Cross Compliance Assessment Tool

CROSS-COMPLIANCE ASSESSMENT TOOL

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Executive summary

The general aim of this report is to explain how the impacts of (cross compliance) standards are translated into indicators. The main focus is on the assessment that will be part of the first prototype of the CCAT-evaluation tool. This tool will indicate a limited number of standards, notably the Nitrate Directive, the Identification and Registration Directive and most of the GAEC requirements. Standards with respect to biodiversity, landscape, health and animal welfare issues are dealt with in an indirect and incomplete way. The second prototype, which will be developed in a next phase will consider a more integral treatment of the CC-standards.

The backbone of the prototype is made up by the CARI and MITERRA models. These models, which are different in nature (economic/environmental) have to be linked. A procedure for this is generated and described which takes care of preserving behavioural consistency at one hand and at the best exploits the strong points of each of the models (e.g. CAPRI in explaining the behaviour of farmers with respect to input-output decisions as a response to market signals; MITERRA in explaining nutrient balances as a function of manure applications, animal activities, crop allocation and soil and groundwater table conditions) at the other hand.

As regards the **economic** indicators the CAPRI part of the tool is able to provide the necessary information, without the need to adjust the model (except for adding some derived calculation rules). The challenge is to feed the model with a percentage change in costs reflecting the additional costs of satisfying cross-compliance standards multiplied with the share of farms, farmland and/or farm animals that is compliant with the standards. A pre-model calculation tool has been developed which is argued to be able to supply this information. From a technical point of view an adequate solution is found and described to analyse the Nitrate Directive and Identification and Registration Directives. The main challenge is now at the empirical side, i.e. determining the costs of compliance as well as creating best-estimates of compliance for the base year. Because no information is currently available about observed improvements in compliance (for example as induced by the cross-compliance enforcement mechanism), improvements in compliance will be analysed scenario-wise by specifying different rates of improvements as compared to the base year 2005.

The MITERRA part of the CCAT-tool includes all **environmental** aspects that can be quantified in a reasonable way on a European wide scale, such as atmospheric emission of ammonia and green house gases (air quality and climate). Depending on feasibility the leaching and runoff of nitrogen and possibly phosphorous and heavy metals (water quality) will also be included. But in prototype 1 a clear emphasis is on an evaluation of CC measures related to the Nitrates Directive and of selected GAECs coupled with the CAPRI-MITERRA model chain. This means that for prototype 1 all nitrogen, phosphate and carbon balances are calculated and only emission and concentrations of nitrogen in water and GHG and ammonia emission to air. The calculations of CC effects on metal and phosphate emissions will be postponed to prototype 2. The impacts on soil erosion and soil organic carbon content will also be assessed but only in prototype 2. The impact of cross-compliance measures on

pesticides is not included in the integrated environmental modelling framework because: (i) pesticides are not under cross compliance measures, (ii) the information on pesticide use on a European wide scale is inadequate and (iii) the complexity of modelling pesticide behaviour makes it difficult to make adequate predictions of pesticide accumulation and leaching in response to measures at a large scale.

For other areas like biodiversity, landscape, public health and animal welfare the linkage to the central modelling tool is often indirect, not always clear-cut, and with respect to some aspects even non-existing. This induced the project team to look for indirect and alternative approaches. With respect to **biodiversity and landscape**, for example, the Prototype 1 tool will contain an expert qualitative estimate of the effectiveness of standards for biodiversity and landscape, an assessments of impacts induced by predicted land use changes as a consequence of compliance to standards, and an impact analysis on habitat quality derived from environmental indicators. The impacts will be assessed for landscape/biodiversity as a whole. The expert qualitative estimate of the standards' effectiveness will concentrate on the standards under the selected SMRs and GAECs and will focus on those that target the preservation of landscapes and biodiversity (Birds and Habitats Directives, and GAECs targeted on habitat/landscape preservation).

Since **public health and animal welfare** are mainly related to the way the production processes are organized rather than to the amount of production factors used, their linkage to the CAPRI-MITERRA model is also rather indirect and often not existing. Therefore a more independent approach is proposed, which focuses on a selected number of aggregate indicators for which either their specification relies on already available data collected for whole EU (EUROSTAT or WHO) or for a selection of Member States, or which have the potential to be linked to the model-tool. In addition it was also decided to further extent the research on this theme according to two lines: a desk study of the existing literature as well as an in-depth case study.

This Deliverable provides the basis for the Prototype I CCAT-tool. At the basis of it are intensive discussion between the various partners, which brought in their expertise and creativity to develop a multidisciplinary framework for an integrative assessment of a selection of cross-compliance standards. Different analytical approaches and models are to be linked and impact indicators will be further operationalized. As such this Deliverable is presenting a sound basis for developing the Prototype I tool.

1 Introduction

1.1 Introduction

In this deliverable it is explained how the impacts of (cross compliance) standards will be translated into impact indicators. The indicators for assessing the effects of CC standards have already been identified for the different impact fields in deliverable 2.1 and 2.2 of this project (Jongeneel et al., 2007). These impact fields include agricultural markets, producer's income, land use, soil, water, air, climate, biodiversity and landscapes, as well as animal welfare and public health. For a selection of SMR and GAEC standards it will be further explained how their potential effect on a selection of most relevant impact fields will be assessed. We will focus only on those SMR and GAEC standards which can also be translated in effect indicators with the models, knowledge and data available to this project. It is assessed whether and how (a selection of) SMR and GAEC standards may cause directly or indirectly (e.g. through changes in cost structures) changes in a farming practice or lead to a change in land use. It is then described how this effect can be measured and translated in one of the effect indicators already selected in Deliverable 2.1 and 2.2 (Jongeneel et al., 2007). The proper linkage between farm behaviour response to price and cost changes (as captured by the economic CAPRI model) and the physical impacts this creates on land use, environment, manure application, animal activities, etc. (as captured by the environmental MITERRA model) will be an important point of attention.

In this report we will only focus on those assessments which can be incorporated in the first prototype of the Cross Compliance Assessment Tool (CCAT). This prototype is planned to be ready by October 2008. The second and last prototype is planned to be finalized by month 34 (October 2009).

Overall we propose that for Prototype 1 we will only do EU-wide assessments at NUTS 2 level. For prototype 2 we will refine the assessments to below Nuts 2 level and case study assessments. In the latter situation we can incorporate more detailed information which is generally not available at EU-wide level. The case studies will also be used for fine-tuning, calibrating and plausibility testing of the modeling results.

In the next section first a description of the conceptual approach to the assessment of the relationship between SMRs and GAECs is given in which it is discussed what (or to what extent) impacts can be related to Cross Compliance, what different compliance levels with standards will be assessed in prototype 1 and what will be used as the baseline for the assessment. A short summary is then given of the Deliverable 2.1/2.2 in relation to selected effect indicators per impact field and the available models and knowledge with which these effects will be assessed for the first prototype of CCAT. In Deliverable 2.1/2.2 (Jongeneel et al., 2007) certain choices for indicators and assessment tools have already been made and these are the starting point for the operationalisation approach described in this report. In the final section a short overview is given of the contents of the rest of the report.

1.2 Focus and scope of assessment: what impacts can be related to Cross Compliance policy?

1.2.1 Standards, enforcement and impacts

As is known in the context of Cross Compliance farmers must comply with 19 Statutory Management Requirements (SMRs) (now already 22 SMRs) defined in Annex III of the regulation, and a number of standards ensuