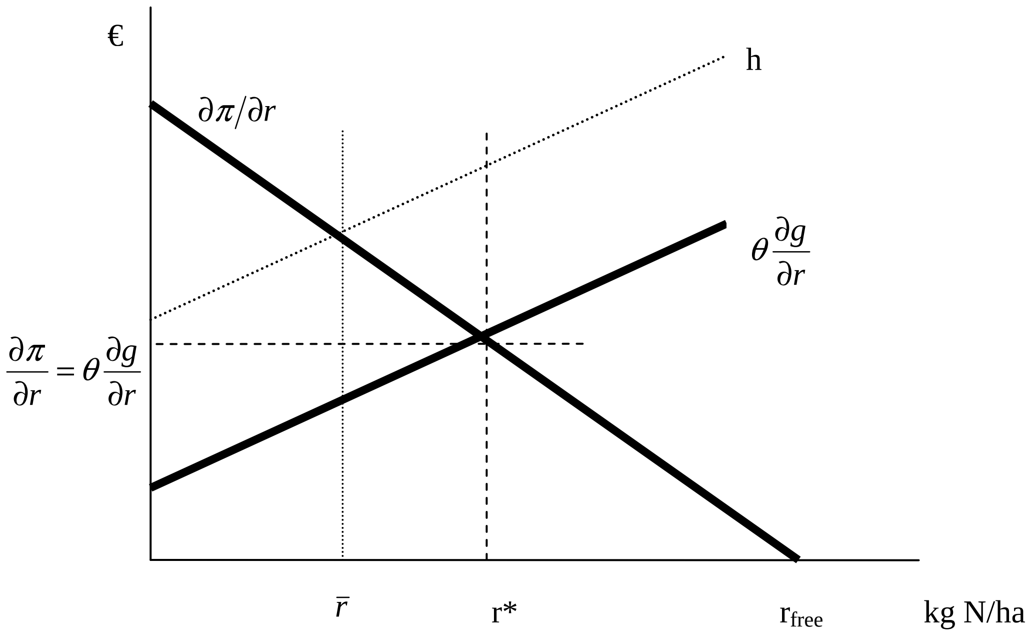


Figure 2.2 Regulatory enforcement and compliance

With the help of Figure 2.2 some further insights can be demonstrated. Everything else kept constant (*ceteris paribus*-clause) it holds that:

- if the probability of detection increases (for example due to a more intensive inspection and monitoring regime) the expected penalty curve will shift upward, implying a decline in the farmer's choice of *r* (the degree of violation will decline);
- if the penalty function *g* changes in such a way that the marginal penalty is increased (curve becomes more steeply upward sloping) this will reduce the amount of violation;
- if the penalty function *g* changes because a fixed penalty amount would be added (e.g. an increase in the intercept or upward parallel shift of the marginal penalty

curve) the penalty could become so high that the for the farmer it becomes optimal to fully comply with the regulation (see penalty curve *h* in Figure 2.2);

- when the conditional farm support payments that are first used to increase the penalty on non-compliance, are subsequently reduced, this leads to a downward shift of the penalty function, with an expected increasing degree of non-compliance;
- a decline in output prices will shift the marginal profit curve downward, implying a decline in the degree of violation of the regulation;
- an increase in input prices will shift the marginal profit curve downward, implying a decline in the degree of violation of the regulation;
- an increase in the direct costs of compliance will shift the marginal profit curve upward and increase the degree of violation of the regulation;
- in general the marginal profit curve will depend on farm scale, the farm's site-specific conditions, and the available set of on-farm and off-farm choices for alternative activities;
- an increase in the restrictiveness of the regulation (reducing the allowed kgN/ha, or moving $\bar{r}$ in the direction of the origin) will increase the degree of violation;
- technical progress (increase in productivity) is likely to create an upwards shift of the marginal profits curve, and as such imply an increase in the degree of violation of the regulation;
- if the regulator could observe information about the farmer's marginal profit relationship, this could be used as a risk of violation-criterion and be included in the sample selection for inspection. Effectively this would imply an increased probability of detection.

The introduction of obligatory cross-compliance together with a system of partially decoupled payments and intervention price declines for certain products (Luxembourg Agreement, 2003) implied a strengthening of the enforcement system of the regulations included in the cross-compliance package. So already before the arrival of CC farmers faced unconditional binding obligations (the pre-existing SMR legislation). However, CC added to this the single farm payment to be made conditional on compliance with these regulations, therewith adding to the leverage exerted on farmers[3]. When violating the regulations, alongside the normal legal punishment, farmers could lose (part) of their single farm payments. Moreover, a more strict monitoring and inspection regime was imposed (1% of the farms should be inspected each year, with sample selection based on risk profiles of farmers). In terms of the model and Figure 2.2, discussed above this implies a combination of impacts. At the same time the effective sanction is increased, and relative to the initial situation the probability of being detected increased (implying an upward shift and upward rotation of the penalty curve). Moreover, some further agricultural product

[3] In their study on environmental cross-compliance the OECD (forthcoming) argues that making legal requirements the subject of cross-compliance creates a redundancy. However, this presupposes that the legal sanction system is adequate and proper in inducing a full compliance with the regulations and that the monitoring and inspection intensity remains the same. With cross-compliance usually a systematic inspection regime is imposed, whereas under normal legal requirement this is not always present. Moreover, in practice the legal sanction systems are often not sufficient to ban out all non-compliance behaviour. So CC can be relevant also for already existing binding statutory management requirements.

price declines were pursued (downward shift of the marginal profit curve), which were partly compensated by means of direct payments (where the latter ones became part of the sanctioning mechanism, thereby increasing its effectiveness)[4]. From the theoretical framework developed so far this should clearly provide farmers an incentive to improve their degree of compliance to the regulations.

The framework as sketched above can be called a pure deterrence model of regulatory compliance, focusing primarily on the certainty and severity of sanctions as key determinants of compliance. The farmer is considered to be a calculating *homo economicus*, making a simple cost-benefit analysis, and basing his compliance decision solely on this exercise. When looking to reality it seems appropriate to acknowledge that the framework presented above only provides a partial explanation. In order to offer a more complete explanation of compliance a more encompassing framework is needed, which also takes into account information from psychology and sociology. A full understanding of compliance behavior requires that both tangible and intangible motivations influencing the farmer's compliance decision are taken into account. Alongside costs and revenues associated with illegal behavior in particular factors like risk-aversion, moral obligation and social influence should be taken into account.

A third approach remedying some of the shortcomings of the cost-benefit evaluation of deterrence model is the socio-economic theory of regulatory compliance (Sutinen and Kuperan, 1999). Rather focusing on profit maximization, farmers are now assumed to maximize utility, where utility $U(.)$ is a function of profits, include moral attitudes $m(r-\bar{r})$ and social influence factors $S(r-\bar{r})$, and the shape of the utility function reflects a farmer's attitude to risk (risk-aversion if the second order derivative $U_{\pi\pi} < 0$). If the individual complies with the regulation than the level of personal moral standing is given by $m(\bar{r}-\bar{r})$. If violating the regulation is contrary to the individual's values than $\partial m/\partial r < 0$ for $r > \bar{r}$. As regarding the social influence-factor, if violating the regulation is against the social norm, than $\partial S/\partial r < 0$ for $r > \bar{r}$. For convenience sake it can be assumed that a farmer's social reputation is affected only when detected and sanctioned by the enforcement authorities[5].

Within this framework, a farmer will decide to violate the regulation if and only if the expected utility of non-compliance is greater than the utility associated with complying to the regulation (e.g. $U(\pi(p,w,\bar{r};t),m(\bar{r}),S(\bar{r}))$). Or alternatively, the farmer will only violate the regulation if

$$\max \theta U([\pi(p,w,r;t)-g(r-\bar{r})],m(r),S(r)) + (1-\theta)U(\pi(p,w,r;t),m(r),S(r)) \geq \max U(\pi(p,w,\bar{r};t),m(\bar{r}),S(\bar{r})) \qquad (4)$$

---

[4] This underscores the need when assessing the impacts of regulatory policies to put them in a proper context and not in isolation. Market and price support policies, modulation of direct payments, cross-compliance and regulations interact.

[5] The social norm is likely to confirm compliance with regulations, but this might weaken if the (perceived) legitimacy of a regulation or the associated monitoring and inspection of it decline in the farm community.

Sutinen and Kuperan (1999) provide a detailed analysis of this model, including a full analysis of its comparative statics. From their analysis several further implications follow with respect to compliance decisions. More specifically:

- a farmer will violate the regulation up to the point where the marginal profit of violating equals the expected marginal penalty augmented by the risk factor. Risk aversion will reduce non-compliance relative to the framework discussed before;
- if violating the regulation is contrary to the farmer's individual moral values (intrinsic motivation), this will reduce his level of non-compliance, and more generally also the number of violations;
- if violation is against the social norm and negatively affects the farmer's social standing, this will reduce the degree of violation of the regulation and also the number of violations.

The main lesson from this socio-economic model of regulatory compliance is that risk aversion, combined with moral obligation and social influence potentially can generate significant levels of compliance, even in the face of a weak deterrent effect. Although the socio-economic framework looks attractive due to its encompassing character, at the same time it includes a number of factors which are rather difficult to operationalize and empirically measure. This holds in particular for moral obligation and social influence and less so for risk-aversion. Although factors like moral obligation and social influence are acknowledged, they cannot easily be taken into account in standard economic production or market models. For this reason the framework as was presented secondly seems to be most suitable for exploiting it in the current analysis.

Aside from the economics of compliance it is worthwhile paying attention to a wider range of economic impacts. As was already suggested by Figure 2.1 imposing regulation on to a sector might lead to changes in individual firm's supplies. Aggregating over all individual firms, regulating has a potential impact on the market supply as a whole. As such this can lead to changes in production, demand and prices, as well as trade patterns (see Larson, 2000 and Larson et al., 2002 for a further discussion of potential trade impacts). Moreover, since different farms are likely to be affected in a different way (e.g. farms inside and outside a Natura 200 area, or inside or outside a Nitrate Vulnerable Zone). With this, it becomes clear that regulation might have distributional impacts. More generally this implies that regulatory constraints potentially impact on internal (within a country) and external competitiveness.

Figure 2.1 already showed that imposing regulatory constraints will induce the profit maximizing farmer to re-optimize his behavior in order to optimally adjust his input and output mix to the new with-regulation-situation. This adjustment process, aimed at mitigating the negative impacts of the imposed regulation, is likely to influence both short-run decisions (adjustment in variable factors; see shift of AVC-curve in Figure 2.1), as well as long-run decisions (adjustment of fixed factors by means of (dis)investments). As a consequence of these short-run and longer-run dynamic adjustments the net costs of regulatory constraints might not be constant, but evolve (decline) over time. Although not illustrated in Figure 2.1, the increase in costs due to the regulation could potentially affect the exit and entry of firms in the sector.

Depending on the severity of the regulatory constraints also the farm size distribution and structure could be affected.

2.3.6 Neo institutional economics and regulation

Neo-institutional economics provides a different perspective to regulation. As compared to the neo-classical approach it focuses more on regulation design, the structure of the regulation requirements, issues of legitimacy, trust in the government, principal-agent relationship, asymmetric information and associated phenomena like moral hazard and adverse selection, etc. It is impossible to provide a complete overview of the institutional economics of regulation. In the following no attempt will be made for completeness, but only a number of selective issues which are considered to be relevant will be discussed. Subsequently, regulation as a coordination device, an institutional comparison of cross-compliance and agri-environmental schemes, the role of imperfect information, screening, signaling, and conflict resolving will be discussed.

One way to look at cross-compliance is to see it as an (additional) element in a context where the government likes the farmers to behave in a certain way and respect certain standards. Regulation, cross-compliance, voluntary certification schemes, etc. are all coordination mechanisms, which however differ in character and functioning. Borgen and Hegrenes (2005) provided an integrating scheme, which is, adjusted to the current context of coordination in agriculture, presented in **Error! Reference source not found.**. Within this scheme four general ways to coordinate behavior or actions:

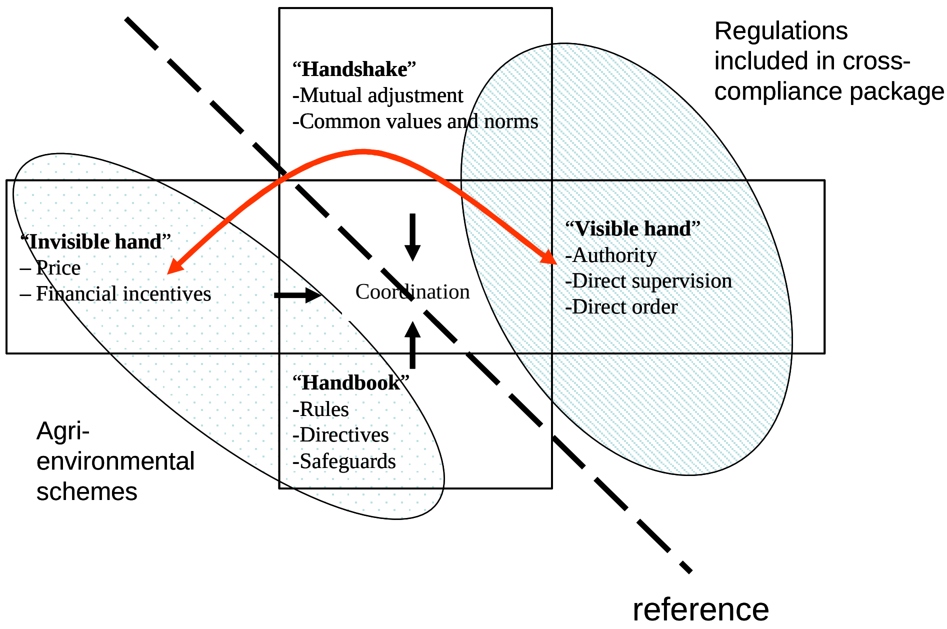
- the 'invisible hand' or market mechanism with the price as a central coordination devise;
- the visible hand approach, characterized by hierarchy, direct orders and supervision;
- 'handshake' based on shared norms, agreed on codes of conduct and mutual adjustment;
- the handbook-approach, in particular relevant when parties rely on the contracting mechanism.

The various regulations and directives in the EU regulating preservation of biodiversity, environmental quality, health, food safety, animal welfare and good agricultural practices, clearly belong to the visible hand-category (see right-hand side of **Error! Reference source not found.**). Where the visible hand nature is clear and dominant, the cross-compliance regulations sometimes include some elements of handshake and handbook. This in particular holds for the GAECs, where member states are left a considerable degree of freedom to specify how codes of good agricultural and environmental practices are defined. Member states used this room for maneuver to adapt their code to local circumstances, practices and often included pre-existing national legislation. Moreover, within the GAECs farmers are required to come up with plans to handle erosion, which should be adequate but are not subject to a large number of pre-specified and strict criteria. As such they reflect an element of contracting.

The European Commission does not exclusively rely on direct regulation in these areas: notable examples are the agri-environmental (AES) schemes, which rely on voluntary contracting and financial compensations. They could be categorized as a hybrid of handbook (contracts) and invisible hand (voluntary participation and price as a used incentive mechanism) (see **Error! Reference source not found.**, left side). The choice for voluntary (AES) schemes or (obligatory) direct regulation as coordination devices seem to be linked to what is considered as a reference level. The reference level specifies some minimum-standards, which agriculture is supposed to meet in order to get its 'license to produce' from society. Behavior falling below this reference line (see dotted line in **Error! Reference source not found.**) is regulated. Desired behavior going beyond the reference level of 'what society could reasonably ask' (see area to the right of the dotted reference line in **Error! Reference source not found.**) is coordinated on a voluntary basis and facilitated by financial compensations. By using the financial compensation mechanism, it is implicitly acknowledged that farmers own the property rights on any actions above the 'minimum'-line, and have to be paid if 'further services' are asked.

The neo-classical economic perspective (see previous subsection) has a natural preference for coordinating behavior by the invisible hand, and if this is not possible (in case of public goods, externalities or other kinds of market failure) to develop coordination devices that come sufficiently 'close' to market allocation (group contracting with financial compensations). The reason for this is the well-established efficiency properties of market allocation (e.g. the First and Second Fundamental Theorem of welfare economics). The institutional economics perspective emphasizes that in a world of incomplete information, with temptations to opportunistic behavior, high transaction costs, and a lack of well-defined property rights direct regulation can be an efficient and practical low cost coordination mechanism. An important difference between the two coordination devices is the degree of voluntariness and compensation for the loss in property rights.

Figure 2.3 Coordination mechanisms (adapted from Borgen and Hegrenes, 2005, 12)



Whereas the linkage of financial compensation and voluntary contracting are natural hybrids, this is less so for direct regulation. However, the specific new element introduced with obligatory cross-compliance is that financial incentives enforcing the regulations are introduced, which come on top of the normal (financial) punishment schemes ruling non-compliance (see the double arrow connecting financial incentives with visible hand measures in **Error! Reference source not found.**).

The principle to combine financial incentives with regulation is known to be effective in case a principal would like to ensure good performance to standards of agents[6]. In a world of imperfect and asymmetric information monitoring farmers' behavior is very costly. Moreover, legal penalties could be sometimes small relative to commercial interests, creating temptations to slack-off and violate regulations even when this is considered to be illegal. By making the direct payments provided to farmers (Single Farm Payment) under the CAP conditional on their compliance with the specified regulations, the government makes it very costly for them to be detected as a violator. As such this contributes to a reduction in the monitoring costs required for an adequate enforcement of the regulations (e.g. Varian, 2003, 686).

The institutional economics approach pays a lot of attention to imperfect information and incentive compatibility issues. Two ways which can help to reduce informational problems mentioned in this literature are screening and signaling. Screening refers to activities undertaken by the regulator (who lacks access to the farmer's private information) in order to separate different types of agents along some dimensions. The regulator than demands and exploits information about observable characteristics

[6] An example is the posting of bonds in order to guarantee good performance. If performance is satisfactory or specified targets are reached the bonds are paid back. Cross-compliance can be interpreted as an inverse way of bonding.

that are assumed to be sufficiently correlated with unobserved or difficult to observe, but desirable behavior of agents. Within the cross-compliance context screening is used in the assessment of risk profiles before making a final selection of farms that will be inspected. Included in this is the farmer's past behavior (earlier detected non-compliance increase the probability to be in a follow-up inspection sample). Screening improves the efficiency of the monitoring and inspection regime, and by increasing the chance of violators to be detected, it will also contribute to an increased compliance with the regulations (see formal analysis provided in previous sub section).

Alternatively farmers may want to signal which type they are, and thereby reveal information. For signaling to be effective the receiver of the information must believe that the signal is credible. Signaling brings in the linkage that might exist between compliance to obligatory standards and voluntary certification schemes, which also imply adherence to certain, sometimes closely related, standards. These voluntary certification schemes, which are primarily commercially driven (often aimed at earning a premium in the market by product quality differentiation), have their own monitoring and inspection mechanisms. A farmer participating in a voluntary animal welfare participation scheme may have committed himself to standards which are as strict or go beyond the legal requirements as specified in the EU regulation. The government may, depending on their having access to the information and trust in the enforcement and monitoring of the private schemes, use information about participation in voluntary certification schemes in their risk profile selection. Moreover, combining participation rates and the number of violations may be used as an indirect way to get a best estimate of the degree of compliance to obligatory standards, in case reliable information is not directly available. Both the screening and signally mechanisms underline the potential importance for farmer of building up reputation.

In particular when contracts or regulations are complex and have a longer-term duration the institutional economics approach emphasizes the need for a conflict-resolving mechanism (Ostrom, 1994, 94-100). This is in particular relevant because most contracts are incomplete (not everything could be specified on forehand). However, a similar phenomenon might play a role in case of direct regulations. Uncertainty and confusion about the exact interpretation of regulatory requirements may lead to inefficiencies (unpredictable treatment of 'similar' cases, legal cases, distrust, additional costs of compliance necessary to be sure to be on the 'good side' of the confusing or complex standard) and lack of commitment (legitimacy problems). There is anecdotal evidence that this too some extent plays a role with respect to cross-compliance[7] (Jongeneel, 2007). The farm advisory system provided alongside the introduction of obligatory cross-compliance could be seen as an instrument to reduce uncertainties about the exact requirements and their interpretation. Moreover, first experiences could be used to learn and further adapt the

[7] Cross-compliance as an enforcement mechanism has to be distinguished from the regulations, which specify and impose the requirements. However, sometimes only a part of certain regulations (e.g. the Nitrate Directive) is included in cross-compliance, which might in itself create confusion, in particular when different inspection agencies come to farms to inspect different aspects of the same underlying regulation.

instrument (the desire of the Commission and Member States to simplify policy regulations indirectly also relates to this issue).

Summarizing, this section motivated which are the key elements that have to be taken into account when evaluating the economic impacts of regulation and the role of CC as an instrument to enhance compliance with regulations. The elements playing a role in the farmer's compliance decision were spelled out. Moreover, a number of institutional economic issues, among them the economics of imperfect information, strategic behavior, conflict-resolving, and potential interrelatedness of obligatory and voluntary standards, have been considered. Economic theory, therewith, provides an instrument to explain the compliance decision, or to include this decision in an endogenous way in economic models. Whether this latter option will be really feasible within the context of this project depends on the availability of sufficient empirical information.

2.4 Environmental science perspective

As discussed in the former, EU agriculture has experienced important changes which has generally lead to both intensification, extensification and land abandonment. In most European countries, agriculture is also one of the most important land use activities and can be considered as a sector with important impacts on the water, air, soil and climate.

The results of the IRENA operation on agri-environmental indicators (EEA, 2005b) but also several other studies (e.g. EEA, 1999; EEA, 2004; EEA, 2005; Carey, 2005 ; Petit et al., 2004; Agra CEAS et al., 2003 ; Jørgensen and Schelde, 2001; Boatman et al., 1999 etc) have shown that the most critical environmental areas agriculture is impacting on are:

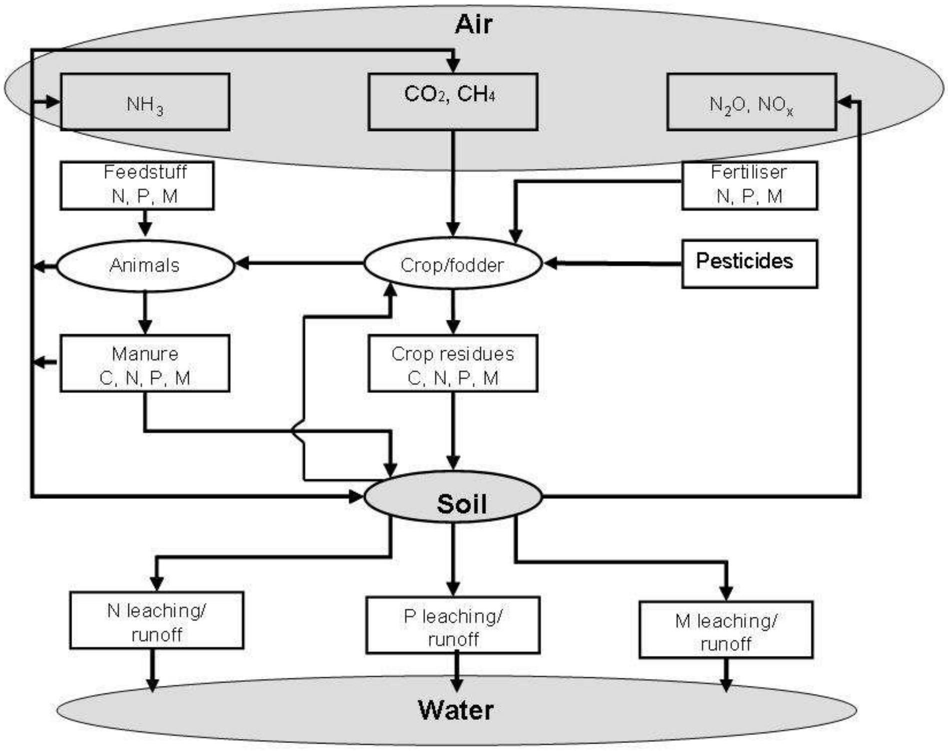
a. Greenhouse gas and ammonia emissions from agriculture caused by high concentrations of livestock, mineral fertiliser consumption, intensive farming practices (tillage and frequent ploughing) affecting both air quality and climate change.

b. Diffuse pollution from agriculture affecting the (chemical) quality of soil, ground and surface waters. Agriculture is viewed as the main non-point source of nitrogen input to ground and surface water. It also contributes significantly to pollution of soil and water through leaching and runoff of phosphorous, heavy metals and pesticides. Key drivers for nutrient losses from agriculture are use of fertilisers, pesticides, concentrate feeding, high livestock densities and farm management practices. Actual losses are further influenced by environmental factors, including soil type and related soil properties, such as organic matter and clay content, hydrological status, temperature and precipitation.

c. Soil erosion and degradation affecting the physical quality of the soil. It is caused by two main agriculturally induced processes: soil compaction and soil erosion. Areas degraded by soil compaction are increasing because wheel loads in agriculture are still increasing (JRC, 2005). Soil compaction of the topsoil or subsoil involves an increase in the density of soil particles and pores. Compaction can reduce water infiltration capacity and increase erosion risk by accelerating run-off. Soil compaction to ever-greater depth has adverse effects on the soil biodiversity and soil structure and may lead to problems, such as disturbed root growth. At this moment we see that European soils are more threatened by soil compaction than ever before. It is now the first in the ranking of soil damages just before soil erosion (EEA, 2005). Soil erosion in Europe is especially a problem in the Mediterranean region, which is characterised by long dry periods followed by heavy bursts of rainfall, falling on steep slopes with instable soils (EEA, 2005). Because of the dry summers in these areas, soil cover is also limited in summer which increases the risk for erosion in autumn when the rainfall starts. In the Northern parts of Europe erosion by water is not such a problem as rainfall is spread out more evenly over the year and there are fewer regions with steep slopes and shallow soils. Nevertheless tightening of crop rotations and increase of maize acreage in the last decades contributed to soil erosion. Beside water erosion, there is also erosion caused by wind. This is a problem in more open, flat or undulating terrain with sandy soils where soil cover is limited over the year and wind-breaking landscape elements are missing.

The agriculturally induced effects on the (chemical) quality of soil, water and air can be systematically illustrated by a flow chart (See Figure 2.4). This flow chart is a simplified picture of the fate of carbon, nitrogen, phosphorous and metals that enter into the environment and affect the quality of the soil, ground and surface water, and air. The resulting chemical changes to the air in terms of increased Green House Gasses (GHG) potentially affect our climate.

Figure 2.4 Main environmental fluxes in agriculture



C = carbon

N = nitrogen

P = phosphorous

M = metals

Fluxes of ammonia and green house gases to the atmosphere occur both in housing and manure storage systems and due to grazing in the field and land application of animal manure and fertilizer. NH_3 and CH_4 emissions from housing and manure storage systems and from (grazing) animals (specifically CH_4 from ruminants) are an important source of N and green house gases from land use systems. The systems in which animal slurries are stored and collected are an important source of NH_3 and CH_4, but emissions of N_2O and NO_x are small in these slurry-based systems. By contrast, the emissions of N_2O and NO_x and total denitrification losses can be high in systems in which solid manures are collected and stored. Ruminants are an important source of CH_4. Methane is produced by bacteria in the rumen as by-product of fermentation and is directly emitted by the animal.

In general NH_3 emissions from the field due to land application of animal manure and fertilizer are lower than those from housing systems, but it is in the same order of magnitude. CH_4 emissions in the field are however much lower, specifically in agricultural areas. Inversely, there is generally a small uptake of CH_4. Unlike this, the emissions of NO_x and N_2O due to land application of animal manure and fertilizer are generally much higher than those from housing systems due to the occurrence of nitrification and denitrification in the field, being the processes in which NO_x and N_2O is formed.

The input of nutrients by animal feed (N, P) and the related inputs of e.g. metals such as Cu and Zn, are largely excreted and this animal manure is then applied on the land. In addition fertilizer is applied, including nutrients (N, P) but also contaminations with metals, such as Cd. When these inputs exceed the net plant removal, it will lead to soil accumulation (specifically for P and metals) and to leaching and runoff to ground water and surface water. In addition, use of pesticides may lead to pesticide leaching.

Farming practices that affect thus the emissions of NH_3 and green house gases and the leaching of nutrients most strongly are:

- A reduction in N excretion (by animal feeding), reducing NH_3 emissions from housing systems but also lowering land application and thereby reducing NH_3, NO_x and N_2O emissions from the land and NO_3 leaching and runoff to ground water and surface water.
- Measures focusing on a reduction of NH_3 emissions by housing systems or land application (e.g injection) but this may lead to increased N_2O emissions and NO_3 leaching (pollution swapping)
- A reduction in P or metal excretion (by animal feeding), reducing P and metal accumulation and leaching and runoff to ground water and surface water.

In CCAT, we include all aspects that can be quantified in a reasonable way on a European wide scale. The lack of information on pesticide use on a European wide scale and the complexity of modelling pesticide behaviour makes it difficult to make adequate predictions of pesticide accumulation and leaching in response to measures. Consequently, the impact of cross-compliance measures on pesticides is not included in the integrated environmental modelling framework but might be considered in a more simple knowledge based indicator not involving any modelling approach.

Considering the information given above, the overall objective of the modelling framework is to assess the impact of cross-compliance measures on air- (and climate), soil-, and water quality in terms of:

- Atmospheric emission of ammonia and green house gases (air quality and climate)

- Soil accumulation or release of carbon (organic matter) and possibly also phosphorous and heavy metals (chemical soil quality)
- Soil erosion (physical soil quality)
- Leaching and runoff of nitrogen and possibly phosphorus, and heavy metals (water quality).

2.5 Ecological science perspective

While numerous studies exist on biological diversity at the micro level (see Cervigni, 2001, for an overview), the knowledge is more limited and less quantifiable regarding the relationship between farming practices and biodiversity at the wider scales. It is however well known that the intensification associated with the Common Agricultural Policy has entailed profound changes in the functioning of European agro-ecosystems. Traditionally, these consisted mainly in complex mosaics of extensive grasslands and crops with interspersed remnants of natural habitats (Potter, 1997). In the last 50 years however, the changes in farming patterns have been driving a process of biodiversity loss which is considered to be equivalent to that foreseen to be caused by climate change (Krebs et al. 1999).

From the biodiversity point of view, the intensification of European agriculture has been linked to two main trends (Potter 1997): 1) An increased use of certain production factors per surface unit, such as agrochemicals (fertilizers, herbicides and pesticides) and machinery (more intensity and frequency of tillage and ploughing practices); 2) A specialisation in farming to maximise economic returns from increased inputs, both through a reduction in the number of crop and livestock varieties and an increment in field and farm size, as well as through a spatial separation between crops and pastures. In parallel, an abandonment of agricultural land use in those less productive parcels and areas has also taken place. As an overall consequence, the heterogeneity of the agricultural habitats, both in space and time, has decreased, with severe impacts on biodiversity (Benton et al., 2003).

Both farming intensification and abandonment have provoked a degradation of habitat quality and decreased diversity and total biomass of those resources used by herbivores (except pest species) and predators. Carey (2005) refers to serious declines in some species associated with arable farmland in the late 20th century, of which evidence is shown in many studies based on national monitoring and long-term studies of birds, butterflies, beneficial invertebrates and annual arable flowers (Peco et al., 2007; Birdlife International, 2004; Vickery et al., 2004; Asher *et al.*, 2001; Baillie *et al.*, 2001; Donald *et al.* 2001, 2002; Aebischer, 1991; Wilson et al 1999; Donald, 1998; Sotherton, 1998; Bernáldez, 1991, etc.). Most of the available information on the relationship between agricultural intensification and biodiversity is about birds, and although this group is a good general indicator of the health of the agro-ecosystem important knowledge gaps remain as to the rest of the groups (Pain & Dixon 1997; Weibull et al. 2000; Sutherland 2004). The process of polarisation, has had an adverse impact particularly on extensive grasslands, where both the abandonment and increases in stocking density have created loss of biodiversity. This particularly applied to the semi-natural grassland areas whose biodiversity values are strongly linked to a continuation of extensive livestock grazing. During the 20th century, semi-natural habitats declined by over 90% in most parts of Europe as a consequence of such polarisation (European Environment Agency, 1998).

Beyond the species diversity inside trophic levels, the diversity of trophic levels in the agro-ecosystems has been affected as well (Benton et al. 2003). In particular, the loss of structural complexity in the agricultural landscapes has been negatively related to the potential for biological control of pests in the system, due to reduced diversity of enemies available to attack pest species (Östman et al. 2001 a, b; Thies & Tscharntke 1999; Tscharntke et al. 2005). In this sense, intensification is not only affecting biodiversity itself, but also to the ecosystemic services provided by certain groups (Tilman et al. 2002). Unfortunately, also as to this aspect there remain doubts, mainly around the type and extension of the changes in trophic webs as a result of intensification and the consequences of these changes on biological control of pests (Schmidt et al. 2003).

The extent of the problem has led in recent times to the recognition of the fact that nature values, environmental qualities and cultural heritage are linked to or dependent on extensive farming in Europe (Beaufoy et al., 1994; Bignal & McCracken, 1996). High Nature Value farming areas have even become one of the indicators for the integration of environmental concerns into the Common Agricultural Policy, which emphasises the importance the European Community connects to extensive farming areas where there seems to be a positive synergetic relationship between farming and biodiversity (see Andersen et al., 2003, EEA-UNEP, 2004, EEA 2005). Nevertheless, the precise identification and mapping of these HNV farming areas at the EU level is still not available, although the EEA and JRC (Paracchini, 2006) have made further progress in up-dating the HNV farmland indicators initially developed by Andersen et al. (2003). Indicators for HNV farmland have also become part of the Common Monitoring and Evaluation framework of the Rural Development Programme, which requires Member States to soon develop their own HNV farmland indicators.

All in all it is clear that a decline in farmland biodiversity across Europe coincided with an increase in the overall intensity of agricultural production. The IRENA indicator 28 (Population trends in farmland birds) shows that between 1980 and 2000 the majority of the farmland birds in the EU-15 suffered strong declines, but this decline levelled off since 1990, which is not surprising as levels have become very low already, especially in the intensively farmed areas. IRENA indicator 33 also showed that 80% of all agricultural Prime Butterfly Areas (PBAs) experience negative impacts from intensification, abandonment or both. 43% of all agricultural sites suffer from intensification, whereas abandonment is a significant problem in 47%. Both impacts occur simultaneously in 10%. Heath et al. (2000) showed for example that the decline in farmland-birds and the intensification of agriculture are correlated.

The above conclusions about how changes in farming have affected farmland biodiversity are mostly based on wider, qualitative studies. These studies focussed on the relationship between several farming practices such as the use of pesticides, herbicides, nutrient inputs, tillage, irrigation, changes in landscape structure and soil organisms, invertebrates, birds, plants and mammals. These relationships have been described systematically in several review reports (e.g. Wadsworth et al., 2003; Boatman et al., 1999; Bignal et al., 1994). So there is already a lot of general, qualitative expert knowledge available on this relationship. However, to predict and model how changes in farming affect biodiversity requires more detailed, quantitative knowledge. Furthermore, there is a lack of good monitoring data enabling us to know more about how organisms are distributed in the landscape, how they function, and how management practices on the land affect them. Modelling the impacts of farm policy measures, such as Cross Compliance, on biodiversity is even more difficult. Modelling these interactions requires explicit incorporation of space in the model framework, as well as exact knowledge on the interaction between farming practices, habitat quality and biodiversity.

Past experience in scientifically assessing the impact of regulations for agricultural practices and land use on biodiversity has relied in the approach Before-After Control-Impact (BACI approach, e.g. Bro et al. 2004). Replicated BACI consists in the comparison of trends in biodiversity on treatment fields and control fields both before and after implementation of the considered treatment. This approach has been applied to the impact assessment of agri-environmental schemes, yet on the basis of pressure (e.g. Primdahl et al., 2003) or state (e.g. Kleijn et al. 2005) indicators. However, a number of complications exist that prevent BACI approach to be used in the context of Cross Compliance impact assessment. On the one hand, baseline data on the state of biodiversity at the field level before CC implementation are rarely available. On the other hand, there are not fields without treatment available to perform the comparison, since CC standards and conditions are compulsory for all farmers in any given region.

Alternatively, we would propose to apply an *ex-ante* assessment approach based on the use of pressure indicators (e.g. Oñate et al., 2000), since the use of state indicators is not possible due to either, lack of univocal and immediate responses of biodiversity to multiple pressures, lack of adequate background by most CCAT-partners to monitor biodiversity changes, and un-affordable cost.

An example of an *ex-ante* assessment approach is MIRABEL (Models for Integrated Review and Assessment of biodiversity in European Landscapes (Petit *et al*., 1998 and 2003). The emphasis in MIRABEL I is on changes in the status of threatened habitat types induced by agricultural pressures. Impact matrices are specified per environmental zone to predict changes in biodiversity based on literature references, expert opinion and where possible semi-quantitative modelling of the response of biodiversity in specific environmental conditions. The impact matrices specify the extent of the effect (in positive and negative terms) on specific habitats occurring in an environmental zone. In Mirabel II attempts have been made to translate these expert based impact tables spatially and estimate the extent of the habitats affected by e.g. eutrophication, intensification, changes in livestock density (see e.g. Petit et al., 2003 and Petit and Elbersen, 2006). The Mirabel studies provide a good reference framework for this study.

2.6 Approaches to assessing changes in land use and landscape

In the EU 42% of the land area is used for agricultural purposes and 80% of the total land area is "rural" (CEC, 2003). This means that agriculture has a major impact on land use and the rural landscape. Changes in land use type lead to changes in the landscape, as do changes in farming practices such as removal of linear features or re-parcelling or an increase in grazing density. According to OECD (2001), agricultural landscapes are *"man-made or cultural landscapes"*. Lim (2002) points out that agricultural landscapes are not homogeneous across regions or countries. This is because agricultural production relies upon location-specific natural conditions including climate, soils, water, and different forms of land management. The types of landscape resulting from traditional and/or extensive agricultural activities have a complete other character than landscapes dominated by modern efficient farming systems.

Man's influence on the landscape goes back several thousands of years. As man progressively cleared the forest and introduced domestic stock and arable cropping practices, the vegetation responded by developing new assemblages and balances of species and the landscape was opened and became more diverse. These changes took place over several centuries and were gradual and depended upon the skills of the farmers in manipulating the available species and introducing new farming practices. This process accelerated with the advent of plant breeding together with modern farming practices. Therefore for about the last 70 years the link between grazing and arable farming and species composition has been progressively broken down to the extent that most lowland grasslands now consist of genetically selected stock and high productive crop breeds. Semi-natural vegetation of mainly native species is almost absent from fields and non-productive landscape elements such as hedges, tree lines, etc. have diminished strongly. Currently in the majority of the lowland regions, especially in northwestern Europe, extensive farming systems have almost disappeared. In many upland and mountain regions and arid zones in southern and central and eastern Europe (see e.g. Baldock *et al*., 1993; Beaufoy *et al*., 1994; Bignal & McCracken, 1996; 2000; Andersen et al., 2003, UNEP-EEA, 2004) however, the stock of native vegetation which is extensively grazed and traditional arable and mixed systems remains high.

Overall it is clear that agricultural landscapes have been exposed to dynamic changes in agriculture which have shaped them and still shape them. Implementation of CC measures on farms may also have effects on land use and on landscape. In order to predict the changes in response to CC it is necessary to first get an understanding of how farmers respond to CC in terms of cropping mixes, rotations, shifts in activities. In this study these choices are assumed to be largely based on economic considerations, as discussed in former sections. Indicators used for expressing changes in land use and landscape will be further discussed in Chapter 4.

2.7 Conclusion

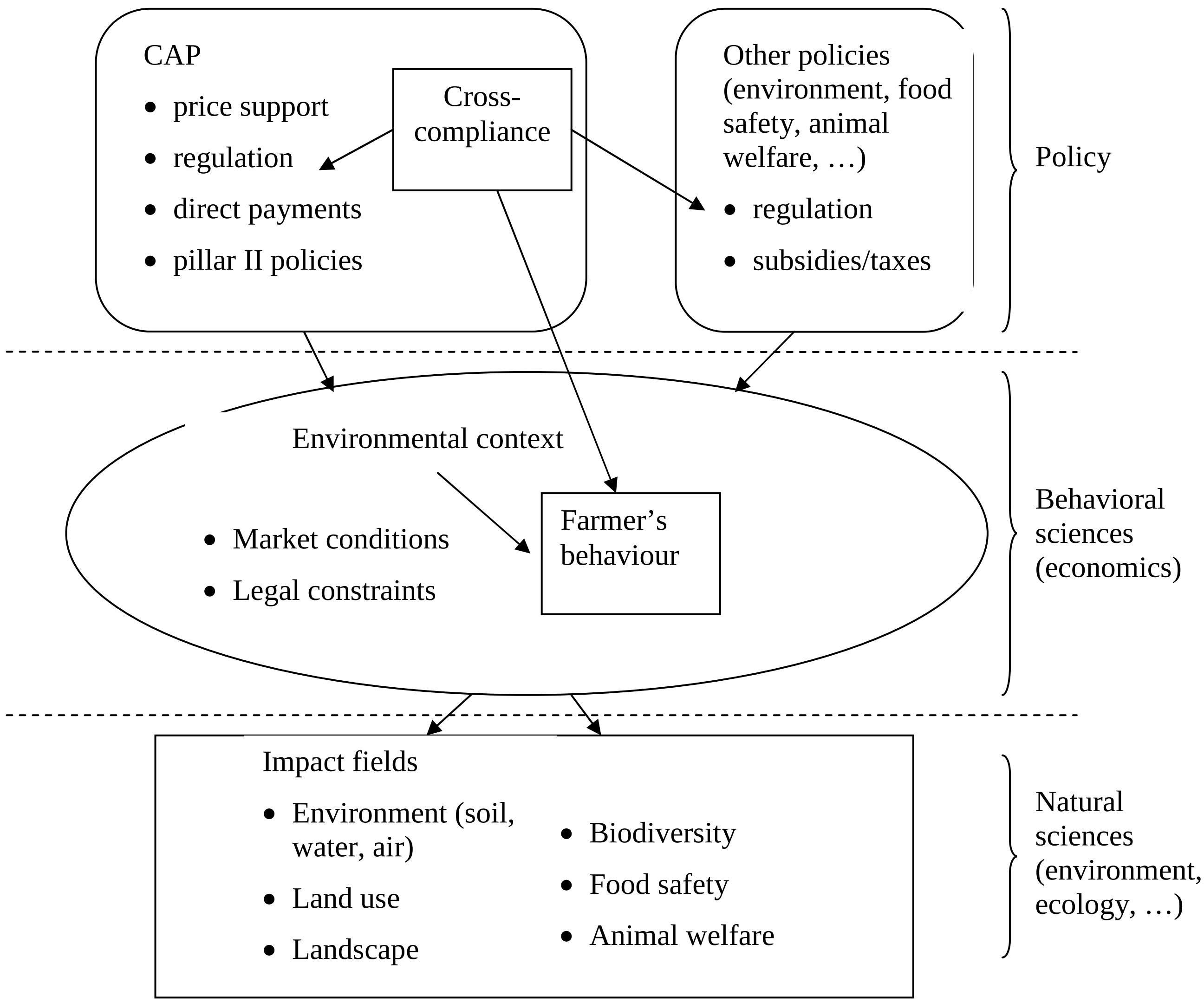
This Chapter starts with an introduction into the main trends that characterized the evolution of agriculture since World War II: intensification, increased input use, high animal densities, technological advancement enhancing productivity, heavy mechanization. Subsequently the economic perspective to regulation and compliance to regulation was discussed. Since farmers operate their businesses primarily for commercial reasons, the evaluation of the impact of regulation on a farmer's costs (forgone profits with compliance to the regulation) and benefits (no penalty if compliant) appeared to play an important role. It was acknowledged that in addition to this also other factors (moral attitude, social standing) are important. The institutional economics approach emphasized the role of (imperfect) information and the room for strategic behaviour this introduces, as well as possibilities for (partly) overcoming these (signalling, risk selection).

Whereas the economics approach focused on the farmer's behaviour, both the environmental, land use and landscape and ecological perspectives focus on the consequences of the farmer's actions for the environment, land use, landscape and biodiversity. As regards the environmental perspective, a flux scheme made clear how air, soil and water are impacted. They appear to be strongly linked with the farmer's decisions on crop mix (crop/fodder), animal stocks (animal density), nutrient provision (fertilizer, organic manure, feedstuffs), housing and farming practices. Whereas economic models treat the 'production function' largely as a black box (only focusing on the use of scarce inputs and production of valuable outputs), the environmental, land use, landscape and ecological perspectives emphasize the need to understand the way production methods change.

As regards the ecological and landscape perspective it became clear that both intensification and land abandonment are going together with a loss of very important farmland habitats and changes in land use and related landscape character. However, especially for nature values a lot of uncertainties still exist about how these are linked to and dependant on farming. The before-after-control-impact, or BACI-approach, appears to be difficult to apply for assessing CC impacts since the considered standards are compulsory for all farmers (excluding with-without comparisons). The state of the art precludes the use of models for analyzing EU-wide impacts. However, ex-ante assessment tools are available (notably MIRABEL I and MIRABEL II) which could be exploited. These tools do not deliver quantitative results in terms of state of biodiversity but more qualitative statements in terms of pressures having both negative or positive effects on certain types of biodiversity (e.g vegetation, birds, mammals etc.)

Since CC is aimed at improving compliance, it is crucial to have reliable information about the rates of compliance before and with the CC mechanism imposed. A few methodologies are proposed to measure and cross-check the degrees of compliance to be discussed further in Chapter 6.

Figure 2.2 Conceptualisation of the relationship between Cross Compliance, farmers response and effects



The disciplinary approaches and the way they interact with each other in the current research project is summarized in Figure 2.2. The economic (market prices) as well as the policy environment affect farmer's behaviour. The policy box includes the CAP as well as other policy fields (e.g. environmental policy, food safety policy, nature policy, animal welfare policy, etc.). Policies can affect farmers either directly, for example by imposing regulations and thereby limiting their room for manoeuvre, or indirectly. An example of the latter is the price support of the CAP, which affects internal prices in the EU and influences the farmer by changing his economic environment. Cross-compliance, here denoted by an explicit box within the CAP, introduces an additional regulation enforcement element (partial reduction in direct payments in case of violation) into the policy framework, thereby also linking different policy fields (direct payments under the CAP are connected to environmental regulation for example). Alongside the classical price support, other elements of the CAP (the so-called Pillar II policies) are the single farm payment (or single area payment for the new member states) and rural policies (e.g. Rural Development Programs, agri-environment schemes).

Changes in farmer behaviour (for example resulting in a different land-use and different farming practices) generate consequences for different impact fields such as the environment (soil, water, air), biodiversity, land use, landscape, animal welfare, and food safety. (see lower box of Figure 2.2). Biodiversity effects from CC are expected to be both direct and indirect. They are usually both directly induced by changes in farming practices that affect the species itself (e.g. ploughing early in the season leading to destruction of bird nests) but also by the effects of farming practices on the quality of the habitat e.g. the state of the environment and the landscape character (e.g. density of habitats).

The right column of Figure 2.2 shows which disciplines are most relevant for analysing the impacts at different parts of the chain.

3 State of play

3.1 Introduction

Cross Compliance implementation in the EU has already been the subject of several projects. The first EU wide study Cross Compliance and the CAP Project (2002-2005) explored the background of cross-compliance in the CAP, lessons learned from its implementation and opportunities for improving its use as an agri-environment instrument in the future. Outputs included national reports on Good Farming Practice under the Rural Development and SAPARD Regulation and on Good Agricultural and Environmental Condition (GAEC) for the Single Farm Payment and Single Area Payment Scheme. This study was then followed by a still on-going project; The Cross Compliance Network project. It aims to develop the understanding of cross compliance further by consolidating research to date, identify future research needs and foster a network on cross-compliance. Both projects delivered very informative reports especially in relation to possible impacts of CC on farm incomes, land use and environment and the conclusions of these reports will be further discussed in the next section. The third project to be discussed is the Cross-compliance project. This project is financed under the 6th Framework Programme and started 1 year earlier than CCAT. The primary focus of this project is to investigate the value-added resulting from the introduction of cross-compliance as a tool to improve compliance with existing standards. It also looks into the cost implications and competition effects of compliance to EU standards on the world market. How this is done and what results are delivered by this project is further discussed in section 3. The *Study on Environmental **C**ross-compliance **I**ndicators in the Context of the **F**arm **A**dvisory **S**ystem* (CIFAS study), which was carried out in 2005/2006 for the European Environment Agency (EEA) under coordination of the Institute for Rural Development Research (IfLS) already provides information on the cross-compliance requirements and standards in the area of the environment in 13 EU-Member States. The results of CIFAS will be further discussed in Section 4 of this chapter. A final CC evaluation project undertaken by the Institute for European Environmental Policy for the European Commission is discussed in the fifth Section.

In the 5th section the results of the IRENA operation are discussed which are a very useful basis on which to build the indicator framework for the evaluation of the impacts on CC in this project.

In the final 2 sections two research projects are discussed, Seamless and NitroEurope, which are developing modelling frameworks and tools and knowledge needed for the evaluation of effects of changes in farming induced by policy measures such as Cross Compliance. The tools and modelling frameworks developed in these projects can also be of use for the assessment of CC effects and will certainly form a basis on which this project will further elaborate.

3.2 Cross Compliance and the CAP and Cross Compliance network project

Under coordination of IEEP two early Cross Compliance projects were executed delivering good initial overviews of how CC is implemented in the different Member States and how potential effects of it can be measured. The first project 'Cross Compliance and the CAP', which was finished in 2005, brought together 10 organisations from across the EU to explore the background of cross-compliance in the CAP, lessons learned from its early implementation and opportunities for improving its use as an agri-environment instrument in the future. A series of six pan-European stakeholder meetings were held during project and four issues of a newsletter were produced. Both the meetings and the newsletters provided a good initial overview, but more useful and recent information for the CCAT project is provided by the second project The Cross Compliance (CC) Network project which finished in April 2007 with a final stakeholder meeting. The project is delivering a large number of research papers. The most interesting from a CCAT perspective are those focussing on the likely impacts of Cross Compliance on farm costs and competitiveness, the environment, land abandonment and on farming systems and land use. This project also provides additional information of how the SMRs are implemented at Member States levels for a selection of countries (Czech Republic, Denmark, France, Germany, Greece, Italy, Lithuania, The Netherlands and UK-England). As such it provides complementary information to the inventory done in the CIFAS project (see next sub-section).

In relation to the effects of Cross Compliance on costs and competitiveness (Farmer, 2007) it is argued that costs can only be attributed to CC SMRs and GAECs if the requirements or standard was not mandatory before the implementation of CC. The exception to this is that there are a number of record keeping, registration and some monitoring and inspection costs, which can be attributed to CC. Because all SMRs reflect pre-existing legislation, this implies that in principle only the GAEC requirements (Annex IV) can lead to costs and competitiveness impacts. And even there it has to be realized that a number of GAEC-constraints were already included in previous national legislation. As far as that is the case, also these GAEC requirements in principle cannot lead to additional costs. In case farmers are non-compliant, (improved) compliance to standards can induce costs. However, these induced costs are not to be considered as costs of cross compliance as such, but rather as costs associated with compliance to the underlying regulations. With this assumption as a starting point and after collection of evidence in a selection of countries it is concluded that most CC requirements or standards pre-existed before the implementation of CC and that compliance levels are generally high. The majority of the farmers therefore face minimal costs due to CC. In our CCAT study as discussed we follow this convention in attributing costs to regulations rather than to the CC instrument. However, the impact of CC on the costs of compliance with standards (which were previously not fully complied with), and the benefits of compliance to standards (improved realization of the objectives aimed at in the various regulations) will be at the centre of the evaluation tool to be developed.

In relation to the potential environmental impacts of CC the Cross Compliance network project highlights some key issues. It concludes that CC is primarily targeted at addressing the main environmental problems in the agricultural sector which relate to water, soils and biodiversity. Air pollution and green house gas emissions are not directly targeted, but may benefit indirectly from the CC measures and standards. It also concludes that CC policy is still rather new and adequate (monitoring) data are needed to assess it's environmental effects. It also says that the effects of CC are quite difficult to measure as it operates alongside other policy measures influencing farmer's behaviour.

With regard to effects on farming systems and land use the conclusions are mostly bringing up new research questions, but they do point to diverse effects of CC per farm type in terms of sectoral specialisation and intensity. It also concludes that CC is likely to speed up modernisation of farms and it could lead to a further specialisation of farms in areas where mixed systems are vulnerable. In relation to effects of CC on land abandonment there is the feeling that it may have some influence on prevention of this process, but that it certainly cannot be regarded as the main instrument to control it.

The results of this project provide a very useful basis for CCAT in several ways. Both project give an excellent view on the present state-of-play in relation to assessing the effects of CC. Both the project documents and the Excel sheets also provide a better understanding of how CC is implemented in different Member States and what the potential effects of CC can be and how they should and/or can be assessed. The CCAT project will extent these projects in explicitly modelling farmers' behaviour under regulation as well as by a scrutinize analysis of the environmental and ecological impacts of the regulations in the CC package.

3.3 Cross Compliance (CC) project

The main aim of the CC project is twofold. A first aim is to assess the impacts of cross-compliance for a selected number of EU member states on the degree of compliance as well as on costs of compliance. A second aim is assessing the impact the analysis of compliance to standards might have on the EU's competitiveness with respect to some key competitors[8]. In that respect also the standards the EU's key competitors may have are analysed and accounted for. In addition to obligatory standards, also the role of voluntary certification schemes is analysed[9].

For seven EU Member States (France, Germany, Italy, Netherlands, United Kingdom, Spain and Poland) an assessment was made the requirements which are part of the cross-compliance package are discussed. For each statutory management requirement (SMRs), as well as for the requirements following from the good agricultural and

[8] Since the analysis of competitiveness impact is still underway no results can yet be reported.

[9] See the synthesis reports made by Jongeneel (2007) and Farmer (2007) for an overview. The current section and associated annex heavily rely on these reports as well as on some specific country reports cited therein.

environmental condition (GAECs), the requirements are noted, relevant implementation issues are discussed and indicative tables are given which are helpful in assessing the potential impacts (sectors affected, number of holdings, animals, area surface of protected zones, etc.). With respect to the SMRs, in particular the requirements following from the Nitrate Directive and the Identification and Registration of animals create tensions with farmers. Implementation of the Nitrate Directive in a number of countries also gave problems, leading to infringement procedures against some Member States. With respect to the GAECs it is noted that there is a lot of variation in the requirements imposed on farmers over Member States. To a large part this is due to the specific situations and different context of the member states. Since some requirements only recently became part of cross-compliance, or will become part not earlier than in 2007 for these requirements difficulties were faced in getting already the desired information.

Conceptual remarks are made about compliance, cost types, ordinary costs of SMRs and additional costs of cross-compliance. As regards the degree of compliance it is concluded that in general the rate of compliance is rather high. This holds both for the SMRs and the GAECs. Two exemptions are the Nitrate Directive and the Identification and Registration of animals, for which there are substantial rates of non-compliance, sometimes as high as 30% (see Table X in Annex X for further details). Although an exact measurement of improved compliance remains a difficult issue, anecdotal evidence showed that cross-compliance induced a lot of farmer activities aimed at improving their farming practice up to EU standards and also, for specific requirements, improvements in compliance of more than 20% were noted.

With respect to the costs of compliance a distinction is made between the ordinary costs associated with compliance to the SMRs and the additional costs as following from cross-compliance. As regards the SMRs cross-compliance in general does hardly imply additional costs to farmers. Costs made by farmers that were previously non-complying but who started to comply due to cross-compliance are no costs of cross-compliance, but rather costs associated with the (underlying) standards. The additional costs of compliance necessary to achieve full compliance depend on the initial rate of compliance. The Nitrate Directive is one involving a significant amount of additional compliance costs. Additional costs of compliance can amount to several thousand euros per farm.

The costs of the GAEC requirements, which are likely to present the main costs of cross-compliance because these requirements were the only introduced new element, were in general found to be small[10]. Partly this is due to the fact that a large part of the farmers already voluntarily do the actions included in the GAECs (examples are preservation of organic matter content in soils and actions to reduce erosion). Because of the variation in requirements however, costs also can vary significantly.

The results obtained for the EU's key competitors Canada, the United States and New Zealand, indicate that none of these countries has a system of requirements comparable to the EU's one, although some form of concern usually existed (see Table X in annex X). A comparative analysis covering all the themes addressed in the

[10] For some countries the GAEC requirements were previously already part of their national legislation and thus not new. As far as this was the case these GAEC requirements cannot create additional costs.

SMRs and GAECs shows that in general the intensity of regulation is less in these countries as compared to the EU. Since also the production intensity in these countries is lower than the EU the need felt for regulation might be lower. A lower regulation intensity does not necessarily imply a higher level of environmental degradation, biodiversity loss, or harm to animal welfare, but indications were found that the local concerns about these issues are increasing. As compared to the EU, the approaches in the three non-EU countries rely relatively much on voluntary action. This action is facilitated and encouraged by financial incentive and assistance schemes. The financial incentives include cross compliance mechanisms (e.g. Canada, where participating in voluntary schemes is sometimes a side condition for receipt of specific direct payments. In a comparative sense, the regulatory intensities in Canada and New Zealand seem to be rather comparable. The US presents the lower end of regulation. The legislation there is usually least restrictive and when existent often not applied to the farm level. This could be because either agriculture is exempted or because the monitoring costs of non-point pollution are felt to be too high to take monitoring and inspection serious. As compared to the US Canada and New Zealand rely to a relatively high degree on exports of sensitive products. This has led them to address in particular themes related to market risk (food safety, surveillance systems on animal diseases).

An investigation into the ‘value added’ or benefits of cross-compliance was beyond the scope of this CC project. The improvement of compliance induced by the imposition of an additional direct payment-related sanctioning system as well as by increasing awareness among farmers is considered to be the main ‘benefit’ of cross-compliance.

Within the CC project the relationship between mandatory cross compliance standards and those set by voluntary certification schemes was examined. It is concluded that there is a potential synergy between cross compliance and certification schemes, not least because both approaches set minimum standards and enforce those standards through inspection protocols. These relationships were explored conceptually and the key similarities and differences were examined through an analysis of 31 certification schemes in seven Member States. This analysis provides the foundation for an examination of the overlap between standards that exist in certification schemes and in cross compliance in three Member States (Netherlands, Spain and the UK). The analysis showed that there is sufficient overlap in the standards set and in approaches to control to warrant further investigation of the potential for harmonisation of standards and collaborative approaches to control. It was suggested that the further assessment of these synergies would provide an additional dimension to current and prospective debates not only on cross compliance, which is reviewed by the European Commission in 2007, but also about the CAP Health Check scheduled to take place in 2008 and the EU budget review expected to occur in 2009. For the three non-EU countries - Canada, New Zealand and the USA –22 relevant certification schemes were reviewed.

The Cross Compliance project is valuable for the CCAT project in that it is the first project that comes up with best estimates of the degree of compliance at the level of individual regulations. This information is useful as a starting point for the current analysis. Moreover, the project develops a costs of compliance calculation methodology which will be exploited also in this project. It also comes up with best estimates of costs, although this information remains somewhat fragmentised. Finally, the Cross Compliance project comes up with a number of economic indicators, including those on competitiveness, which will be taken into account in the discussion about indicators (see Chapter 4). The CCAT project has a broader scope in that it not only focuses on a subset of seven EU member states, but on the EU as a whole. Moreover, while acknowledging the importance of the economic aspect in explaining farmers' behaviour, the CCAT project will mainly extent the Cross Compliance project in providing an in depth analysis of the 'value added' in terms of a realized better achievement of the multiple goals as aimed for in the regulations underlying CC. At the same time it will try to get a further inside into the behavioural aspects of compliance, which might lead to an analysis in which the degree of compliance is endogenized (see extensive discussion in Section 2.2 of previous chapter).

3.4 CIFAS project

According to Council Regulation (EC) No 1782/2003, Member States are obliged to set up, by 1st January 2007, farm advisory systems (FAS) providing advice to farmers at least on statutory management requirements (SMRs) referred to in Annex III and the good agricultural and environmental conditions (GAECs) established under Article 5. FAS tailored to help farmers during their decision making process are expected to play a major role in adjusting European agriculture towards cross-compliance.

These FASs were the **focus** of the *Study on Environmental **C**ross-compliance **I**ndicators in the Context of the **F**arm **A**dvisory **S**ystem* (CIFAS study), which was carried out with a duration of 1 year in 2005/2006. CIFAS was financed by the European Commission and managed and coordinated by the European Environment Agency (EEA). The Institute for Rural Development Research (IfLS) in Frankfurt/Germany was selected by EEA according to his tender to carry out the CIFAS-study.

The **aim of CIFAS** was to support the building and functioning of FASs by contributing to the development of farm advisory tools (FATs) including farm level indicators (FLIs) related to cross-compliance requirements and standards related to the environment.

The CIFAS project was structured along **five key steps**:

1. Collection of information on SMRs and GAECs in 14 EU Member States[11];
2. Compilation and reviewing of information on FASs already in place or under development in the selected 14 EU Member States at a broad level.
3. Collection of information on FATs and FLIs in the selected 14 EU Member States that could help to provide advice to farmers to meet cross-compliance requirements related to the environment;

[11] Austria, Czech Republic, Germany, Denmark, Estonia, Spain, France, Greece, Hungary, Italy, Poland, Sweden, Slovenia and UK

4. Selection of 11 case study areas[12] for in-depth investigations on the appropriateness of FATs already existing. Appropriateness is to be understood in terms of functionality and practicability in relation to helping farmers to comply with environmental obligations and with the aim to highlight best practices.
5. Drawing up proposals for FATs that, together with the best practice examples identified in step 4, could be recommended for the FASs to be set up by the Member States by January 2007.

The description of the objectives and focus of the CIFAS-study above reveals, that in particular the collected information on SMRs and GAECs in step 1 and how this information has been structured, is of importance for the CCAT-project.

The implementation of cross compliance in terms of SMRs and GAECs is of high relevance for CCAT, since this information is the basis for any impact assessment of CC and will be used as input data in CCAT.

In the following it is **outlined how the information on SMRs and GAECs in the area of the environment has been collected and structured** in the CIFAS project. This method of structuring may also be adopted in CCAT for the additional collection of data on implementation of SMRs and GAECs in other Member states (for which CIFAS data have not yet been collected) and in also in other areas, e.g. animal health and welfare and food safety.

The collection of different information according to the CIFAS key steps 1 to 3 has been carried out by national teams in the investigated EU-Member States. A central element for entering and analysing the collected information has been a data base, developed specifically for the CIFAS-study based on Access 2000.

The benefit of the **CIFAS-data base** is, that on the one hand national teams are able to directly enter their relevant data and information into the data base. On the other hand different output-tables and analyses, based on the information collected, can be done either in Access, Excel or other programmes.

<u>Brief description of CIFAS-data base</u>

In the following the CIFAS-data base and the collection of information will be described focusing only on the collection of SMRs and GAECs. The CIFAS co-ordinator provided each national partner with an individual copy of the data base and the partner was asked to specify for his/her respective country on the way the different SMRs and GAEC were implemented

The database contains an input mask in order to define administrative regions where the standards and requirements are defined in the respective Member State (e.g. in the case of United Kingdom: England, Scotland, Wales, North-Ireland).

---

[12] 1. Czech Republic, 2. Denmark, 3. Estonia, Germany (4. Lower Saxony, 5. Saxony, 6. Rhineland-Palatinate), Spain (7. Andalusia, 8. Murcia, 9. Navarra) and United Kingdom (10. England and 11. Scotland).

With reference to the collection of information on SMRs and GAECs, two separate input masks exist. The following information was entered in he respective input masks for each SMR and GAEC collected:

- Full text of SMR/GAEC per Member State;
- EU-Directive, Article and/or Paragraph, the respective SMR and GAEC refers to (by selection from a provided list in the mask);
- Definition of a short name for each SMR/GAEC in order to reduce the full text of SMR/GAEC to the main contents, since it is often quite detailed and explicative. “Short names” could be selected from a provided list in the mask. Short names gave the possibility to group cross-nationally similar SMRs and GAECs.

After the information had been collected in Member States the individual copies have been consolidated in the common CIFAS-data base and output tables have been produced.

The resulting CIFAS databases for SMRs and GAECs are now further used in the CCAT project and they are included as Annexes to this report (see Annex V and VI). How they are used and linked to the different fields of impact of CC is further discussed in Chapter 4 of this report.

3.5 IEEP CC-Evaluation (to be extended and completed by Merit)

Institute for European Environmental Policies (IEEP) coordinated the Cross Compliance Evaluation (*Evaluation of the Application of Cross Compliance Foreseen Under Regulation 1782/2003*) as part of their Alliance Environment Framework Contract for the evaluation of the environmental impact of measures taken by common market organisations and CAP direct support measures (Contract No. 30 CE-0067379/00-89). This was the first EU-25 inventory of the implementation of Cross Compliance for the Commission. This 11 month evaluation project ran from June 2006 until May 2007 and gives a comprehensive description of the implementation of Cross Compliance in each Member State and answers the Evaluation Questions for each evaluation theme.

Main tasks of the project involved: inventories of Statutory Management Requirements (SMR), Good Agricultural and Environmental Conditions (GAEC) and minimum permanent pasture levels. The inventory also gives an overview of the bodies responsible for the provision of information to farmers and for carrying out controls. Description of the modalities for calculating reductions of Direct Payments, an assessment of the number and types of detected infringements, as well as an assessment of payment reductions applied were made. Based on above, a typology of the different approaches in the implementation of cross compliance by the Member States, including a description of the level of harmonisation amongst different systems implemented in different Member States was developed within the framework of the project. The project also includes case studies.

It is clear that the information collected in this project would be of great value to the CCAT project. It could give a range of valuable CC data for all EU Member States, e.g. full list of SMRs and GAECs, information related to CC inspections and breaches

(e.g. number of breaches related to each GAEC standard and SMR/Directive, degree of compliance, description of penalty system and penalty severity categories applied).

Currently there is no access to the information of this project, but future access will be discussed with the relevant persons at DG-Agri. Not getting access to this data will lead to a lot of additional data collection work within the CCAT project and would be highly inefficient given the fact that the data has already been collected.

3.6 IRENA

The IRENA operation (Indicator Reporting on the Integration of Environmental Concerns into Agriculture Policy), which describes the interface between agriculture and environment, is coordinated by the European Environment Agency (EEA). It is a joint exercise between the EEA and DG Agriculture and Rural Development, DG Environment, Eurostat and DG Joint Research centre. The operation developed agri-environmental indicators for monitoring the integration of environmental concerns into the Common Agricultural Policy (CAP) in the European Union. The results until now provide an assessment of 35 indicators (identified in COM (2000) 20) for the EU-15. It's products are:

- Two reports:
    - Agriculture and the environment in EU-15 – the IRENA indicator report (EEA, 2005)
    - Integration of environment into EU agriculture policy – the IRENA indicator-based assessment report on the integration of environmental concerns into the CAP (EEA, 2006)
- 35 detailed indicator fact sheets available on the IRENA website (http://webpubs.eea.eu.int/content/irena/index.htm.

Until now the 35 indicators have only been developed for the EU-15, but at present these indicators are also developed for the new Member States. All indicators developed have also been evaluated on their usefulness in relation to policy relevance, responsiveness, analytical soundness, data availability and measurability, ease of interpretation and cost effectiveness. On the basis of this evaluation the indicators were classified in useful, potentially useful and low potential. The result of the evaluation showed that out of the 42 (sub-)indicators, 11 were useful, 30 potentially useful and 1 had low potential. It was also concluded that 14 indicators need either conceptual or model improvement or both.

The indicators were developed at the lowest possible scale given data availability. The result was that 33% of the indicators were based on data at regional level (NUTS2/3) and the rest were only specified at national-level. Several indicators of the state/impact domains were developed on the basis of modelled data or case studies. Half of all indicators used time series (1990 and 2000).

The aim of the project is to provide indicators which can be used for an assessment of the successfulness of the integration of environmental objectives in the agricultural sector policy. According to the assessment report (EEA, 2006) done within this project it appears that the agri-environment schemes could be better targeted, i.e. be applied in regions of the highest biodiversity concern. Alongside geographic targeting also a case study assessment of effective scheme design and implementation was done, indicating positive about effectiveness of these schemes.

The IRENA project contributes in an important way to CCAT, in particular by its indicator development part. A detailed overview of all IRENA indicators is beyond the scope of this brief overview, but is discussed further in Chapter 4. In that chapter we also indicate which of the IRENA indicators are most useful to be specified in this study as impact indicators for the assessment of CC. A link is established between useful IRENA indicators and fields of impact of CC. Whereas IRENA focuses on (voluntary) agri-environment schemes (Pillar II of the CAP), CCAT will limit itself to the obligatory SMR and GAEC requirements following from CC.

3.7 SEAMLESS

SEAMLESS (System for Environmental and Agricultural Modelling; Linking European Science and Society) is an Integrated Project (IP) funded by the 6th research framework program of the EU. Thirty European and non-European participate over the four year period from 2005 to 2009.

Focus (of project) and scope (e.g. countries, regulations)

SEAMLESS aims at developing a computerized, integrated framework (SEAMLESS-IF, van Ittersum et al. 2006) to assess and compare, ex-ante, alternative agricultural and environmental policy options allowing to analyse:

- at the full range of hierarchical levels (farm to EU and global), whilst focusing on the most important issues at each level
- the environmental, economic and social contributions of a multifunctional agriculture towards sustainable rural development.
- a broad range of issues and drivers of change, such as climate change, environmental policies, rural development options, an enlarging EU, international competition and effects on developing countries.

SEAMLESS focuses on the agricultural sector, but is rather broad in terms of scales and policies to be assessed. The scale of instruments such as indicators, databases and models, spans from field to global level. Policies range from trade measures on the one side to farm level instruments on the other.

In principle, the tools cover all EU-member States and some related to competitiveness issues and impacts on developing countries go further. The system will generally be capable to analyse impacts of some measures related to CC at the farm level including up-scaling to market level if relevant.

Approaches and methods used

SEAMLESS-IF uses

- a multi-perspective set of *economic, social and environmental indicators* of the sustainability and multifunctionality of systems, policies and innovations in agriculture and agroforestry, derived through so-called *indicator frameworks* facilitating interactive and systematic selection of indicators with users and stakeholders.

- quantitative models, tools and databases for integrated evaluation of agricultural systems at multiple scales and for varying time horizons. These models include bio-physical production and externality simulators at farm scale, bio-economic farm models for a representative sample of regions, upscaling models, and an EU market model as the backbone of the modelling chain. Those are connected to global and developing country economic models and to models assessing impacts at the territorial level (landscape, biodiversity, and environment).
- a software architecture, SeamFrame, that allows reusability of indicators, models, data and knowledge, also ensuring transparency of models and developed procedures.

SEAMLESS-IF aims to facilitate translation of policy options into alternative scenarios that can be assessed through a set of indicators that capture the key economic, environmental, social and institutional issues of the questions at stake. The indicators in turn are assessed using selected linkages of quantitative models. These models have been designed to simulate aspects of agricultural systems at specific levels of organisation, i.e., point or field scale, farm, region, EU and world. SEAMLESS aims at an integrated use of these partly existing models. SEAMLESS also assembles pan-European databases for environmental, economic and social issues. Some indicators, particularly social and institutional ones, will be assessed directly from data.

Linkage of models designed for different scales and from biophysical and economic domains requires software architecture, and a design and technical implementation of models that allows this. The software backbone of the project, SeamFrame, serves that purpose.

Main results obtained, as far as currently available, expected future results with relevance to CCAT

Prototype 2 of SEAMLESS-IF is currently in preparation and completed by July 2007 (SEAMLESS, WP0 2007). No meaningful integrated assessment results will be available soon, but the conceptual and technical integration of the system has progressed significantly. The following intermediate results are of interest to CCAT:

- EU-wide farm typology differentiated by economic size, specialisation, and intensity and based on the most recent FADN data
- The CAPRI DynaSpat project results on crop shares in homogeneous mapping units used in SEAMLESS to further spatially allocate individual FADN farms to these same homogeneous spatial mapping units. This spatially disaggregated information is only available for EU-15. The advantage of this spatial allocation is that all FADN farms, to be used for modelling effects of CC in CCAT, can be placed in their bio-physical environment. This specific bio-physical context enables the further environmental impact assessment of changes in farming
- other biophysical databases for soil and climate conditions which can be matched to FADN based farm types

In the future, additional tools and databases will become available:

- Bio-economic, representative farm type models covering the 25 SEAMLESS sample regions mentioned above. They could potentially be used to evaluate farm impacts of relevant CC measures and also linked to CAPRI in case of market relevance.
- The agricultural productions and externality simulator (APES) which would allow simulating environmental and production consequences of CC-induced management changes at field level.
- The spatial allocation of FADN farms will be the basis for an approach to spatially allocate policy induced changes of environmental impacts. Depending on its evaluation, this approach might also be relevant if farm models (from SEAMLESS or CAPRI) are employed in CCAT.

3.8 NEU

The Integrated Project NitroEurope (or NEU for short) has started in February 2006 to address the prime issues of European N budgets in relation to C cycling and greenhouse gas exchange, while at the same time being aware of the interactions with other environmental issues. A key point of integration is the recognition that climate change policy requires integrated assessment of Net Greenhouse Gas Exchange (NGE) rather than just CO_2. This is vital for future strategy development, since approaches that maximise CO_2 uptake may not optimize NGE (Li et al., 2005). Apart from the obvious links between N and C cycles, there is a requirement to assess overall ecosystem N budgets, since other N losses, e.g. NH_3 emissions and leaching of nitrate (NO_3^-), are considered as indirect sources of N_2O emissions under the IPCC methodology (IPCC 1997). NEU thus recognizes the need to integrate the analysis Nr and GHG at linked field-, farm- and landscape-scales, including consideration of the spatial interactions with NH_3 emissions and NO_3^- leaching..

The NitroEurope IP addresses the major question: What is the effect of reactive nitrogen supply on the direction and magnitude of net greenhouse gas budgets for Europe? Key questions related to this major question include:

- What are the quantitative components of ecosystem N budgets and how do these respond to global change? How much does the form of reactive N affect N and C budgets and Net Greenhouse gas Exchange (NGE)?
- What is the effect of changes in land use/land cover, agricultural N inputs and atmospheric N deposition over recent decades on the net CO_2 uptake and NGE of European ecosystems? Can we simulate the effects of land-management, land-use and climate change on NGE at various scales?
- How and to what extent can independent measurements and modelling be used to verify greenhouse gas (GHG) and Nr emission inventories officially submitted to the UN Framework Convention on Climate Change (UNFCCC) and the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP)? How can the accuracy of these inventories be improved?
- To what extent would a more-integrated management of the N-cycle and its interactions with the C-cycle have potential to reduce greenhouse gas and N emissions simultaneously?

In relation to the questions noted above, it is hypothesized that extra N may increase or decrease average net European GHG emissions, due to opposing effects, such as:

- N supply increases N_2O emissions from agricultural soils but also from (i) non-agricultural soils in response to elevated NH_3 emission and related N deposition and (ii) surface water in response to elevated N inputs by runoff and leaching of NO_3 (Mosier et al., 1998; Butterbach-Bahl et al., 2002).
- N supply may increase CH_4 emissions from wetlands, while reducing CH_4 oxidation in soils (MacDonald et al., 1996).
- Increased N loads may cause a small reduction in ruminant CH_4 emissions (Soussana, 2005).
- Fertilizer and atmospheric N inputs increase primary productivity and carbon sequestration by vegetation, specifically in non-agricultural systems (Smith et al., 2006).

The effect of increased primary production due to N may be either augmented or offset by changes in rates of soil organic matter decomposition. Contradictory effects have been observed, with increased rates of decomposition observed in some arable and bog systems (Sutton et al., 2000; Smith, 2006), but decreased rates in many forest systems (Franklin et al., 2003).

In NitroEurope (NEU), the various questions are addressed by six main science Components, consisting of measurements in flux networks (C1), at manipulation sites (C2) and in landscape (C4), combined with modelling at plot scale (C3), landscape scale (C4) and European scale (C5) with an independent component on verification, again with the focus on the European scale (C6). Within the context of Nitro Europe, the INTEGRATOR model, described in this report aims to quantify the net N and GHG exchange at the European scale, being part of component 5.

The NEU project and the CCAT project can share a lot of knowledge, modelling tools and input data as both projects aim at assessing effects of changes in land use and farming practices on N budgets, C cycling and greenhouse gas exchange. Which impact indicators will exactly be specified will be further discussed in chapters 4 and 5. Components of the INTEGRATOR model developed in NEU will also be further developed and used in CCAT in order to assess the impacts of CC. Input data on farming characteristics, practices, and the bio-physical environment will also potentially be shared between NEU and CCAT. These will also include farming data and spatially allocated farm information in homogeneous spatial mapping units elaborated in the SEAMLESS project. How these data are used to model impacts of CC will be further discussed in Chapter 5.

3.9 Conclusion

In this chapter a brief review is given of a selection of the most important (previous) projects regarding cross-compliance, or related to the issues covered by the cross compliance requirements. The linkage of the reviewed projects to the current project is summarized in Table 3.1, which alongside a short project description (see column 2) summarize the useful components of each of the projects for CCAT (see second third column) as well as how the CCAT project will add to the existing knowledge, either by integrating it with other aspects or elements of CC, by modifying or improving upon it, or by extending it.

Table 3.1 Complementarities and extensions of CCAT project to reviewed projects

Project title	Short description	Useful components for this project	What new is added by this project (where does this project start?)
IEEP Cross-compliance network project	Two early CC projects providing an overview on implementation and identification of potential impacts and their measurment	• Useful background material on implementation • Provides information of first experiences • Linking costs to regulations rather than to CC	- Provides a more formal analysis of environmental, ecological, landscape and land-use effects - CCAT will follow convention to attribute costs to regulations rather than to CC
Cross Compliance (6th IFP, 6489)	Analysis of (additional) degrees of compliance and costs of compliance with SMR and GAEC regulations included in CC, as well as a quantitative assessment of potential impacts on competitiveness	- Best estimates for degree of compliance at regulation level (see Tables in Annex) - Calculation methodology for determining the costs of compliance at farm level - Economic indicators about the impact of 'CC'-regulations, including competitiveness indicators	- CCAT considers whole of EU rather than subset of 7 member states - CCAT analyses the 'value added' at environmental, ecological, landscape and land-use fields - effort will be made to model the degree of compliance in an endogenous way - regionalised impact assessment at farm-level
CIFAS (for the European Environmental Agency 2005-06)	The general aim is to help the building and the functioning of requested farm advisory systems, by contributing to the development of suitable advisory tools, and particularly 'farm level indicators' related to cross-compliance requirements and standards in the area of the environment.	• Provide an overview of requirements and standards and other relevant information on the implemented cross-compliance measures in the domain of the environment in 13 EU Member • Indicators for environmental CC-measures at farm-level (see Chapter 4 for more details about how this information is used in this project)	- Will provide detailed and quantitative rather than indicative assessment of the sustainability impacts of the SMR and GAECs - Has a broader focus than 'environment' and includes all regulations rather than the subset taken into account in CIFAS
IEEP CC-Evaluation Study	Evaluation done for the Commission about state of the art of CC at member state level	• Information on this project is limited • Future access is important in order to improve and obtain best estimates of the degree of compliance to	- Assesses impacts of compliance to regulations on the economics of farming, the environment, ecology, landscape and land-use

		regulations, full list of SMRs and GAECs per MS,CC inspections and breaches	
IRENA	Provide 35 indicators helping to summarise agri-environment relationships. Cover the period from 1990 to 2000.	- Useful environmental baselines (1990 and 2000) on which assessing CC impacts. - Assessment of useful data sets	• Will explore the formal links between indiators and the regulated agricultural production process • Will simulate quantitative changes from the baselines under various scenarios w.r.t. compliance to regulations (regional and national level).
Seamless	The project will develop an integrated and operational framework (SEAMLESS-IF) which integrates approaches from economic, environmental and social sciences to enable assessment of the impact of policy and behavioural changes and innovations in agriculture and agroforestry.	- EU wide integrated data bases and typologies - Spatialized (disaggregated) farm specific information - Farm management information - Model components (e.g. CAPRI) - Interfaces (e.g. externality simulator)	- Additional data and information relevant for the assessment of impacts of CC - Improved insight into the behavioral response of farmers to regulations and associated enforcement mechanisms - Indication of possible changes in farm management per farm type and region in response to CC implementation - Adaptation and refinement of the CAPRI model and a further extension of the Coco database for the assessment of the impacts of CC on sustainability of farming - Specific model components for the assessment of effects of CC on the sustainability of farming - A specialized analytical tool for the assessment of the impacts of CC
NitroEurope (NEU)	NitroEurope investigates the nitrogen cycle and its influence on the European greenhouse gas balance, focusing on interactions with the carbon cycle.	- Relationships between land use change and atmospheric emissions of ammonia and greenhouse gases - Relationships between various measures and impacts on atmospheric emissions and N leaching	- Inclusion of impacts on phosphorus and metal balances - Relationships between land use change and atmospheric emissions of ammonia and greenhouse gases

As Table 3.1 shows except for the IEEP projects, all reviewed projects provide important information, indicator or modelling tools which can be input for the CCAT project. As regards the IEEP CC and network projects, which were early projects both inventorying first experiences, the limited scope for explicit inclusion in the current project is quite clear, since already more and more precise information has become available (see also reviews of other projects). As regards the IEEP evaluation study, the information from this project seems to be highly valuable, but a balanced evaluation was impossible since there is currently no public access to the results of this study.

Although Table 3.1 indicates that there is a lot of knowledge available from various project where upon CCAT could built, it also makes clear that several challenges remain for this project. To mention a few:

- Best estimates of the degree of compliance and costs of compliance are only available for a subset of member states. Insights into the additional compliance induced by the CC enforcement mechanism is still very limited. More information on this is however crucial for the project. More efforts have to be made on this and disclosure of all possible known information is key to the success of this project;
- Several tools are available, but need to be integrated and linked to each other. Therewith various issues have to be faced in terms of input-output relationships, levels of aggregation and scale, etc.;
- The linkage between tools and indicators will need further attention. A number of indicators are likely to be already implicitly available in the modelling tools, for others linkages will have to be established;
- The reviewed studies were relatively ‘silent’ on issues of biodiversity, food safety, animal welfare and landscape. As they are part of the planned assessment tool particular attention will have to be given to these aspects and maybe new tools or complementary modules have to be developed.

It is in particular striking that although several research projects have been done, there is still a lack on data about compliance. Since this kind of information is crucial for the project, in the final conclusions (see Chapter 6) this issue will be separately discussed.

4 Regulations, standards and potential impacts

4.1 Introduction

In this chapter it is assessed which impact indicators can be developed for assessing the different impacts of CC. Since this cannot be done in isolation of the objectives and the intervention logic of cross-compliance, the first part of this chapter (see Section 4.2) further explores the policy context. Together with the intervention logic this provides insight into the issues which are of importance in evaluating the cross-compliance policy. Three types and levels of objectives (global, specific, operational) and related achievements (impacts, results, outputs) are distinguished. The intervention logic provides a framework for identifying and categorizing different indicators. For example, a result indicator (number of farms inspected) will differ from an output indicator (level of reduction in direct payments due to non-compliance). At the same time they will be more or less related. When at a result level no indicator can be operationalised, maybe at the outputs-level it can be done and the correlation between both type of indicators can be exploited to provide a balanced assessment.

To get a better understanding of indicator-based assessments of the impacts of CC, in section 4.5 the so-called "intervention logic" is first described (see Section 4.2). Both, for subsidies (e.g. the new EU Rural Development Regulation) and for direct regulations (i.e. according to CC). The intervention logic establishes the causal chain from the application of SMRs and definition of GAECs[13] as input, via the output and the results of standards and requirements[14], to their impact. Thus, the intervention logic guides the consecutive assessment of a contribution of SMRs and GAECs to achieving the objectives of CC. The objectives of CC are described in section 4.2.1.

In the subsequent part of the chapter (see Section 4.3) an overview is given of the different SMRs and GAECs, their different implementation pathways as specified in the CIFAS project for a large selection of EU-countries (see section 3.4). For the different SMRs and GAECs, depending on the way they are implemented in every Member State, fields of impact can be identified (see Annex V and VI). The fields of impact already give an indication of potential impacts of CC. However, to really assess these impacts in a quantitative, transparent and comparable way indicators have to be identified per field of impact which candidate to be modelled with the tools and data available in this project. This will be further discussed in Chapter 5 and 6 and further elaborated in next CCAT Deliverables (Deliverable 2.3. 4.1.1, 4.2.1, 4.3.1 and 4.4.1).

Indicators are used as tools to assess at each level (output, result, impact) how far the expected objectives have been achieved. For the selection of the candidate indicators we will make use, as much as possible, of existing indicators from policy relevant indicator frameworks. These indicator frameworks already have policy relevance, and

---

13 In case of subsidies there is a budgetary input

14 In case of subsidies the results of measures are described.

their indicators have usually already been operationalised and specified. Their practical implementation has already been tested and their input data needs are clear. They may also provide a baseline situation against which the effects of CC to be modelled in CCAT can be compared. This is why we first give an overview of the indicator frameworks that provide indicators for the same fields of impact as CC policy in Section 3 of this chapter. In the next Section the link is then established between the impact fields of the SMRs and GAECs and a selection of indicators from the different indicator frameworks described in section 3 which may potentially be used for assessing the impacts of CC in this project, provided they can be specified with the models, tools and data in this project. This however will also be further discussed in chapters 5 and 6.

In the described indicator frameworks a distinction is made in type of indicators either according to the Driver, Pressure, State, Impact, Response (DPSIR) framework, or the Common Monitoring and Evaluation Framework (CMEF) which is more in line with the intervention logic of CC. Both indicator frameworks were developed for assessing impacts of policy. They therefore also provide a good basis for assessing the effects of CC and will help to position the types of indicators that can be employed in this project. The combination of CC measures, fields of impacts and potential indicators will provide a first basis from which we can select the final indicators to be further specified in this study.

4.2 The objectives and intervention logic for Cross-Compliance

4.2.1 Objectives of cross-compliance

The objectives of cross compliance can be found in:

- the Preamble to Regulation No. 1782/2003 which establishes the legal basis for this policy, and;
- further statements on the purpose of cross compliance included in Regulation No. 796/2004 which lays down detailed rules for the implementation of cross-compliance and associated policy measures.

These are usefully summarised in a background paper on cross compliance prepared by IEEP (2006) as follows:

- to integrate basic standards for environment, food safety, animal health and welfare and good agricultural and environmental condition in the common market organisations by linking direct aid rules relating to agricultural land, agricultural production and activity;
- to avoid the abandonment of agricultural land and ensure that it is maintained in good agricultural and environmental condition;
- to maintain the existing area of permanent pasture on the basis of its environmental importance;

- to promote more sustainable agriculture
- to provide an incentive for farmers to respect existing legislation.

The objectives for cross compliance listed above suggest that, if effective, the policy *will* influence land management decisions and *will* have positive environmental benefits.

But in order to understand how cross compliance might achieve these objectives (and therefore be effectively evaluated) it is necessary to explore the "intervention logic" of the policy.

4.2.2 EU Common Intervention Logic

The European Commission has been increasingly committed since the mid-1990s to greater monitoring and evaluation of all EU structural assistance programmes in order to:

a) review, revise and improve the effectiveness of funding programmes at achieving strategic policy objectives
b) enhance the "transparency" and "accountability" of EU funding programmes
c) ensure that EU assistance programmes deliver "good value for money" for the European taxpayers that fund them

In order to achieve this, the Commission imposes an "operational framework" upon Member States that obliges them to report the results of their monitoring and evaluation activities according to certain common structures that allow data to be combined at EU level and for comparisons to be made between Member States. For example, as described in Section 4.4 (below) in the case of the new EU Rural Development Regulation No. 1698/2005 (the so-called EAFRD[15] Regulation) all Member States are currently required to follow a Common Monitoring and Evaluation Framework (CMEF) for all measures included in national/regional rural development programmes financed under Pillar 2 of the Common Agricultural Policy (CAP) for the period 2007-2013.

All operational frameworks for the monitoring and evaluation of different programmes are actually based upon a common intervention logic of EU assistance that was first developed under the so-called MEANS programme - an undertaking launched in the 1990s by the European Commission with the aim of improving and promoting evaluation methods[16].

---

[15] The European Agricultural Fund for Rural Development (EAFRD)

[16] See the *"MEANS Collection - Evaluation of socio-economic programmes"* – this is a six-volume collection of technical guides published by the European Commission in 1999 to provide reliable and consistent reference sources to assist professional and non-professional evaluators to deal effectively with the problems they encounter when working on the assessment of public-sector schemes in general and in particular measures under the EU Structural Funds

This common intervention logic is outlined in Figure 4.1 and should be viewed from two different perspectives – top down and bottom up:

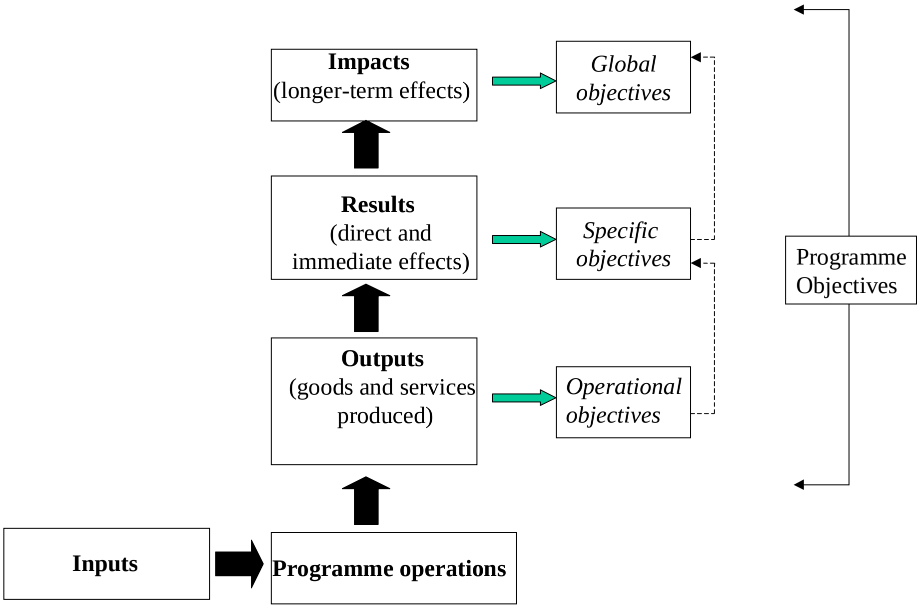
a) Starting from the top down, there is a logical relationship between the three levels of programme objectives:

- All EU assistance programmes are developed and implemented according to **Global (**or **General) Objectives** that relate to the specific context of the intervention and the strategy for intervention. These are sometimes expressed as responding to the **Needs** of wider society;
- These global objectives give rise to **Specific Objectives** that correspond to priority areas for action that are implemented via targeted policy measures/schemes;
- Each of these measures/schemes then have **Operational Objectives** relating to their day-to-day administration.

b) At the same time, from the bottom up:

- All measures/schemes are implemented using various resources (financial, human, technical or organisational) that are referred to as **Inputs**;
- The use of these inputs gives rise to a series of physical **Outputs** that demonstrate the progress made in implementing the measure/scheme (e.g. number of farmers participating);
- The direct and immediate effects arising from the progress made in implementing the measure/scheme are called the **Results** (e.g. the increased area of farmland being managed in a specific environmentally-friendly way)
- These results can further be expressed in terms of their longer-term effects or **Impacts** on the achievement of the assistance programme's global objectives (e.g. to protect and improve natural resources and the rural environment). It is these Impacts that satisfy the **Needs** of wider society and create the **Utility** of the intervention which, in practice, should outweigh the total costs incurred by the EU assistance programme.

Figure 4.1: **The Common Intervention Logic of all EU Assistance Programmes**



Source: EC, 1999

As Figure 4.1 shows, the overall the achievement of Outputs, Results and Impacts is then clearly linked to the programme objectives as follows:

> **Global Objectives** are expressed in terms of **Impacts**
> **Specific Objectives** are expressed in terms of **Results**
> **Operational Objectives** are expressed in terms of **Outputs**

Within this hierarchy there is also an important shift in emphasis from EU level to farm level.

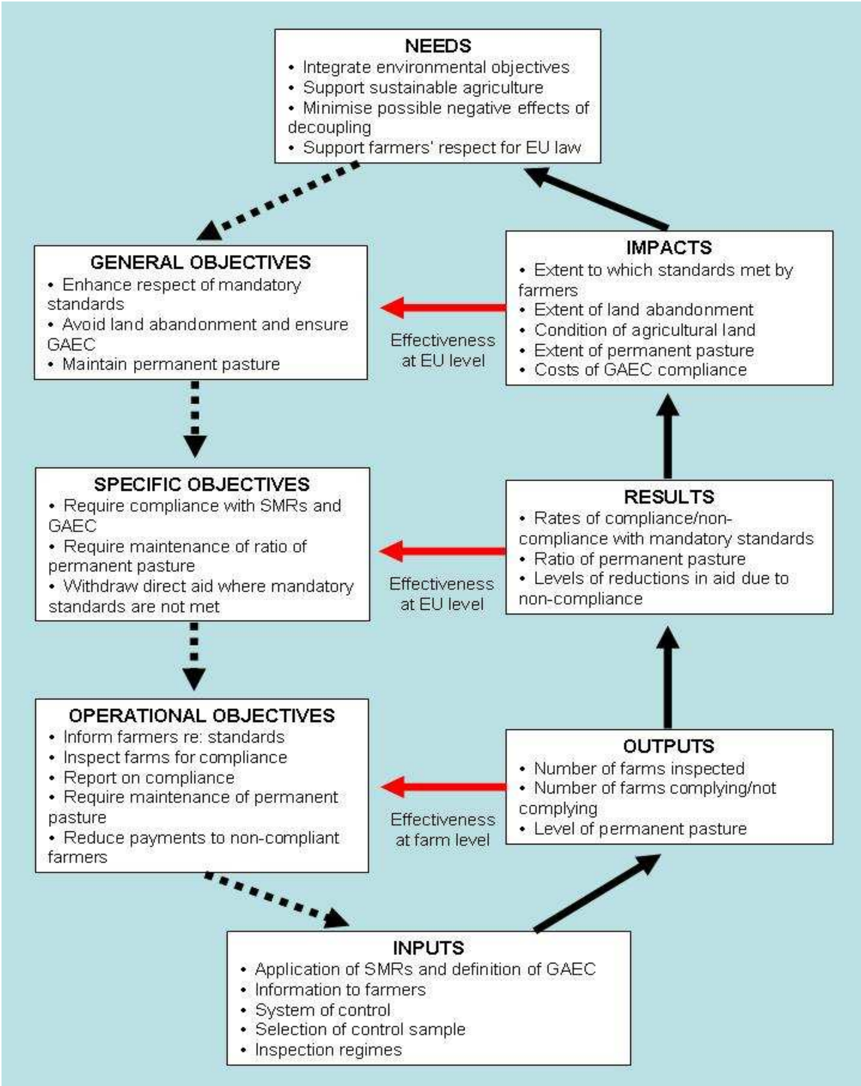
4.2.3 Intervention Logic of Cross Compliance

Figure 4.2 presents an interpretation of the intervention logic of cross compliance as elaborated by Swales (2007).

This is very helpful for understanding:

- how cross compliance should, theoretically, achieve its own objectives, and;
- the factors that contribute to this achievement e.g. the application of SMRs, the definition of GAECs, provision of information and advice to farmers, and the system of control.

Figure 4.2: **The Intervention Logic of Cross Compliance (Source: adapted from Swales, 2007)**



4.2.4 Policy reform

In the health check the CC policy will be reviewed. Now it becomes already clear that this is likely to imply a number of changes. As such these changes are unlikely to affect the objectives and intervention logic. However, in particular at the level of the operational objectives (and associated inputs and outputs) things might change. At the stage of writing this Deliverable it can only be observed that this is something which is going to happen in the near future. The outcome of the evaluation process and the consequences this might have for the selection and operationalization of indicators is still unclear, but will be a point to pay attention to in future project steps.

4.3 Possible fields of impact of CC

4.3.1 Potential fields of impact of CC requirements and regulations

With regard to the fields of impacts of SMRs and GAECs we distinguish the following general and sub-categories:

a) Agricultural markets and producer's income
   - Agricultural markets
   - Producer's income

b) Environment
   - Ground water
   - Surface water
   - Water quantity
   - Air quality
   - Climate
   - Physical soil quality
   - Chemical soil quality

c) Land use

d) Biodiversity
   - Birds
   - Mammals
   - Invertebrates
   - Vegetation

e) Landscape
   - Landscape diversity
   - Landscape aesthetic quality

f) Animal Welfare
   - Animal health
   - Animal welfare

g) Public Health

In Annex IV it is specified per SMR what the exact requirements to the farmer are given different national implementation pathways and an estimate is made of the potential impact fields of the SMR. In Annex V the same was done for the GAECs. An overall result of this exercise is that some SMRs and GAECs target at specific environmental issues, but that they may also have a side effect on other issues. E.g. in the case of the Nitrate Directive the target is improving water and soil quality, but it may also lead to a reduction of GHG emission.

In Chapter 2 it was already described that for a good assessment of CC we ideally need to have information on the initial rate of compliance, on the increase in compliance in time and on full compliance if already achieved. Since information on the rate of compliance at present stage is generally not available, assessments on possible impacts for identified SMRs and GAECs have been made based on the assumption that there was non-compliance before (see Annex IV and V). Based on this assumption all SMRs in general require changes in farm management and/or land use and have therefore potentially income effects. In principle everything that has impacts on income and in line with this profits has also potential market effects (see Annex IV).

Potential effects of SMRs on environment, land use and landscape may be similar in countries although some different implementation paths within different environmental context may certainly cause national and regional differences in impacts. From the present CIFAS results (IFLS, 2006) we see for example that the Birds Directive can be assumed to have a direct positive effect on bird populations but usually may also have other positive side effects on other biota, and the quality of habitats, e.g. water, air and/or soil and landscape quality and diversity. However, in the countries where the Birds Directive measures have a much wider focus, with an higher number of codes of practice which do not only focuss on prevention of direct disturbance and injuring and damaging of birds and nests but also on encouraging farming practices that are beneficial, the positive side-effects are greater. They are also beneficial for other biota and may lead to an improved habitat quality. The implementation of a wider range of measures under this SMR is typical in Austria and Spain. For the implementation of the habitat directive we also expect more beneficial side-effects on environment in countries like Austria, Spain, UK and Greece where a wider number of measures is taken to enforce this SMR not only targeting directly at the preservation of the habitats and the natural flora and fauna but also at specific land and farm management requirements that may indirectly benefit habitat quality.

SMRs dealing with the fertilization of soils with nitrate above all have a potential impact on groundwater quality and in line with surface run-off of water also with surface water. Together with physical, chemical, biological factors of the soil as well as climatic factors, the SMRs might also impacts on air quality and climate. Since the N-content in soils has an impact on habitats and biodiversity, these have also been identified as potential areas of impact.

SMRs according to the ‘Sewage Sludge Directive’ have in particular potential impacts on the chemical soil quality. In line with the avoidance of soil contamination (e.g. by heavy metals) the requirements are also of potential impact for animal health and food safety. Furthermore sewage sludge also contains nitrate and possibly other toxic pollutants and is used as fertilizer. In consequence a reduction of its use has also potential positive impacts on groundwater, surface-water and air and biodiversity. It may also increase food-safety.

The ‘groundwater directive’ naturally has mainly potential impacts on the groundwater and in line with this - under given circumstances - also for the quality of surface water. The listed substances, which are not allowed to discharge into groundwater are also detrimental for the soil quality and SMRs according to the groundwater directive have also potential impacts on chemical soil quality and potential positive effects on biodiversity, especially plants and soil organisms.

In relation to GAECs the diversity in implementation between countries is even greater (see Annex V) which will also be a main cause for regional differences in CC effects. Firstly because the number of GAEC per country and region ranges. And secondly the type of GAECs can be very different even when aiming at the same environmental issues. We see that a very large number of GAECs are applied in Spain (21) and Scotland, while at the lower end we find Lithuania (5), Slovenia (3) and The Netherlands (6). Also in particular impact fields the number of GAECs ranges strongly. Estonia for example has no soil erosion GEACs while Spain has specified 13 GAECs to prevent it (See also next Section).

4.3.2 SMRs and GAECs in the different Member States

As already briefly discussed before there are two major aspects of CC in the Single Area Payment:

- Compliance with 18 Statutory Management Requirements (SMRs) covering the environment, food safety, animal and plant health and animal welfare (set out in Annex III of CR 1782/2003). An overview of these is given in Annex III.
- Compliance with a requirement to maintain land in Good Agricultural and Environmental Condition (GAEC). GAECs are carried out at national or regional level and should warrant appropriate soil protection, ensure a minimum level of maintenance of land and avoid the deterioration of habitats (set out in Annex IV of CR 1782/2003). In general, the definition of GAECs must be in accordance with the framework set out in Table 4.1. Since there is a large range in agricultural farming systems operating in very different pedo-climatic circumstances, a great deal of freedom has been left to Member States and regions to implement GAECs.

Table 4.1 EU Good Agricultural and Environmental Condition Framework (GAECs).

Issue	Standards
Soil erosion	• Protect soil through appropriate measures • Minimum soil cover • Minimum land management reflecting site-specific conditions • Retain terraces
Soil organic matter	• Maintain soil organic matter levels through appropriate practices • Standards for crop rotations where applicable • Arable stubble management
Soil structure	• Maintain soil structure through appropriate measures • Appropriate machinery use
Minimum level of maintenance	• Ensure a minimum level of maintenance and avoid

	the deterioration of habitats • Minimum livestock stocking rates or/and appropriate regimes • Protection of permanent pasture • Retention of landscape features • Avoiding the encroachment of unwanted vegetation on agricultural land

In principle the SMRs are uniform for all Member States and should be implemented in national and regional legislation in a similar way. However, in practice there is still a large difference in the way these are translated in national and regional requirements and standards. For the GAECs Member States are allowed a great level of freedom in selecting the number of GAEC standards and determining how they should be implemented. Although the differences in implementation are not to be discussed extensively in this report as it will be discussed in separate Deliverables (D 3.2 and 3.3 to be produced in a later stage), we will still pay some attention to it as it influences the regionalisation of CC effects which should also be discussed in this report. The CIFAS project showed that for SMRs and GAECS the national and regional implementations show large differences. CIFAS provided an overview of national implementations for 12 Member States concerning SMR and for 21 Member States concerning GAECs (see also section 3.4). The differences of national implementation among SMRs and GAECs is due to the fact, that SMRs will be in force only from 2009 in the new EU-Member States.

The initial results of CIFAS are used here to categorize the different fields of impacts of CC. For SMR implementation these CIFAS implementation overview is included in Annex V of this report. For GAECS this is done in Annex VI. Additional information on other Member States will be included later in the project. It should therefore be mentioned that the CIFAS results were only collected for a limited number of countries and the interpretation of the implementation pathways in CIFAS was done on the basis of best knowledge at the time of data collection. For several countries however management plans for CC were not yet finished at the time of data collection. The results of CIFAS presented here should therefore be interpreted with care and additional information collection on implementation pathways of SMRs and GAECS will still be done in a later stage of the CCAT project.

On the basis of the present CIFAS results (See Annex IV and V) we can conclude that the extent to which the same paragraph (in the case of SMRs) or issue (in the case of GAECs) has been translated into a precise requirement or standard varies greatly between Member States. While in some Member States it is quite detailed and explicative, in others it is more general. In the CIFAS project this has been made clear by grouping the different implementation pathways in the Member States in so-called “short names”. Each SMR and GAEC in the CIFAS data base has been linked with such a short name. In some cases a short name is relevant for several similar SMRs. In other cases it is specific to a given SMR or GAEC in only one Member State. For this report the CIFAS-short names have been used to provide an overview on different implementation pathways and the possible areas of impact (cf. Annex V and VI). The CIFAS-short names contain information on the EU-Directive they refer to and the main topic of the standards and requirements at different level of aggregation. At present stage they have been of use for the CCAT-project, but in line with the objectives of CCAT they will probably have to be revised once again in forthcoming months.

Overall Annex V and VI show that there are differences in which Member States have implemented the SMRs and GAECs. The overlap between the implementations is that they clearly target the same issue but the difference occurs because some Member States seem to interpret the Directives/Regulation (in the case of SMR) and "issues" (in the case of GAEC) in a much broader way and implement a wider number of requirements respectively standards than others.

For the Wild Birds Directive we can see that most Member States (investigated in the CIFAS project) concentrate the implementation on measures that directly discourage the killing-injuring of birds through e.g. hunting, catching and destruction of nests. However, in a limited number of countries additional requirements are also defined under this Directive that limit farming practices that adversely affect bird populations and their habitats (e.g. quality of habitats + landscape features). This is most strongly the case for Austria, UK and Spain.

A similar pattern is seen in the implementation of the Habitat Directive where all countries have formulated requirements that directly prohibit afflicting damage to or destroying natural habitats, flora and fauna. In some countries however, especially Spain and Austria but also UK and Greece a larger number of measures is taken to prevent changes to land use, landscape structure and adjustments in farming practices in favour of natural habitats, flora and fauna.

According to the 'Nitrate Directive' in several Member States requirements are formulated with reference to the application of organic and mineral fertilisers, the storage of fertilisers (in particular manure and slurry), defined areas (slopes) and soil conditions not allowing fertilisation and upper limits of N-fertilisation per hectare. Details and limits vary among Member States. In addition, in individual Member States specific SMRs exist, such as fertilization distance to waters (Germany) on manure trading (Denmark) and crop rotation (Austria).

SMRs based on the 'Sewage Sludge Directive' mainly refer to general application restrictions, requirements to avoid to exceed of upper limits of heavy metals levels in soils and restrictions on grazing, forage crops, vegetables and fruits on fields, where sewage sludge is applied. Equally to the Nitrate Directive in several Member States soil conditions are defined (frozen, snow-covered, water-saturated), when it is not allowed to apply sewage sludge. Some Member States additionally have defined specific SMRs such as for application (restrictions to soil types, vulnerable zones), or the requirement to carry out soil analyses.

The requirements according to the 'Groundwater Directive' in several Member States mainly deal with the avoidance of discharge of listed substances into the groundwater. The SMRs in general are flexibly formulated here and the farmer just has to ensure, that discharge is avoided. Some Member States, in additional codes of practice are obliged to avoid discharge and even complete prohibitions exist in some Member States.

What should be emphasised here is that differences in implementation and (additional) compliance in combination with differences in specific regional environmental conditions and farming system patterns will eventually be the cause for regionally specific CC effects. Furthermore we see that some MS implement SMRs in a much more detailed way than is required at EU level. This was discussed above and the question is whether the effects of such different implementation pathways can really be assessed within the scope of this study or whether only the general standardized SMR requirements can be measured assuming uniform implementation pathways.

For GEACs however the starting point will certainly be different per MS, firstly because the number of GAECs is very different and the definition ranges strongly in character as they are adapted to specific local circumstances.

4.3.3 Statutory Management requirement for animal welfare and food safety

The respective relevance of the 19 statutory management requirements for animal welfare and food safety considerations differs between the different directives and regulations. This is displayed in Table 4.2 where the expected impact of each single requirement on animal welfare and food safety is rated. The relevance is graded into strong influence (++), moderate influence (+) and not relevant (0). The symbol (0/+) means that a consistent scientific position could not be reached during the last years. In addition to this the SMRs and GAECs have also been further translated in national and regional requirements and standards in Annex VI and how they impact on different fields.

Table 4.2 Statutory management requirements and their impact on animal welfare and food safety considerations

Mandatory implementation of respective acts	**Articles**	**Impact on animal welfare**	**Impact on food safety**
Council Directive 79/404/EEC: Conservation of wild birds	Articles 3, 4 (1), (2), (4), 5 7 and 8	0	0
80/68/EEC Council Directive: Protection of groundwater	Articles 3 and 4	0	0
86/278/EEC Council Directive: Sewage sludge	Articles 3	**0**	**++**
91/676/EEC Council Directive: Nitrates from agriculture	Articles 4 and 5	**0**	**0**
92/43/EEC Council Directive: Conservation of natural habitats, wild flora and fauna	Articles 6, 13, 15 and 22 (b)	**0**	**0**
Council Directive 92/102/EEC: Identification and registration of animals	Articles 3, 4 and 5	0	0

Commission Regulation (EC) No 2629/97: Identification and registration of bovine animals	Articles 6 and 8	+	+
Regulation (EC) No 1760/2000: Identification of bovine animals, labelling of beef	Articles 4 and 7	+	+
Council Regulation (EC) No 21/ 2004: Identification and registration of ovine and caprine animals	Articles 3,4 and 5	+	+
Council Directive 91/414/EEC: Placing of plant protection products on the market	Article 3	0/+	++
Council Directive 96/22/EC: Use of hormones	Articles 3, 4, 5 and 7	0/+	0/+
Regulation (EC) No 178/2002: Requirements of food law	Articles 14, 15, 17(1), 18, 19 and 20	0	++
Regulation (EC) No 999/2001: Prevention, control and eradication of spongiform encephalopathies	Articles 7, 11, 12, 13 and 15	++	0/+
Council Directive 85/511/EEC: Control of foot-and-mouth disease	Article 3	++	0
Council Directive 92/119/EEC: Control of swine vesicular disease	Article 3	++	0
Council Directive 2000/75/EC: Control of bluetongue	Article 3	++	0
Council Directive 91/629/EEC: Standards for the protection of calves	Articles 3 and 4	++	0
Council Directive 91/630/EEC: Standards for the protection of pigs	Articles 3 and 4(1)	++	0
Council Directive 98/58/EC: Protection of animals kept for farming purposes	Article 4	++	0

The final specification of the SMRs impacts will be one objective of this project as so far no comprehensive survey exists of all single measures in every Member State. Additionally these measures have only recently started to become implemented so monitored results of their implementation and effects are still scarce. Therefore all indicated impacts have to be identified as expected ones (see Annex VI).

The short names of SMRs in this area to be derived from a detailed inventory of the requirements of the legal acts as implemented in every Member State are not yet available, but an initial overview is given in Annex VI. These national differences in implementation will be addressed by the case regions located in a selected number of countries. CCAT will therefore not deliver a full overview of differences in implementation of SMRs in relation to animal welfare and food safety.

The “Hygiene Package” (Regulations 852/2004, 853/2004 and 183/2005) requirements are addressed, too, although their final legal status as being a requirement for Cross-Compliance has not been clarified yet.

No explicit GAECs for cross-compliance for the issues animal welfare and food safety are defined, however one GAEC which can be considered as linked to this area is stocking rates. Limiting the stocking rate to a maximum will certainly be beneficial for animal welfare in certain cases.

4.4 Overview available indicator frameworks

Indicators are in general used for the reduction of complex information to single figures and information. Indicator-based-research in line with this intends to focus on a reduced number of indicators, allowing assessments of more or less complex situations. The central aim of this study is to assess the impacts of CC, so of SMRs and GAECs and for this assessment use indicators. A complicating factor is however that our knowledge on the connection between policy, farming and the different fields of impact is generally limited and imperfect.

This was already acknowledged in several studies in which agri-environmental indicators were developed and the pragmatic approach to this problem was introduced by the OECD through the Driving Forces, Pressures, State, Impact, Response (DPSIR) concept (see for example OECD, 1999a and OECD, 1999b). This concept developed by OECD and applied in several studies since then (e.g. IRENA operation (EEA, 2005 and 2006); Dobris assessment (Stanners and Bourdeau, 1995)). The DPSIR approach helps to understand interlinkages between policy measures, economic activities and impacts. The concept has been developed by the OECD, the European Environment Agency (EEA) and other institutions. It was developed in relation to environmental themes, biodiversity and landscape, but can also be used for other impact categories. In the IRENA report it is emphasised that the DPSIR framework is only a ‘tool’ to “capture the key factors involved in the relationships between agriculture and the environment, but it is not meant to reflect the complex chain of causes and effects”. In this study it is also suggested to use the DPSIR framework in a similar way as in the IRENA study. The DPSIR framework will enable a systematic assessment between the Cross Compliance measures, farmers decisions and related changes in farming practices and possible effects on environment, land use, biodiversity, landscape, animal welfare and health and food safety.

In this sub-section we will first give an extensive but not inclusive overview of the most relevant indicator frameworks covering impact fields of CC. It should also be mentioned that work on indicators is an ongoing process where new frameworks often build upon previous ones. There is a long list of existing indicator frameworks which provide a useful basis for assessing CC. This list is extensive because the impact fields of CC are quite diverse. Interesting indicator frameworks will be further discussed underneath per theme and further supported by detailed information in Annex VII.

The outcome of inspections and controls on Cross Compliance in the different Member States are also done according to checklists which may also deliver interesting indicators in relation to compliance, degree of compliance and if repeated for several years also changes in degree of compliance. However in this chapter they will not receive much attention as it is not likely that this inspection and control information will be made available to the project and it is also unclear what exact indicators are specified in the checklists.

4.4.1 Economic indicator frameworks

In the field of agricultural income and markets the main existing indicator frameworks are the indicators provided by Eurostat-CAPRI, DEFRA, the Cross Compliance project, the IFAS project, OECD and Capri-Dynaspat. These are typically indicator frameworks that have already been used extensively for assessing impacts of policy and changes in agricultural markets.

4.4.2 OECD agri-environmental, biodiversity and landscape indicators

Work on agri-environmental indicators has taken place at an international level as well as at individual country basis. Internationally, the OECD has played a major role in methodological discussions on agri-environmental indicators (see for example OECD, 1999a and OECD, 1999b) and in the more practical work of actually calculating and interpreting agri-environmental indicator trends (OECD, 2001 and a new indicator report is expected in 2007[17]). Since the beginning of the 1990s extensive work on environmental indicators was already done by the OECD based on the DPSIR concept (initially according to the PSR concept). The agri-environmental indicators of the OECD focus on the following areas:

- Agriculture in the broader economic, social and environmental context
  - Contextual information and indicators
  - Farm financial resources
- Farm management and the environment
- Use for farm inputs and natural resources
  - Nutrient use
  - Pesticide use and risks
  - Water use
- Environmental impacts of agriculture
  - Soil quality
  - Water quality
  - Land conservation
  - Greenhouse gases
  - Biodiversity

[17] Volume 4 shall be published in 2007

- Wildlife habitats
- Landscapes

4.4.3 ELISA agri-environmental, biodiversity and landscape indicators

Also within the European Union substantial efforts have been made to develop agri-environmental indicators. Agri-environmental aspects were already included in the Dobris assessment from the European Environmental Agency as early as 1995 (Stanners and Bourdeau, 1995). In 2003 the IRENA operation started leading to a full operationalisation and calculation of more than 40 agri-environmental indicators for EU-15 and this is presently extended to the whole EU.

Before the IRENA project started an EU Concerted Action project *Environmental Indicators for Sustainable Agriculture* (ELISA), co-ordinated by the European Centre for Nature Conservation, developed a conceptual framework for indicators in which a set of core agri-environmental indicators was proposed (Washer, 2000). Indicators were identified for three environmental fields, i.e. soil, water and air, two environmental systems, i.e. biodiversity and landscape, and three types of agricultural driving forces, i.e. land use intensity, nutrients and pesticides. There are several biodiversity indicators in ELISA which have a potential to be further elaborated in this project in relation to CC impacts. Out of the 13 *state* indicators, the following still rather general indicators can be of relevance for this project:

- Spatial complexity
- Corridors and linkages between habitat types
- Size and relative share of characteristic habitat types
- Flagship species
- Species richness
- Species population trends
- Genetic diversity in semi-natural agro-ecosystems
- Genetic diversity in farm species

As to the landscape indicators of ELISA, the following 4 state indicators can be selected to be relevant within this project:

- Biophysical adequateness of land use
- Openness versus closedness
- Adequateness of key cultural features
- Land recognized for its scenic or scientific value

Further, *pressure* indicators of ELISA were analysed as well, and we selected 12 which have potential to be assessed in relation to CC:

- Share of irrigated area
- Land use intensity
- Yield of cereals
- Share of farms with > 50% cereals
- Share of UAA in total area
- Livestock density

Nutrients

- N-discharge
- Nitrate surplus

Pesticides

- Direct usage data per pesticide
- Sales data per pesticide
- Pesticides cost per crop
- Estimated usage data per crop
- Pesticide risk

Some of the indicators proposed in ELISA were further developed and finally operationalised in the IRENA operation. However, for the majority of the indicators proposed severe limitations of data availability were found and most of them have never been operationalised. Data gaps were especially found to affect the indicators on biodiversity and landscape.

4.4.4 The IRENA indicators

The most substantial and up-to-date operationalisation of indicators was done in the IRENA operation. The indicators produced were all used for ex-post assessments mostly over the period 1990-2000. At this moment all IRENA indicators have been specified for the EU-15 and some indicators are presently being specified for the new Member States (see also Section 3.6). An overview of all IRENA indicators is given in Annex VI of this report. IRENA has produced a number of very informative indicator fact sheets, each with precise references to the DPSIR framework (European Environment Agency, 2005). IRENA is focusing on the following areas of impact:

- Agricultural water use;
- Agricultural input use and the state of water quality;
- Agricultural land use, farm management (practices) and soils;
- Climate change and air quality;
- Biodiversity and landscape.

Some of the IRENA indicators will be a good basis for this project as they have been worked out on the basis of existing data sources and they cover the wide range of impact fields the CCAT project should also cover.

4.4.5 The CMEF-framework

According to Article 84 of the new EU Rural Development Regulation No. 1698/2005 (the so-called EAFRD[18] Regulation), the European Commission requires

[18] The European Agricultural Fund for Rural Development (EAFRD)

all Member States to follow a Common Monitoring and Evaluation Framework (CMEF) for all measures included in national/regional rural development programmes financed under Pillar 2 of the Common Agricultural Policy (CAP) for the period 2007-2013. This includes a comprehensive set of agri-environment indicators for the measures included under Priority Axis 2 of the EAFRD Regulation relating to the promotion of sustainable land management practices for "improving the environment and the countryside".

Monitoring and evaluation are increasingly important aspects of the normal 'cycle' of EU rural development programming and typically includes both an "internal" and "external" function.

At the 'internal' level, the main aim of monitoring and evaluation activities is to provide feedback to policy-makers and programme managers at Member State level on how well rural development measures are functioning and whether they are actually achieving the objectives and targets that have been established for them. At the 'external level', the main aim of monitoring and evaluation activities is to fulfil the obligation for reporting to European Commission on the progress and performance of rural development programming by each Member State.

The CMEF establishes five types of indicators in line with the general EU approach to a) rural development programming and b) the increasingly stringent reporting obligations.

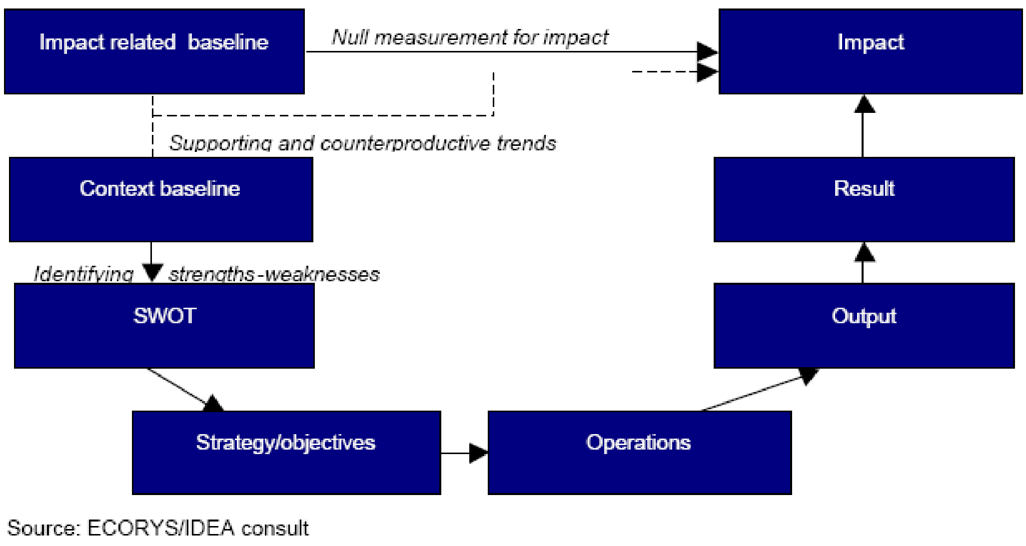


Figure 4.1 The CMEF indicator framework

- **Input indicators** refer to the financial and other resources allocated to the rural development programme and its measures. Financial indicators are commonly used to monitor progress in terms of the annual commitment and payment of the funds to farmers for specific measures and/or activities within the programme.

Example: expenditure per measure declared to the Commission

- **Output indicators** refer to activity which happens as a result of the inputs – they are usually measured in physical or monetary units.

  Example: number of training sessions organised, number of farms receiving investment support

- **Result indicators** refer to the direct and immediate effect brought about by a measure/scheme and provide information on changes to the behaviour, capacity or performance of the direct beneficiaries and are measured in physical or monetary terms.

  Example: increased value of agricultural production under recognized quality label, successful training outcomes

- **Impact indicators** refer to the longer-term consequences of the programme/measures beyond the immediate effects on its direct beneficiaries. These indicators are linked to the wider objectives of the programme.

  Example: increase in employment in rural areas, increased competitiveness of agricultural sector.

- **Baseline indicators** are used in the SWOT analysis that forms the basis of the rural development programme strategy. They fall into two categories:

  Impact related baseline indicators - these are directly linked to the wider objectives of the programme and are the basis for measuring effectiveness. They are the baseline (or reference) of the programme's impact;
  Context related baseline indicators - these provide information on the relevant aspects of the general context in which a programme is implemented and that are likely to have an influence on the performance of the programme, but which are not be targeted (directly) by the programme. These indicators are important for explaining impacts observed within the programme which are related to changes in the general economic, social, structural or environmental context rather than the programme itself.[19]

The European Commission has proposed a comprehensive list of common indicators applicable to all rural development programmes and measures for 2007-2013. Those indicators used for assessing the impact upon biodiversity, landscape, soil and water of the measures under Priority Axis 2 (sustainable land management) are listed in Table 4.3 below. These should be supplemented by additional, more specific indicators, by the individual Member States.

---

[19] For examples, the contribution of a rural development programme to employment creation will depend on overall trends in growth and employment.

Full details of the CMEF, including detailed technical fiches for all the CMEF common indicators, are available at:
http://ec.europa.eu/agriculture/rurdev/eval/index_en.htm

Table 4.3: List of CMEF Draft (2006) Indicators for Priority Axis 2 of the EAFRD Rural Development Regulation that are relevant to the sustainable management of agricultural land

Output Indicators

Measure	Output Indicators
Natural handicap payments to farmers in mountain areas	▪ Number of supported holdings in mountain areas ▪ Supported agricultural land in mountain areas
Payments to farmers in areas with handicaps, other than mountain areas	▪ Number of supported holdings in areas with handicaps, other than mountain areas ▪ Agricultural land area supported in areas with handicaps, other than mountain areas
Natura 2000 payments and payments linked to Directive 2000/60/EC (WFD)	▪ Number of supported holdings in Natura 2000 areas/under WFD ▪ Supported agricultural land under Natura 2000/under WFD
Agri-environment payments	▪ Number of farm holdings and holdings of other land managers receiving support ▪ Total area under agri-environmental support ▪ Physical area under agri-environmental support under this measure ▪ Total Number of contracts ▪ Number of applications related to genetic resources
Non-productive investments	▪ Number of farm holdings and holdings of other land managers receiving support ▪ Total volume of investments
First afforestation of agricultural land	▪ Number of beneficiaries receiving afforestation aid ▪ Number of ha afforested land

Result Indicators

Axis/Objective	Indicator
Improving the environment and the countryside through land management	Area under successful land management contributing to: (1) bio diversity and high nature value farming/forestry (2) water quality (3) climate change (4) soil quality (5) avoidance of marginalisation and land abandonment

Impact Indicators

Indicator	Measurement
Reversing Biodiversity decline	Change in trend in biodiversity decline as measured by farmland bird species population
Maintenance of high nature value farming and forestry areas	Changes in high nature value areas
Improvement in water quality	Changes in gross nutrient balance
Contribution to combating climate change	Increase in production of renewable energy.

Baseline Indicators

a) Context-related

Indicator	Measurement
Land cover	% area in agricultural / forest / natural / artificial classes
Less Favoured Areas	% UAA in non LFA / LFA mountain / other LFA / LFA with specific handicaps
Areas of extensive agriculture	% UAA for extensive arable crops
	% UAA for extensive grazing
Natura 2000 area	% territory under Natura 2000
	% UAA under Natura 2000
Water quality	% territory designated as Nitrate Vulnerable Zone
Water use	% irrigated UAA

b) Impact-related

Indicator	Measurement
Biodiversity: Population of farmland birds	Trends of index of population of farmland birds
Biodiversity: High Nature Value farmland areas	UAA of High Nature Value Farmland areas
Water quality: Gross Nutrient Balances	Surplus of nitrogen in kg/ha
Water quality: Pollution by nitrates and pesticides	Annual trends in the concentration of nitrate in ground and surface waters Annual trends in the concentrations of pesticides in ground and surface waters
Soil: Areas at risk of soil erosion	Areas at risk of soil erosion (classes of T/ha/year)
Soil: Organic farming	UAA under organic farming

Climate change: Production of renewable energy from agriculture	Production of renewable energy from agriculture (ktons)
Climate change: UAA devoted to renewable energy	UAA devoted to energy and biomass crops
Climate change: GHG emissions from agriculture	Agricultural emissions of GHG (ktons)

4.4.6 Animal welfare indicator frameworks

In the area of animal welfare general development systems of animal welfare indicators can be distinguished from already existing indicator frameworks. In contrast to the indicator frameworks the development systems do not specify certain indicators but recommend their selection criteria.

There are four relevant development systems of animal welfare indicators available:

1) The “Five freedoms” which were developed by the British Farm Animal Welfare Council (FAWC) in 1979. They describe five objectives relevant for general animal well-being considerations in 1979 (FAWC, 1993):

    a. Freedom from thirst, hunger and malnutrition
    b. Freedom from lack of appropriate comfort and shelter
    c. Freedom from pain, injury or disease
    d. Freedom to display most normal patters of behaviour
    e. Freedom from fear and distress.

    These so called Five Freedoms can be translated by various physical, physiological, anatomical, ethological and pathological indicators. They can be considered as general indicators for animal well-being. Animal-based measures indicating the welfare of animals somatically as well as production system-based measures displaying housing and shelter conditions are part of this system. The operationalisation of the Five Freedoms was inter alia conducted through the Animal Needs Index.

2) Based on the “Five freedoms” of the FAWC the British Royal Society for the Prevention of Cruelty to Animals (RSPCA) recommends specific welfare standards developed from scientific research, veterinary advice and practical experience form the farming industry that cover nutrition, environment, health, management, transport and slaughter for nine farm animals commonly farmed for food (RSPCA, 2007).

3) The Welfare Assessment System is an instrument to establish a welfare protocol which serves as an aggregated indicator for animal well-being. It was developed by the Danish Institute of Agricultural Science. Disaggregated welfare indicators are divided into four groups:

    - Animal behaviour
    - Animal health
    - Production system
    - Management of the production system.

Aggregating welfare indicators into a welfare protocol involves evaluating the suggested indicators step by step in a tripartite ‘bottom-up’ process (Rousing et al., 2001). First, multiple indicators are considered regarding their welfare influence. Second, each indicator’s information on animal welfare is evaluated in relation to all the other potential welfare indicators and the most relevant ones are selected depending on the highest marginal welfare relevance. The final step in developing an operational welfare protocol is to evaluate the suitability of indicators for use in on-farm studies. Reliability characteristics of indicators have to be taken into consideration as well as cost of measurement and tests.

4) The quantification of animal welfare as an economic value based on consumer perceptions is an interesting approach measuring animal welfare and developing an indicator being independent from the animal- and production-system-level. If the level of animal welfare is perceived to be low then these concerns about farm animal suffering might reduce society’s utility. If consumers have sufficient information about production methods they are enabled to act on their animal welfare preferences. This allows consumers to purchase the desired welfare characteristics, and producers have an incentive to satisfy the demand by using animal welfare friendly production methods (FAWC, 2006). Bennett and Larson (1996) used the method of contingent valuation to conduct a study about the willingness to pay of consumers depending on hypothetical animal welfare scenarios.

As <u>existing indicators</u> for animal welfare only two sets exist:

1) The Animal Needs Index was developed in 1985 by the Austrian Federal Research Institute for Agriculture in Alpine Regions and specifies the housing and shelter conditions of farm animals based on the Five Freedoms schema (Bartussek, 1999). Details of this index are further discussed in Annex VII.
2) The British Department of Environment, Food and Rural Affairs (Defra) compiles important statistics about the British food and farming sector. Especially the Number and results of visits and inspections undertaken by the State Veterinary Service (SVS) on farms and at livestock markets as well as the Number of live farm animals exported for slaughter or further fattening are suitable for the project.

The frameworks for animal welfare deliver different types of indicators that are measured at different levels and that can be categorized according to the DPSIR framework.

Table 4.4 Characterisation of animal welfare indicator frameworks in relation to type of indicators

No.	Organisation/ author	Name of indicator / indicator framework	Level of measurement			Type of indicators *				
			Animal-level	Production-system-level	Sector-level	D	P	S	I	R
1	Federal Research Institut for Agriculture in Alpine Regions, Austria	Animal Needs Index	X	X					X	
2	Department of Environment, Food and Rural Affairs (Defra) (UK)	Number of live farm animals exported for slaughter or further fattening			X			X	X	
		Number of visits and inspections undertaken by the State Veterinary Service (SVS) farms and at livestock markets			X			X		X
		Results of SVS assessments of the welfare of animals on farm in Great Britain			X		X	X	X	

* According to the DPSIR framework distinguishing indicators between **D**riving forces, **P**ressure, **S**tate, **I**mpact and **R**esponse

Public health indicator frameworks

With regard to the public health a general problems lies in the dominance of response-indicators as indicated in table 4.5. Four existing indicators frameworks can be identified which provide useful indicators or may provide these in the future:

1) Infectious foodborne diseases (EFSA): Food-borne diseases indicators could come from the European Food Safety Authority which has published a comprehensive report on outbreak and trends of food-borne diseases and zoonoses (EFSA, 2006). The most frequently food-borne diseases in the EU are ampylobacteriosis and salmonellosis infections. For these infections several indicators are available. For developing other comprehensive indicators of food safety a Eurostat Task Force has been established to identify the most important infections. Data shall be available in 2008 (Eurostat, 2007).
2) Indicators on public health (Eurostat): The best 'available' indicator regarding chemicals management and food safety is the index of production of

chemicals by toxicity class. In the area of food safety Eurostat has compiled information on the availability of data for pesticide use in the EU. Data about production and consumption of pesticides are available in different public and private institutions in EU Member States (Eurostat, 2004). The best ‘needed’ indicator is the index of apparent consumption of chemicals by toxicity class. Even data is available for pesticide residues in products of vegetal origin (fruit and vegetables, fresh and processed), in some raw products of animal origin (raw meat, raw milk, natural honey and aquaculture) and feed products, the comparability across EU Member States and between monitoring systems is not possible. The Eurostat Task Force is working on the establishment of common definitions and sampling strategies to construct reliable indicators for apparent consumption of chemicals (Eurostat, 2007). For CCAT the outcome of this Task force’s work is very relevant and will therefore be followed closely. In the area of public health Eurostat distinguishes some other suitable indicators for this project e.g. the occurrence of salmonellosis per 100000 people or the national government investments in food safety measures. Whereas these indicators are already existing, the important indicator of controls of food and feed is still in development and not yet available. Controls and inspections on food and feed establishing a database on controls of food and feed and monitoring activities has high priority. Data on official controls in EU Member States are already submitted to the European Commission, but they are scattered in different Commission reports and a functioning indicator does not exist. Therefore a common controls database will be established containing the monitoring intensity in the agri-business and the conformity with food safety legislation (Palou, 2006):

f. Number of inspections carried out, per 100 establishments
g. Number of samples analysed, by food product
h. Number of (non-)complying samples, by food product and hazard
i. Number of establishments with infringements.

3) Environment and Health Indicators (WHO): Within the framework of the WHO Surveillance Program the WHO-European Centre for Environment and Health is developing an environmental health indicator system aiming to establish a methodical basis for a European information and monitoring system of environment and health (WHO, 2004a). On the basis of the European Commission-sponsored WHO project ‘Development of environment and health indicators for the EU countries’ a set of environment and health indicators was developed among these indicators of food safety. Data of incidence of food-borne diseases are collected. For further information the indicator “General Food Safety Policy” was designed which is based on the assessment of national legislation of food safety (WHO, 2004b). A summarizing index is composed of components implying the existence and intensity of legislation and components assessing the level of implementation in the agri-business. Other important indicators of the WHO are the potential exposure to chemical hazards in food measured in mg/kg (Acceptable Daily Intake / Provisional Tolerable Weekly Intake), the dioxin levels in human

milk as well as the effectiveness of food safety controls which is a composite index for quantitative output parameters. Results of the latter are at the moment not available.

The indicators for public health can also be measured at different levels and the DPSIR framework identifies the scarcity of impact indicators.

Table 4.5 Characterisation of food-safety indicator frameworks in relation to type of indicators

No.	**Organi-sation**	**Name of indicator/ indicator framework**	**Level of measurement**			**Type of indicators** *				
			Animal-level	**Product-level**	**Sector-level**	**D**	**P**	**S**	**I**	**R**
1	EFSA	Infectious food-borne diseases and zoonoses	X	X		X	X	X	X	
2	Eurostat	Controls and inspections on food and feed			X		X			X
		Government investments in food safety measures			X		X			X
		Occurence of salmonellosis			X			X	X	
		Production of chemicals by toxicity class			X	X				
3	WHO	Monitoring chemical hazards in Food: potential exposure		X			X	X	X	
		Food-borne illness: 1) Number of outbreaks of food-borne illness 2) Incidence rate for all type of food-borne illness, food-borne infections & intoxications			X			X	X	
		General Food safety policy: Composite index for basic food safety measures			X		X			X
		Effectiveness of food safety controls: Composite index for quantitative out-put parameters of food safety control			X		X			X
		Persistent organic pollutants in human milk: Dioxin levels in human milk in selected countries		X			X	X	X	

* According to the DPSIR framework distinguishing indicators between **D**riving forces, **P**ressure, **S**tate, **I**mpact and **R**esponse

4.5 Fields of impact of Cross Compliance and indicators

The development and specification of indicators is an ongoing process where new indicator frameworks often build upon previous ones. In the former an overview was given of main indicator frameworks in the different fields of impact of CC. In the following a selection is made of indicators from these frameworks which candidate to be used to assess impacts of CC. They will be confronted with the main impact fields of CC and their position in the DPSIR framework is discussed.

4.5.1 Agricultural markets and producer's income

The indicator frameworks described in the previous sections are generally used to measure potentially negative external effects of agricultural production. These indicators often have specific conceptual relationships to the underlying externality suggesting a clear distinction according to the DPSIR approach. Typical economic indicators for describing markets and producer income always fit in the State and Impact category and an explicit categorisation of this sort seem not be necessary. The proposed indicators shall enable to describe the impact of CC measures on economic sustainability.

Table 4.6 Candidate indicators for assessing the effects of CC on agricultural markets and farmer's income

No.	Organisation / Model	Name of framework / Indicator	Level of measurement			Unit
			Product-level	Farm-level	Sector-level	
1	Eurostat, CAPRI, DEFRA	Gross Margin	X			Euro
2	Eurostat, CAPRI	Land price		X	X	% change
3	Eurostat, CAPRI	Production of main agricultural Products	X	X	X	Tons
4	Eurostat, CAPRI	Land Allocation		X	X	Ha %
5	Eurostat, CAPRI	Export/Import Ratio of Main Agricultural Products	X		X	%
6	Eurostat, CAPRI	Budgetary expenditure			X	Euro
7	Eurostat, CAPRI	Agricultural Income		X	X	Euro

8	n.a.	Costs of controlling CC	?	?	X	Euro
9	Eurostat, CAPRI	Welfare changes related to agricultural production			X	Change in Euro
10	DEFRA	Short-run viability of an enterprise		X	X	Proportion
11	DEFRA	Long-run viability of an enterprise		X	X	Proportion
12	CC-project	Costs of compliance	X	X	X	Euro
13	CC-project	Competitiveness: profitability		X		Euro
14	CC-project	Competitiveness: change market share			X	Percentage change
15	CC-project	Competitiveness: DRI and SCB indicators			X	Index

1 Gross margin is the difference between revenue and variable cost where revenues include premiums. CC will probably lead to increasing variable cost, declining revenues or - in the case of not complying CC – loosing premium payments. Changing gross margins will be the driving force for changes in land and input allocation.

2 Change of land prices identify income effects depending on land tenure and are important for substitution with non agricultural activities. Because of the design of the CAPRI model the change between scenarios is more reliable than the absolute value.

3 Production of main agricultural products gives a basic overview on agricultural productivity and production structure. Main products respectively product groups are wheat, (other) cereals, beef, pork, dairy products, sugar and oilseeds.

4 Land allocation refers to the area covered by important crops or groups of crops: wheat, cereals, oilseeds, fodder, specialty crops, perennials and fallow land. As CC might impact the relative competitiveness of activities this could result in changes of the land use pattern.

5 Export/Import Ratio is the volume of Exports divided by the volume of imports for a specific commodity. This indicator describes a regions competitiveness compared to others.

6 Budgetary expenditure refers mainly to the first pillar of the CAP. Although under the current legislation the budget is fixed until 2013 CC enables the EU to refuse payments when breaches are detected what reduces total expenditures.

7 Agricultural income here measures the total income of the sector and is perhaps the most compressed indicator to measure economic sustainability.

8 Costs of Controlling CC are necessary to judge the overall welfare of CC. More controlling of farms leads to higher cost but reduces on the other hand the probability of non-compliance.

9 Total welfare refers to the aggregated monetary utility of different sections of society who are all linked by common economic activities and thus affect the utility of others trough market exchanges.

10 Short-run viability of an enterprise refers to the proportion of businesses and production whose gross margins are negative before and after the costs of regulation are included.

11 Long-run viability of an enterprise refers to the proportion of business and production whose net margins (includes imputed or non-cash costs) are negative before and after the costs of regulation are included

12 **Costs of compliance** refers to the costs that have to be made in order to satisfy the regulation, and includes costs associated with material efforts as well as non-material ones (record keeping costs, charges, licenses, etc.)

13 **Profitability** (and the change therein caused by the regulatory requirements) provides an index of the competitiveness of an activity.

14 **Market share** (and the change therein caused by the regulatory requirements) is an indicator for a sector (or country's) competitiveness

15 **Domestic resource costs (DRI) and social cost-benefit ratio (SBC)**: are established indicators signalling a sector's (external) competitiveness (the indexes fit in the so-called policy analysis framework (PAM)).

4.5.2 Environment

In the field of agri-environment there is a wide range of indicators already developed both within the OECD, IRENA, and CMEF. They all provide a good basis to select indicators from. In Table 4.7 a selection of indicators of these indicator frameworks is given which are connected to the impact fields of CC as indicated in Annex IV and V and that have a potential direct or indirect linkage to farming practices that are influenced by CC SMRs and GAECs. Most of the possible indicators are in the pressure category.

Whether these indicators can be specified in this project in relation to CC and at what scale they can be produced is to be discussed in Chapter 5. It depends very much on the modelling tools available and the input data required. Another important issue is whether a link can really be established between the CC measures implemented and the indicators. For example emissions in farming are caused by a combination of farming practices of which some can be changed under influence by the implementation of CC, but there are many other factors inducing changes.

Table 4.7 Main environmental impact fields and candidate indicators for assessing CC measures

Environmental field of impact	**Indicator**	**Source (indicator framework**	Type of indicator DPSIR
Ground and surface water quality	Gross nitrogen balance	IRENA, OECD agri-environmental Indicators, CMEF, ELISA	P
	Gross phosphorus balance	IRENA, OECD agri-environmental Indicators	P
	Share of nitrates in ground and surface water derived from agriculture	IRENA, OECD agri-environmental Indicators, CMEF	S
	Pesticides in ground and surface water	IRENA, CMEF	S
	Pesticide usage per crop	ELISA	P
	Pesticide sales	ELISA	P
	Share of agriculture in total nitrogen leaching to surface waters	IRENA	I
Air quality	Contribution of agriculture to total atmospheric emissions of ammonia (NH3)	IRENA, OECD agri-environmental Indicators	P
Climate	Emissions of methane by agriculture	IRENA	P
	Emissions of nitrous oxide by agriculture	IRENA	P
	Gross total GHG emission from agriculture in CO2 equivalents	IRENA, OECD agri-environmental Indicators	P
	Contribution of the agriculture to total emissions of greenhouse gases CO_2, CH_4, and N_2O.	IRENA, OECD agri-environmental Indicators	P
Physical soil quality	Annual soil erosion risk by water	IRENA, CMEF	P
	Area and share of agricultural land affected by water erosion	OECD agri-environmental indicators	S
	Area and share of agricultural land affected by wind erosion	OECD agri-environmental indicators	S
Chemical soil quality	Use of sewage sludge	IRENA	P
	Gross phosphorus balance	IRENA, OECD agri-environmental Indicators	P
	Pesticide soil contamination	IRENA	P
	Top soil organic carbon content	IRENA	S

4.5.3 Land use, biodiversity and landscape

Impact fields land use, biodiversity and landscape are taken together because they are strongly linked. Basically it is clear that farmland biodiversity will be influenced by any change in the state of a habitat it depends on. These habitats may be part of farmed and non-farmed features on agricultural land. So all environmental indicators discussed in the former will have influence on the quality of the habitat and therefore on a certain species that depends on it. An improvement in surface water quality for example will be beneficial to practically all species living in the water and beside it. Soil organisms and most vegetation types will benefit from a clean soil (with no or limited pollution) and high soil organic matter content. The same mechanism applies for aspects related to land use and landscape features in relation to biodiversity. Generally there is a strong positive relationship between biodiversity and a high density of semi-natural and/or extensive farmland features (see e.g. Baldock *et al*., 1993; Beaufoy *et al*., 1994; 1994; Bignal & McCracken, 1996; 2000, Andersen et al., 2003). The same applies for biodiversity and landscape diversity. This is underpinned by for example Vickery et al. (2004) who showed that declines in farmland bird populations in the UK continue and that this is certainly related with the quantity and quality of habitats available, especially the gaps in resource provision in intensive agricultural landscapes. Vickery shows that the creation of non-cropped habitats and field margins and so called 'arable pockets' in grassland regions and 'grassland pockets' in arable regions could be effective measures to support bird biodiversity.

In the indicator frameworks discussed in the former there are several indicators related to land use, biodiversity and landscape that may be of interest for assessing impacts of CC. The general indicator groups of interest which are strongly influenced by farming practices and therefore might be directly or indirectly influenced by CC measures have been summed in Table 4.8. but this selection is still very rough and only gives a direction as it is still rather difficult at this stage to make a clear selection of indicators that may be specified in this project for assessing impacts of CC.

Table 4.8 Main impacts fields and candidate groups of indicators for assessing impacts of CC measures on land use, landscape and biodiversity

Environmental field of impact	**Indicator groups**	**Source (indicator framework**	Type of indicator DPSIR
Land use	Cropping patterns: Trend in/ share of UAA of major/intensive/extensive crops/land use	IRENA, CMEF, ELISA	D
	Share of irrigated area	IRENA, ELISA	P
	Livestock density	ELISA	P
Biodiversity	Area and share of semi-natural (extensive)habitats (e.g. fallow, permanent grassland)	IRENA, OECD agri-environmental indicators, ELISA	P
	Share of High Nature Value farmland of UAA	IRENA, CMEF	P
	Spatial complexity/corridors	ELISA	P

	and linkages between habitats		
	Species richness/species population trends (Farmland birds)	ELISA, IRENA, CMEF	S
	Change in habitat quality (e.g. change in quality of water, soil, air)	IRENA	S
Landscape	Change in openness versus closedness	IRENA, ELISA	I
	Agricultural land use diversity change	IRENA, ELISA	I
	Change Area/share of land recognized for its scenic/scientific value	ELISA	I

As already made clear in Chapter 2, this project can initially only provide an *ex-ante* assessment of CC on biodiversity at an EU wide scale. Specifying state indicators is not possible due to either, lack of univocal and immediate responses of biodiversity to multiple pressures, lack of adequate resources (time and costs) to monitor biodiversity changes, especially at a wide national or regional scale. So the indicators provided for biodiversity are mostly pressure indicators either referring to habitat quality, environmental state of resources such as water, soil and air, and land use and landscape state. In a selection of case studies in a later stage of this project there might be room to also develop some biodiversity state or effect indicators in relation to species presence and changes in numbers/density of species.

The indicator of High Nature Value (HNV)farmland can probably not be used as an impact indicator, but the location of HNV farmlands can be confronted with the spatialised changes in other pressure indicators influenced by CC which may affect the state of biodiversity in HNV. The same applies to trends of farmland birds. In this project we will not be able to quantify changes in farmland bird density caused by CC, but we may be able to indicate where CC will be beneficial for farmland birds populations given changes in pressures, expressed by the pressure indicators given under agri-environment, land use and landscape (Table 4.7 and 4.8). In table 4.8 the OECD indicator referring to genetic diversity within farming (e.g. crop varieties and animal breeds) have not been included as in our biodiversity concept indicators should focus on wildlife values in agricultural land.

In relation to landscape several indicators may be of relevance. In IRENA there is an indicator called Landscape state and diversity (IRENA 32). This indicator is however very complex as it has several dimensions. In ELISA Wascher et al. (2000) unravelled the different landscape qualities of European policy concern which provide a good basis for identifying useful landscape impact indicators.

Whether these indicators can be specified in this study will be further discussed in chapter 5 and in next deliverables of this project specifying the assessment approaches of impacts on landscape, land use and biodiversity in greater detail.

4.5.4 Animal welfare and food-safety

For animal welfare and food safety different indicator frameworks were summed in the former but it is still rather difficult at this stage to make a clear selection of indicators that may be specified in this project for assessing impacts. In Table 4.9 only for a selection of SMRs a link can be established with certain indicator frameworks, but a choice for a specific indicator will not yet be made. In Table 4.9 only the scientific or physical effects are addressed and not consumer-related impacts like willingness-to-pay which can also be relevant for animal welfare.

Table 4.9 Statutory management requirements and possible indicators for assessing their impact on animal welfare and food safety considerations

		Animal welfare		**Food safety**	
Mandatory implementation of respective acts	**Articles**	**Expec-ted impact**	**linkage to indicators**	**Expec-ted impact**	**linkage to indicators**
Environment					
Council Directive 79/404/EEC: Conservation of wild birds	Articles 3, 4 (1), (2), (4), 5 7 and 8	0	No linkage	0	No linkage
80/68/EEC Council Directive: Protection of groundwater	Articles 3 and 4	0	No linkage	0	No linkage
86/278/EEC Council Directive: Sewage sludge	Articles 3	0	No linkage	++	Consumption of chemicals as well as food and feed control (both Eurostat) are indicators referring to this directive.
91/676/EEC Council Directive: Nitrates from agriculture	Articles 4 and 5	0	No linkage	0	No linkage
92/43/EEC Council Directive: Conservation of natural habitats, wild flora and fauna	Articles 6, 13, 15 and 22 (b)	0	No linkage	0	No linkage
Public and animal health; identification and registration of animals					
Council Directive 92/102/EEC: Identification and registration of animals	Articles 3, 4 and 5	+	The directives and regulations are linked with one of the FAWC's Five Freedoms, namely freedom from pain, injury or diseases. A traceability	+	In general

Commission Regulation (EC) No 2629/97: Identification and registration of bovine animals	Articles 6 and 8	+	system allows identifying the cause of diseases and helps to prevent their dispersion. This impedes the infection of further animals and reduces the number of animals suffering pain.	+	legislation for identification and registration is an instrument for increasing food safety because it is a precondition for traceability systems. The indicator General Food Safety Policy of the WHO denotes whether national food safety legislation exists and whether authorities are well prepared in food-borne emergencies.
Regulation (EC) No 1760/2000: Identification of bovine animals, labelling of beef	Articles 4 and 7	+		+	
Council Regulation (EC) No 21/ 2004: Identification and registration of ovine and caprine animals	Articles 3,4 and 5	+		+	
Public, animal and plant health					
Council Directive 91/414/EEC: Placing of plant protection products on the market	Article 3	0/+	The directive is linked to FAWCs Five Freedoms, namely freedom from malnutrition and from pain and injury. Other indicators can be Eurostats consumption of chemicals as well as feed control data.	++	Consumption of chemicals as well as food and feed control (both Eurostat) are indicators giving evidence that application of chemicals and hormones was incorrect.
Council Directive 96/22/EC: Use of hormones	Articles 3, 4, 5 and 7	0	No linkage	0/+	
Regulation (EC) No 178/2002: Requirements of food law	Articles 14, 15, 17(1), 18, 19 and 20	0	No linkage	++	
Regulation (EC) No 999/2001: Prevention, control and eradication of spongiform encephalopathies	Articles 7, 11, 12, 13 and 15	++	The regulation is linked with one of the FAWCs Five Freedoms, namely freedom from pain, injury or diseases. The regulation aims to impede the infection of further animals and thus reduces the number of animals suffering pain.	0/+	Food and feed control as well as food-borne diseases and zoonoses (both Eurostat) are indicators for the effectiveness of this regulation in terms of food safety.
Notification of diseases					
Council Directive 85/511/EEC: Control of foot-and-mouth disease	Article 3	++	The directives are linked with one of the FAWC's Five Freedoms, namely freedom from pain, injury	0	No linkage

Council Directive 92/119/EEC: Control of swine vesicular disease	Article 3	++	or diseases. They impede the infection of further animals and reduce the number of animals suffering pain.	0	No linkage
Council Directive 2000/75/EC: Control of bluetongue	Article 3	++		0	No linkage
Animal welfare					
Council Directive 91/629/EEC: Standards for the protection of calves	Articles 3 and 4	++	The directives lay down concrete requirements of housing conditions and surveillance. Calves, pigs and other animals kept for farming purposes must be treated and housed to standards defined in these directives. The Animal Needs Index of the Austrian BAL represents a suitable indicator for assessing the adherence to these standards because the main spheres of influence for animals' welfare are similar to those in the directives.	0	No linkage
Council Directive 91/630/EEC: Standards for the protection of pigs	Articles 3 and 4(1)	++		0	No linkage
Council Directive 98/58/EC: Protection of animals kept for farming purposes	Article 4	++		0	No linkage

4.6 Conclusion

This chapter started with providing an overview of the objectives and intervention logic of the cross-compliance policy tool. Several types and level of objectives were distinguished (notably general objectives, specific objectives and operational objectives). Associated with each of these several types of effectiveness indicators are identified (notably impacts, results and outputs). It is argued that awareness of this context is crucial for making a final selection of indicators and also for a better understanding of the linkage of a certain indicator to a specific kind of objective.

The subsequent part of this chapter gave an overview of the different SMRs and GAECs and how they have been implemented in the different Member States investigated already in the CIFAS project. The overlap between the implementations is that they clearly target the same issue but the difference occurs because some Member States interpret the Directives/Regulation (in the case of SMR) and "issues" (in the case of GAEC) in a much broader way and implement a wider number of requirements respectively standards than others. A wider implementation with more standards is often found in Austria, Spain and the UK. Differences in implementation and (additional) compliance in combination with differences in specific regional environmental conditions and farming system patterns will eventually be the cause for regionally specific CC effects.

Potential fields of impact are specific to the main aim of the SMRs and GAECs but overall we can expect that that they may also have a side effect on other issues.

In order to measure the effect of CC it is necessary to select indicators which have policy relevance. This is why in the final part of this chapter a final rough selection havs been made of indicators from the existing indicator frameworks which seem to fit best with the fields of impact of SMRs and GAECs and that are directly and indirectly linked to (changes) in farming.

For the economic effect of CC several impact indicators could be selected which candidate well for the assessment of CC whether they can be specified in this project will depend on the models available, which will be discussed further in Chapter 5 and next deliverables, but much more on the information available on level of compliance and change in compliance since the implementation of CC policy. Main economic indicators identified refer to gross margin and agricultural income, viability and competitiveness of an enterprise and the costs of compliance. A good estimation of the first indicators all relies on a good estimation of the last indicator.

The candidate indicators for assessing the impacts of CC on environment; water, soil, air and climate could be easily derived from the IRENA indicator framework but also other frameworks like OECD and CMEF provided some potential indicators. The intital indicators selected can mostly be categorized as pressure indicators. The most important pressure indicators identified are the nitrogen and phosphorous balances, agricultural emissions of ammonia, and different GHGs, soil erosion risk and pesticide soil contamination. Possible State indicators could be the share of nitrates and pesticides in water, pesticides in soil, the share of agricultural land affected by soil erosion and top soil organic carbon content. Whether these indicators can really be specified in the project depends on the models available to be discussed in Chapter 5 and next deliverables. Overall it is clear already that pressure indicators will be more likely to be specified than State indicators which require the modelling of much more complicated chemical and hydrological processes and detailed environmental input data.

In relation to effects on land use the most likely indicators to be specified were changes in livestock density, cropping patterns and shares of intensive and extensive land use categories such as cereals or permanent grassland and semi-natural grassland, share of irrigated land.

The landscape indicators that candidate include landscape measures such as length of linear features, agricultural land use diversity, openness-closedness of the landscape. Whether these can be operationalised depends very much on the input information. But at this stage it is expected that these measures cannot be quantified, and only an estimation can be made of whether CC will affect them at all. The same applies for the biodiversity indicators. A rough selection of initial indicators was made, and it is clear that for an EU level assessment only pressure indicators for biodiversity candidate indicating towards changes in habitat quality, size and connectivity.

For the fields of impact of animal welfare and food safety several indicator frameworks were described, but until now it turned out to be too early in the project to propose candidate indicators which can be specified in the project in relation to CC impacts. For Biodiversity indicators it is expected that quantitative effects in terms of changes in species groups or loss of habitats can not be made, but estimates can be made of pressures exerted by CC affecting the general state of biodiversity or certain species groups in a positive or negative way. A similar qualitative assessment is also expected to be developed for animal welfare and food safety.

Overall it is clear that no definite choice for indicators can be made at this stage, especially in the field of land use, landscape, biodiversity, animal welfare and public health. First the knowledge, tools and data availability will need to be further investigated. This is further discussed in chapters 5 and 6 and next deliverables (D 2.3, 4.1.1, 4.2.1, 4.3.1, 4.4.1)

Another interesting challenge in the project is to specify the indicators at geographic levels that enable to display the real diversity in CC effects. For the environmental, land use and landscape effects it will be crucial to make assessments of changes in farming induced by CC taking the specific diversity in environmental endowment into account. This will require up-and downscaling approaches which will also be further discussed in Chapter 5.

5 Tools and models

5.1 Introduction

The integrated framework of tools focuses specifically on the assessment of impacts of cross compliance. In this context, a first general selection of indicators was made in Chapter 4 to get a better idea on the overall capabilities of the models and tools to be needed. In the analytical tool in the first stage of the project we will focus on assessing impacts that can be quantified in a reasonable way at an EU wide scale, given data and model and knowledge availability. As for the environmental impact part for example we already know that the inadequacy of information on pesticide use on a European wide scale and the complexity of modelling pesticide behaviour makes it difficult to make adequate predictions of pesticide accumulation and leaching in response to measures. Consequently, the impact of cross-compliance measures on pesticides leaching to soil and water is not included in this first stage of the project.

In this chapter we will first discuss the approach to modelling the environmental impacts of CC on water, soil, air and climate. This will include a description of the different models to be used and their linkages. This also includes the link between the environmental modelling and the economic modelling with CAPRI. This latter link is very important as in this project we assume that economic considerations are the starting point for the response of farmers towards CC. On the basis of CC impacts on farmer's income changes in farming practices may take place. These changes in practices which lead also to changes in land use are the main input for the environmental models. First it needs to become clear from CAPRI modelling which changes in land use and practices take place. Then assessments of potential environmental impacts can be made. The same applies for impacts on landscape and biodiversity.

In the next section first the general integrated environmental modelling approach is discussed identifying the main environmental models to be used, their mutual links and their links with the CAPRI economic model. In Section 3 the CAPRI model is described in further detail and how it will be adapted to assess the effects of CC. This is followed by Section 4 where the core environmental models of Miterra and Integrator are discussed and how they link to other models. In Section 5 the up-and downscaling approaches are discussed to explain further how models can be linked which involves the use of modelling output and input for the next model. In section 6 the EPIC model is discussed, how it links to other models and how it assesses soil erosion risk. In Section 7 the DNDC model is described mainly used as a sub-model of Miterra for refining the emission calculations and calibration of other models. In section 8 approaches to assessing CC impacts on land use, landscape and biodiversity are described which will be both model and knowledge based. In Section 9 a short and preliminary description is given on assessing CC impacts on animal welfare and public health. The chapter is concluded in Section 10.

5.2 An integrated framework of environmental and economic modelling tools

Considering the information given in the former, the overall objective of the environmental modelling framework is to assess the impact of CC on air- (and climate), soil-, and water quality in terms of:

- Atmospheric emission of ammonia and green house gases (air quality and climate)
- Soil accumulation or release of carbon (organic matter), phosphorous and heavy metals (chemical soil quality)
- Soil erosion (physical soil quality)
- Leaching and runoff of nitrogen and possibly phosphorus, and heavy metals (water quality).

The word possibly for phosphorus and heavy metals is because it is not yet sure whether predictions are feasible in view of the data demand and present modelling capabilities available in this project.

5.2.1 General environmental modelling approach

An integrated approach focusing on all the impacts mentioned above depends on the availability of models and data at the European scale. For the environmental assessment, existing models will be further adapted and integrated into the framework or modelling outputs will be translated into knowledge rules and integrated into the analytical tool (WP5). The existing and tested models to be used are: (i) MITERRA-Europe in combination with CAPRI and INITIATOR2, being a set of integrated and relatively simple models for use at the EU level and (ii) DNDC and EPIC, being detailed biogeochemical and hydrological soil models, for use at the plot level and the regional level.

The main idea is to extend the MITERRA Europe model, based on knowledge in INITIATOR2 and where relevant CAPRI, to assess the impacts on all air, soil and water quality indicator on a European wide scale with the exception of soil erosion. Regarding soil erosion, a separate metamodel, in terms of e.g. simplified regression functions, will be derived from the EPIC model. The main idea of using DNDC and EPIC is further to assess impacts of specific CC measures on air, soil and water quality indicators, that can not be evaluated by MITERRA Europe. Results will then be transferred to MITERRA Europe, e.g. in terms of percentage reduction in emission of NH_3 or greenhouse gases or leaching of nitrate for specific combinations of land use and soil, for application on a European scale. Furthermore, the more elaborated calculation of uptake in EPIC may be used in MITERRA Europe in a simplified way. The use of DNDC and EPIC for this purpose has to be further elaborated (see also section 2.2). Furthermore, a comparison will be made between MITERRA Europe and DNDC and EPIC predictions on a European wide scale for e.g. the present situation and one set of CC measures as one way to evaluate the uncertainty in the MITERRA Europe predictions.

The indicators that are predicted by the extended MITERRA Europe model and the detailed models DNDC and EPIC, being relevant in the CCAT project, are given in Table 5.1.

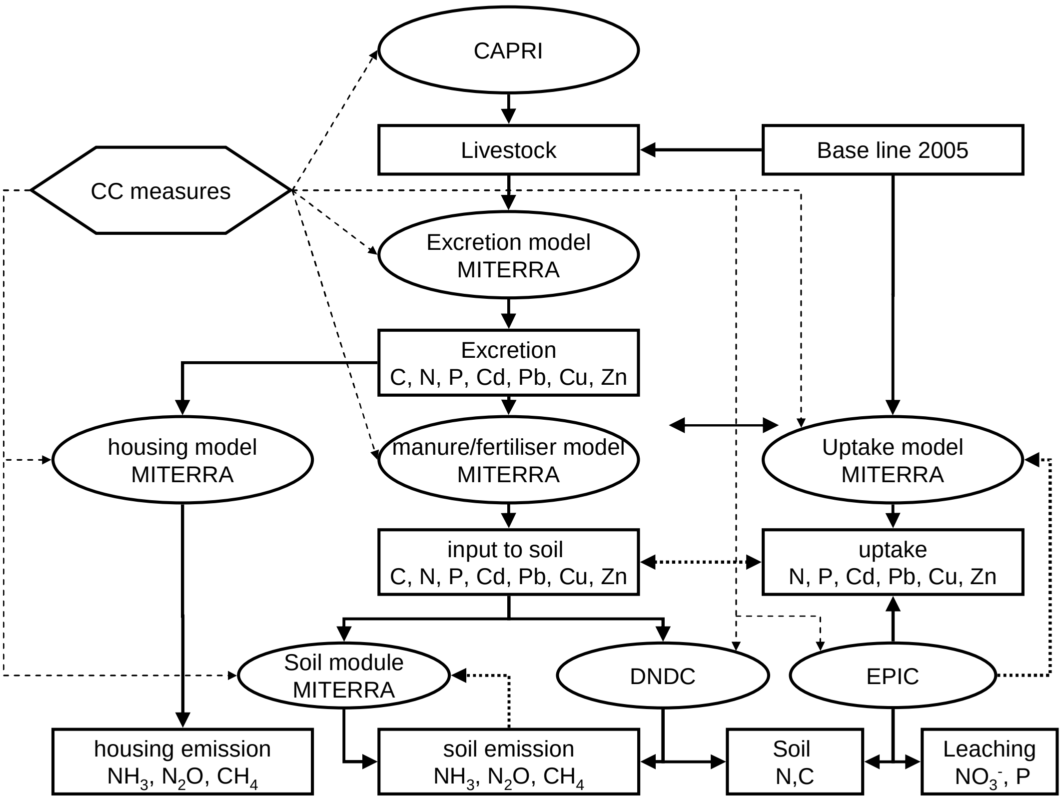
Table 5.1 Indicators predicted by the extended MITERRA Europe, DNDC and EPIC model, being relevant in CCAT.

Compartment	Indicator	MITERRA Europe extended	DNDC	EPIC
Air	NH_3 emission	X	X	X
	GHG emission	X	X	-
Soil	Nitrogen balance	X	X	X
	Carbon balance	X	X	X
	Phosphorous balance	X	-	X
	Metal balance	X		
	Erosion	-	-	X
Water	Nitrogen leaching	X	X	X
	Phosphorous leaching	(X)	-	(X)
	Metal leaching	(X)		

For phosphorous leaching, the prediction by MITERRA Europe and EPIC is put in brackets, since application of the models on a European scale is doubtful in view of available soil data. Actually, EPIC also predicts long-term soil compaction due to natural processes, but not the compaction in response to heavy machinery, being the relevant aspect with respect to cross compliance. Furthermore, it predicts pesticide leaching, but only at a plot scale and application of this model on a European scale is not possible (see before)

The specific approach to predict air, soil and water quality indicators with the aid of extended MITERRA Europe model, making use of the detailed models DNDC and EPIC, is further illustrated in Figure 5.1.

Figure 5.1 Approach to predict air, soil and water quality indicators with the aid of extended MITERRA Europe model, making use of the detailed models DNDC and EPIC.



The approach will be to:

Further develop and apply *mechanistic models* (DNDC, EPIC) and possibly river shed (SWAT) hydrological models for the assessment of the impacts of *specific* CC measures on air, soil and water quality indicators, that can not be evaluated by MITERRA Europe.

Develop a metamodel for soil erosion (See Figure 5.2) to be used as an analytical tool for the assessment of the specific impacts of CC on erosion.

Further develop the MITERRA Europe model as an integrated tool for the assessment of the specific impacts of CC on air (ammonia and green house gas emissions) soil (organic matter, nutrients, metals) and water quality indicators (nutrients and metal loads).

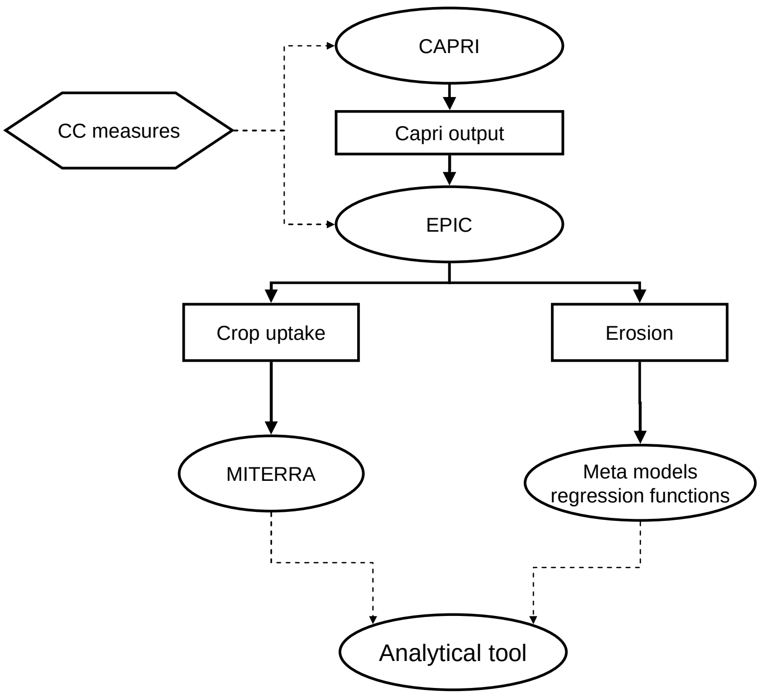
Assess impacts of CC on air, soil and water quality indicators using the input data from WP3 and the tools identified (MITERRA Europe and erosion metamodel) with the aid of DNDC and EPIC simulations for *specific* CC measures.

Provide the indicator calculation pathways to be incorporated in the final analytical tool (WP5). This will be the metamodel for erosion and might be the extended MITERRA Europe model or the results of CC measures in terms of e,g regression functions between inputs and outputs, comparable to the soil erosion model.

5.2.2 Use of the detailed models EPIC and DNDC

The approach to predict physical soil quality indicators (focused on erosion) is to apply the EPIC model and derive a metamodel from the results for inclusion in the analytical tool as illustrated in Figure 5.2. The EPIC model is also best suited for the calculation of crop uptake and thus for the prediction of nutrient balances and leaching. For phosphorus, it is however not yet sure whether predictions are feasible in view of the data demand. It is therefore the idea to link the EPIC model to Miterra Europe in this context. This can either be done by using the elaborated calculation of uptake in EPIC in Miterra Europe in a simplified way or by using results of EPIC in MITERRA Europe. In that case, results for the impact of CC measures on the crop uptake of nutrients will flow from the EPIC model to MITERRA. This aspect has to be further elaborated.

Figure 5.2 Approach to predict soil erosion by applying EPIC and deriving a meta model for inclusion in the analytical tool and the role of EPIC in assessing impacts of CC measures on crop uptake



The focus of the DNDC model is on GHG emissions and to a lesser extent on NH_3 emissions from soils (livestock NH_3 emissions are calculated in MITERRA-EUROPE) and therefore this model is specifically used for those indicators. Nevertheless, DNDC also calculates N uptake and N leaching. For the overall nitrogen and carbon balance some benchmarking tests will thus be made to assess the difference between EPIC and DNDC and to ensure consistency between all simulated emission fluxes. The variation of the results obtained from both models is an indicator for the uncertainty of the uncertainty due to process formulations.

To apply the detailed models, the following steps will be required:

- Compilation of measures to be assessed linked to implementation of CC (WP3), ranking according complexity (to implement directly in tool and/or (process) model)
- Compilation of the cost of the measures in relationship to environmental conditions. With CAPRI an estimation of the costs could be made related to regional specific changes in farming practices and from this the most likely changes in farming measures can be derived for which the environmental effects need to be assessed.
- Parameterize the measures for evaluation by the process-based models
- Evaluate the CC measures, perform sensitivity analyses for most influential parameters, derive factors to implement in MITERRA Europe where needed.

For example, a detailed investigation of green house gas emissions will be carried out using the DNDC model to:

- reliably estimate baseline emissions as function of environmental and management parameters
- elaborate regional differences in emissions (on the basis of environmental and management differences (farm typology)
- assess the impact of selected measures on emissions
- derive simplified functions to better represent regional differences in MITERRA Europe
- derive regionalized abatement factors for the selected measures – including cost/benefit estimates in combination with Capri.

5.3 The CAPRI-model

5.3.1 Model description

We assume that production according to standards, or an increasing degree of compliance to standards (for example as induced by the CC policy) causes (additional) costs that are different depending on the specific production activity. Within CCAT the CAPRI model can be used to asses the impact of changes in the relative competitiveness on regional production.

To give a brief overview on key properties of this system we note that the economic model is split into two major modules. The *supply module* consists of independent aggregate non-linear programming models representing activities of all farmers at regional or farm type level captured by the Economic Accounts for Agriculture (EAA). The programming models follow a hybrid approach, as they combine a Leontief-technology for variable costs covering a low and high yield variant for the different production activities with a non-linear cost function which captures among others the effects of labour and capital on farmers' decisions. The non-linear cost function allows for perfect calibration of the models and a smooth simulation response as is plausible for observations on aggregate behaviour. The models capture in considerable detail the current premiums paid under CAP and a module with feeding activities covering nutrient requirements of animals. Main constraints outside the feed block are arable and grassland, set-aside obligations and milk quotas. Prices are exogenous in the supply module and provided by the market module.

The module for marketable agricultural outputs is a spatial, non-stochastic global multi-commodity model for about 40 primary and processed agricultural products, covering about 40 countries or country blocks in 18 trading blocks. Bi-lateral trade flows and attached prices are modelled based on the Armington assumptions (Armington, 1969). The behavioural functions for supply, feed, processing and human consumption apply flexible functional forms where calibration algorithms ensure compliance with micro-economic theory. The parameters are synthetic, i.e. to a large extent taken from the literature, other modelling systems or own expert assessments. Policy instruments cover Product Support Equivalents and Consumer Support Equivalents (PSE/CSE) from the OECD, (bi-lateral) tariffs, the Tariff Rate Quota (TRQ) mechanism and, for the EU, intervention stocks and subsidized exports. This module allows for market analysis at global, EU and national scale, including a full assessment of price effects in all regions as a consequence to changes in exogenous inputs (e.g. policy shifts).

5.3.2 *Model extensions* (endogenous compliance)

Cross compliance will mostly affect the supply part of the CAPRI model. This module currently has some shortcomings in representing effects of CC which shall be addressed in the course of the project.

First the CAPRI model works on an aggregated Nuts2 level or representative farm type level while measures of cross compliance mostly refer to a single farm. It is often observed that some restrictions, e.g. the maximum application of manure per ha, are not binding at an aggregated level but for some farms within this region or farm type. Hence a measure will have an effect at the aggregate level even if the average value of the region indicates that there are no binding restrictions. In the case of expectable impacts at aggregate level, methodologies to estimate these effects will be closely investigated.

A second issue is the specification of alternative production technologies, e.g. conservation tilling or ploughing, which are actually missing in the data base. Hence the model cannot find out whether production according to cross compliance can be achieved by changes in the production system or the production program. Theoretically it would be possible to define production systems that are cross compliance conform or not, where the latter would have the risk that premiums are not paid when the violation of CC is detected by officials.

We would propose to develop a tool that translates the effects of CC in regional, activity specific changes of gross margin. By including this change in gross margin in the core model we can asses the impact of changes in the relative competitiveness on regional production. The new tool can make use of the CAPRI database but would also need additional expert knowledge or information from other sources/WPs.

Cross compliance will mostly affect the supply part of the CAPRI model. This module currently has some shortcomings in representing effects of CC which shall be addressed in the course of the project.

First the CAPRI model works on an aggregated Nuts2 level or representative farm type level while measures of cross compliance mostly refer to a single farm. It is often observed that some restrictions, e.g. the maximum application of manure per ha, are not binding at an aggregated level but for some farms within this region or farm type. Hence a measure will have an effect at the aggregate level even if the average value of the region indicates that there are no binding restrictions. In the case of expectable impacts at aggregate level, methodologies to estimate these effects will be closely investigated. This will require the development of a post-modelling calculation/disaggregation tool.

A second issue is the specification of alternative production technologies, e.g. conservation tilling or ploughing, which are actually missing in the data base. Hence the model cannot find out whether production according to cross compliance can be achieved by changes in the production system or the production program. Theoretically it would be possible to define production systems that are cross compliance conform or not, where the latter would have the risk that premiums are not paid when the violation of CC is detected by officials.

We would propose to develop a tool that translates the effects of CC in regional, activity specific changes of gross margin. By including this change in gross margin in the core model we can asses the impact of changes in the relative competitiveness on regional production. The new tool can make use of the CAPRI database but would also need additional expert knowledge or information from other sources/WPs.

Currently compliance to regulations is not explicitly taken into account. For this project the compliance issue will be explicitly taken into account, which will not only require some changes in the model-code, but also the development of some pre-model calculation steps (see more for more about this Chapter 6)

5.4 The MITERRA Europe model

The modelling tool that we intend to expand and use at the continental (EU) level is an integrated simple model entitled MITERRA Europe. The model will be extended with knowledge available in INITIATOR2 (Dutch model). Where needed, information of CAPRI-Dynaspat will also be included. This development is mainly taking place within the context of the NitroEurope-IP in which MITERRA Europe is the basis for an agricultural submodel in an overall European scale modelling framework entitled INTEGRATOR. This framework also includes the interaction between agriculture and nature by emission-deposition relationships.

5.4.1 MITERRA model description

MITERRA-EUROPE is a simple, integrated model (including parameters and data) developed by Alterra in 2006 under a contract from EU Directorate-General Environment ("Service contract: integrated measures in agriculture to reduce ammonia emissions") and will be available and operational in March 2007. (Velthof et al., 2007). MITERRA-EUROPE is transparent and simple model to quantitatively the effectiveness, of mitigation options and strategies for NH_3 and non–CO_2 greenhouse gas emissions (N_2O and CH_4) and N (specifically NO_3) leaching in agriculture. The model is based on experience in building and data and calculation rules in existing models. The scope and range is EU25 plus Romania and Bulgaria. MITERRA-EUROPE is programmed in GAMS., being equal to the CAPRI model This contributes to the flexibility of the tool to be used in CCAT in co-operation with CAPRI. It consists of an input module with activity data and emission factors, a set of (packages of) measures to mitigate NH_3 emission and NO_3 leaching, a calculation module, and an output module presenting results in tables and maps. As a documented calculation sheet MITERRA-EUROPE allows the Commission to make its own and additional simulations.

5.4.2 MITERRA model extension

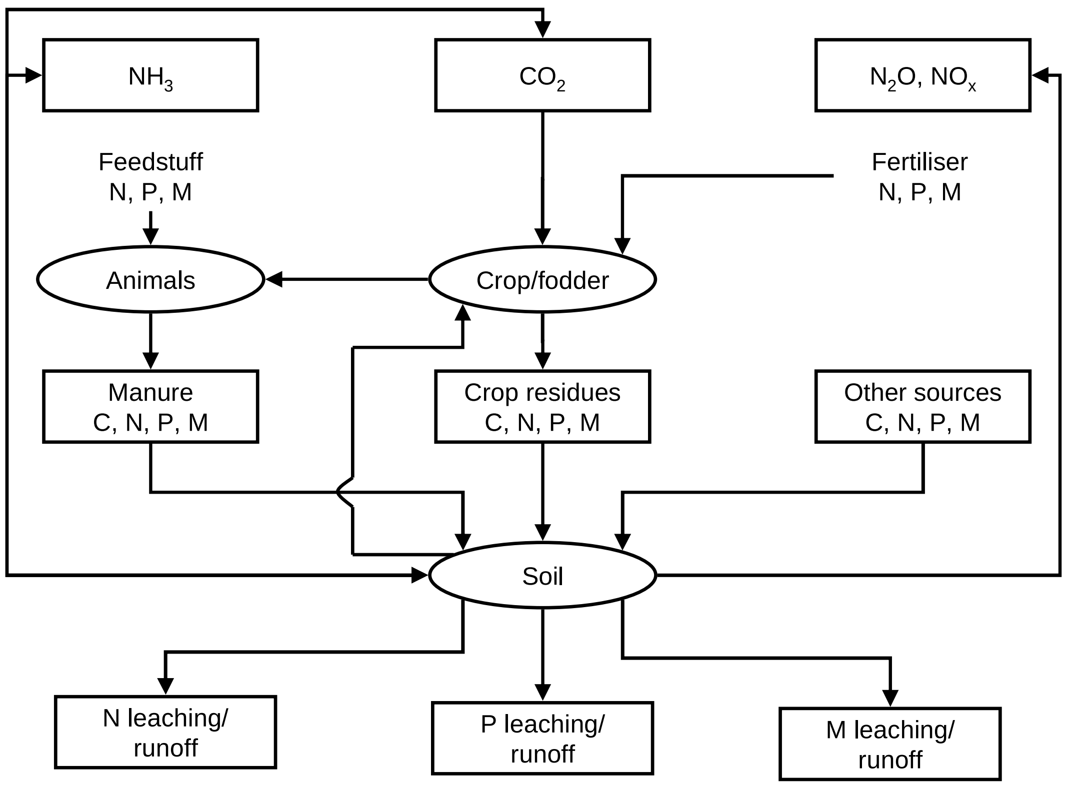
The fluxes to be considered with the extended MITERRA Europe tool are summarized in Table 5.2 and Figure 5.3. The expansions are inclusion of the metal balance, including metal leaching, and phosphorous leaching. The idea is to include these aspects in MITERRA Europe on the basis of the INITIATOR2 approach developed for the Netherlands. More information on INITIATOR2 is given below.

Table 5.2 A summary of the fluxes considered in MITERRA Europe in its original and extended form

Compartment	Indicator	MITERRA Europe original	MITERRA Europe extended
Air	NH_3 emission	X	X
	N_2O emission	X	X
	CH_4 emission	X	X
Soil	Nitrogen balance	X	X
	Phosphorous balance	X	X
	Metal balance	-	X[1]
Water	Nitrogen leaching	X	X
	Phosphorous leaching	-	X[1]
	Metal leaching	-	X[1]

The formulation of these fluxes will be based on the Dutch INITIATOR2 model.

Figure 5.3 Fluxes to be considered with the extended MITERRA tool



5.4.3 INITIATOR

The INITIATOR2 model**,** which stands for Integrated Nutrient ImpacT Assessment Tool On a Regional scale (De Vries et al., 2005a, 2007a) is developed as an integrated model to gain insight in all environmental impacts of excessive manure application simultaneously. INITIATOR2 is an extension of the model INITIATOR (Integrated NITrogen Impact Assessment Tool On a Regional scale) that was developed to: (i) gain insight in the fate of all major nitrogen flows in the Netherlands (De Vries et al., 2003), (ii) calculate 'regional specific nitrogen ceilings' (maximum amounts of reactive nitrogen that does not lead to exceedance of critical limits or targets) (De Vries et al., 2001a) and (iii) assess the impacts of improved farming practices and technical measures such as changes in animal housing on nitrogen fluxes in the Netherlands (De Vries et al., 2001b).

Apart from all N fluxes, INITIATOR2 also includes the emissions of all CO_2 and non-CO_2 greenhouse gases, fine particles and odour and the accumulation, runoff and leaching of phosphate, base cations and heavy metals (De Vries et al., 2005a, 2007a). For carbon a modelling approach comparable to the CESAR model is used (Vleeshouwers and Verhagen, 2002). This is a carbon balance model that considers C flows at field level and allows evaluation of changes in farm management and differences in effects at regional level for the whole EU. The policy aim of INITIATOR2 is to provide information on the effectiveness of specific (single target oriented) policies on the simultaneous reduction of relevant element fluxes (greenhouse gases, nutrients and heavy metals) to atmosphere, ground water and surface water. INITIATOR2 has been applied in the Netherlands to demonstrate: (i) the evaluation of mitigation measures and policies on ammonia and greenhouse gas emissions and phosphorous and metal leaching (De Vries et al., 2005a, 2006) and (ii) the use of the model to improve the national IPCC based assessments of soil emissions of nitrous oxide (De Vries et al., 2005b). Furthermore, INITIATOR2was applied at a landscape scale to make an integrated assessment of present farm management on atmospheric emissions, leaching and runoff of ammonia, greenhouse gases and nutrients (De Vries et al., 2007b). The model will require adaptation to include the changes in farming measures coming from implementation of CC as these measures may be different from the measures related to management changes already evaluated with this model.

5.4.4 INTEGRATOR

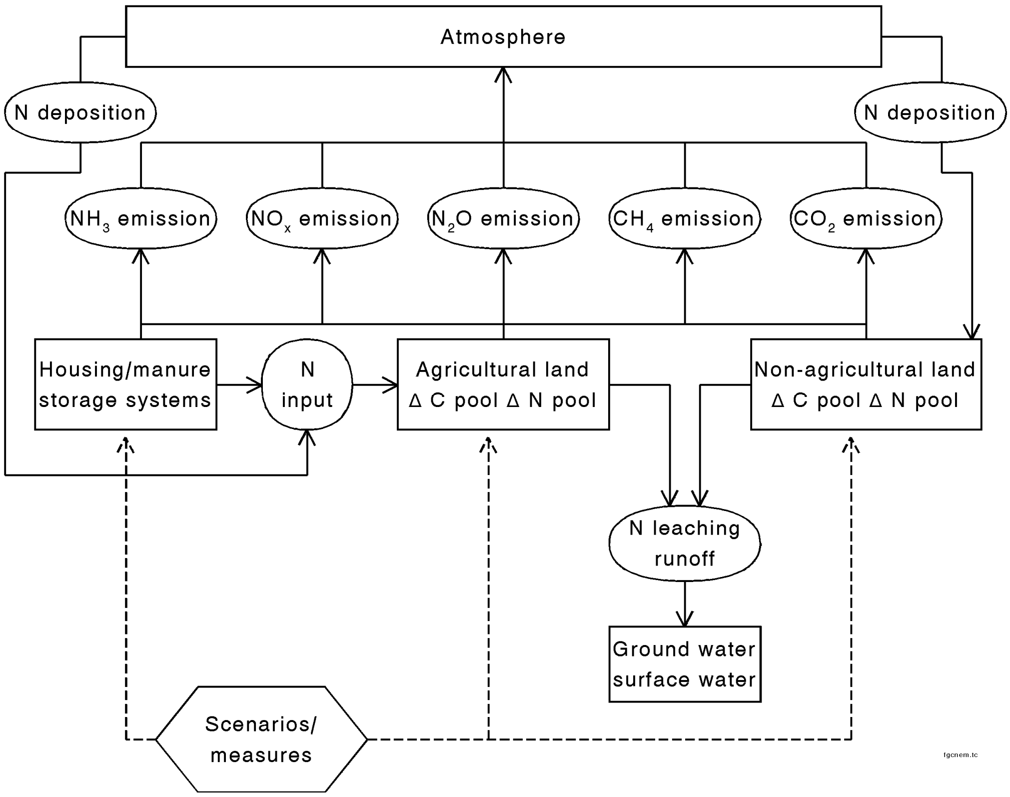
INTEGRATOR (Integrated Nitrogen Tool across Europe for Greenhouse gases and Ammonia Targeted to Operational Responses) is an integrated, GIS-based, multi-component modelling tool for the European scale, that is currently developed within the context of the Integrated Project NitroEurope. This 5 year project has started in February 2006 and addresses the prime issues of European N budgets in relation to C cycling and greenhouse gas exchange. The objective of INTEGRATOR is to:

- Assess present atmospheric nitrogen (NH_3, NO_x) and greenhouse gas (GHG: CO_2, N_2O, CH_4) emissions and sinks from terrestrial systems.
- Assess the interactions between C and N and between agricultural and non-agricultural systems.

- Predict past, present and future N and GHG emissions and sinks in response to various scenarios reflecting: (i) past and present land cover changes and land management decisions and (ii) various policies and actions that affect nitrogen emissions in interaction to greenhouse gas emissions and climate change.

The word multi-component implies that INTEGRATOR includes GHG exchange from all relevant sources, such emissions from terrestrial and aquatic ecosystems, industry, transport, agriculture etc. INTEGRATOR will thus consist of various modules, calculating N and GHG emissions from: (i) industrial sources, (ii) farms: housing and manure storage systems, (iii) agricultural soils, (iv) non-agricultural soils and (v) surface waters (indirect emissions), while accounting for the interaction between agricultural and non-agricultural soils through an (vi) emission-deposition model for N compounds (NH_3 and NO_x), as illustrated in Figure 5.4.

Figure 5.4 Set up of INTEGRATOR in terms of considered N and GHG fluxes and compartments



The focus will be on N and GHG releases from terrestrial systems, with a special focus on agricultural systems. Unlike MITERRA Europe, INTEGRATOR also includes industrial emissions in the modelling tool, whereby ‘industrial’ stands for all non-terrestrial and anthropogenic emissions of N and GHG and the interaction between agricultural and non- agricultural emissions. This is needed to:

- Provide a complete N budget for Europe

- Calculate an adequate N deposition on the basis of total (industrial and terrestrial) NO_x and NH_3, emissions
- Provide a complete budget (total annual fluxes) of methane (CH_4) and nitrous oxide (CH_4 and N_2O) into the atmosphere (from all sources in Europe - including combustion and industrial sources), being also needed as an input for the inverse modelling of these compounds in the context of verification studies.
- Allow comparison of the terrestrial source of CH_4 and N_2O to other anthropogenic sources, such as combustion.
- Gain insight in the impact of scenarios regarding changes in land cover and agricultural management on the terrestrial emissions of CH_4 and N_2O in view of the non- terrestrial emissions.

The agricultural component of INTEGRATOR is highly based on MITERRA Europe, and this model will be further developed within the context of Nitro Europe. Within the context of the CCAT project, this further development of MITERRA Europe is most important since CCAT focuses on cross compliance measures in agriculture.

5.4.5 RAINS/GAINS

The Regional Air Pollution Information and Simulation (RAINS) model has been developed at the International Institute for Applied Systems Analysis (IIASA) as a tool for the integrated assessment of emission control strategies for reducing the impacts of air pollution (Alcamo et al., 1990). The present version of RAINS addresses health impacts of fine particulate matter and ozone, vegetation damage from ground-level ozone as well as acidification and eutrophication. To explore synergies between these environmental effects, RAINS includes emission controls for sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC), ammonia (NH_3) and fine particulate matter (PM) (Cofala et al., 2000). RAINS contains activity data to assess national emissions, both as a present-day inventory and as emission projections, applying business-as-usual conditions as well as pathways of different economic or technological developments. Considering the new insights into the linkages between air pollution and greenhouse gases, work has begun to extend the multi-pollutant/multi-effect approach that RAINS presently uses for the analysis of air pollution to include emissions of greenhouse gases (GHG). The new tool is termed ‘GAINS’: GHGAir pollution INteractions and Synergies (Klaassen et al., 2004; Klimont & Brink, 2004; Höglund-Isaksson & Mechler, 2005; Winiwarter, 2005).

The RAINS/GAINS emission modules at IIASA predict NO_x and NH_3 emissions (RAINS) and CO_2, CH_4 and N_2O emissions (GAINS) at a country level. In the present MITERRA-Europe model, data from RAINS/GAINS on excretion factors for N and P and emission factors for NO_x, NH_3, CH_4 and N_2O from housing and animal storage systems per animal category per country are taken as a first estimate of these emissions.

5.5 Up- and downscaling procedures based on DYNASPAT and SEAMLESS

In this section the Dynaspat-Seamless approach to spatially allocating land use and individual farm information from FADN (Farm Accountancy Data network)[20] to a specific environmental context is presented. From existing European statistical sources (e.g. FADN and FSS) land use and the farm information is only available at administrative level, which are usually quite large regions with a very large variation in environmental characteristics. The spatial allocation approach adds a spatial dimension to all land uses and farm types making it possible to aggregate the types both to natural and to administrative regions.

The spatially allocated farm types therefore facilitate the model linking, as they relate different scales to each other, just as different dimensions/domains (administrative, environmental, social). This spatial flexibility provides input data to the models used in CCAT (e.g. CAPRI, Integrator. MITERRA, EPIC and DNDC) in which a link has to be established between the farm activities and their environmental endowment (climate and soil attributes). Such input data also enable the linking of CAPRI output (in relation to farmers responses) to the environmental models in which the farm in its bio-physical environment is central.

The spatial allocation of FADN farm information is a complicated process which involves several steps to allocate the FADN farm information. The result of the allocation approach is a methodology that enables us to add a locational dimension to every individual farm contained in the FADN data base. This locational dimension is a reference to either a Homogenous Spatial Mapping Unit (HSMU) or a cluster of HSMUs. Since HSMUs can be clustered to administrative or bio-physical entities the farms can also be grouped to these different spatial entities.

First it is described how the land use or cropping zones database was developed by the University of Bonn and the Joint Research Centre (JRC, Climate Change Unit, Ispra) within the DYNASPAT project. The DYNASPAT project developed a statistical approach combining a binary choice model with a Bayesian highest posterior density estimator to break down land use choices from European administrative regions (NUTS 2) to 100.000, so called, Homogeneous Spatial Mapping Units (HSMUs). These units were the basis to link the large-scale economic model CAPRI with the bio-physical model DNDC (see below). One HSMU is regarded as similar both in terms of agronomic practices and the natural environment, embracing conditions that lead to similar emissions of greenhouse gases or other pollutants.

---

[20] FADN data are the main input data source for the CAPRI model. *Farm Accountancy Data Network (FADN)* (sample of holdings, representing a large share of agricultural production, with information on costs and revenues, income generated from agriculture, also including subsidies). A database, provided by the Commission of the European Communities. Figures are available on an annual basis for the European Union as a whole, distinguishing FADN regions (NUTS ½) representative for the main farm types. FADN is based on a representative sample of holdings. Users of this database can work with individual farm data. Special permission is needed to work with this database. The LEI, partner in this project, has access to the database.

Definition of HSMU

The HSMUs are built from four major geographical data sources, which were available for the area of the European Union i. e. the European Soil Database V2.0 (European Commission, 2004) with about 900 Soil Mapping Units, the CORINE Landcover map (European Topic Centre on Terrestrial Environment, 2000), and a Digital Elevation Model (CCM DEM 250, 2004). Prior to further processing all maps were re-sampled to a 1 km raster map (ETRS89 Lambert Azimuthal Equal Area 52N 10E, Annoni, 2005) geographically consistent with the European Reference Grid and Coordinate Reference System proposed under INSPIRE (Infrastructure for Spatial Information in the European Community, Commission of the European Communities, 2004).

One HSMU is defined as the intersection of a soil mapping unit, one of 44 Corine land cover classes, administrative boundaries at the NUTS 3 level (EC, 2003; Statistical Office of the European Communities (EUROSTAT), 2003), and the slope according to the classification 0 degree, 1 degree, 2-3 degrees, 4-7 degrees and 8 or more degrees. As the HSMU of at least two single pixel of one square kilometre are not necessarily contiguous, we can speak from the HSMU as of "pixel cluster".

Procedure for the allocation of crops

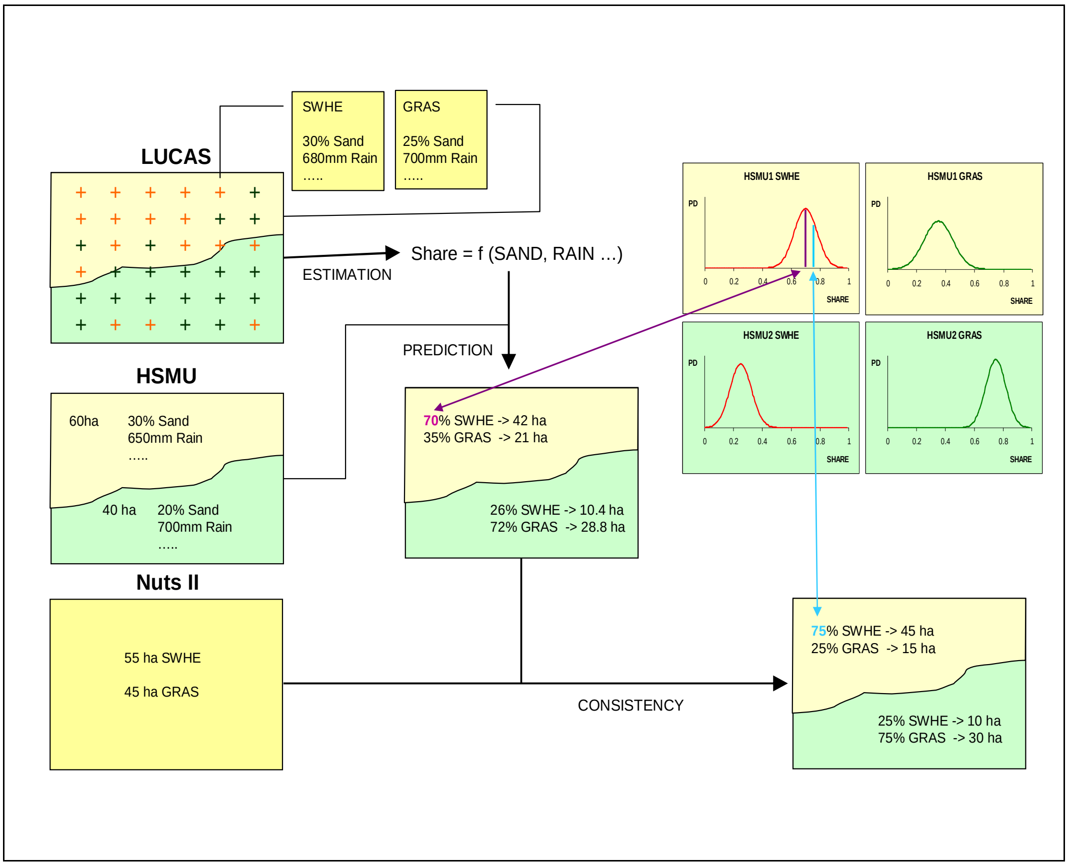
A two step approach is then followed to predict the crop shares in every HSMU. These two steps were applied a couple of times in an iterative process in which the outcome of the following validation provides new ideas for improvements of the previous steps.

<u>Step 1:</u> The first step regresses cropping decisions in each HSMU on bio-physical factors (soil characteristics, climate, slope class and land cover), using results of the LUCAS survey point information. This is done through the application of a spatial statistical technique, a *Locally Weighted Logit model,* which results in normally distributed predictions of crop shares per HSMU. This approach results in the expression of expected shares of agricultural crops as probability density functions (pdf), i.e. in each HSMU mean and variance of the shares of 30 agricultural crops and one aggregated non-agricultural land use are estimated.

<u>Step 2:</u> The creation of an optimal distribution of the agricultural crops over the HSMUs according to total crop areas at Nuts 2 level provided by FSS. This optimalisation is based on a *Bayesian Highest Poterior Density* method and maximizes the posterior density of crop shares within the totals for the Nuts regions. It aims at creating an optimal consistency between scales, i.e. between the totals at Nuts 2 and HSMU levels.

In Figure 5.5 the spatial allocation procedure is illustrated for an example of a Nuts II region comprising two HSMUs and two crops – grassland (GRAS) and soft wheat (SWHE). Combining the LUCAS survey with digital maps provides several observations of crops grown at a defined points characterised by a set of natural conditions. By using an adequate estimation model we can regress the probabilities of finding a crop at a certain location with specific natural conditions. This probability can be interpreted as the share of the crop in a homogeneous region. Applying these estimated coefficients to the average natural conditions in a the HSMU gives a normally distributed prediction of crop shares for this HSMU under corresponding assumptions on the stochastic processes governing crop choice. This *a priori* information on cropping shares is generally not consistent with the "known" cropping area in the Nuts II region. The "best" set of data-consistent shares given the prior information is then identified by a Bayesian *highest posterior density* (HPD) approach. The concept of the HPD estimator allows the direct inclusion of the uncertainty of the prior mean. The variance can be derived from asymptotic properties or bootstrapping procedures. For a more detailed description of the statistical allocation procedure see Figure 5.5.

Figure 5.5 Scheme of land use allocation procedure



Extension of the HSMU approach

Based on the experiences gained in the CAPRI-DynaSpat project, we will further develop the HSMU approach. Specific improvements that are envisaged are:

- Applying a high resolution forest mask on Europe
- Removing the Corine land cover map from the delineation process but include the information as an explanatory variable in the regression model
- Adding information at the "soil unit level" scale (not geo-referenced) in the 'delineation' procedure allows sharper definition of soil characteristics

- Minor modifications in the application of the Digital Elevation Model (DEM) in the delineation procedure

These modifications will have to be tested in small regions. Final decisions on the final procedure for the derivation of HSMU in CCAT will be taken on the basis of these case studies.

Allocation of FADN farm information to HSMUs

For the spatial allocation of the FADN farm information the land use information and other attributes assigned to the HSMUs in the Dynaspat project are taken as the main input basis. The methodology for the farm allocation is very similar to that used for producing the land use allocation in Dynaspat. The main difference is however, that instead of using the HSMUs as the basic spatial entities to which farms are allocated a clustering of HSMUs, so-called Farm Mapping Units, are used. This clustering is necessary to reduce the complexity of the allocation procedure. The final allocated results are still linked back to the original HSMUs of which the FMUs composed. This linking back is easy since the link to the HSMUs the FMU is a cluster of is maintained. For the presentation of the results farm allocation results are therefore first linked to HSMUs and than aggregated to what ever cluster of HSMUs, in the case of Seamless Agri-environmental zones are used. For the allocation of FADN farm information first the aggregation of HSMUs into FMUs is done. Secondly, a fixed distribution of FADN farms over dominant altitude and LFA and non-LFA zones is created. Finally the optimal match between farm cropping patterns and potential yield levels and land use patterns in (a regional cluster of) FMUs is identified by applying a *Bayesian Highest Poterior Density* method.

The results of both disaggregation approaches for land use in the Dynaspat project and for FADN farm information in SEAMLESS are delivering good results in terms of validation. The allocation results for land use and FADN farms is available for the whole EU-15. However, both approaches are planned to be further improved and it is now explored whether they can be extended to the New Member States.

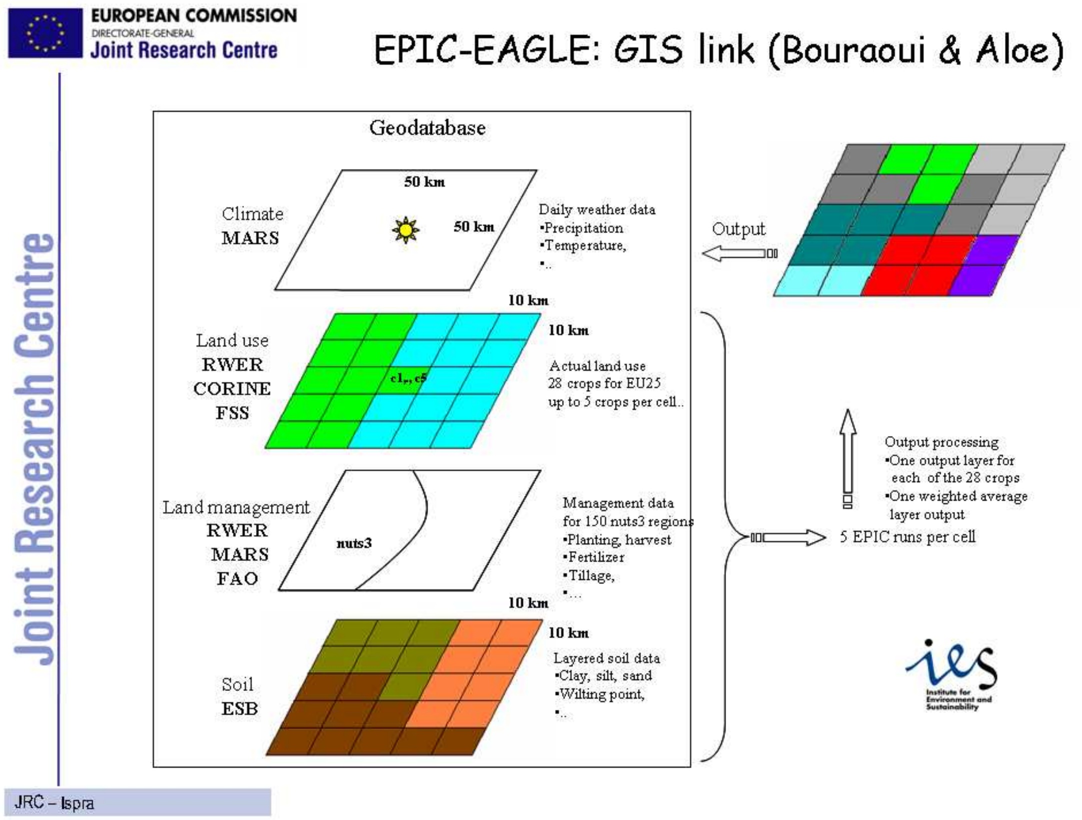
5.6 EPIC

5.6.1 Model description

The EPIC model is a soil/crop model composed of several simulation components for weather, hydrology, nutrient cycling, pesticide fate, tillage, crop growth, soil erosion, crop and soil management and economics. The model was originally focused on the effect of soil erosion on productivity and EPIC was originally named as the Erosion Productivity-Impact Calculator. However, since the model expanded, it is nowadays also known as the Environmental Policy Integrated Climate model (see EPIC website: http://www.brc.tamus.edu/epic/). EPIC is now an integrated field scale crop-soil model especially well-suited to evaluate crop growth, irrigation requirements (including an option for auto-irrigation), nutrient uptake and cycling, and erosion. It is composed of several simulation components for weather, hydrology, nutrient cycling, pesticide fate, tillage, crop growth, soil erosion, crop and soil management and economics (Williams, 1995). It predicts the effects of management decisions on soil, water, nutrient, and pesticide movements and their combined impact on soil loss, water quality, and crop yields for areas with homogeneous soils and management. EPIC has been thoroughly evaluated and applied from local to continental scale (Gassman et al., 2005). Typical applications including the effect of N and P losses as affected by different tillage systems, crop rotation and fertiliser application, etc. The model had been used to assess crop yield as affected by various farming practices and climate change scenarios.

As with DNDC, EPIC is a mechanistic detailed model, specifically developed for use at the field level. However, much efforts have been made to apply the model also on a regional scale. At the RWER unit of JRC the EPIC-EAGLE interface has been developed, an integrated ARC-GIS front-end to run EPIC (see Bouraoui and Aloe, 2007). EAGLE is short for the European Agrochemicals Geospatial Loss Estimator with most of the parameters required to run EPIC readily available at EU level (Mulligan et al., 2006). A graphic presentation of the GIS link between EPIC and needed databases on climate, land use, land management and soil is given in Figure 5.6.

66 Graphic presentation of the EPIC-EAGLE GIS link.



5.6.2 Model use

The approach chosen here consists of the incorporation of EPIC modelling results through a metamodelling framework into the CAPRI model. The metamodel approach will provide flexibility to perform repeated policy scenarios without having to rerun the complete model. Metamodels can be thought of as statistical summary functions of generated model output. The metamodeling approach in combination with EPIC has been used before to address agricultural policy issues (see Lakshminarayan et al., 1996). However, the current implementation of EPIC-EAGLE will need also to be calibrated for different parameters. As a first step, the EPIC model will be calibrated on, for example, measured crop yields. Modelled erosion will be harder to 'validate' and here the number of previous studies indicating a good capacity of the model to present erosion and crop yields at the field scale provides a certain degree of confidence in the model output (Wang et al., 2006). After calibration or 'verification' of certain model outputs, the EPIC model will be executed using the EPIC-EAGLE interface at pan-European scale using the current 10 by 10 km grid-cell setup. The EPIC output may then be aggregated to the desired regional (NUTS 2) or HSMU level and regression functions will be used to define metamodel relations. For example, if we are interested in erosion, based on the simulation data, we can specify erosion as a function of a selection of management factors; soil; and topographic properties and climate properties. The metamodel will allow us to get a reasonable confidence in the response of crop yields or erosion to management, landscape and meteorological variables without having to rerun the EPIC model.

5.7 DNDC

5.7.1 Model description

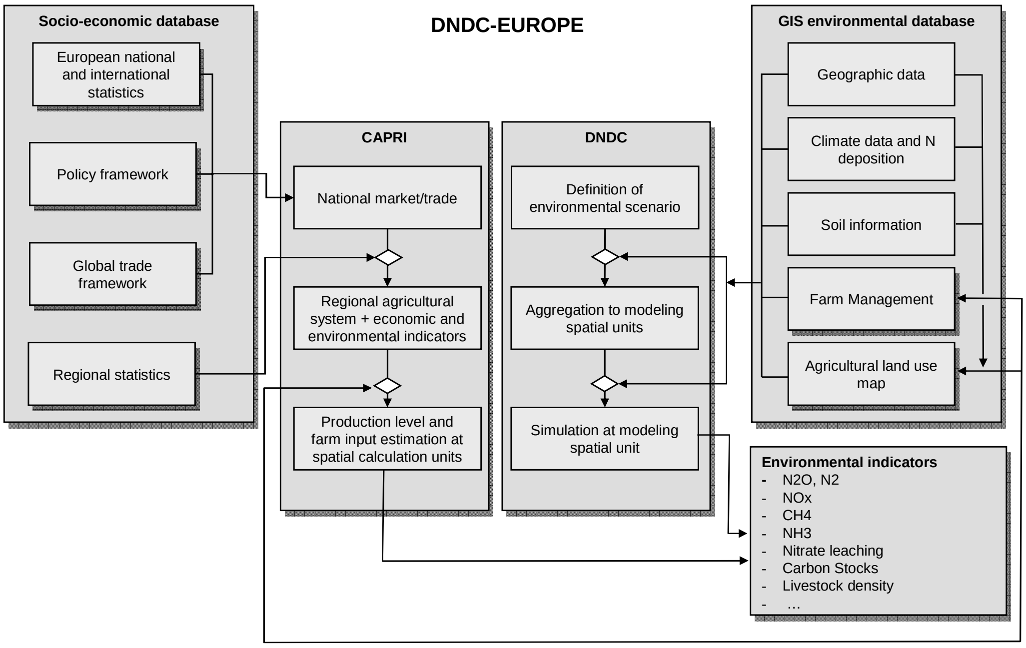
The Denitrification-Decomposition (**DNDC**) model is a process-oriented computer simulation model of soil carbon and nitrogen biogeochemistry (Li, 2000; Li et al., 1992; Li et al., 2006; Li et al., 2004). It is a mechanistic detailed model, originally developed for use at the field level and further developed for the use at regional scale. DNDC is a multi-ecosystem model designed for assessing the emissions of N_2O, CH_4, and NH_3 from the soil into the atmosphere and the stock changes of organic carbon in the soil profile on the basis of mechanistic process-understanding. The model consists of two components. The first component, consisting of the soil climate, crop growth and decomposition sub-models, predicts soil temperature, moisture, pH, redox potential and substrate concentration profiles driven by ecological drivers (e.g., climate, soil, vegetation and anthropogenic activity). The second component, consisting of the nitrification, denitrification and fermentation sub-models, predicts greenhouse gas emissions from the soil (CO_2, N_2O, CH_4), the dynamics in soil carbon pools and NH_3 fluxes based on the modeled soil environmental factors. The model has been extensively validated and applied at plot level and regional to continental scale, such as the United States of America (e. g., Tonitto et al., 2007), China (Li et al., 2006; Xu-Ri et al., 2003), India (Pathak et al., 2005), and Europe (e. g., Brown et al., 2002; Butterbach-Bahl et al., 2004; Neufeldt et al., 2006; Sleutel et al., 2006).

5.7.2 Extension of the model

DNDC will be further developed within EU NitroEurope IP and the data base for application for EU will be compiled. The linkage with the livestock sector will be done using the **CAPRI** model, within which the representation of NH_3 N_2O and CH_4 emissions have been updated / implemented in the EU CAPRI-*DynaSpat* project. In the CAPRI-*DynaSpat* project a link was further established between DNDC and CAPRI in order to better assess the environmental impact of agriculture considering both socio-economic and environmental factors. The modelling framework of the combined CAPRI-DNDC modelling framework is schematically shown in Figure 5.7 and includes the generation of (i) agricultural land use maps at the level of so-called homogeneous soil mapping units (HSMUs) for 29 different crops for CAPRI *ex post* or *ex ante* calculations; (ii) the estimation of farm management (in terms of nitrogen application rates) at the HSMU-level; (iii) the definition of environmental scenarios and the set-up of DNDC model runs; and (iv) the integration of the results into a common database.

It can be expected that not all measures that should be simulated are already parameterized in a sufficient quality in DNDC. Improvements will be necessary for example in the representation of different nitrogen application techniques or tillage systems. If required, these models will further be improved to better represent farm type specific fluxes of pollutants and farm-internal flows of material (leading to pollutant-swapping effects) on the basis of dedicated farm-scale models (e.g. FASSET).

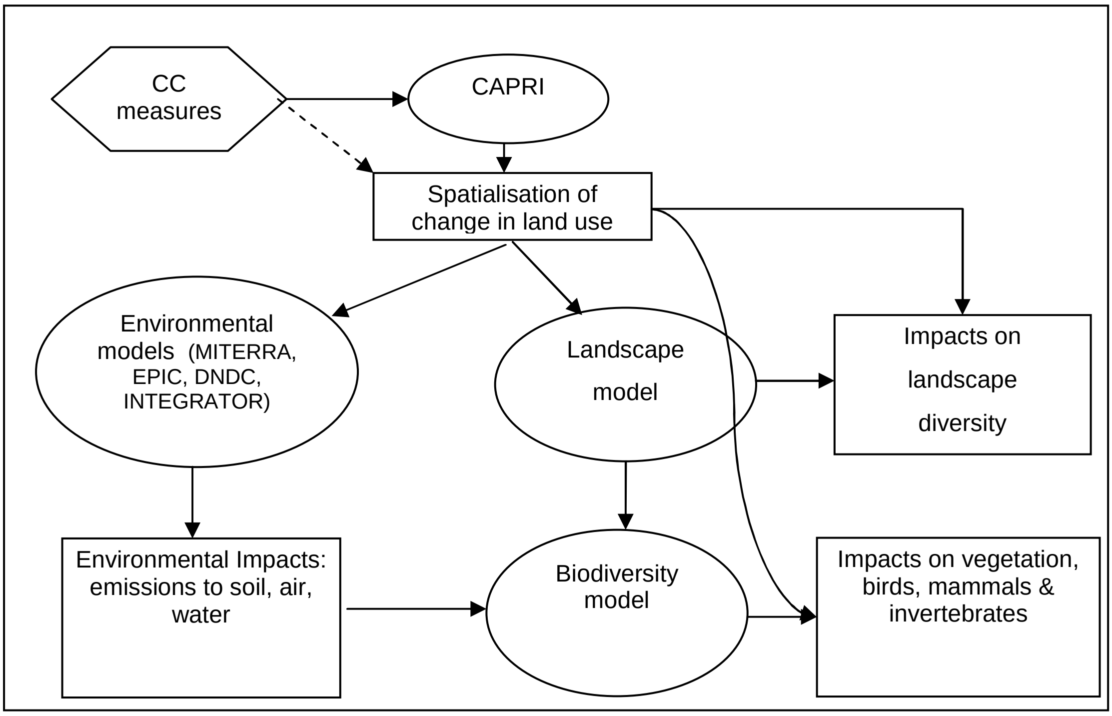
Figure 5.7 Modelling framework of the combined CAPRI-DNDC modelling approach on a European scale



5.8 Approaches to assessing CC impacts on land use, landscape and biodiversity

To assess the impacts of CC on land use, landscape and biodiversity we rely strongly on the output of the Capri and the environmental models. These relationships are further specified in Figure 5.8.

Figure 5.8 Input-output relationships between models for assessing CC effects on land use, landscape and biodiversity



For the prediction of land use changes we use the modelled regional specific responses by CAPRI (see Figure 5.8 and Section 5.3). It is now foreseen that this response information from CAPRI will then be linked in a post-model desegregation procedure to more spatially explicit information sources such as sub-regional entities as Nitrate Vulnerable zones (NVZs), High Nature Value (HNV) and Natura 2000 farmland. For this disaggregation we will make use of the detailed land use map of Dynaspat and the detailed farm type allocation information from Seamless Dynaspat. Both sources provide the present distribution of land use and FADN farms per Homogeneous Spatial Mapping Unit (see Section 5.5). From this relative changes can be deduced in type of land use changes and changes in farming practices and below-regional (more detailed than Nuts 2) differences in farmer's responses to CC. This output will also enable a spatially explicit mapping of CC induced land use changes at the level of e.g. NVZs and HNVs within Nuts 2 regions. Once the land use changes are mapped some more complex land use change indicators can also be estimated from this such as changes in UAA, in cropping pattern, stocking densities.

Impacts on landscape

For the assessment of the changes in landscape the predicted land use changes will form the main starting point from which more specific landscape indicators can be estimated (see Figure 5.8). A methodology to make this estimation will come from the KELK model (Roos *et al*. 2004; Roos-Klein Lankhorst *et al*. 2004), developed for and used by The Netherlands Environmental Assessment Agency (MNP). This model was explicitly developed to assess landscape quality changes caused by land use and land management changes.

The KELK model uses knowledge rules to evaluate impacts of land use changes on the landscape structure (spaciousness), on historic natural and cultural values, and computes expected (changes in) appraisal of the current landscape and the recreational capacity of the landscape. The model is developed and used for the Dutch situation and uses detailed information on topographic features, historic data and land use data. For the European situation those detailed data are not available, and the knowledge rules will have to be adapted and simplified.

Knowledge on European landscapes and landscape assessments will be derived from other European studies such as PEENHAB and ALCAI (Mücher et al, 2004, 2005; Wascher (ed), 2004, 2005).

Impacts on biodiversity

For assessing the potential impacts on biodiversity the changes in land use and landscape are a main input, but also the predicted changes in environmental state as these give an understanding in changes in habitat quality. The assessment of biodiversity impact therefore comes at the end of the modeling chain. For assessing the biodiversity impact from the output on environmental changes and changes in land use and landscape we need to apply expert rules as qquantitative models for assessing impacts on biodiversity at the EU-wide scale considered in this project do not exist. Therefore, the effects of CC on this impact field have to be assessed in a more qualitative way, at least for the analysis at the EU scale.

There are several points connected to the assessment of potential effects of Cross Compliance on biodiversity, which should be taken into account in this study:

a. Large differences at regional level and farming system as to the extant biodiversity elements.

b. Large differences at regional level in which Habitats and Birds directives are implemented.

c. CC conditions vary strongly per farming system within regions.

d. There are no models available that quantify effects on biodiversity which are usable at an EU wide basis.

e. The relationship between agricultural practices and biodiversity values are complex and specific per farming system and site.

As mentioned above, these circumstances prevent the use of state indicators and *ex-post* approaches to the evaluation of CC effects on biodiversity.

Alternatively, pressure indicators and an *ex-ante* approach will be used in this study. Three variant *ex-ante* approaches can be considered, the first two of which could only be applied to case study regions and the third to the whole EU:

a. Estimate goodness of design by comparing CC measures implemented, farming practices and biodiversity requirements (e.g. Llusia & Oñate 2005).

b. Obtain information on changes in farming practices before and after CC implementation through interviews with farmers (e.g. Primdahl et al., 2003).

c. Matrix approach estimating whether the CC implementation leads to extra or less pressures (intensification or extensification) on the environment and different biota per region. This approach could be combined with mapped information on sensitive regions (e.g. HNV areas, UAA inside Natura 2000 sites) to get a better understanding of whether CC has indeed been targeted well. This approach builds on MIRABEL (Models for Integrated Review and Assessment of biodiversity in European Landscapes) (Petit *et al*., 1998 and 2003) which uses the DPSIR framework for assessing the consequences of environmental change for biodiversity. It allows expert judgement to be related to present and potential future states of habitats using known relationships. The model segregates information on the pressures acting on the environment, the state of the individual environmental components and the anthropogenic responses. The driving force is agriculture, the pressure is exerted by changes in agricultural practices influenced by CC measures, the state is reflected by the composition of habitats and related biodiversity and the impacts follow from their interactions.

The third approach seems the most suitable as it is the only way, given state-of-play and resources in the project to make a spatially explicit (below NUTS 2 region), but EU-wide assessment of CC effects on biodiversity. In this approach first pressures on biodiversity are assessed that may come from changes in farm practices and agricultural land use induced by CC measures. A matrix is devised to show the pressures on biodiversity for the separate agricultural habitats and different biota (e.g. birds, invertebrates, soil organisms, mammals and vegetation). On the basis of knowledge from the literature review and also expert knowledge, the matrix is filled per region showing the direction of impacts of CC on biodiversity. This matrix information can then be used as expert knowledge to spatialise impacts at the lowest possible geographical level. This level will however be determined by the data availability. For specifying the matrix we will also use the modelled and spatially specific environmental impacts of CC and the effects on land use and landscapes as input and possibly combine these with spatial indicators on sensitive areas such as HNV farmland and Natura 2000 farmland areas. From the combined information, the effects on biodiversity can be assessed spatially in terms of risk indicators for certain biota (e.g. farmland birds, vegetation groups) and their habitat and semi-natural habitats, provided that input data are available. This can be done at a general level for the all EU regions, but an application of the same approach to a couple of case regions for which more detailed input data are available on present state of biodiversity can also be applied resulting in more spatially detailed and quantified results.

Beside applying a matrix approach for the EU-wide assessment, it will also be considered to apply the approaches in options 1 or 2, to a selection of case study regions in order to take detailed biodiversity requirements into account and use the outcomes of these case study assessments to further validate the quality of the more simple matrix approach.

Final selection of impact indicators for land use, landscape and biodiversity

In any case, the selection of the final indicators to be used is difficult at this stage of the project, given the wide variety of existing CC measures (SMRs and GAECs) and the need to connect them, by means of influenced agricultural practices, to the requirements of the also varied land use, landscape and biodiversity assets. Therefore, we will first formulate criteria according to which this selection will be made and in the next chapter a further selection of the pre-selected indicators in Chapter 4 will be presented using these criteria. The criteria for selection of indicators are:

1) The indicator needs to have a clear link with the CC measure (SMR or GAEC) and should be meaningful in terms of the direct and indirect pressures exerted on biodiversity components.
2) The indicator should have a spatial dimension, meaning it needs to be spatially explicit.
3) The indicator should enable a link to sensitive areas from the biodiversity point of view, such as HNV farming spots or UAA inside Natura 2000 sites.
4) The indicator should enable a comparison in time, so that a baseline situation for the indicator can be selected.

5.9 Models for assessing impacts on animal welfare and public health

Impacts on Public Health hardly refer explicitly to the farm but to the processed sector which is expressed by the set of existing indicators (Chapter 4) and therefore cannot be derived by other models' results as part of this project. For animal welfare some results of CAPRI simulations on land use and animal densities might be indirectly relevant.. These type of indicators are described as "indirect" indicators in chapter 6.5.4.

5.10 Conclusion

Quantitative models and their integrated application play an important role in deriving indicators for the assessment of CC measures in this project. The combination of different existing models and their partial extension aims at covering economic and environmental impacts of the policy. Integrated use of economic and biophysical models also through the incorporation of up- and downscaling procedures already developed in DYNASPAT-SEAMLESS allows achieving a consistent set of indicators focussing on regional economic impacts related to agriculture and land use and environmentally relevant emissions to air, soil, and water and land use. Assessing the effects on landscape, biodiversity, animal welfare and public health is more complicated as quantified approaches to this have not been developed well enough and data needed to do this at an Eu wide scale are practically absent.

Although the core models are already functional, a key challenge of the project is to achieve their integration in a correct, efficient and transparent fashion. At first, a concrete list of model inputs and outputs relevant for linking have to be identified and procedures to overcome gaps and detailed conceptual specifications of corresponding modules need to be developed. Prioritizing envisaged model extensions with regard to the relevance of CC impacts is another important task.

It still seems unclear, for example, whether we can expect that CC really significantly affects agricultural production structure at regional level. Evidence from completed and still ongoing projects on CC will be gathered to decide if developing a module translating farm measures to consistent policy representations at regional level is worth the effort. Instead or in addition, a further investment in more spatially explicit representation of agricultural production might be fruitful. For example, a central problem for the accuracy of Nitrogen balances at lower spatial scales is the uncertainty of animal distributions and land use in space and the related application of manure. Progress in this area, e.g. land use and farm allocation to HSMUs, promises better quality indicators. Quality assurance of integrated model use also requires attention. Concepts for the validation of indicators calculated in new or integrated way have to be specified.

Quantitative models for assessing CC effects on land use, landscape and biodiversity do not exist. Therefore the effects on these impact fields will be assessed in a more qualitative way by using the modelled output of the CAPRI and the environmental models as input. This input is made as spatially explicit as possible and is then combined with detailed spatial information on the state of land use, landscape and biodiversity. From this combination prediction are made of the pressures on these impact fields and the possible changes induced by these pressures.

For assessment of impacts on animal welfare and public health there are also no models available that support the calculation of relevant indicators. Only for Animal Welfare some indirect relations can be drawn from changes in production as calculated by CAPRI. Instead we will have to rely on other methodologies such as interviews and their systematic exploitation in terms of relevant and feasible indicators.

In the field of economic and environmental impacts it can now be concluded that a large selection of the candidate indicators summed in Chapter 4 can really be specified in this project with the modelling tools available. The final selection of these indicators in given in next concluding chapter. For the economic indicators we expect CAPRI to be able to produce all candidate indicators with the exception of indicators referring to viability of the farm. How these may be modelled within the project is still to be seen,but will be specified in next deliverables (D2.3 and D4.1.1).

In the field of environmental impacts, the set of available models used (MITERRA Europe, DNDC and EPIC) will probably be able to specify most of the candidate indicators from Chapter 4. They will include all indicators on emissions of ammonia and greenhouse gases, gross balance of the nutrients N and P, nitrates in water, soil organic carbon content in the topsoil, inputs of heavy metals to soil by sewage sludge and soil erosion. Environmental indicators for which it is not yet clear whether they can be covered by the models include pesticide accumulation (occurrence in soil) and leaching (occurrence in water). The same applies to evaluation of measures related to Groundwater protection which requires the modelling fate of dangerous substances. The final selection of environmental indicators is given in Section 5 of the concluding chapter.

Regarding the mentioned indicators, environmental targets relevant to agriculture have been set at country or regional level for atmospheric emissions of ammonia and green house gases, nitrates in water and the consumption of pesticides (IRENA 03). Furthermore, measures are defined in view of the:

- Nitrates Directive: 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, p. 1)
- Sewage Sludge Directive: Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (OJ L 181, 4.7.1986, p. 6)

that can be evaluated by the models. Not all CC measures defined in these directives can however be evaluated with the set of available models. This has to be further elaborated during the execution of the project.

For the assessment of impacts of CC on land use, landscape and biodiversity it is clear that these assessment will not be modelled quantified assessment but will require the application of knowledge rules to spatially explicit model outputs of the CAPRI and environmental models. The final selection of the indicators for these assessments is presented in the next chapter.

Finally it can be concluded that for the assessment of impact of CC on animal welfare and public health no modelling tools are available at all. It is therefore expected that only some simple indicators can be specified in relation to some indirect effects of CC on these impact fields which will be further discussed in the next Chapter.

6 Conclusion

6.1 Evaluative summary

This Deliverable provides an overview of the literature, state of play, other research projects with respect to CC and the specific fields of regulation included in this. Moreover, a separate chapter (see Chapter 4) was spent on making and inventory of available indicators and linking them to their fields of impact. The same was done with the regulations and standards included in the CC package, where the regulations were decomposed into different requirements at a rather detailed level.

As regards the different approaches of analysis it was found that:

- Within the economic approach the behavioural understanding of the compliance decision is crucial. Factors influencing the compliance decision are costs (punishment) and benefits (lower costs, higher revenues) of non-compliance as compared to costs (higher costs, lower revenues) and benefits (no punishment or sanctions, i.e no reduction in the single farm payment) of compliance. However, also other factors such as risk aversion, moral attitude, social standing and institutional economic issues, which go beyond a costs/benefit-evaluation appear to be potentially relevant;
- Central elements in the environmental sciences approach are the analysis and understanding of the main environmental fluxes in agriculture and the impacts they have on soil, water and air quality. The analysis focuses on the linkage of various farming activities (like number of animals, fodder regimes, crop residues, manure excretion and application, fertilizer and pesticides applications, etc.).
- The biodiversity perspective contains a literature comprising a lot of detailed case studies on the impacts of agricultural practices on farmland habitats and biodiversity (plant species and bird and wildlife). These studies often have a qualitative character. Moreover, the results of the analyses appear to have their own scale and scope, which precludes simple generalization to other areas and cases, even if these share a number of similarities.
- As regards approaches to changes in land-use and landscape the first issue is well-explored in the literature, both from agronomic and economic sides. The landscape-issue is also addressed but here the literature is relatively weaker. Also these studies often have a qualitative character although there are already several methodologies for specifying specific land use and landscape change measures which may also be useful to adopt in this project, provided good input data are available.

Within the context of the current project, with its scope to evaluate the impacts of CC at an ultimately EU-wide level, it is noted that the literature about the economic and environmental science approaches best fits in with the planned tool development. As regards biodiversity and landscape the literature and the current state of science is likely to create limitations in terms of developing quantitative assessment tools. This does not exclude treatment of these aspects, but the quantification and detail will be more limited then for the other fields as this project is not to be expected to go beyond the current state of the literature.

The state of play or review of other projects on or related to CC made clear that there are a number of interesting modelling tools and indicator frameworks available, which can be exploited for assessing the impacts of CC, in particular the economic and environmental ones (see details below). There is a lot of knowledge available from various projects where upon CCAT could built. In particular information from the Cross Compliance project, the CIFAS project, the IRENA project, and the SEAMLESS and NEU project will be used. Whereas the first three contribute with respect to classifications, characteristic descriptions and indicator frameworks, the latter two projects are contributing in terms of modelling tools (CAPRI) or modelling elements (INTEGRATOR of which information will be used to develop MITERRA-Europe).

From the inventory of available indicator framework a large set of indicators resulted. In a scrutinize analysis these indicators were linked to various fields of impact. A similar exercise was done for all the SMRs and GAECs, where the regulations were decomposed into several requirements. Together this inventory and classification enabled a further indicator selection, where the established linkages make it possible to guarantee that each aspect of the CC regulations is properly linked to indicators.

Quantitative models and their integrated application play an important role in deriving indicators for the assessment of CC measures in this project. The combination of different existing models and their partial extension aims at covering economic and environmental impacts of the policy. Integrated use of economic and biophysical models allows achieving a consistent set of indicators focussing on regional economic impacts related to agriculture and environmentally relevant emissions to air, soil, and water.

As regards the available modelling tools the economic CAPRI-Dynaspat model (as it is and further will be developed within SEAMLESS), and the environmental MITERRA-Europe model are found to be useful. In particular the CAPRI-MITERRA-Europe combination, with the use of the DNDC and EPIC models as complementary modules, looks promising. The MITERRA-Europe model has to be further developed in the coarse of this project. At this stage it is however already clear that with the CAPRI model most of the relevant economic indicators can be modelled, which include all indicators to make a good estimation of the market and income effects of CC. In the field of environmental impacts, the set of available models used will probably be able to specify most of the candidate indicators which will include all indicators on emissions of ammonia and greenhouse gases, gross balance of the nutrients N and P, nitrates in water, soil organic carbon content in the topsoil, inputs of heavy metals to soil by sewage sludge and soil erosion. Environmental indicators for which it is not yet clear whether they can be covered by the models include pesticide accumulation (occurrence in soil) and leaching (occurrence in water). The same applies to evaluation of measures related to Groundwater protection which requires the modelling fate of dangerous substances.

Although a lot of information and tools are available the review of the current work also made clear that several challenges remain for this project. To mention a few:

- Best estimates of the degree of compliance and costs of compliance are only available for a subset of member states. Insights into the additional compliance induced by the CC enforcement mechanism is still very limited. More information on this will be crucial for a successful impact assessment;
- Related to the previous point is also the choice of a base level. Ideally this choice would be a comparison of the state before and after the imposition of the CC policy. However, it might be necessary the let this choice depend on the type of information that can be found for the degree of compliance at certain dates;
- The integration and linking of the modelling tools will require the necessary efforts and impose challenges in terms of connecting different aggregation and scale levels;
- The linkage between tools and indicators will need further attention. Whereas a number of indicators are directly available from the modelling tools, for others linkages will have to be established;
- The reviewed studies were relatively ‘silent’ on issues of biodiversity, food safety, animal welfare and landscape. As they are part of the planned assessment tool particular attention will have to be given to these aspects and maybe new tools or complementary modules have to be developed.

Some of these are key-issues and are further explored below.

6.2 Measurement of compliance and its costs

Best estimates of the degree of compliance and costs of compliance are only available for a subset of member states. Insights into the additional compliance induced by the CC enforcement mechanism is still very limited. More information on this will be crucial for a successful impact assessment. Further efforts on this are recommendable.

Regarding the measurement of compliance several approaches could be followed. The most direct way is to simply rely on the results of the monitoring and inspection services. This could be labelled as the official approach. If only a few violations are detected this can than be interpreted as signalling a high degree of compliance. Unfortunately this information is often not yet made available for research. Where information is published, it is often done in such a way that no clear estimates of the degree of compliance can be assessed. For example a number of found detections of a certain regulation is reported, but his number is not related to a total sample size, and no information is given about the sample selection procedure that was used. This makes it hardly possible to obtain estimates for the full population based on this information.

A second approach is to rely on expert estimates. For example, extension service people or organisations representing farmers’ interests might be able to come up with a reasonable estimate of the degree of compliance for certain regulations. The problem with this kind of information is its uncertainty and the potential bias it may have.

A third approach could be to do a survey among farmers. Because farmers have no interest in signalling non-compliance to any external source, direct questions about the degree of compliance will give inflated answers. However, it might be possible to get answers on several other questions, which provide an insight into the farm characteristics and farm practices that in a subsequent step could be used for predicting the degree of compliance (see Jongeneel 2007 who followed such a procedure for the Netherlands).

A fourth approach could be to exploit information about participation and compliance to voluntary certification schemes, in particular those ones covering criteria similar to those of cross compliance, or even directly referring to standards included in the cross compliance package.

Three out of the four mentioned approaches are indirect and will often not work for all, but only for compliance to some of the regulations and requirements covered by cross-compliance. As regards this research project having access to reliable estimates of the degree of compliance is crucial for the later analysis. See in particular Subsection 2.2.5 on the economic and non-economic determinants of compliance, the operationalization of which will strongly rely on empirical information about current and past rates of compliance. As such it might be necessary to do some further inquiries into this issue.

What holds for estimates of degrees of compliance to a lesser extent also holds for the costs of compliance. Whereas some information on this is available, it often has a fragmentised nature. As it explicates the agricultural production process, even at farm level, the modelling framework used can further help to asses costs of compliance. For example, when details about manure excretion, manure application, fertilizer application and land-base and land-use are known manure surpluses and associated disposal costs might be recoverable under reasonable assumptions. As was made clear, however, the cost/benefit evaluation a farmer makes whether or not to comply is more complex than linking expected financial punishments to expected monetary profit gains.

An related issue, which has not been discussed in detail in this report, is the reference level. The choice of a reference level is crucial for determining the (additional) costs of compliance, as well as the level of compliance (which is likely to be a function of the time the requirement is already obligatory). As was already discussed before there is currently a lack of data on the degree of compliance. The type of data that will become available is likely to also determine the reference level that will be chosen. This issue will be further settled in follow-up steps of the project.

In Section 2.3 economic and non-economic aspects of a farmer's compliance decision were analysed. If sufficient information would be available this would open up possibilities to endogenize the compliance decision in the CAPRI model. Based on the data limitations it was decided within the project team to treat the compliance level exogenous. Also then the discussion on factors influencing compliance of Section 2.3 is helpful since it also contributes to improve the best estimates of compliance under various scenarios. Since this issue is considered to be crucial for the project, some investigations will be done to further improve the insight in the compliance decision.

6.3 Regionalization of different effects

The regionalisation of input and output data will be a crucial step in this project. It will require up- and downscaling of farm information and bio-physical information in order to establish a link between both fields. This link is crucial for assessing the effect of changes in farming based on the response of farmers to CC. This response translated further to changes in land use and farming practices is the input for the environmental models.

The regionalisation of the effects of CC taking account as much as possible of differences in environmental conditions will be ensured in 4 ways:

1. By further collection of data and further improvement of the analysis done in CIFAS on the national and regional implementation pathways of SMRs and GAECs and implementation levels. This will be most challenging.
2. By using the spatialised land use and farm information linked to HSMUs in Dynaspat and SEAMLESS as weighing factors to spatially disaggregate the modeled output results from CAPRI. The spatially allocated farm types therefore facilitate the model linking, as they relate different scales to each other, just as different dimensions/domains (administrative, environmental, social). This spatial flexibility provides input data to the models used in CCAT (e.g. CAPRI, Integrator. MITERRA, EPIC and DNDC) and the assessment of effects on land use, landscape and biodiversity in which a link has to be established between the (changes in) farm activities and their environmental endowment (climate and soil attributes). Such input data also enable the linking of CAPRI output (in relation to farmers responses) to the environmental models in which the farm in its bio-physical environment is central.
3. Trying to make all environmental assessments using the most detailed environmental databases.

6.4 Limitations of data and models

The integration and linking of the modelling tools will require the necessary efforts and impose challenges in terms of connecting different aggregation and scale levels;
The linkage between tools and indicators will need further attention. Whereas a number of indicators are directly available from the modelling tools, for others linkages will have to be established.
Prioritizing envisaged model extensions with regard to the relevance of CC impacts is another important task. It still seems unclear, for example, whether we can expect that CC really significantly affects agricultural production structure at regional level. Evidence from completed and still ongoing projects on CC is gathered to decide if developing a module translating farm measures to consistent policy representations at regional level is worth the effort. Instead or in addition, a further investment in more spatially explicit representation of agricultural production might be fruitful. For example, a central problem for the accuracy of nitrogen balances at lower spatial

scales is the uncertainty of animal distributions in space and the related application of manure. Progress in this area promises better quality indicators. Quality assurance of integrated model use also requires attention. Concepts for the validation of indicators calculated in new or integrated way have to be specified.

As regards issues of biodiversity, food safety and animal welfare the possibilities to exploit existing models are limited. Especially for the animal welfare and public health fields, developing specific tools or modules that can be linked up with the proposed set of integrated modelling tools is still a thing which requires more research. Even than it cannot at this moment be overseen what results this may yield. Most likely we have to rely on other methodologies such as interviews and their systematic exploitation in terms of relevant and feasible indicators. Especially the field of animal welfare poses a challenge and room for conceptual innovation as there exist no established indicators.

As for biodiversity assessments it is however already more clear what approach is to be taken. As mentioned above, quantitative models for assessing CC effects on biodiversity and landscape do not exist and ex-post approaches are not applicable in the framework of this project. Therefore, the effects on these impact fields have to be assessed in a more qualitative way, at least for the analysis at the EU scale. Non-availability of adequate state indicators will force the use of pressure indicators instead, in the framework of an ex-ante approach. The estimation whether CC implementation leads to extra or less pressures (intensification or extensification) on the environment and different biota per region will be approached through matrices and expert judgement using known relationships between present and potential future states of habitats and biodiversity and land use and management practices (affected by CC).

Beside the approach for an EU wide assessment of biodiversity effect we will also elaborate a more precise approach in case study regions. These regions will be selected in order to take detailed biodiversity requirements into account and use the outcomes of these case study assessments to further validate the quality of the simpler matrix approach. In these case study areas two additional approaches could be adopted: 1) An estimation of goodness of design by comparing CC measures implemented, farming practices and biodiversity requirements; 2) An assessment of changes in farming practices before and after CC implementation, identified through interviews with farmers.

6.5 Initial selection of Impact Indicators of Cross Compliance

After having analysed the various indicators available a process of selecting the relevant indicators followed. The final selection is based on several inputs:

- review of policy interest as indicated by the policy goals specified in the relevant legislation;
- feasibility to calculate the indicators with the available methods, models and tools, or with tools from which it could reasonable expected that these can be developed within the course of the project;
- discussions with endusers;
- extensive discussion with project team.

The outcome of this exercise is discussed in the subsequent sub sections.

6.5.1 Selected economic impact indicators

The selected economic indicators are provided in Table 6.1. Out of the complete list of indicators detected before (see Table 4.6), it is expected now that most indicators could be implemented within the CAPRI modelling framework as described in chapter 5. Since the CAPRI model does not work at the individual farm level, but distinguishes certain farm types and their relative production shares, the lowest level at which indicators will be evaluated is at farm group level. This necessarily implies that indicators reflecting changes in individual farm profitability (and derived farm short-run and long-run 'survival' statistics) had to be dropped. Also some competitiveness indicators (DRI and SCB) were dropped because the modelling tool precluded the calculation of these (trade- and border price-related) indicators.

Table 6.1 Final selection of economic indicators

Indicator	Model available				
		group of farms (e.g. types)	region	country	EU
Gross Margin/hectare[21]	CAPRI	X	X	X	X
Land price	CAPRI		X	X	X
Production of main agricultural Products	CAPRI	X	X	X	X
Land Allocation	CAPRI	X	X	X	X
Export/Import Ratio of main Agricultural Products	CAPRI			X	X
Budgetary expenditure	CAPRI	X	X	X	X

[21] This indicator can also be interpreted as an indicator of competitiveness.

Costs of controlling CC[22]	CAPRI			X	X
Welfare changes related to agricultural production	CAPRI			X	X
Agricultural Income	CAPRI	X	X	X	X
Costs of compliance	CAPRI	X	X	X	X
Competitiveness: change market share	CAPRI			X	X

6.5.2 Selected environmental criteria

Based on the model descriptions and links in Chapter 5 it is now clear that with the set of available models in this project and the model extensions further planned we will be able to specify most of the candidate indicators presented in Chapter 4. The final impact indicator set will therefore include all indicators on emissions of ammonia and greenhouse gases, gross balance of the nutrients N and P, nitrates in water, soil organic carbon content in the topsoil, inputs of heavy metals to soil by sewage sludge and soil erosion. Environmental indicators for which it is not yet clear whether they can be covered by the models include pesticide accumulation (occurrence in soil) and leaching (occurrence in water). The same applies to evaluation of measures related to Groundwater protection which requires the modelling fate of dangerous substances. The final list of indicators to be specified in the first stage of the project is specified in Table 6.2 together with the main models used to calculate them.

Table 6.2 Main environmental indicators to be operationalised in the first phase of the project.

Environ-mental field of impact	**Indicator**		Level of calculation				
		Model used	farm	group of farms (e.g. types)	region	country	EU
Air/ climate	Total atmospheric emissions of ammonia (NH_3) from agriculture[1]	MITERRA Europe ext., DNDC, EPIC			X	X	X
	Emissions of methane by agriculture	MITERRA Europe Ext., DNDC			X	X	X
	Emissions of nitrous oxide by agriculture	MITERRA Europe Ext., DNDC			X	X	X

[22] This indicator is made conditional on availability of information about monitoring and inspection costs, and will be only taken into account if compliance is endogenized.

	Gross total GHG emission from agriculture in CO_2 equivalents	MITERRA Europe Ext., DNDC			X	X	X
Physical soil quality	Soil erosion by water in m^3 soil/ha/yr [2]	EPIC			X	X	X
Chemical soil quality	Inputs of heavy metals to soil by sewage sludge in g/ha/yr	MITERRA Europe Ext.			X	X	X
	Gross phosphorous balance in P in kg P/ha/yr	EPIC			X	X	X
	Top soil organic carbon content in g/kg	EPIC			X	X	X
Ground and surface water quality	Gross nitrogen balance in kg N/ha/yr	MITERRA EUROPE Ext.			X	X	X
	Nitrate leaching to ground water and runoff to surface water from agriculture[3]	MITERRA EUROPE Ext.			X	X	X

[1]The IRENA indicator gives “Contribution of agriculture to atmospheric emissions of ammonia (NH_3)”

[2] The IRENA indicator gives “Annual soil erosion risk by water” and “Area and share of agricultural land affected by water erosion”

[3]The IRENA indicator gives “Share of nitrates in ground and surface water derived from agriculture”

6.5.3 Selected land use, landscape and biodiversity indicators

In Chapter 4 an initial rough selection of indicators was made to assess impacts of CC on land use, landscape and biodiversity. The way to assess the CC impacts was then further described in chapter 5. It was concluded that each of the indicators to be considered needs to be meaningful in terms of pressures exerted on the components of biodiversity and, at the same time, have clear links with CC measures. Given the amplitude and varied nature of both these extremes, the selection of indicators still has not been decided. Further criteria which will orient the selection of indicators include that candidates must have an spatial dimension, that they should enable a link to sensitive areas from the biodiversity point of view, such as Natural 2000 sites and HNV farming areas, and that a baseline situation for the indicator is available, so that comparison in time is enabled. Apart from existing indicator frameworks, recorded variables in FADN will be explored as candidate indicators for as far as they can be linked to implementation of CC measures.

This sets limits on the type of indicators that can be produced for assessing the impacts. This is why we have done a first approach to applying the 4 above mentioned criteria to come to a further selection of indicators. In Table 6.3 it is indicated in a first step how these 4 criteria work out on the initial indicators selected in chapter 4 from the different existing indicator frameworks. In next deliverables D2.3 and D4.3.1 the selection of final indicators will be further elaborated as this is just a first rough step.

Table 6.3: Overview of indicators for land use, biodiversity and landscape, the possible model output used as input for assessing these indicator and the first rough application of the 4 criteria to select the most feasible indicators to specify in this project

Environ-mental field of impact	Indicator groups	Model output from	Scoring on 4 selection criteria*			
			1	2	3	4
Land use	Cropping patterns: Trend in/ share of UAA of major/intensive/extensive crops/land uses	Capri, post model disaggregation	Yes, indirectly	Yes, nuts 2 and maybe below	Yes	Yes
	Share of irrigated area	-	No, not directly	Yes, nuts 2 not below	no	Yes
	Livestock density	Capri, post model disaggregation	Yes, indirectly	No	Yes	Yes
Biodiversity	Area and share of semi-natural (extensive)habitats (e.g. fallow, permanent grassland)	Capri, post model disaggregation	Yes, indirectly	Yes	Yes	Yes
	Share of High Nature Value farmland of UAA	-	no	Yes	Yes	Yes/no
	Spatial complexity/corridors and linkages between habitats	-	Yes, but limited	Yes	Yes	No
	Species richness/species population trends (farmland birds)	Estimate from change in habitat quality in matrix approach	Yes	Yes	No	Possibly, but not EU wide
	Change in habitat quality (e.g. change in quality of water, soil, air)	Miterra, EPIC, DNDC	Yes	Yes, nuts 2 and maybe below	Yes	Yes, from env. Models
Landscape	Change in openness versus closedness	Capri, post model disaggregation	Yes, possibly	yes	Yes	Yes
	Agricultural land use diversity change	Capri, post model disaggregation	Yes, possibly	Yes	Yes	Yes
	Change area/share of land recognized for its scenic/scientific value	Capri, post model disaggregation	Yes, possibly	Yes	Yes	Yes

* The 4 selection criteria:

1. The indicator needs to have a clear link with the CC measure (SMR or GAEC) and should be meaningful in terms of the direct and indirect pressures exerted on biodiversity components.
2. The indicator should have a spatial dimension, meaning it needs to be spatially explicit.
3. The indicator should enable a link to sensitive areas from the biodiversity point of view, such as HNV farming spots or UAA inside Natura 2000 sites.
4. The indicator should enable a comparison in time, so that a baseline situation for the indicator can be selected.

From Table 6.3 it becomes clear that at this moment the most likely indicators to be operationalised for assessing the impacts on land use are the cropping pattern indicators and the indicator of livestock density. Both indicators can be produced with the output of the CAPRI model and a post-model disaggregation procedure.

As for biodiversity the most likely indicators that candidate are changes in the share of semi-natural habitats and changes in habitat quality. The first one should mainly be produced with the output of the Capri model and the second one can be derived with the output of the environmental models. Once the indicators have been selected, the effects on biodiversity will be assessed using the modelled output of the CAPRI and the environmental models as input. This input should be as spatially explicit as possible and will be used for specifying the matrices that will help to translate the pressure indicators in a real effect on different biodiversity groups, biota. It will be investigated whether we will be able to specify the matrix specifically for sensitive areas but this can only done if we obtain the environmental pressure indicators at the appropriate spatial level. Combinations between the matrices and the present state of biodiversity will also be made where state data are available as it will enable us to make a real prediction of changes in certain species groups. This however will only be possible for case studies.

All three landscape indicators can be produced provided CAPRI produces precise output on cropping patterns and the post-model disaggregation procedure enables to specify this output to smaller landscape entities. This means that we will try to translate changes in land use further to changes in landscape characteristics. Changes in land use will be the most direct output of the CAPRI model. However, in a post model procedure these changes need to be further spatialised to smaller spatial units within Nuts 2 regions including sensitive areas such as HNV farmland areas and NVZs but also landscape entities whose boundaries usually not correspond to administrative ones.

Further specification on final selection and operationalisation of indicators, will be done in next deliverables (D2.3 and D 4.3.1).

6.5.4 Selected public health and animal welfare indicators

In area of public health and animal welfare some specific problems are faced: for public health the impact can be mainly observed at the end of the overall food chain whereas the SMRs refer to one single level of the chain, i.e. the farm level. Accordingly, already existing indicators on public health reflect the final outcome like the outbreak of a certain disease. Therefore it is difficult to select indicators which both target at the SMRs and refer to the final outcome as impact indicator. Especially in this area therefore response indicators will be the most appropriate ones. Additionally, in this area and especially for animal welfare the number of existing indicators is limited and therefore a specific effort lies in the method of selection or in the further development of feasible indicators.

The selection of indicators will be carried out along the line of the following criteria, which are defined as relevant for this project and which ensure similar quality of indicators regarding the other impact area facing limitations regarding existing indicators, i.e. landscape and biodiversity. Direct indicators reflect in the following those indicators which directly address final impacts whereas indirect ones are derived from models of this project and serve as proxies.

1. Selected SMRs to be addressed by indicators.

This selection will be based on the relevance of SMRs in terms of whether both, an economic impact and a respective impact on Animal Welfare and Public Health can be expected. The first impact assumption will be derived from the Cross Compliance project (see Section 3.3) and the second concluded from existing studies. For these selected SMRs the existence of direct or indirect indicators will be identified as explained at 2) and 3) or new ones will be developed as explained under 4.

2. Identification of existing direct indicators for selected SMRs

- EU-wide dimension

At a first step indicators that are directly and regularly surveyed at European level will be identified. For Public Health existing SMRs hardly are addressed by any existing indicators, therefore mainly response indicators will be used such as the “effectiveness of control system”. Animal Welfare is so far not addressed at all by any EU-wide indicator.

- Coverage of European Member States

Not all of the available indicators are surveyed in all European Member States (e.g. the Eurostat indicator on safety investments). Minimum requirement for the selection will be that at least those Members are coveredin which the case studies will be explored.

- Regular survey before and after starting Cross Compliance

Not for all existing and relevant indicators a time set in the important period, i.e. before implementing CC and after exists. In order to evaluate the effects of introducing CC a set before the respective implementation year and after that year as well as the foreseen future survey is relevant.

3. Identification of indirect indicators covered as results from modesl used in this project

Some results of CAPRI can be used in order to identify dimensions by a change in compliance: the increased compliance may lead to a change in animal production and by that for the affected number of animals an increased animal welfare can be assumed.

4. Additionally needed indicators

For some of the relevant SMRs additional indicators have to be developed which are addressed in the targeted surveys. This will mainly refer to all farm-level related SMRs like husbandry system requirements for Animal Welfare and Health.

The following table indicates potential indicators to be used for Public Health and Animal Welfare.

Table 6.3: Optional indicators to be used or to be developed

Public Health				
	SMR	MS	Time	Regular
1. Direct Indicators				
Controls and inspections of the food and feed system (Eurostat)	response to SMR	EU-27	To be specified	annual
Effectiveness of the Food control systems (WHO)		To be specified	To be specified	annual
Government investments in food safety measures (Eurostat)		Germany (-2005), Belgium (-2005), Czech Republic (2002-2005), Denmark, Irland (-2005), Italy (1991-2001; 2005), Greece (-2005), Spain (-2005), Netherlands, Austria, Slovenia (1996-2005), Switzerland (1992; 1994; 1996; 1998; 2000; 2002; 2004), Finland, UK (-2005)	1991-2006	annual
WHO: Food-borne illness: 1) Number of out-breaks of food-borne illness 2) Incidence rate for all type of food-borne illness, food-borne infections & intoxications	(1) - (2) Cautious treatment of food (Regulation (EC) No 178/2002).	Belgium (1996-2005), Croatia, Bosnia & Herzegovina (1998, 1999, 2001-05), Czech Republic, Denmark, Finland, Georgia (1999-2005), Hungary, Ireland (1997-2005), Israel, Kazakhstan, Kyrgisistan, Lithuania (1993-1998, 2000-2004), Malta (1998-2005), Netherlands, Republic of Moldova, Serbia (2000-03), Slovakia, Slovenia, Spain (1993-2002), Switzerland (1993-2004), Macedonia, Ukraine (1993-	1993-2005	annual

		2000, 2003-05)		
Salmonella in fresh pig meat	Forbidden to have or fed unhealthy feed (Regulation (EC) No 178/2002). Animals must be cared for when they are ill or injured (Council Directive 98/58/EC) SMR´s of the Regulation (EC) No 852/2004 SMR´s of the Regulation (EC) No 183/2005	Some member states running a monitoring programme: Belgium, Denmark, Finland, Sweden, Norway	2001-2005	annual
Salmonella in fresh bovine meat	-	Some member states running a monitoring programme: Belgium (2002-2005), Denmark, Finland, Sweden, Norway		
3. Own development				
Compliance level	Data need			
Membership in certification schemes	Cross Compliance project (LEI)			
Animal Welfare and Health				
1. Direkt Indicators				
Results of SVS assessments of the welfare of animals on farm in Great Britain	Health related elements of Calves Directive 91/629, Pigs directive 91/630, Animal Welfare Directive 98/58	UK	2004; 2006	annual
2. Indirect Indicators				
Affected animal population indicated by change in animal production	response to SMRs	EU-25 (CAPRI)	Annual	annual
3. Own development				
Compliance level	Data need			
Farm-attributes	survey in case regions			
Physical stress indicators at slaughterhouses	survey in case regions			

6.6 Main challenges

In this project there are many challenges. They are related to several aspects. The first and most important one is access to good data on changes in compliance specified per region, farm type group. The second is related to the assessment of factors that determine farmers response to CC. This type of information is need to endogenize the estimation of compliance level in our economic models. Endogenizing this will have many advantages of which the main is that we become less data dependent. Another major concern is whether we can indeed assess the impacts of additional compliance with the tools we have and are we able to separate the effects of CC policy from other policy measures? It is also very challenging to identify the effects of CC on regionally explicit levels, especially at levels within meaningful environmental entities which will enable us to make a good estimation of effects on environment, biodiversity and landscape. Finally there is an important challenging to assess impacts on the more recently introduced CC measures on animal welfare and public health. For both fields it will be very challenging to get information on implementation levels and even more complicated to get tools to assess effects. Models and indicators for measuring effects in this field are very limited or practically absent and if available not useful for applying them at an EU wide level.

Insights into additional compliance with measures after the introduction of CC is still very limited. Getting information, especially for creating the baseline situation against which changes can be measured is very important but very challenging.

At this moment we expect that we may be able to get information about compliance and additional compliance in 4 different ways:

- Collect per country the monitoring and inspection results. When using this information we need to know how representative these data are for the whole farming population. Obtaining a good estimate of the representativity will probably not be possible and will therefore be an additional complication.
- Obtain expert estimates from extension services. This will deliver better representative results then the first option, but it will be very time intensive to get these estimates for all regions in EU.
- Through a farmers survey. This will certainly require a good picture of what is really happening on the ground. However, since surveys like this are very time consuming it will only be feasible within the scope of this project to do such a survey in a limited number of case study areas.
- Participation in voluntary certification schemes. This information can be collected from the organizations managing these certification schemes. Also collecting this information EU wide will require much time investment.

Overall it is already clear that the last 3 data collection options are not feasible to apply to the whole EU within the scope of this project. Probably the best option is to go for the first option and try to be as efficient as possible be not repeating the data collection exercise but try to get access to data that have already been centrally collected by IEEP and DG-Agri. Additional data collection can then be done in different case study areas.

Another challenge is the integration of the response of farmers to CC measures into the CAPRI model. This would certainly have many advantages as it will enable us to model responses to CC without the obligation of collecting input information in the field on the present level of compliance. This is especially useful because the level of compliance is dynamic in time. Another advantage of this endogenisation is that it will become more easy to link farmers response to CC farm types, land use and this is necessary to assess the impacts on environment, land use, landscape and biodiversity. Hwever to initially endogenize the farmers response in CAPRI there is a need to collect survey information in different regions in Europe as this information provides an understanding of the behavioral response parameters needed to specify the model. Endogenizing CC response will therefore not be done in the first phase of this project but it's feasibility will first be investigated in a couple of case studies.

Another point of attention is the observation that it will be very difficult to trace the reason why farmers comply with CC measures. Their compliance can be caused by the CC policy itself, but it cult also be related to the decision of the farmer to go into an agri-environmental support scheme. In this project we will not be able to separate the additional compliance caused by CC policy and other factors. This should be taken into consideration when interpreting the impact assessment results.

At this stage it is also clear that it will become impossible to assess the effect of every SMR and GAEC separately. This is because several CC measures are implemented at farm level at the same time and several SMRs and GAECs will also cause the same type of impact directly or indirectlyFor our assessment we will therefore probably need to cluster SMRs and GAECs according to their direction of impact.

Defining the baseline situation against which CC impacts should be measured will be complicated and needs much attention in project. Ideally the baseline situation should be the January 2005 state, as this was the moment from which CC was implemented, at least in EU-15. However, in practice we know that for many impacts there is simply no data available for this starting situation and alternative baseline situations need to be chosen. It is also expected that the baseline situations will be different per field of impact and indicator.

Finally it is clear that spatialisation of impacts of CC below the level of the Nuts 2 boundaries is needed to make a good assessment of the CC impacts. However this spatialisation is complicated and requires:

- Understanding of the different regional implementation pathways of SMRs and GAECs
- Linking moddeled CAPRI output to below administrative boundaries in a post model approach. The disaggregation approaches developed in Dynaspat and Seamless will be very useful for doing this.
- Using spatially detailed data sources and incorporating the range in environmental circumstances in the modeling approaches

References

Aebischer, N.J. (1991). *Twenty years of monitoring invertebrates and weeds in cereal fields in Sussex.* In: The ecology of temperate cereal fields (eds L.G. Firbank, N. Carter, J.F. Derbyshire & G.R. Potts), pp. 373-397. Blackwell Scientific Publications, Oxford.

Agra CEAS Consulting Ltd (2003). *Accession of Central and Eastern European Countries to the EU and its impact on land use and the environment.* Final report for the Royal Society for the Protection of Birds. Wye.

Andersen, E. et al (2003). *Developing a High Nature Value Farming area indicator.* Report to the European Environment Agency. Copenhagen.

Alcamo et al., 1990

Annoni, A., (ed.) 2005. European Reference Grids. Proposal for a European Grid Coding System. Proceedings & Recommendations of the European Reference Grids Workshop, Ispra, 27-29 October 2003, Vol. EUR Report 21494 EN: European Communities

Armington, P. S. (1969): A theory of demand for products distinguished by place of production, Washington D.C.

Asher, J. et al. (2001). *The millennium atlas of butterflies in Britain and Ireland*. Oxford University Press, Oxford.

Baillie, S.R. et al (2001). *Breeding birds in the wider countryside: their conservation status 2000*. Report No. 252, British Trust for Ornithology, Thetford.

Baldock, D., Beaufoy, G., Bennett, G. & Clark J. (1993). *Nature Conservation and New Directions in the Common Agricultural Policy*. Institute for European Environmental Policy (IEEP), London.

Baldock, D., G. Beaufoy, F. Brouwer and F. Godeschalk (1996) Farming at the margins; abandonment or redeployment of agricultural land in Europe. London/The Hague, Institute for European Environmental Policy (IEEP) and Agricultural Economics Research Institute (LEI).

Bartussek, H. (1999): A review of the animal need index (ANI) for the assessment of animals' well-being in the housing system for Austrian proprietary products and legislation, *Livestock Prod. Sci*. 61, 179–192.

Batie, S.S. and A.G. Sappington (1986). Cross-compliance as a soil conservation strategy: a case study. American Journal of Agricultural Economics, 68(4), p.880-885.

Beaufoy, G. et al. (1994). *The Nature of Farming – low intensity farming systems in nine European countries.* IEEP, London.

Bennett, R.M. and D. Larson (1996). Contingent valuation of the perceived benefits of farm animal welfare legislation: An exploratory survey. *Journal of Agricultural Economics* 47, 224-35.

Bennett, 1996

Benton, T.G., Vickery, J.A. & Wilson, D.J. (2003). Farmland diversity: is habitat heterogeneity the key? *Trends in Ecology and Evolution*, 18: 182-188.

Bignal, E.M. & D.I. McCracken (2000). *The nature conservation value of European traditional farming systems.* Environmental Reviews 8: 149-171.

Bignal, E.M. & D.I. McCracken (1996). *Low-intensity farming systems in the conservation of the countryside.* Journal of Applied Ecology 33: 413-424.

Bignal, E.M., McCracken, D.I., Pienkowski, M.W. & Branson, A. (1994) *The nature of farming: traditional low intensity farming and its importance for wildlife*. World Wide Fund for Nature International, Brussels.

Birdlife International (2004). *Biodiversity Indicator for Europe:Population trends of wild birds.*

Boatman, N. et al. (1999). *The environmental impact of arable crop production in the European Union.* Practical options for improvement. EC-study contract B4-3040/98/000703/MAR/D1. Allerton Research and Educational trust.

Borgen, S.O. and A. Helgreness, 2005. How can transaction costs economics add to the understanding of new contractual formats in the Norwegian Agri-food System. Working Paper 2005-7, Centre for Food Policy, Norwegian Economics Agricultural Economic Research Institute

Bouraoui, F. and Aloe, A. 2007. European Agrochemicals Geospatial Loss Estimator: Model Development and Applicatoins. European Commission, Directorate-General Joint Research Centre, Institute for Environment and Sustainability. ISBN 978-92-79-05053-4, 107 pages.

Bro, E., Mayot, P., Corda, E. & Reitz, F. (2004). Impact of habitat management on grey partridge populations: assessing wildlife cover using a multisite BACI experiment. *Journal of Applied Ecology*, 41, 846– 857.

Brown, L., Syed, B., Jarvis, S. C., Sneath, R. W., Phillips, R. L., Goulding, K. W. T. , and Li, C.: Development and application of a mechanistic model to estimate emission of nitrous oixde from UK agriculture, Atmos. Environ., 36, 917-928, 2002.

Buckwell A E and Armstrong-Brown S (2004), Changes in farming and future prospects: technology and policy, IBIS International journal of Avian Science, 146, s2, 14-21.

Butterbach-Bahl, K., L. Breuer, R. Gasche, G. Willibald & H. Papen, 2002. Exchange of trace gases between soils and the atmosphere in Scots pine forest ecosystems of the northeastern German Lowlands, 1. Fluxes of N2O, NO/NO2 and CH4 at forest sites with different N-deposition. Forest Ecol. Manage. 167 (1-3), 123-134.

Butterbach-Bahl, K., Kesik, M., Miehle, P., Papen, H. , and Li, C.: Quantifying the regional source strength of N-trace gases across agricultural and forest ecosystems with process based models, Plant Soil, 260, 311–329, 2004.

Campbell, L.H. & Cooke, A.S., eds. (1997). *The indirect effects of pesticides on birds*. Joint Nature Conservation Committee, Peterborough.

Caporale, V., Giovannini, A., Francesco, D., Calistri, P. (2001): Importance of the traceability of animlas and animal products in epidemiology, Scientific Review of the International Office of Animal Health, 20 (2), p. 598-604.

Carey, P. A review of research into the environmental impacts of arable cropping systems for biofuels and crops used for biomass. Background report to the study Elbersen. B. et. al. (2007). Large-scale biomass production and agricultural land use – potential effects on farmland habitats and related biodiversity. Technical report. (Contract EEA/EAS/03/004, expected, July 2007)

CCM DEM 250 (2004) EuroLandscape/Agri-Environment Catchment Characterisation and Modellig Activity, Land Management Unit, Institute for Environment and Sustain-ability, EC-Joint Research Centre. 250 Meter DEM, compiled on the basis of data acquired from data providers and national mapping agencies over Europe for internal use, 2004.

Cervigni, 2001

Cofala et al., 2000

Commission of the European Communities: Proposal for a directive of the European Parliament and of the Council establishing an infrastructure for spatial information in the Community (INSPIRE). COM(2004) 516 final, 2004.

DEFRA (2005) Agriculture and the economics base on farm regulation: A summary paper of Defra’s economic evidence base on farm regulation –November 2005.

De Vries, W., J. Kros, O. Oenema and J. W. Erisman, 2001a. Assessment of nitrogen ceilings for Dutch agricultural soil to avoid adverse environmental impact. The Scientific World (2001) 1(S2): 898-907.

De Vries, W., J. Kros and O. Oenema, 2001b. Modeled impacts of farming practices and structural agricultural changes on nitrogen fluxes in the Netherlands. The Scientific World (2001) 1(S2): 664-672.

De Vries, W., J. Kros, O. Oenema and J. de Klein, 2003. Uncertainties in the fate of nitrogen II: A quantitative assessment of the uncertainties in major N fluxes in the Netherlands. Nutrient Cycling in Agroecosystems 66: 71-102.

De Vries, W., J. Kros and G. Velthof, 2005a. Integrated evaluation of agricultural management on environmental quality with a decision support system. In: Z Zhu, K. Minami and G. Xing (eds) 3rd International Nitrogen Conference, October 12-16, 2004, Nanjing. China, Science Press: 859-870.

De Vries, W., J. Kros, P.J. Kuikman, G.L. Velthof, J.C.H. Voogd, H.J.J. Wieggers, K. Butterbach-Bahl, H.A.C. Denier van der Gon and A.R. van Amstel, 2005b. Use of measurements and models to improve the national IPCC based assessments of soil emissions of nitrous oxide. Environmental Sciences 2 (2-3): 217-233.

De Vries, W., J. Kros and G. Velthof, 2006. Integrated evaluation of impacts of a transition in agricultural management on environmental quality. Proceedings SWOME/KSI Marktdag 2006: Beleid in transities, Sander van den Burg, Ria van der Ham & John Grin (Redactie):94-102.

De Vries, W., J. Kros and G.L. Velthof (eds), 2007a. INITIATOR2: instrument voor een integrale milieuanalyse van de gevolgen van aanpassingen in de landbouw. Berekening van de emissies van ammoniak, broeikasgassen, fijn stof en geur en de accumulatie, uit- en afspoeling van koolstof, stikstof, fosfaat, basen en zware metalen Wageningen, Alterra Rapport (in prep).

De Vries, W. J. Kros, G.L. Velthof, E. Gies J. C. Voogd, A. Bleeker, J. Schröder and M.P.W. Sonneveld, 2007b. Integrated assessment of atmospheric emissions, leaching and runoff of ammonia, greenhouse gases and nutrients at a landscape level. Proceedings "First International Ammonia Conference in Agriculture", March 2007, Ede, the Nederlands.

Donald P.F.; Pisano, G.; Rayment, M.D.; & Pain, D.J. (2002). *The Common Agricultural Policy, EU enlargement and the conservation of Europe's farmland birds*. Agriculture, Ecosystems & Environment.

Donald, P.F.; Green, R.E. & Heath, M.F. (2001). *Agricultural intensification and the collapse of Europe's farmland bird populations.* Proceedings of the Royal Society of London B, 268, 25-29.

Donald, P.F. (1998) *Changes in the abundance of invertebrates and plants on British farmland*. British Wildlife, 9, 279-289.

EC (1999). *Indicators for Monitoring and Evaluation: An Indicative Methodology* – Working Paper **3** from a series of methodological working papers for the new programming period 2000 – 2006 published by DG XVI (Regional Policy and Cohesion), European Commission, Brussels.

European Commission: On the establishment of a common classification of territorial units for statistics (NUTS), Official Journal of the European Union, L 154/1, 2003.

European Commission: European Soil Database (version V2.0), CD-ROM EUR 19945 EN, March 2004, European Commission, Directorate General Joint Research Centre, Institute for Environment and Sustainability, 2004.

European Commission, DG-Agriculture (2003), Reform of the Common Agricultural Policy. Medium-term prospects for agricultural markets and income in the European Union 2003-2010. Brussels.

European Commission, DG-Agriculture (2002), Analysis of the impact on agricultural markets and incomes of the EU enlargement to the CEECs. Brussels.

European Commission, DG-Agriculture (2002), Agricultural situation in the Candidate Countries. Country reports.

European Commission, DG- Agriculture (2003), Reform of the Common Agricultural Policy. Medium term prospects for agricultural markets and income in the European Union 2003-2010. Brussels, December 2003.

EEA (2004). *Agriculture and the environment in the EU accession countries.* Environmental issue report No 37. EEA, Copenhagen. http://www.eea.eu.int/

EEA (2005). *Agriculture and environment in EU-15-the IRENA indicator report*. EEA Report, no. 6/2005.

EEA/UNEP (2004). *High nature value farmland. European Environmental Agency and UNEP regional office for Europe.* Luxembourg: Office for official publications of the European Communities.

EEA (1999). *Environment in the European Union at the turn of the century.* Environmental assessment report No 2. EEA, Copenhagen. http://www.eea.eu.int/

EEA (1998). *Europe's Environment: the second assessment.* Office for Official Publications of the European Communities. Oxford, Luxembourg/Elsevier Science.

European Environment Agency (2005): Agriculture and environment in EU-15 – the IRENA Indicator Report, EEA Report No 6/2005.

EFSA (2006): The Community Summary Report on trends and Sources of zoonoses, zoonotic agents, antimicrobial resistance and foodborne outbreaks in the European Union in 2005, *The EFSA Journal* (2006), 94.

EPA. (1999) *Inventory of Greenhouse Gas Emissions and Sink 1990-1997*. Environmental Protection Agency, Washington.

European Topic Centre on Terrestrial Environment, 2000 Corine land cover database (Version 12/2000), 2000.

Eurostat (2004): Food Safety Statistics, Inventory of data available in the EU Member States, EFTA and candidate countries, Luxembourg.

Eurostat (2007): SDI review – Proposals for public health theme, Luxembourg.

Farmer, M. (2007), Future policy options for Cross Compliance, A background paper for the 26 of April, 2007 Cross Compliance Policy Seminar in Brussels. A research paper of the Cross Compliance network. London, 2007.

FAWC (1993): Second Report on Priorities for Research and Development in Farm Animal Welfare, MAFF, Tolworth.

FAWC (2006): Report on Welfare Labelling, London.

Franklin, O., P. Hogberg, A. Ekblad & G.I. Agren, 2003. Pine forest floor carbon accumulation in response to N and PK additions - bomb 14C modelling and respiration studies. Ecosystems 6, 644-658.

Gardner, B.L. (1979). Economic analysis of the regulation of agriculture. *American Journal of Agricultural Economics*, 61(4), p.732-740.

Gassman, P.W., Williams, J.R., Benson, V.W, Izaurralde, R.C., Hauck, L., Jones, C.A., Atwood, J.D., Kiniry, J., Flowers. J.D., 2005. Historical development and applications of the EPIC and APEX models. Working Paper 05-WP 397, Center for Agricultural and Rural Development Iowa State University.

Golan, E., Kuchler, F. (1999): Willingness to Pay for Food Safety: Costs and Benefits of Accurate Measures, in *American Journal of Agricultural Economics*, Vol. 81, No. 5, Proceedings Issue, pp. 1185-1191.

González-Bernáldez, F. (1991). Ecological consequences of the abandonment of tradicional land use systems in central Spain. *Options Mediterranees*, 15: 23-30.

Hägg, P.G. (1997). Theories on the economics of regulation: a survey of the literature from a European perspective. *European Journal of Law and Economics*, 4, p.337-370.

Heath, M.F.et al. (2000). *Important Bird Areas in Europe: priority sites for conservation.* Volume 1: Northern Europe, Volume 2: Southern Europe. BirdLife International Conservation Series No. 8. Cambridge, Great Britain, BirdLife International, 791 p.

Hofmann, 2001;

Höglund-Isaksson & Mechler, 2005;

Infrastructure for Spatial Information in the European Community, Commission of the European Communities, 2004

IEEP (2006). *Impacts of, and Responses to, Cross Compliance – A Background Paper for the Cross Compliance Seminar held in Copenhagen on 13 November 2006*. Deliverable **22** of the Cross Compliance Network study (SSPE-CT-2005-022727). Institute for European Environmental Policy, London.

IPCC 1997

Jongeneel, R. (2007). Deliverable 5: Mandatory standards in 7 EU countries and 3 non-EU countries. Country Report: Netherlands. Agricultural Economics Institute, The Hague.

Jørgensen, U. and Schelde, K. (2001). *Energy crop water and nutrient use efficiency*. Report for the International Energy Agency. Tjele (Denmark).

JRC (2005): Soil Atlas. Joint Research Center, Ispra (Italy), p. 115

Klaassen et al., 2004;

Kleijn, D., Baquero, R.A., Clough, Y., Díaz, M., De Esteban, J., Fernández, F., Gabriel, D., Herzog, F., Holzschuh, A., Johl, R., Knop, E., Kruess, A., Marshall, EJP., Steffan-Dewenter, I., Tscharntke, T., Verhulst, J., West, T.M, & Yela, J.L. 2006. Mixed biodiversity benefits of agri-environment schemes in five European countries. *Ecology Letters* 9: 243-254.

Klimont & Brink, 2004;

Krebs, J.R., Wilson, J. D., Bradbury, R. B., & Siriwardena, G. M. (1999). The second silent spring? *Nature* 400: 611-612.

Lakshminarayan, P.G., Gassman, W., Bouzaher, A. and Izaurralde, R.C. 1996. A metamodeling approach to evaluate agricultural policy impact on soil degradation in Western Canada. Canadian Journal of Agricultural Economics 44, 277-294.

Larson, B.A. (2000). Evaluating the impact of specific environmental regulations on exports. *Land Economics* 76(4), p.534-549.

Larson et al (2002) The impact of environmental regulations on exports: case study results from Cyprus, Jordan, Morocco, Syria, Tunisia and Turkey. *World Development* 30(6), p.1057-1072.

Li, C., Frolking, S. , and Frolking, T. A.(1992) Model of nitrous oxide evolution from soil driven by rainfall events: 1. Model structure and sensitivity, J. Geophys. Res., 97, 9759-9776.

Li, C. (2000) Modeling trace gas emissions from agricultural ecosystems, Nutr. Cycl. Agroecosyst., 58, 259-276, 2000.

Li, C., Mosier, A. R., Wassmann, R., Cai, Z., Zheng, X., Huang, Y., Tsuruta, H., Boonjawat, J. , and Lantin, R. S. (2004) Modeling greenhouse gas emissions from rice-based production systems: Sensitivity and upscaling, Global Biogeochem. Cycles, doi: 10.1019/2003GB002045.

Li, C., S. Frolking & K. Butterbach-Bahl, 2005. Carbon Sequestration in arable soils is likely to increase nitrous oxide emissions, offsetting reductions in climate radiative forcing. Climatic Change 72 (3), 321-328.

Li, C., Salas, W., DeAngelo, B. , and Rose, S.(2006) Assessing Alternatives for Mitigating Net Greenhouse Gas Emissions and Increasing Yields from Rice Production in China Over the Next Twenty Years, J. Environ. Qual., 35, 1554-1565.

Lim (2002

Llusia, D. & Oñate, J.J. 2005. Are the conservation requirements of pseudo-steppe birds adequately covered by Spanish agri-environmental schemes? An ex-ante assessment. *Ardeola*, 52: 31-42.

MacDonald, J.A., U. Skiba, L.J. Sheppard, K.J. Hargreaves, K.A. Smith & D. Fowler, 1996. Soil environmental variables affecting the flux of methane from a range of forest, moorland and agricultural soils. Biogeochem. 34, 113-132.

MAFF (1998). *Official Group on OPs: Report to Ministers 1998*. MAFF, London

Mosier, A., C. Kroeze, C. Nevison, O. Oenema, S. Seitzinger & O. van Cleemput, 1998. Closing the global N2O budget: nitrous oxide emissions through the agricultural nitrogen cycle. (OECD/IPCC/IEA phase II development of IPCC guidelines for national greenhouse gas inventory methodology). Nutr. Cycl. Agroecosyst. 52 (2-3), 225-248.

Mücher, C.A., R.G.H. Bunce, R.H.G. Jongman, J.A. Klijn, A.J.M. Koomen, M. Metzger and D.M. Wascher (2003). Identification and Characterisation of Environments and Landscapes in Europe. Alterra Report 832. Wageningen.

Mücher, C.A., R.G.H. Bunce, S.M. Hennekens and J.H.J. Schaminée (2004). Mapping European habitats to support the design and implementation of a Pan-European Ecological Network; The PEENHAB project. Alterra Report 952. Wageningen.

Hazeu, G.W. & C.A. Mücher (2005). Historic land use dynamics in and around Natura2000 sites as indicators for impact on biodiversity; Phase I of the BioPress project for the Netherlands. Alterra-report 1077. Wageningen.

Mulligan, D., Bouraoui, F., Grizzetti, B., Aloe, A., 2006. An Atlas of pan-European data for investigating the fate of agrochemicals in terrestrial ecosystems. EUR report 22334 EN, DG JRC, Institute for Environment and Sustainability, 52pp.

Neufeldt, H., Schafer, M., Angenendt, E., Li, C., Kaltschmitt, M. , and Zeddies, J. (2006) Disaggregated greenhouse gas emission inventories from agriculture via a coupled economic-ecosystem model, *Agriculture, Ecosystems & Environment*, 112, 233-240.

OECD (1999a): Environmental indicators for agriculture. Volume 1: Concepts and framework. Paris, OECD.

OECD (1999b): Environmental indicators for agriculture. Volume 2: Issues and design. Paris, OECD.

OECD (2001): Environmental indicators for agriculture. Volume 3: Methods and results. Paris, OECD.

Oñate, J.J., Andersen, E., Peco, B. y Primdahl, J. 2000. Agri-environmental schemes and the European agricultural landscapes: The role of indicators as valuing tools for evaluation. *Landscape Ecology*, 15: 271-280.

Östman, Ö., Bengtsson, J., Ekbom, B. & Weibull, A. (2001a). Condition of polyphagous predatory carabid beetles in relation to farming system and landscape complexity. *Ecological Applications* 11: 480-488.

Östman, Ö., Ekbom, B. & Bengtsson, J. (2001b). Landscape heterogeneity and farming practice influence biological control. *Basic and Applied Ecology* 2: 365-371.

Ostrom, 1994

Palou, A. M. M. (2006): Food Safety Statistics, CEIES seminar on Consumer protection, Ljubljana.

Pain D. & Dixon J. (1997). Why farming birds in Europe? In: D. Pain & D. Pienkowski (Eds.), *Farming birds in Europe*, pp.1-24. Academic Press. London.

Pathak, H., Li, C. , and Wassmann, R.: Greenhouse gas emissions from Indian rice fields: calibration and upscaling using the DNDC model, *Biogeosciences*, 2, 113-123, 2005.

Peco, B., Sánchez, A.M., & Azcárate, F.M. (2006). Abandonment in grazing systems: Consequences for vegetation and soil. *Agriculture, Ecosystems & Environment*, 113: 284-294.

Petit, S. & Elbersen, B.S. (2006), Assessing the risk of impact of farming intensification on calcareous grasslands in Europe. *Ambio*, vol. 35, no. 6, 2006.

Petit et al., (1998), MIRABEL, Models for IntegRated Assessment of Biodiversity in European Landscapes. Report to the European Topic Centre for Nature Conservation.

Petit, S.; L. Maskell, S. Smart & S. Wright (2003), MIRABELII. Models for predicting the impact of terrestrial eutrophication, farming intensification and land abandonment on biodiversity in European landscapes. CEH-Study under contract European Environment Agency, Topic Centre Nature Conservation and Biodiversity, Integrated Assessment. CEH, Lancaster.

Petit, S. et al (2004). MIRABEL *II-Models for predicting the impact of terrestrial eutrophication, farming intensification and land abandonment on Biodiversity in Europeran landscapes*. CEH, Lancaster.

Potter C. (1997). Europe's changing farmed landscapes. In: D. Pain & M.W. Pienkowski (Eds.), *Farming birds in Europe*, pp. 25-42. Academic Press. London.

Pretty J.N. (1998). *The Living Land: Agriculture, Food and Community Regeneration in Rural Europe*. Earthscan, London.

Primdahl, J., Peco, B., Schramek, J. Andersen, E. y Oñate, J.J. 2003. Environmental effects of agri-environmental schemes in Western Europe. *Journal of Environmental Management*, 67: 129-138.

Roos, Janneke, Sjerp de Vries, Peter Verweij, Hans Farjon (2004). KELK gunt bestuurders een blik op toekomstige kwaliteit landschap. ViMatrix juni 2004, jaargang 12, nr. 4, Pp 38-39.

Roos-Klein Lankhorst, J, S. de Vries, J. van Lith-Kranendonk, H. Dijkstra en J.M.J. Farjon (2004). Modellen voor de graadmeters landschap, beleving en recreatie, Kennismodel Effecten Landschap Kwaliteit KELK, Monitoring Schaal en BelevingsGIS, Planbureaurapport 20. Wageningen.

Rousing, T., Bonde, M., Sørensen, J. T. (2001): Aggregating Welfare Indicators into an Operational Welfare Assessment System: A Bottom-up Approach, *Acta Agric. Scand., Sect. A, Animal Sci*. 2001: Suppl. 30, 53–57.

Schmidt M., Lauer A., Purtauf T, Thies C., Schaefer M. & Tscharntke T. (2003). Relative importance of predators and parasitoids for cereal aphid control. *Proceedings of the Royal Society of London Series B,* 270: 1905-1909.

SEAMLESS, WP0 2007. Implementation plan for months 25-42.

Slangen et al., 1996

Sleutel, S., De Neve, S., Beheydt, D., Li, C. , and Hofman, G.(2006) Regional simulation of long-term organic carbon stock changes in cropland soils using the DNDC model: 1. Large-scale model validation against a spatially explicit data set, *Soil Use Manage*., 22, 342-351.

Smith, 2006

Smith, J.U., P. Smith, M. Wattenbach, S. Zaehle, R. Hiederer, R.J.A. Jones, L. Montanarella, M.D.A. Rounsevell, I. Reginster & F. Ewert, 2006. Projected changes in mineral soil carbon of European croplands and grasslands, 1990-2080. Glob. Change Biol. (under review).

Sotherton, N.W. (1998) *Land use changes and the decline of farmland wildlife: an appraisal of the set-aside approach*. Biological Conservation, **83**, 259-268.

Soussana, J.-F., et al., 2005. GREENGRASS: Sources and sinks of greenhouse gases from managed European grasslands and mitigation strategies. Final Report to EC. DG Research. INRA, Clermont-Ferrand, France.

Stanners and Bourdeau, 1995

Starbird, A. (2005): Moral Hazard, Inspection Policy, and Food Safety, in: American Journal of Agricultural Economics 87 (1), 15–27.

Statistical Office of the European Communities (EUROSTAT) (2003) The Geographic Information System of the European Commission (GISCO) reference database: Version: 07/2003, Brussels.

Stonehouse, D.P. (1996) A targeted policy approach to inducing improved rates of conservation compliance in agriculture. *Canadian Journal of Agricultural Economics*, 44(1996), pp.105-119.

Sutherland, W.J. (2004). A blueprint for the countryside. *Ibis*, 146: 120-124.

Sutinen, J.G. and P. Andersen (1985) The economics of fisheries law enforcement. *Land Economics* 61(4), p.387-397.

Sutinen, J.G. and K. Kuperan (1999) A socio-economic theory of regulatory compliance. *International Journal of Social Economics*, 26 (1/2/3), p.174-194.

Sutton, M.A., S. Chapman, T. Christensen, B.A. Emmett, J.W. Erisman, D. Fowler, M.R. Hoosbeek, M. Jones, C. Milford, E. Nemitz, K. Pilegaard, M. Riedo, J.K. Schjoerring & P.A. Wookey, 2000. Trace gas fluxes and ecosystem functioning. In: Sutton, M.A., J.M. Moreno, W. van der Putten & S. Struwe (Eds). *Terrestrial Ecosystem Research in Europe: Successes, Challenges and Policy*. European Commission, Luxembourg, pp. 65-74.

Swales, V. (2007). *The Likely Effects of Cross Compliance on the Environment*. Deliverable **20** of the Cross Compliance Network study (SSPE-CT-2005-022727). Institute for European Environmental Policy, London.
Thies, C. & Tscharntke, T. (1999). Landscape structure and biological control in agroecosystems. *Science*, 285: 893-895.

Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R. & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, 418: 671-677.

Tonitto, C., David, M. B., Li, C. , and Drinkwater, L. E. (2007) Application of the DNDC model to tile-drained Illinois agroecosystems: model comparison of conventional and diversified rotations, Nutr. Cycl. Agroecosyst., DOI 10.1007/s10705-006-9074-2.

Tscharntke, T., Klein, A.M., Kruess, A., Steffan-Dewenter, I. & Thies, C. (2005). Landscape perspectives on agricultural intensification and biodiversity-ecosystem service management. *Ecology Letters*, 8: 857- 874.

Van Ittersum, M., Ewert, F., Alkan Olsson, J., Andersen, E., Bezlepkina, I., Brouwer, F., Donatelli, M., Flichman., G., Heckelei, T., Olsson, L., Oude Lansink, A., Rizzoli, A., van der Wal, T., Wery, J. 2006. Integrated assessment of agricultural and environmental policies: Towards a computerized framework for the EU (SEAMLESS-IF). *In: Voinov, A., Jakeman, A., Rizzoli, A. (eds). Proceedings of the iEMSs Third Biannual Meeting "Summit on Environmental Modelling and Software". International Environmental Modelling and Software Society, Burlington, USA, July 2006. CD-ROM. Internet: http://www.iemss.org/iemss2006/sessions/all.html ISBN 1-4243-0852-6.*

Varian, H.R. (2003) *Intermediate microeconomics*. New York, Norton.

Velthof, G., D. Oudendag & O. Oenema, et al., 2007. Development and application of the Intergated model MITERRA-Europe. Alterra raport (in prep).

Vickery, J. et al (2004). *The role of agri-environment schemes and farm management practices in reversing the decline of farmland birds in England.* Biological conservation 119, p. 19-39.

Vitiello, D., Thaler, A. (2001): Animal Identification: links to food safety, Scientific Review of the International Office of Animal Health, 20 (2), p. 598-604.

Vleeshouwers, L.M. & A. Verhagen (2002) *Carbon emission and sequestration by agricultural land use: a model study for Europe*. Global Change Biology

Wadsworth, R.A. , Carey, P.D.; Heard, M.S.; Hill, M.O.; Hinsley, M.S.; Meek, W.R.; Panell, D.; Ponder, V; Renwick; A & James, K. (2003). *A review of Research into the environmental and socio-economic impacts of contemporary and alternative cropping systems.* Report to Defra, pp 85.

Wang, X., Harmel, R.D., Williams, J.R. and Harman, W.L. 2006. Evaluation of EPIC for assessing crop yield, runoff, sediment and nutrient losses from watersheds with poultry litter fertilization. Transactions of ASABE, 49 (1), 47-59.

Wascher, D.M.(ed.) (2000). *Agri-environmental indicators for sustainable agriculture in Europe*. ECNC Technical report series. Tilburg.

Wascher, D.M. and Pérez Soba, M (eds.) (2004). Learning from transfrontier Landscapes – Project in support of the European Landscape Convention. Alterra Report 964. Published by Landscape Europe in collaboration with Alterra Wageningen UR.

Wascher, D.M. (ed.) (2005), European Landscapes Character Areas - Typologies, Cartography and Indicators for the Assessment of Sustainable Landscapes. Final Project Report as deliverable from the EU's Accompanying Measure project European Landscape Character Assessment Initiative (ELCAI), funded under the 5th Framework Programme on Energy, Environment and Sustainable Development (4.2.2). Published by Landscape Europe in collaboration with ALCAI partners. Alterra Report 1254. Wageningen.

Wascher, Dirk & Burghard Christian Meyer (2006). Sustainable Land Use in Intensively Used Agricultural Regions. Alterra Report 1338. Wageningen.

Weibull, A.C., Bengtsson, J. & Nohlgren, E. (2000). Diversity of butterflies in the agricultural landscape: the role of farming system and landscape heterogeneity. *Ecography*, 23: 743-750.

WHO (2004a): Development of Environment and Health Indicators for European Union Countries, Report on the Berlin Meeting May 2003, Bonn.

WHO (2004b): Environmental Health Indicators: Projekt des Europäischen WHO-Zentrums für Umwelt und Gesundheit, Abschlussbericht, Bonn.

Williams, J.R. 1995. The EPIC model. In V.P. Singh (ed.). Computer models of watershed hdryology, p. 909-1000. Water Resources Publ. Highlands Ranch, CO, USA.

Wilson, J.D., Morris, A.J., Arroyo, B.E., Clark, S.C. & Bradbury, R.B. (1999). A review of the abundance and diversity of invertebrate and plant foods of granivorous birds in northern Europe in relation to agricultural change. *Agriculture, Ecosystems & Environment*, 75: 13-30.

Winiwarter, 2005

Xu-Ri, Wang, M. , and Wang, Y. (2003) Using a modified DNDC model to estimate N2O fluxes from semi-arid grassland in China, *Soil Biol. Biochem.,* 35, 615-620.

unused:

OECD (forthcoming 2007) Environmental Indicators for Agriculture, Volume 4. Paris.

OECD (fortcoming) *Environmental cross-compliance: concept, design and implementation.* COM/TAD/CA/ENV/EPOC(2007)3.

Ostrom, E., 1990, 1998. Governing the Commons; The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, 280 p.

Ostrom, E., 1998. A Behavioral Approach to the Rational-Choice Theory of Collective Action. Presidental Adress, American Political Science Association, 1997. American Political Science Review, Vol.92, No. 1., March 1998.

Annex I Estimating degree of compliance

Table I.1 Estimated degree of compliance (observations mainly based on 2005 data)

	Environment	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland *)
Environment	Birds and Habitat Directives	n.a.; probably very high	management plans not yet in place in most areas	management plans not yet in place in most areas	very high	very high	very high	low
	Protection of groundwater	not very high for exhaustible oils	very high	very high	high	very high	very high	extremely low
	Sewage Sludge Directive	very high	very high	very high	very high	very high	very high	very high
	Nitrate Directive	dairy farmers low and beef farmers extremely low	not high	extremely low; national implementation tool place only recently	low, (mainly due to recent change in the regulations)	very high	high	extremely low to very low
	Identification and registration	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland *)
Identification and Registration of Animals	Identification and Registration of bovine animals	high, but not always within 7 days	very low	n.a.; databank working since 2005	very high	low	very high	very high
	Identification and Registration of ovine and caprine animals	extremely low; new regulation since 2005	very low	n.a.; databank working since 2005	high	very high	very high	very high
	Public, Animal and Plant Health	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland *)
Public, Animal and Plant Health	Plant protection products	high, no precise estimate available	n.a	n.a.	high	n.a	n.a.	estimated to be high
	Food Traceability and Food Safety	n.a.	n.a.	n.a.	high	n.a.	n.a.	
	Hormones and beta-antagonists	n.a.	n.a.	n.a.	n.a.	nearly all farmers comply	n.a.	
	Notification of diseases	high, no precise estimate available	n.a	n.a.	high	n.a.; since 1 January 2006 imposed	n.a.	
	Animal welfare	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland *)
Animal Welfare	Housing of calves	expected to be high	expected to be high	expected to be high	expected to be high	expected to be high	n.a.	very low
	Housing of pigs	expected to be high	expected to be high	expected to be high	expected to be high	expected to be high	n.a.	very low
	Good Agricultural and Environmental Condition	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland *)
Good Agricultural and Environmental Condition	Soil erosion control	n.a.	very high	n.a.	not high	very high	very high	high
	Maintain Soil Organic Matter	n.a.	very high	n.a.	not high	very high	very high	high
	Soil Structure	n.a.	very high	n.a.	not high	very high	very high	high
	Minimum Level of Maintenance	n.a.	very high	n.a.	not high	very high	very high	high

Source: Cross Compliance project

Table I.2 Indications about costs of compliance with SMR standards

	Environment	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
Environment	Birds and Habitat Directives	€190/ha; depends on management plan; farmers may be compensated (Rural Development)	n.a. ; depends on management plan; farmers may be compensated (Rural Development)	n.a. ; depends on management plan; farmers may be compensated (Rural Development)	€160/ha; depends on management plan; farmers may be compensated (Rural Development)	low; Directive does not compel farmers to carry out positive management	€33/ha, excluding any AES compensation payment	€200/arable farm; €500/animal farm
	Protection of groundwater	Low, as for management of exhausted oils; €30/farm	Return system of exhausted oils is free of charge; considerable costs might be incurred with storage	Delivery charge for exhausted oils and pesticide containers is zero	Delivery charge of exhausted oils (low); costs for storage	Costs of requesting authorization and correct storage	€1000-€8000 costs for flow measurement system	€500 per household
	Environment	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
	Sewage Sludge Directive	All costs of soil testing, transportation and application are met by sewage producers; Sewage sludge is free source of nutrients providing net gain: approximate €33/ha as fertilization value	No costs; farmers are usually paid for applying sewage sludge	n.a.	No significant costs; main costs come from record keeping	All costs of soil testing, transportation and application are met by sewage producers; Sewage sludge is free source of nutrients providing net gain.	n.a.	analysis costs €75/ha.yr

Source: Cross Compliance project

Table I.2 (continued)

	Environment	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
	Nitrate Directive	Costs for storage and spreading manure: €205/head for intensive dairies	Costs for exceeding manure and storage: €4/m3 fee paid by supplier; €120-€175/ha (land rent price); €50-€200/m3 (costs storage facilities)	In pig sector of Lombardy adjustment costs will rise from €0.11-€0.23 per kg of liveweight meat (transport, spreading right, storage)	€40 million (manure disposal costs dairy sector) in 2006.; will increase to €60 million in 2009; €5000-€7000/farm benefit for specialized arable farms (spreading right payments)	Approx. €29 million per annum, of which €11.9 milion storage and transport costs, and 17 million record keeping costs	n.a.	storage €350-500/cow; full costs €500-750/cow
	Identification and Registration	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
Identification and Registration of Animals	I & R of bovine animals	€1.80/animal; €109/farm; €0.004/kg milk; €0.003/kg meat	€2.65-€3.19 per animal (including services)	n.a.	€2.75 per animal +0.15h/animal*€ 7.00=€4.50 (excl.loss), €5.00 including loss	€4.20 per animal (replacement); passports are for free; replacement costs passport €70	2,2-2,5 €/animal (depending on the system used)taking into account amortisation, movements, labour 12,2-15,70€/animal and year	€5-10 per LAU
	I & R of ovine and caprine animals	n.a.	n.a	n.a	€1.35 per animal +0.15h*€7.00=€ 3.10 (exl.loss)	n.a	1,63 €-4,64€/animal and year (depending on the system used)	idem
	Public, Animal and Plant Health	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
Public, Animal and Plant Health	Plant protection products	zero	cupboard costs €200-€2000	n.a.	n.a.; but non-zero	n.a.; no additional costs	zero	n.a
	Food Traceability and Food Safety	zero	construction costs of new silo's (cereals storage)	n.a.	n.a.; record keeping time costs	no additional costs	zero	n.a
	Hormones and beta-antagonists	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a
	Notification of diseases	zero	n.a.	zero	zero	zero	zero	n.a

Table I.2 (continued)

	Animal Welfare	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
Animal Welfare	Housing of calves	extra costs €10/calf	n.a.	n.a.	n.a.	n.a.	n.a.	n.a
	Housing of pigs	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a
	Good Agricultural and Environmental Condition	France	Germany	Italy	Netherlands	United Kingdom	Spain	Poland
Good Agricultural and Environmental Condition	Soil erosion control	no costs for animal farms; average total cost €222/arable farm	no major costs; there are costs of soil cover, but this is compensated by expected additional returns	creation of water gullies €66/ha	operational costs low; annual investment costs varying from €0-€100/ha, with a medium value of €5/ha	no detailed estimates available, but no major costs identified	No cost for animal farms; about 200 €/arable farm	n.a, but expected to be low
	Maintain Soil Organic Matter			extra ploughing costs €20/ha; cleaning channels €17/ha; expenses for shredding and planting €2/ha				
	Soil Structure			costs for surface levelling and water drainage €36/ha; cleaning ditches €6/ha				
	Minimum Level of Maintenance			varying from €20/ha to €1740/ha				

Annex II Examples of fields and policy approaches covered in Cross Compliance Policy in EU and other non-EU countries

Table II.1 A comparative overview of themes and their coverage with regulation

Theme	US	Canada	New Zealand	EU
Biodiversity	No specifics	Protection of habitats	Decline in indigenous biodiversity; habitat preservation	Protection and preservation of habitats
Environment	Water quality; environmental pressure from Concentrated Animal Feeding Operations	Pesticide use, water (save drinking wells, increasing importance of nitrate contamination, and air quality (odour)	Degrading water quality; increasing importance of nitrate contamination	Nitrate, heavy metals, water quality
Health	Food safety	Food safety; hormone growth promoter products use; animal disease surveillance	Food safety; hormone growth promoter products use;	Food safety; hormone growth promoter products use; registration and traceability of animals; contagious animal diseases; use of plant protection products;
Animal welfare	Long-distance transportation	Minimum housing requirements; intensive livestock farming practices; humane transportation and slaughter	Minimum requirements, dry sow stall	Minimum space, and minimum requirements regarding other animal 'needs'
Good agricultural and environmental practice	Mainly erosion	Erosion, and soil quality (has improved already)	Erosion and sustainable land use (vegetation clearance ad soil disturbance)	Erosion, organic matter content, soil structure

Table II.2 A comparative overview of policy approaches used by the EU's key-competitors

Policy instrument	**US**	**Canada**	**New Zealand**	**EU**
Direct regulation	In particular applied for regulation food safety, plant protection products	In particular applied for regulation food safety, plant protection products	In particular applied for regulation food safety, plant protection products	Dominant kind or regulation applied
Cross-compliance	Compliance only required for cost-sharing assistance with best management practices	Farmers can receive payments if they comply with standards embodied in a voluntary codes of practice	Instrument not used	Obligatory cross-compliance since Luxembourg agreement (2003) covering biodiversity, environment, health and animal welfare
Taxes and subsidies	Financial incentives linked to voluntary conservation programs	Financial incentives linked to specific 'good' agricultural practices	Some financial assistance for farm erosion schemes	Selectively used to encourage collection of used transmission oil, a.o.; implicit subsidisation of farm assistance (see below)
Technical assistance	Plays an important role, in particular wrt environment and good farming practices	Plays an important role, in particular wrt environment and good farming practices	Plays an important role, in particular wrt environment and good farming practices	Farm advisory service complementary to cross-compliance, will be in place in 2007
Contracts and voluntary schemes	Play an important role in particular wrt environment, animal welfare, registration of animals	Play an important role in particular wrt environment, animal welfare, registration of animals	Play an important role in particular wrt environment, animal welfare, registration of animals	No use of voluntary schemes for achieving minimum standards as in the CC package, instrument only used for achieving 'services' going beyond minimum standards

Annex III Overview of 18 Statutory Management Requirements (SMRs)

Box 1 Cross Compliance requirements according to the Statutory Management Requirements (Annex III of Regulation (EC) 1782/2003)

Ref. No.	EC Directive / Regulation	What will be the Cross Compliance requirement to be met by the farmer?
1	Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (OJ L 103, 25.4.1979, p. 1). Articles 3, 4 (1), (2) and (4), 5, 7 and 8.	Article 3 requires Member States to take action to secure or re-establish habitats for all naturally occurring wild birds Article 4 requires Member States to take special protection measures for certain species of bird, including the establishment of Special Protection Areas (SPAs). Appropriate steps have to be taken to avoid pollution or deterioration of habitats or disturbance of birds on these sites. There is a similar requirement for habitats outside protected sites. Article 5 prohibits the deliberate killing and significant disturbance of wild birds, deliberate destruction of, or damage to, their nests and eggs, removal of their nests or taking of their eggs except under licensed conditions e.g. for protection of crops. Article 7 permits hunting of wild birds subject to conditions. Article 8 prohibits certain means of killing wild birds. This Directive is principally of relevance to farmers in the following circumstances: - action which breaches article 4 (protection of SPAs and other habitats of birds elsewhere in the countryside) may lead to cross-compliance penalties. - killing or significant disturbance of birds, or damage to nests and eggs, contrary to the Wildlife and Countryside Act 1981 and subsequent legislation on the protection of birds.
2	Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (OJ L 20, 26.1.1980, p. 43). Articles 4 and 5.	The major consequence of this Directive is that farmers require authorisation for disposal of spent sheep dip and pesticide washings to land. Where List I and List II substances are otherwise used, manufactured, stored or handled, farmers will be expected to comply with relevant legislation, codes of practice or other relevant good practice.
3	Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (OJ L 181, 4.7.1986, p. 6), Article 3.	Use only of sludge treated in accordance with the Directive. Observation of specified harvesting intervals and other requirements to prevent contaminants (e.g. heavy metals) reaching the human food chain. Farmers in NVZs will be expected to record the use of sludge in their Fertiliser and Manure Plan and to observe the relevant closed period, as necessary.
4	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, p. 1) Articles 4 and 5.	Farmers with land in NVZs should comply with the mandatory measures contained in the Nitrate Directive, i.e. limits to the application of Nitrogen in animal manure, special measures for the storage, application methods and timing of fertilizer and animal manure.
5	Council Directive 92/43/EEC of 21 May 1992 on the conservation of	Article 6 requires (i) Special Areas of Conservation (SACs) to be designated for habitats (listed in Annex I) and species (listed in Annex II) to be protected

	natural habitats and of wild flora and fauna (OJ L 206, 22.7.1992 p. 7) Articles 6, 13, 15 and 22(b).	from damage, deterioration of habitats or disturbance of species; and (ii) the effects of plans or projects that could cause adverse effects to be considered. Article 13 requires prohibition of destroying, cutting or uprooting of protected plant species listed in Annex IV(a) of the Directive. Article 15 requires prohibition of certain methods of killing or taking wild species. Article 22 requires regulation of introduction of non-native species where prejudicial to native wildlife. This Directive is principally of relevance to farmers in the following circumstances: - action which breaches article 6 (protection of SACs) may lead to Cross Compliance penalties.. - deliberate killing or disturbing of protected animal species, including activities deleterious to their breeding sites or resting places. - destruction, cutting or uprooting of protected plant species, use of prohibited methods of killing or taking wild species or evidence of non-compliance with measures designed to regulate introduction of non-native species.
6	Council Directive 92/102/EEC of 27 November 1992 on identification and registration of animals (OJ L 355, 5.12.1992 p. 32) Articles 3,4 and 5.	Farmers are required to comply in full with the domestic legislation which implements EU requirements governing the identification (tagging/tattooing etc), record keeping, and movement requirements for cattle, sheep, goats and pigs.
7	Commission Regulation 2629/97 of 29 December 1997 laying down detailed rules for the implementation of Council Regulation 820/97 as regards to eartags, holding registers and passports in the framework of the system for the identification and registration of bovine animals (OJ L 354, 30.12.1997, p. 19) Articles 6 and 8.	Farmers are required to comply in full with the domestic legislation which implements EU requirements governing the identification (tagging/tattooing etc), record keeping, and movement requirements for cattle, sheep, goats and pigs.
8	Regulation 1760/2000 of the European Parliament and of the Council of 17 July 2000 establishing a system for the identification and registration of bovine animals and regarding the labelling of beef and beef products and repealing Council Regulation (EC) No 820/97 (OJ L 204, 11.8.2000, p.11) Article 4 and 7	Farmers are required to comply in full with the domestic legislation which implements EU requirements governing the identification (tagging/tattooing etc), record keeping, and movement requirements for cattle, sheep, goats and pigs.
9	Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market (OJ L 230, 19.8.1991, p. 1) Article 3	1. That the farmer has not retained products that are no longer approved for use. 2. That the farmer is carrying out spray operations on approved crops only, following the Green Code using the pesticide at the correct dosage levels and leaving sufficient ‘buffer zones’ so that the spray does not enter water courses.
10	Council Directive 96/22/EC of 29 April 1996 concerning the prohibition on the use in stockfarming of certain substances	No illegal use of substances having a hormonal, thyrostatic action, or the use of beta agonists. Where confirmed residues of banned substances are found following MHS inspection the SVS will carry out an on-farm investigation,

	having a hormonal or thyrostaic action and of beta-agonists (OJ L 125, 23.5.1996, p. 3) Articles 3, 4, 5 and 7.	including taking extra samples.
11	Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (OJ L 31, 1.2.2002, p. 1) Articles 14,15,17(1),18,19 and 20	(i) Ensure that the food and feed safety requirements, specified in Articles 14 and 15 of Regulation 178/2002, are met. (ii) Ensure that all stages of production, processing and distribution within the businesses under their control, satisfy the food and feed safety requirements of food law which are relevant to those activities, and verify that such requirements are met (Article 17). (iii) Maintain traceability systems (Article 18). (iv) Withdraw and/or recall food or feed from the market if this is not in compliance with food or feed safety requirements, and notify competent authorities (Articles 19/20).
12	Regulation (EC) 999/2001 of the European Parliament and of the Council of 28 January 2002 laying down rules for the prevention, control and eradication transmissible spongiform encephalopathies. (OJ L 147, 31.5.2001 p. 1) Articles 7, 11, 12, 13 and 15.	Article 7: The farmer must not feed to ruminants protein derived from mammals or feed any products of animal origin to farmed animals, in accordance with Annex IV. Further, the farmer must not export or store feed intended for farmed animals which contains protein derived from mammals or feed intended for mammals, except for the feeding to dogs and cats. Article 11: The farmer must immediately notify the DVM of any animal suspected of being infected by a TSE. Articles 12, 13: Once notification of a TSE suspect is made, the farmer must fully comply with movement restrictions or any other notices served on that animal or animals by an inspector under these articles. Article 15: This Article moves away from the individual farmer by largely focusing toward the trade aspects of the industry. However, should the farmer have in his possession a TSE suspect animal(s) which is already covered in Articles 12 and 13, he must remain in full compliance of any movement restrictions.
13	Council Directive 85/511/EEC of 18 November 1985 introducing Community measures for the control of foot-and-mouth disease (OJ L 315, 26.11.1985, p. 11) Article 3.	This Directive requires any person who has in his possession or under his charge an affected or suspected animal or carcass to notify the fact to the authorities.
14	Council Directive 92/119/EEC of 17 December 1992 introducing general Community measures for the Control of certain animal diseases and specific measures relating to swine vesicular disease (OJ L 62, 15.3.1993, p. 69) Article 3.	The notification of this Directive requires a person who has in his possession or under his charge an animal or carcase which he knows or reasonably suspects is infected to notify the authorities.
15	Council Directive 2000/75/EC of 20 November 2000 laying down specific provisions for the control and eradication of bluetongue (OJ L 327, 22.12.2000, p. 74) Article 3.	The notification of this Directive requires any person who knows or suspects that an animal or carcass in his possession or under his charge is diseased to notify the authorities.
16	Council Directive 91/629/EEC of	This Directive provides Recommendations and standards for the Welfare of

	19 November 1991 laying down minimum standards for the protection of calves (OJ L 340, 11.12.1991, p. 28). Articles 3 and 4	calf rearing. Failure to comply with the Regulations and Code may lead to loss of subsidy.
17	Council Directive 91/630/EEC of 19 November 1991 laying down minimum standards for the protection of pigs (OJ L 340, 11.12.1991, p. 33) Article 3 and 4 (1)	This Directive provides Recommendations and standards for the Welfare of pigs. Failure to comply with the Regulations and Code may lead to loss of subsidy.
18	Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes (OJ L 221, 8.8.1998, p. 23) Article 4	This Directive provides Recommendations and standards for the Welfare of farmed animals. Failure to comply with the Regulations and Code may lead to loss of subsidy..

Annex IV Statutory management requirements (SMRs) and how they have been implemented in 12 different Member States (results from CIFAS project)

		Agricultural markets and producer's income		Environment							Land use	Biodiversity				Landscape		Animal welfare and health		Food safety			
	Short name SMR	Agricultural markets	Producer's income	Ground water quality	Surface water quality	Water quantity	Air quality	Climate	Physical soil quality	Chemical soil quality	Land use	Birds	Mammals	Invertebrates	Plants	Landscape diversity	Landscape aesthetic quality	Animal welfare	Animal health	Food safety	Number of relevant EU-States (12 investigated states)	Name of relevant EU-States	Indivudual SMRs forming the background for short-name
Wild Birds Directive: Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (OJ L 103, 25.4.1979, p. 1).	Birds - Prohibited practices - death, hunt catch or possession	X	X									X									5	AT, DE, IR, ES, UK	17
	Birds - Prohibited practices - non-selective destruction	X	X									X									4	AT, ES, IR, UK	7
	Birds - Protection measures -	X	X																		4	AT, DE, DK,	20

																						UK	
	Birds - Protection measures - disturbance	X	X									X									4	ES, IR, SE, UK	5
	Birds - Protection measures - nests	X	X									X									4	AT, ES IR, UK	10
	Birds - Hunting issues - closed season	X	X									X									3	ES, SE, UK	3
	Birds - Management requirements	X	X								X	X	X	X	X	X	X				3	GR, DK, UK	12
	Birds - Prohibited practices -	X	X									X									2	ES, SE	3
	Birds - structural elements -	X	X		X			X	X		X	X	X	X	X	X	X				2	DE, ES	4
	Birds - closed season for hunting	X	X									X									1	AT	4
	Birds - damaging operations	X	X									X									1	AT	2
	Birds - Hunting issues -	X	X									X									1	DE	4
	Birds - Hunting issues - closed season - sale	X	X									X									1	UK	2
	Birds - Management notification	X	X								X	X	X	X	X	X	X				1	UK	3
	Birds - prohibited farming practices	X	X	X	X			X	X	X	X	X	X	X	X	X	X				1	AT	60

	Birds - Prohibited farming practices - vegetation	X	X		X			X	X		X	X	X	X	X	X	X				1	AT	5
	Birds - prohibited farming practices_boscage/hedges	X	X					X	X		X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_change cultures relevant for landscape	X	X								X	X	X	X	X	X	X				1	AT	6
	Birds - prohibited farming practices_change of natural conditions meadows/rough grazing/forest	X	X					X			X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_clearing bank wood	X	X		X			X			X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_cultivation/utilization bank wood	X	X		X			X			X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_cutting bushes/heges	X	X					X	X		X	X	X	X	X	X	X				1	AT	3

	Birds - prohibited farming practices_cutting hedges time limit	X	X									X	X	X	X		X				1	AT	4
	Birds - prohibited farming practices_cutting riparian woods	X	X		X			X			X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_field hedges/bushes/boscage	X	X					X	X		X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_flaming dry meadows	X	X				X	X				X	X	X	X		X				1	AT	3
	Birds - prohibited farming practices_flaming meadows time limit	X	X				X	X				X	X	X	X		X				1	AT	3
	Birds - prohibited farming practices_flaming reed/ground cover	X	X				X	X				X	X	X	X		X				1	AT	2
	Birds - prohibited farming practices_flaming vegetation; some regions	X	X				X	X				X	X	X	X		X				1	AT	1
	Birds - prohibited farming practices_flaming/cutting	X	X		X		X	X				X	X	X	X		X				1	AT	2

	Birds - prohibited farming practices_grassland conversion	X	X		X			X			X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_landscape elements	X	X									X	X	X	X	X	X				1	AT	6
	Birds - prohibited farming practices_mowing reed time limit	X	X		X							X	X	X	X	X	X				1	AT	2
	Birds - prohibited farming practices_reed banks	X	X		X						X	X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_time limit cutting bushes	X	X									X	X	X	X		X				1	AT	3
	Birds - prohibited farming practices_trees in nature protection areas	X	X									X	X	X	X	X	X				1	AT	2
	Birds - prohibited farming practices_trees/shrubs in flood-plain	X	X					X				X	X	X	X	X	X				1	AT	3
	Birds - prohibited farming practices_trees/shrubs in nature protection areas	X	X					X				X	X	X	X	X	X				1	AT	3

	Birds - Prohibited practices - ban on nonbiodegradable products	X	X		X					X		X	X	X	X						1	ES	3
	Birds - Prohibited practices - ban on retention	X	X									X									1	ES	1
	Birds - Prohibited practices - burning vegetation and hedges	X	X				X	X				X	X	X	X	X	X				1	AT	2
	Birds - Prohibited practices - chemically treated seeds	X	X									X	X	X							1	ES	3
	Birds - Protection measures - field margins	X	X		X							X	X	X	X	X	X				1	GR	2
	Birds - Protection measures - moorland and meadows - drainage	X	X	X	X	X		X	X		X	X	X	X	X	X	X				1	AT	8
	Birds - Protection measures - no possessing	X	X									X									1	UK	1
	Birds - Protection measures - raptors and stepparic birds	X	X									X									1	ES	3
	Birds - Protection measures - restoration of hedges	X	X					X				X	X	X	X		X				1	UK	1
	Birds - Protection measures - vertebrates/baits	X	X									X	X								1	GR	1

	Birds - Protection measures - waters	X	X		X							X	X	X	X	X	X				1	AT	3
	Birds - Pseudostepparic birds' areas -	X	X								X	X	X	X	X	X	X				1	ES	3
	Birds - Sanction - Nests	X	X									X									1	ES	3
Groundwater protection: Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (OJ L 20, 26.1.1980, p. 43).	Groundwater - Discharge of listed substances -	X	X																		5	DE, ES, IR, SE, UK	11
	Groundwater - Codes of practice -	X	X	X	X					X		X	X	X	X						4	DE, FI, IR, UK	7
	Groundwater - Authorisation - discharge of listed substances	X	X	X	X					X		X	X	X	X						3	IR, IT, UK	10
	Groundwater - Prohibited direct discharge -	X	X	X	X					X		X	X	X	X						3	DE, DK, F,	10
	Groundwater - Codes of practice - mineral oil	X	X	X	X					X		X	X	X	X						2	DE, UK	3
	Groundwater - Plant protection -	X	X	X	X					X		X	X	X	X						2	GR, SI	2
	Groundwater - Prohibited direct discharge - ovine baths and pesticides waste wash	X	X	X	X					X		X	X	X	X						2	ES, GR	6

	Groundwater - Spraying instruments washing -	X	X	X	X					X		X	X	X	X						2	GR, IT	2
	Groundwater - Authorisation - sheep dip, pesticides	X	X	X	X					X		X	X	X	X						1	UK	5
	Groundwater - codes of practice_overflow pipes	X	X	X	X					X		X	X	X	X						1	AT	2
	Groundwater - codes of practice_seepage drain	X	X	X	X					X		X	X	X	X						1	AT	2
	Groundwater - Discharge of waste water -	X	X																		1	SI	5
	Groundwater - Installations maintenance -	X	X																		1	GR	2
	Groundwater - Mechanical cleaning of irrigation and drainage networks -	X	X	X	X					X		X	X	X	X						1	GR	2
	Groundwater - Prohibited direct discharge - on ground and top of subsoil	X	X	X						X		X	X	X	X						1	IT	2
	Groundwater - Prohibited direct discharge - phytosanitaries waste	X	X	X	X					X		X	X	X	X						1	ES	6
Habitats Directive: Council																							
	Habitat - damaging operations -	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				4	AT, ES, IR,	15

Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna (OJ L 206, 22.7.1992 p. 7)																						UK	
	Habitat - non-native species -	X	X									X	X	X	X						4	DE, ES, IR, UK	6
	Habitat - protection of plants - keeping, transport, selling	X	X									X	X	X	X						4	DE, ES, IR, UK	6
	Habitat - protection of plants - picking, collecting, destroying	X	X									X	X	X	X						4	AT, ES, IR, SE	4
	Natura - Management requirements -	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				4	DK, ES, IT, UK	6
	Habitat - protection of animals - prohibited methods	X	X									X	X	X	X						3	DK, ES, UK	6
	Habitat - protection of plants -	X	X									X	X	X	X						3	AT, ES, UK	4
	Habitat - management requirements -	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				2	SI, UK	6
	Habitat - norms of compliance -	X	X			X					X	X	X	X	X	X					2	DE, ES	7
	Habitat - protection of species -	X	X									X	X	X	X						2	SI, UK	7
	Habitat - protection of species - catching and killing methods	X	X									X	X	X	X						2	AT, DE	6

	Natura - Natural aquate receipents preservation -	X	X	X	X					X	X	X	X	X	X	X	X				2	ES, GR	2
	Natura - Non-native species -	X	X									X	X	X	X						2	GR, UK	2
	Natura - Protection of natural vegetation -	X	X	X	X							X	X	X	X	X	X				2	GR	3
	Habitat - Authorisation - alteration in land structure	X	X		X				X			X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - alteration of refuges	X	X		X				X			X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - changes in animal housing	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - changes in crops	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - changes in non-cropped land	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - changes of waters	X	X	X	X	X			X	X	X	X	X	X	X	X	X				1	AT	6
	Habitat - Authorisation - closings	X	X										X								1	ES	1

	Habitat - Authorisation - drainage	X	X	X	X	X		X	X	X		X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - earth spills and dumps	X	X	X	X				X	X		X	X	X	X		X				1	ES	1
	Habitat - Authorisation - electrical layings	X	X	X	X				X	X		X	X	X	X		X				1	ES	1
	Habitat - Authorisation - forestation	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - grubbing or cutting of vegetation	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X				1	ES	2
	Habitat - Authorisation - irrigation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - modification of tracks	X	X	X	X				X	X	X		X	X	X	X	X				1	ES	1
	Habitat - Authorisation - new rafts	X	X	X	X	X	X			X	X	X	X	X	X	X	X				1	ES	1
	Habitat - Authorisation - vegetation in water environment	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	ES	2
	Habitat - Authorisation general	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	SE	1

	Habitat - damaging operations - wet land	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	AT	6
	Habitat - impact report -	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	IT	2
	Habitat - management notification	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	UK	5
	Habitat - prohibited farming practices -	X	X	X	X		X		X	X		X	X	X	X						1	GR	1
	Habitat - prohibited farming practices - changing cultures	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X				1	AT	1
	Habitat - prohibited farming practices - drainage	X	X	X	X	X	X			X	X	X	X	X	X	X	X				1	AT	9
	Habitat - protection of animals -	X	X									X	X	X	X						1	UK	3
	Habitat - protection of animals - restocking authorisation	X	X									X	X	X	X						1	ES	1
	Habitat - protection of species - structural elements	X	X									X	X	X	X		X				1	UK	2
	Habitats - Authorisation general	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	DE	1
	Habitats - unintentional disturbance	X	X									X	X								1	DE	1
	Natura - Comply with management notices -	X	X									X	X	X	X						1	GR	1
	Natura - Fallow, set-aside -	X	X	X	X				X	X		X	X	X	X	X					1	ES	1

	Natura - GMO plants cultivation restriction -	X	X									X	X	X	X						1	ES	1
	Natura - Harvest time -	X	X									X									1	ES	1
	Natura - Height of cut -	X	X									X									1	ES	1
	Natura - hunting specification	X	X									X	X								1	GR	1
	Natura - Integrated production of rice -	X	X	X	X					X		X	X	X	X						1	ES	1
	Natura - Manure storage -	X	X	X	X		X			X		X	X	X	X		X				1	GR	1
	Natura - Mowing requirements -	X	X									X	X								1	GR	1
	Natura - Preservation of sites -	X	X									X	X	X	X	X	X				1	F	2
	Natura - Preservation of sites - beaches	X	X									X	X	X	X	X	X				1	DK	3
	Natura - Preservation of sites - dunes	X	X									X	X	X	X	X	X				1	DK	3
	Natura - Preservation of sites - waters etc	X	X	X	X	X	X			X	X	X	X	X	X	X	X				1	DK	3
	Natura - Removal of straw -	X	X									X	X	X							1	ES	1
Nitrates Directive: Council Directive 91/676/EEC of 12 December 1991	Nitrates - Storage issues - capacity	X	X	X	X		X	X				X	X	X	X						8	DE, DK, ES, F, GR, IT, SE, UK	22

concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375, 31.12.1991, p. 1)	Nitrates - Application time -	X	X	X	X		X	X													7	AT, DE, DK, F, IT, SE, UK	18
	Nitrates - Farm records -	X	X																		6	DE, DK, ES, F, IR, UK	13
	Nitrates - N limits per hectare - manure	X	X	X	X		X	X				X	X	X	X						6	DE, DK, ES, IT, SI, UK	10
	Nitrates - Fertilization distance to waters -	X	X	X	X		X	X				X	X	X	X						5	DE, F, ES, IT, UK	10
	Nitrates - Storage issues -	X	X	X	X		X	X													5	DK, ES, IT, SI, UK	8
	Nitrates - Application requirements	X	X	X	X		X	X													4	DE, DK, SE, UK	6
	Nitrates - Application to steep slopes -	X	X	X	X		X	X				X	X	X	X						4	AT, F,	13

																						IT, UK	
	Nitrates - Application to steep slopes, frozen, snow-covered, water-saturated soil -	X	X	X	X		X	X				X	X	X	X						4	DE, IT, SI, UK	5
	Nitrates - Winter coverage -	X	X	X	X							X	X	X	X						4	DK, SE	4
	Nitrates - Application to frozen, snow-covered, water-saturated soil -	X	X	X	X		X	X				X	X	X	X						3	AT, F, SE	4
	Nitrates - land-use/cultivation requirements	X	X	X	X		X	X				X	X	X	X						3	AT, F, UK	5
	Nitrates - N limits per hectare -			X	X		X	X				X	X	X	X						3	F, IT, UK	5
	Nitrates - N limits per hectare - crop specific	X	X	X	X		X	X				X	X	X	X						3	ES, GR, UK	6
	Nitrates - N limits per hectare - vulnerable zone	X	X	X	X		X	X				X	X	X	X						3	ES, GR, UK	4
	Nitrates - Planning and farm records -	X	X																		3	ES, IT, UK	3
	Nitrates - Storage issues - ensilage facilities, dung yards	X	X	X	X		X	X				X	X	X	X						3	DE, DK, ES	3
	Nitrates - Application restrictions	X	X	X	X		X	X													2	IT, SE	2

	Nitrates - Application to steep slopes - liquid manure	X	X	X	X		X	X				X	X	X	X						2	IT, SI	2
	Nitrates - N limits per hectare - organic fertilisers	X	X	X	X		X	X				X	X	X	X						2	DE, UK	6
	Nitrates - outflows to water courses -	X	X	X	X		X	X				X	X	X	X						2	DK, ES	3
	Nitrates - Planning and farm records - N fertilisers	X	X																		2	DK, F	2
	Nitrates - Storage issues - avoiding leakage	X	X	X	X		X	X				X	X	X	X						2	DE, F	2
	Nitrates - Storage issues - effluent storing	X	X	X	X		X	X				X	X	X	X						2	DE, ES	2
	Nitrates - Vulnerable zone - fertilization distance to waters	X	X	X	X		X	X				X	X	X	X						2	ES, GR	3
	Nitrates - Zones of reinforced action -	X	X																		2	ES, F	1
	Nitrates - application time	X	X	X	X		X	X				X	X	X	X						1	AT	4
	Nitrates - fertilization distance to waters	X	X	X	X		X	X				X	X	X	X						1	AT	2
	Nitrates - organic manure application rates	X	X	X	X		X	X	X			X	X	X	X						1	AT	2
	Nitrates - Application restrictions - after harvesting	X	X	X	X		X	X				X	X	X	X						1	DE	2

	Nitrates - Application time - farms in specific action programme	X	X	X	X		X	X				X	X	X	X						1	F	1
	Nitrates - Application time - liquid manure	X	X	X	X		X	X				X	X	X	X						1	SI	2
	Nitrates - Application time - vulnerable zone	X	X	X	X		X	X				X	X	X	X						1	ES	1
	Nitrates - cleaning water -	X	X	X	X		X	X				X	X	X	X						1	ES	1
	Nitrates - direct application of slurry -	X	X	X	X		X	X				X	X	X	X						1	ES	1
	Nitrates - Fertilization distance to waters - liquid manure	X	X	X	X		X	X				X	X	X	X						1	DE	1
	Nitrates - Fertilization distance to waters - mineral fertilizers	X	X	X	X		X	X				X	X	X	X						1	DE	1
	Nitrates - Maintenance of machinery -	X	X	X	X		X	X				X	X	X	X						1	ES	1
	Nitrates - Manure application time -	X	X	X	X		X	X				X	X	X	X						1	IT	1
	Nitrates - Manure application time - limits in autumn	X	X	X	X		X	X				X	X	X	X						1	SE	2
	Nitrates - Manure stacks, shelters, outdoor yards -	X	X	X	X		X	X													1	DE	1
	Nitrates - Manure trading	X	X																		1	DK	1
	Nitrates - maxiumum number of animals			X	X		X	X	X			X	X	X	X						1	SE	1

	Nitrates - N limits per hectare - crop and soil specific	X	X	X	X		X	X				X	X	X	X						1	SE	1
	Nitrates - N limits per hectare - crop rotation	X	X	X	X		X	X				X	X	X	X						1	AT	2
	Nitrates - N limits per hectare - manure without grazing	X	X	X	X		X	X	X			X	X	X	X						1	UK	3
	Nitrates - New vulnerable zone - action plan	X	X																		1	ES	1
	Nitrates - outdoor areas -	X	X	X	X		X	X													1	ES	1
	Nitrates - Planning and farm records - high N production	X	X																		1	IT	1
	Nitrates - Planning and farm records - manure	X	X																		1	SI	1
	Nitrates - Planning and farm records - pig breeding	X	X																		1	IT	1
	Nitrates - pluvial waters -	X	X	X	X																1	ES	1
	Nitrates - Preservation of flooded meadows -	X	X	X	X							X	X	X	X						1	F	1
	Nitrates - Preservation of humid zones	X	X	X	X							X	X	X	X						1	F	1
	Nitrates - Reversal of the meadows -	X	X	X	X							X	X	X	X						1	F	1
	Nitrates - Spreading authorisation - slurry	X	X																		1	IT	1

	Nitrates - Spreading notification	X	X																		1	IT	1
	Nitrates - Storage issues - compost	X	X	X	X		X	X				X	X	X	X						1	DK	2
	Nitrates - Storage issues - liquid manure	X	X	X	X		X	X				X	X	X	X						1	DE	1
	Nitrates - Storage issues - livestock holdings	X	X	X	X		X	X				X	X	X	X						1	ES	1
	Nitrates - Storage issues - notification	X	X									X	X	X	X						1	DE	1
	Nitrates - Storage issues - on field	X	X	X	X		X	X				X	X	X	X						1	AT	2
	Nitrates - Storage issues - silage	X	X	X	X							X	X	X	X						1	DK	1
	Nitrates - Storage issues - solid manure	X	X	X	X		X	X				X	X	X	X						1	DK	2
	Nitrates - Vulnerable zone - action plan	X	X																		1	GR	1
	Nitrates - Vulnerable zone - fertilization distance to waters - liquid livestock wast	X	X	X	X		X	X				X	X	X	X						1	GR	2
	Nitrates - Vulnerable zone - min vegetation cover	X	X	X	X		X	X				X	X	X	X						1	F	1
	Nitrates - Vulnerable zone - N limits	X	X	X	X		X	X				X	X	X	X						1	IT	1
	Nitrates - Vulnerable zone - surplus N	X	X	X	X		X	X				X	X	X	X						1	F	1

	Nitrates - Vulnerable zone - management requirements	X	X	X	X		X	X				X	X	X	X						1	ES	1
	Nitrates - Vulnerable zone - new action plan	X	X																		1	ES	1
	Nitrates - Vulnerable zone - steep slopes	X	X	X	X		X	X				X	X	X	X						1	GR	2
	Nitrates - Water protection strips with perennial vegetation -	X	X	X	X		X	X				X	X	X	X						1	F	1
	Nitrates - water protection zones	X	X	X	X		X	X				X	X	X	X						1	SI	1
	Nitrates - Winter coverage - > 5 ha arable land	X	X	X	X							X	X	X	X						1	SE	1
	Nitrates - Winter coverage - sowing 15. Oct.	X	X	X	X							X	X	X	X						1	SE	1
	Nitrates - Winter coverage - sowing 5. Oct.	X	X	X	X							X	X	X	X						1	SE	1
	Nitrates - Zones of complementary action -	X	X																		1	F	1
	Nitrates - Fertilization by inclination	X	X	X	X		X	X				X	X	X	X								
	Nitrates - Mineral P and N			X	X		X	X		X		X	X	X	X								
	Nitrates - N amount 170			X	X		X	X				X	X	X	X								
Sewage Sludge Directive: Council																							
	Sewage - application restrictions -	X	X	X	X					X									X	X	4	DE, DK, IT,	7

Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (OJ L 181, 4.7.1986, p. 6)																						UK	
	Sewage - application restrictions - frozen, snow-covered, water staurated soil	X	X	X	X		X	X		X		X	X	X	X						4	AT, DE, IT, UK	6
	Sewage - grazing and forage crops restrictions	X	X	X	X		X	X		X		X	X	X	X			X	X	X	4	DE, ES, IR, UK	7
	Sewage - heavy metal limits -	X	X	X	X					X		X	X	X	X			X	X	X	4	DE, IT, SE, UK	5
	Sewage - max application rate -	X	X	X	X		X	X		X		X	X	X	X					X	4	AT, DE, IT, SE,	13
	Sewage - sludge treatment	X	X	X	X					X		X	X	X	X			X	X	X	4	AT, GR, IR, IT	4
	Sewage - application notification -	X	X																		3	DE, IT, UK	5
	Sewage - documentation -	X	X																		3	DK, ES, UK	3
	Sewage - harvest restrictions - grazing, forage	X	X	X	X		X	X		X		X	X	X	X			X	X	X	3	AT, IR, UK	7

	Sewage - record keeping -	X	X																	X	3	AT, IT, SI	3
	Sewage - application authorisation -	X	X																	X	2	IT, UK	3
	Sewage - application restrictions - grasslands	X	X	X	X		X	X		X		X	X	X	X				X	X	2	DE, UK	2
	Sewage - application restrictions - vegetable	X	X	X	X					X		X	X	X	X					X	2	AT, DE	2
	Sewage - application technique -	X	X	X	X		X	X		X		X	X	X	X						2	DE, UK	2
	Sewage - harvest restrictions	X	X	X	X		X	X		X		X	X	X	X			X	X	X	2	AT, UK	4
	Sewage - manager's certification -	X	X																	X	2	ES, F	2
	Sewage - soil pH limits -	X	X	X	X		X	X		X		X	X	X	X						2	DE, UK	2
	Sewage - application restrictions - arable land	X	X	X	X		X	X		X		X	X	X	X				X	X	1	AT	1
	Sewage - application restrictions - before sowing	X	X	X	X		X	X		X		X	X	X	X				X	X	1	AT	1
	Sewage - application restrictions - forest	X	X	X	X		X	X		X		X	X	X	X						1	DE	1
	Sewage - application restrictions - moorland	X	X	X	X		X	X		X		X	X	X	X						1	AT	1

	Sewage - application restrictions - organic persistenten pollutants	X	X	X	X		X	X		X		X	X	X	X				X	X	1	DE	1
	Sewage - application restrictions - soil classification	X	X	X	X		X	X		X		X	X	X	X						1	AT	1
	Sewage - application restrictions - soil erosion	X	X	X	X					X		X	X	X	X						1	AT	2
	Sewage - application restrictions - time	X	X	X	X		X	X		X		X	X	X	X						1	DK	1
	Sewage - application restrictions - vegetable and fruits	X	X	X	X					X		X	X	X	X					X	1	At	2
	Sewage - application restrictions - water pollution	X	X	X	X					X		X	X	X	X						1	DK	1
	Sewage - application restrictions - water protection zones	X	X	X	X					X		X	X	X	X						1	DE	1
	Sewage - heavy metal limits - content of the field	X	X	X	X					X		X	X	X	X			X	X	X	1	SE	1
	Sewage - max. application rate_2LU	X	X	X	X		X	X		X		X	X	X	X						1	AT	1
	Sewage - max. application rate_P-soil-content	X	X	X	X		X	X		X		X	X	X	X						1	AT	1
	Sewage - N limits per hectare -	X	X	X	X		X	X		X		X	X	X	X						1	IT	1

Cross Compliance Assessment Tool

	Sewage - soil analysis -	X	X																		1	DE	1
	Sewage - soil analysis - phosphorus	X	X																		1	DE	1
	Sewage - storage	X	X	X	X		X	X				X	X	X	X						1	DE	1
	Sewage - use of codes of practice -	X	X	X	X		X	X		X		X	X	X	X						1	UK	1

Annex V Good Agricultural and Environmental Conditions (GAECs) and how they have been implemented in 12 different Member States (results from CIFAS project)

			Agricultural markets and producer's income		Environment							Land use	Biodiversity				Landscape		Animal welfare and health		Food safety		
		Short name	Agricultural markets	Producer's income	Ground water quality	Surface water quality	Water quantity	Air quality	Climate	Physical soil quality	Chemical soil quality	Land use	Birds	Mammals	Invertebrates	Plants	Landscape diversity	Landscape aesthetic quality	Animal welfare and health	Animal health	Food safety	States (21 investigated states)	Name of relevant EU-States
Soil erosion	Minimum coverage	Field greening		X	X	X				X	X	X	X	X	X	X	X					3	AT, GR, UK
		Soil erosion - minimum coverage		X	X	X				X	X	X	X	X	X	X	X					3	HU, NL, UK
		Soil erosion - minimum coverage - arable land		X	X	X				X	X	X	X	X	X	X	X					3	DE, ES, UK
		Maintenance - minimum maintenance		X	X	X				X	X	X	X	X	X	X	X	X				2	IR, NL
		Maintenance - grazing and outdoor feeding sites								X		X						X				1	UK
		Maintenance - minimum maintenance - non cultivated land		X	X	X				X	X	X	X	X	X	X	X					1	ES

		Maintenance - set-aside - catch crops		X	X	X				X	X	X	X	X	X	X	X	X				1	SE
		Maintenance - set-aside - establishment of plant cover		X	X	X				X	X	X	X	X	X	X	X					1	DK
		Maintenance - set-aside - must of plant cover		X	X	X				X	X	X	X	X	X	X	X					1	DK
		Maintenance - set-aside - oil plants rules		X	X	X				X	X	X	X	X	X	X	X					1	SE
		Maintenance - set-aside - re-establishment of plant cover		X	X	X				X	X	X	X	X	X	X	X					1	DK
		Maintenance - set-aside - species		X	X	X				X	X	X	X	X	X	X	X					1	DK
		Maintenance - set-aside - tillage Sept 1								X		X	X	X	X	X	X					1	SE
		Prohibition of ploughing up permanent grassland - change by 10%			X	X		X	X	X		X	X	X	X	X	X					1	DK
		Soil erosion - minimum coverage - fallow and set-aside land		X	X	X				X	X	X	X	X	X	X	X					1	ES
		Soil erosion - minimum coverage - fallow and set-aside land herbicide use		X	X	X				X	X	X	X	X	X	X	X					1	ES
		Soil erosion - minimum coverage - non-cropped land		X	X	X				X	X	X	X	X	X	X	X					1	ES
		Soil erosion - minimum coverage - olives		X	X	X				X	X	X	X	X	X	X	X					1	ES

		Soil erosion - minimum coverage - permanent crops		X	X	X				X	X	X	X	X	X	X	X					1	ES
		Soil erosion - minimum coverage - post-harvest management		X	X	X				X	X	X	X	X	X	X	X					1	UK
		Soil erosion - minimum coverage - temporary cover crop		X	X	X				X	X	X	X	X	X	X	X					1	UK
	Minimum land management reflecting site-specific conditions	Soil erosion - steep slopes				X				X		X	X	X	X	X	X					3	PL, SK, UK
		Soil erosion - grazing and poaching				X				X		X	X	X	X	X	X					2	IR, UK
		Maintenance - appropriate livestock density - upland overgrazing		X		X				X		X	X	X	X	X	X					1	UK
		Maintenance - supplementary feeding sites - rotation		?		X				X		X	X	X	X	X	X		X			1	UK
		Prohibition of ploughing up permanent grassland - slopes and protection zones		X		X		X	X	X		X	X	X	X	X	X					1	AT
		Soil erosion - collection of rainwater		X		X				X		X										1	
		Soil erosion - cultivation distance to waters		X		X				X		X										1	IT
		Soil erosion - drainage		X		X				X												1	UK
		Soil erosion - grass margins		X		X				X		X	X	X	X	X	X					1	F

		Soil erosion - livestock access to watercourses				X				X									X			1	UK
		Soil erosion - minimum coverage - wind erosion		X						X		X	X	X	X	X	X					1	UK
		Soil erosion - modification of plots		X						X		X	X	X	X	X	X					1	ES
		Soil erosion - no row crops on slopes				X				X												1	HU, NL, UK
		Soil erosion - supplementary feeding sites				X				X												1	UK
		Soil erosion - tillage on slope - arable land				X				X												1	ES
		Soil erosion - tillage on slope - permanent crops		X		X				X												1	ES
		Soil erosion - uncultivated margins		X		X				X		X	X	X	X	X	X					1	HU
	Retain terraces	Maintenance - landscape features - terraces		X		X				X		X	X	X	X	X	X	X				4	AT, DE, ES, HU
		Maintenance - landscape features		X		X				X		X	X	X	X	X	X	X				1	GR
		Soil erosion - maintenance of landscape and other features		X		X				X		X	X	X	X	X	X	X				1	CZ
	Other standards?																						
Soil organic matter	Standards for crop rotations where applicable	Soil organic matter - crop rotation		X	X					X	X	X					X	X				5	DE, F, GR, HU, IR

		Soil organic matter - break crops		X	X					X	X	X					X	X				1	UK
		Soil organic matter - crop rotation - humus balance		X	X					X		X										1	DE
		Soil organic matter - crop rotation - three crops		X						X		X	X	X	X	X	X	X				1	DE
	Arable stubble management	Soil organic matter - arable stubble management		X						X		X	X	X	X	X	X					4	ES, GR, HU, IR
		Field greening		X	X	X				X	X	X	X	X	X	X	X					1	AT
		Soil organic matter - manure managemnt		X	X			X	X	X												1	UK
		Soil organic matter - stubble burning management		X				X	X	X			X	X	X	X						1	IT
		Soil organic matter - stubble burning prohibition		X				X	X	X			X	X	X	X						1	AT
	Other standards?																						
Soil structure	Appropriate machinery use	Soil structure - appropriate machinery use - water-saturated soils								X												3	GR, IR, UK
		Soil structure - appropriate machinery - frozen, snow-covered and water-saturated soils								X												2	AT, ES
		Soil structure - appropriate machinery use								X												2	AT, HU
		Soil structure - deep cultivation								X												2	HU, SI

	Other standards?																						
Minimum level of maintenance	Minimum livestock stocking rates or/and appropriate regime	Maintenance - minimum maintenance - mowing, grazing				X					X		X	X	X	X	X	X	X	X	X	2	EE, UK
		Maintenance - appropriate livestock density - overgrazing				X		X	X	X			X	X	X	X	X	X	X	X	X	1	UK
	Protection of permanent pasture	Prohibition of ploughing up permanent grassland		X		X			X	X	X	X	X	X	X	X	X	X				6	DK, F, IT, IR, NL, UK
		Maintenance - appropriate livestock density				X		X	X	X			X	X	X	X	X	X	X	X	X	3	ES, HU, UK
		Maintenance - minimum maintenance - mowing		X		X					X	X	X	X	X	X	X	X				3	DE, IT, SK
		Maintenance - permanent grassland				X			X	X	X	X	X	X	X	X	X	X				2	DK, GR
		Maintenance - EIA			X	X				X	X	X	X	X	X	X	X	X				1	UK
		Maintenance - EIA - agricultural land			X	X				X		X	X	X	X	X	X	X				1	UK
		Maintenance - landscape features		X								X	X	X	X	X	X	X				1	UK
		Maintenance - minimum maintenance - arable land		X		X					X	X	X	X	X	X	X	X				1	PL
		Maintenance - permanent grassland - application of agrochemicals			X	X		X	X		X		X	X	X	X		X				1	UK

		Maintenance - permanent grassland - burning or ploughing							X	X	X	X	X	X	X	X	X	X				1	ES
		Maintenance - permanent grassland - contingent				X			X	X	X	X	X	X	X	X	X	X				1	DE
		Maintenance - permanent grassland - grazing				X		X	X	X		X	X	X	X	X	X	X				1	SE
		Maintenance - preservation of natural grasslands				X			X	X	X	X	X	X	X	X	X	X				1	HU
		Maintenance - preservation of permanent grassland - re-sowing				X			X	X	X	X	X	X	X	X	X	X				1	NL
		Maintenance - retention of habitats				X			X	X	X	X	X	X	X	X	X	X				1	UK
		Maintenance - set-aside - mowing restrictions				X						X	X	X	X	X	X	X				1	DK
		Prohibition of ploughing - areas				X			X	X	X	X	X	X	X	X	X	X				1	DE
	Retention of landscape features, including where appropriate the prohibition of the grubbing up of olive trees	Maintenance - landscape features			X	X				X	X		X	X	X	X	X	X				3	AT, GR, HU
		Maintenance - landscape features - terraces	X	X		X				X	X	X	X	X	X	X	X	X				3	AT, ES, IT
		Maintenance - landscape features - felling of trees			X	X		X	X	X	X	X	X	X	X	X	X	X				2	DE, UK
		Maintenance - landscape features - hedgerows			X	X		X	X	X	X		X	X	X	X	X	X				2	DE, UK
		Maintenance - landscape features -											X					X				2	IR, UK

		historic features																				
		Maintenance - landscape features - trees				X				X	X		X	X	X	X	X	X				2	DE, UK
		Maintenance - landscape features - wetlands			X	X	X	X	X		X		X	X	X	X	X	X				2	DE, UK
		Maintenance - EIA - forest land			X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	UK
		Maintenance - landscape features - field boundaries			X	X		X		X	X		X	X	X	X	X	X				1	UK
		Maintenance - landscape features - monuments											X					X				1	UK
		Maintenance - landscape features - stone walls											X	X	X	X		X				1	UK
		Maintenance - minimum maintenance			X	X	X			X	X		X	X	X	X	X	X				1	SE
		Maintenance - protection of SSSI			X	X	X	X	X	X	X	X	X	X	X	X	X	X				1	UK
		Maintenance - supplementary feeding sites			X	X							X	X	X	X						1	UK
		Soil erosion - cultivation distance to waters				X							X	X	X	X						1	AT
	Avoiding the encroachment of unwanted vegetation on agricultural land	Maintenance - unwanted vegetation			X	X					X		X	X	X	X	X					8	BE, DK, ES, FI, GR, HU, PL, UK

		Maintenance - appropriate livestock density - undergrazing			X	X				X	X		X	X	X	X		X				2	IR, UK
		Maintenance - minimum maintenance - abandoned land		X	X	X					X		X	X	X	X	X					2	EE, UK
		Maintenance - permanent grassland - management			X	X					X		X	X	X	X	X					2	DK, SE
		Maintenance - unwanted vegetation - invasive plants			X	X					X		X	X	X	X	X					2	IR, UK
		Field greening			X	X				X	X		X	X	X	X		X				1	AT
		Maintenance - minimum livestock density											X	X	X	X	X	X				1	GR
		Soil structure - appropriate machinery use		X ?	X	X				X	X		X	X	X	X						1	AT
	Maintenance of olive groves in good vegetative conditions			X		X				X	X		X	X	X	X	X	X					
	Other standards?																						

Annex VI Statutory management requirements (SMRs) for animal welfare and public health and how they have been implemented in 12 different Member States

Field of impact

		Agricultural markets and producer's income		**Environment**							**Land use**	**Biodiversity**				**Landscape**		**Animal welfare and health**		**Food safety**
	Short name SMR	**Agricultural markets**	**Producer's income**	**Ground water quality**	**Surface water quality**	**Water quantity**	**Air quality**	**Climate**	**Physical soil quality**	**Chemical soil quality**	**Land use**	**Birds**	**Mammals**	**Invertebrates**	**Plants**	**Landscape diversity**	**Landscape aesthetic quality**	**Animal welfare**	**Animal health**	**Food safety**
Animal Registration Directive: Council Directive 92/102/EEC of 27 November 1992 on the identification and registration of animals (OJ L 355, 5.12.1992, p. 32)	registration of farmers keeping animals	x	x																	x
	each farmer holds a register of all animals	x	x																	x
	double eartag	x	x															x		x
	in terms of loss replacement of eartags	x	x															x		x
	movement document for transport	x	x																	x
	notification of all livestock changes within a restricted time period	x	x																	x

Bovine Animal Registration Regulation: Commission Regulation (EC) No 2629/97 of 29 December 1997 laying down detailed rules for the implementation of Council Regulation (EC) No 820/97 as regards eartags, holding registers and passports in the framework of the system for the identification and registration of bovine animals (OJ L 354 , 30.12.1997 p. 19)	holding a register of all bovine animals on farm (eartag number, birth date, sex, breed and eartag number of the dam, and name and address of suppliers or buyers of animals, and dates)	x	x																	x
	notification of all livestock changes (birth, buy, sell, death, slaughter, import, export) within three working days	x	x																	x
	keeping registers in specific time	x	x																	x
	movement document for transport	x	x																	x
	cattle passport required per animal	x	x																	x
Bovine Animal Registration Regulation: Regulation (EC) No 1760/2000 of the European Parliament and of the Council of 17 July 2000 establishing a system for the identification and registration of bovine animals and regarding the labelling of beef and beef productsand repealing Council Regulation (EC) No 820/97 (OJ L 204, 11.8.2000, p. 1)	holding a register of all ovine and caprine animals on farm	x	x																	x
	double eartag	x	x															x		x
	in terms of loss replavement of eartags	x	x															x		x
	movement document for transport	x	x																	x
	notification of all livestock changes in a restricted time	x	x																	x
Ovine and Caprine Registration Regulation: Council Regulation (EC) No 21/2004 of 17 December 2003 establishing a system for the identification and registration of ovine and caprine	farmers must keep and register	x	x																	x
	double eartag	x	x															x		
	animals born before 9 July 2005 need to have only	x	x															x		x

animals and amending Regulation (EC) No 1782/2003 and Directives 92/102/EEC and 64/432/EEC (OJ L 5, 9.1.2004, p. 8)	one eartag																			
	movement document for transport	x	x																	x
	notification of all livestock changes in a restricted time	x	x																	x
Plant Protection Product Directive: Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market (OJ L 230, 19.8.1991, p. 1)	authorization	x	x	x	x	x					x	x	x	x	x	x				x
	certificate of competence	x	x	x	x	x					x	x	x	x	x	x				x
	regular checks of equipment	x	x	x	x	x					x	x	x	x	x	x				x
	contrainst in nature parks	x	x	x	x	x					x	x	x	x	x	x				
	constrains to protect bees	x	x											x	x					
Hormones Directive: Council Directive 96/22/EC of 29 April 1996 concerning the prohibition on the use in stockfarming of certain substances having a hormonal or thyrostatic action and of ß-agonists, and repealing Directives 81/602/EEC, 88/146/EEC and 88/299/EEC (OJ L 125, 23.05.1996, p. 3)	only veterinarian application for therapeutical use	x	x															x	x	x
	authorised products for therapy and breeding	x	x															x	x	x
	treatment for breeding by identifying treated animals	x	x															x	x	x
	documentaion of breeding treatment	x	x															x	x	x
Food Law Regulation: Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (OJ L 31, 1.2.2002, p. 1)	documentation of plant protection	x	x																	x
	forbidden to have or process unhealthy feed	x	x															x	x	x
	forbidden to fed unhealthy feed	x	x															x	x	x
	traceability of feed in all stages of production	x	x															x	x	x
Regulation (EC) 999/2001 on prevention, control and	immediate notification	x	x															x	x	x
	movement restrictions	x	x															x	x	x

eradication transmissible spongiform encephalopathies																				
Foot-and-Mouth Disease Regulation: Council Directive 85/511/EEC of 18 November 1985 introducing community measures for the control of foot-and-mouth disease (OJ No. L 315, p. 11, No. L 14/1986, p. 19)	immediate notification	x	x															x	x	x
	movement restrictions	x	x															x	x	x
Svine Vesicular Disease Directive: Council Directive 92/119/EEC of 17 December 1992 introducing general Community measures for the control of certain animal diseases and specific measures relating to swine vesicular disease (OJ L 62 , 15.03.1993, p. 69)	immediate notification	x	x															x	x	x
	movement restrictions	x	x															x	x	x
Bluetongue Directive: Council Directive 2000/75/EC of 20 November 2000 laying down specific provisions for the control and eradication of bluetongue (OJ L 327, 22.12.2000, p. 74)	immediate notification	x	x															x	x	x
	movement restrictions	x	x															x	x	x
Claves directive: Council Directive 91/629/EEC of 19 November 1991 laying down minimum standards for the protection of calves (OJ L 340, 11.12.1991, p. 28)	housing space	x	x															x	x	
	indiviudal boxes	x	x															x	x	
	atmosphere	x	x															x	x	
	lightening	x	x															x	x	
	diet	x	x															x	x	
Pigs Directive: Council Directive 91/630/EEC of 19 November 1991 laying down minimum standards fo the protection of pigs (OJ L 340, 11.12.1991, p. 33)	housing space	x	x															x	x	
	condition of flooring	x	x															x	x	
	no harmful materials used for construction	x	x															x	x	
	electrical circuits and equipment	x	x															x	x	

	atmosphere	x	x															x	x	
	inspection of automated or mechanical equipment once a day	x	x															x	x	
	lightening	x	x															x	x	
	inspection of pigs once a day	x	x															x	x	
	access to feed and water	x	x															x	x	
	desinfection of housing and equipment	x	x															x	x	
Animal Welfare Directive: Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes (OJ L 221, 8.8.1998, p. 23)	knowledge of staff	x	x															x	x	
	inspection of animals kept in husbandry systems once a day	x	x															x	x	
	lightening	x	x															x	x	
	animals must be cared for when they are ill or injured	x	x															x	x	
	record keeping of medicinal treatment for at least three years	x	x															x	x	
	freedom of movement appropriate to the physiologial and ethnological needs	x	x															x	x	
	no harmful materials used for construction	x	x															x	x	
	atmosphere	x	x															x	x	
	inspection of automated or mechanical equipment once a day	x	x															x	x	
	access to feed and water	x	x															x	x	
Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on	hygiene on transport, storage and handling and for whole equipment	x	x															x	x	x

the hygiene of foodstuffs (OJ L 139, 30.4.2004, p. 1)	appropriate transport of live animals	x	x															x	x	x
	control of hazards relateing to veterinarian drugs, biocides…	x	x															x	x	x
	measures relating to animal health with impact on public health	x	x															x	x	x
	cleaninisess of animals going to slaughter	x	x															x	x	x
	good health and training of personnel	x	x															x	x	x
	prevent animals and plants from causing contamination	x	x									x	x	x	x			x	x	x
	correct use of feed additives,veterinarian drugs, pesticides	x	x									x	x	x	x			x	x	x
	Record keeping of nature and origin of feed	x	x															x	x	x
	Record keeping of treatments and dates of withdrawal periods	x	x															x	x	x
	Record keeping of occurence of diseases	x	x															x	x	x
	Record keeping of reports on checks	x	x																x	x
	control contamination	x	x															x	x	x
	control use of water, fertilisers	x	x															x	x	x
	appropirate use of veterinarian drugs, feed additives, tracebaility	x	x															x	x	x
	preparation and storage of feed	x	x															x	x	x

	proper disposal of dead animals, waste and litter	x	x															x	x	x
	avoid transmission of contagious diseases to humans	x	x																	x
	measures to the cleaniness of slaugther	x	x																	x
Regulation (EC) No 853/2004 of the Europan Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin (OJ L 226 of 25.6.2004, p. 22)	registration of the preparation establishments by the competent authority	x	x																	x
	ensure that certificates or documents accompany consignments of products of animal origin	x	x																	x
	carefull handling of animals during collection and transport	x	x															x	x	
	permition of the transport of animals showing symptoms of disease or originating in herds contaminated with pathogens by the competent authority	x	x															x	x	x
	assure that the animals are in a good general state of health prior to the milking process	x	x															x	x	x
	observation of the withdrawal periods of prescribed substances prior to the milking process	x	x															x	x	x
	isolation of animals that are infected with a disease prior to the milking process	x	x															x	x	x

Regulation (EC) No 183/2005 of the european Parliament and of the Council of 12 January 2005 laying down requirements for feed hygiene (OJ L 35, 8.2.2005, p.1)	keep clean all facilities	x	x															x	x	x
	prevent animals and pests from causing contamination	x	x									x	x	x				x	x	x
	use clean water	x	x															x	x	x
	store and handle wastes separately	x	x																	x
	avoid that packaging material is a source of contamination	x	x																	x
	record-keeping on any treatment	x	x															x	x	x
	record keeping on GM seeds	x	x															x	x	x
	record keeping on pests and diseases	x	x																x	x
	record keeping on the source and quantity of each input and output of feed	x	x															x	x	x
	recommondations for guides to good practice	x	x															x	x	x

Annex VII Description of existing indicator frameworks

1. Markets and producer's income indicators

Eurostat indicators

………

Capri-Dynaspat indicators

……..

2. Agri-environmental Indicators

IRENA-indicators

DPSIR		No	Indicator
Domain	***Sub-domain***		
Responses	*Public policy*	1	Area under agri-environmental support
		2	Regional levels of good farming practice
		3	Regional levels of environmental targets
		4	Agricultural areas under Nature protection (Natura 2000)
	Market signals	5.1	Organic producer prices and market share
		5.2	Organic farm incomes
	Technology and skills	6	Farmers' training levels and use of environmental farm advisory services
	Attitudes	7	Area under organic farming
Driving forces	*Input use*	8	Mineral fertiliser consumption
		9	Consumption of pesticides
		10	Water use intensity
		11	Energy use
	Land use	12	Land use change
		13	Cropping/Livestock patterns
	Farm management	14	Farm management practices
	Trends	15	Intensification/extensification
		16	Specialisation/diversification
		17	Marginalisation (Risk of land abandonment)
Pressures and benefits	*Pollution*	18	Gross nitrogen balance
		18sub	Atmospheric emission of ammonia
		19	Emissions of methane and nitrous oxide
		20	Pesticide soil contamination
		21	Use of sewage sludge
	Resource depletion	22	Water abstraction
		23	Soil erosion
		24	Land cover change
		25	Genetic diversity
	preservation and enhancement of the environment	26	High nature value farmland
		27	Production of renewable energy
St ate	*Biodiversity and habitats*	28	Population trends of farmland birds

	Natural resources	**29**	Soil quality
		30.1	Water quality – Nitrate pollution
		30.2	Water quality - Pesticide pollution
		31	ground water levels
	Landscape	**32**	Landscape - state and diversity
Impac	*Biodiversity and habitats*	**33**	Impact on habitats and biodiversity
	Natural resources	**34.1**	Agricultural share of GHG
		34.2	Agricultural share of nitrate contamination
		34.3	Agricultural share of water use
	Landscape	**35**	Impact on landscape diversity

OECD-indicators

Since the beginning of the 1990s extensive work on environmental indicators based on the DPSIR concept (initially according to the PSR concept) has been carried out by the OECD. A number of studies deal with environmental impacts of agricultural practices and indicators of these. An extensive report on specific agri-environmental indicators has been published in 2001 (OECD, 2001) and will be renewed in 2007[23].

The agri-environmental indicators of the OECD are focusing on the following areas:

- Agriculture in the broader economic, social and environmental context
  - Contextual information and indicators
  - Farm financial resources
- Farm management and the environment
- Use for farm inputs and natural resources
  - Nutrient use
  - Pesticide use and risks
  - Water use
- Environmental impacts of agriculture
  - Soil quality
  - Water quality
  - Land conservation
  - Greenhouse gases
  - Biodiversity
  - Wildlife habitats
  - Landscapes

[23] Volume 4 shall be published in 2007

Animal welfare Indicators:

a. Five freedoms

The British Farm Animal Welfare Council laid down five objectives relevant for general animal well-being considerations in 1979 (FAWC, 1993):

j. Freedom from thirst, hunger and malnutrition
k. Freedom from lack of appropriate comfort and shelter
l. Freedom from pain, injury or disease
m. Freedom to display most normal patters of behaviour
n. Freedom from fear and distress.

These so called Five Freedoms can be translated by various physical, physiological, anatomical, ethological and pathological indicators. They can be considered as general indicators for animal well-being. Animal-based measures indicating the welfare of animals somatically as well as production system-based measures displaying housing and shelter conditions are part of this system. The operationalization of the Five Freedoms was inter alia conducted through the Animal Needs Index.

b. Animal Needs Index

In 1985 the Austrian Federal Research Institute for Agriculture in Alpine Regions started to construct a system indicating the housing and shelter conditions of farm animals which is built on the Five Freedoms schema (Bartussek, 1999). The Animal Needs Index is an assessment tool grading different housing conditions with respect to animal welfare; the main focus lays on the production-level. It is in use now for cows, young and beef cattle, calves, laying hens, fattening pigs (including piglets) and pregnant sows. Especially five elements are considered concerning the animal's environment:

b. Possibility of mobility
b. Social contact
b. Condition of flooring for lying, standing and walking
b. Climatisation (including ventilation, light and noise)
b. Intensity or quality of human care.

c. Welfare Assessment System

The Welfare Assessment System is an instrument to establish a welfare protocol which serves as an aggregated indicator for animal well-being. It was developed by the Danish Institute of Agricultural Science. Disaggregated welfare indicators are divided into four groups:

- Animal behaviour
- Animal health
- Production system
- Management of the production system.

Aggregating welfare indicators into a welfare protocol involves evaluating the suggested indicators step by step in a tripartite ‘bottom-up’ process (Rousing et al., 2001). First, multiple indicators are considered regarding their welfare influence. Second, each indicator’s information on animal welfare is evaluated in relation to all the other potential welfare indicators and the most relevant ones are selected depending on the highest marginal welfare relevance. The final step in developing an operational welfare protocol is to evaluate the suitability of indicators for use in on-farm studies. Reliability characteristics of indicators have to be taken into consideration as well as cost of measurement and tests.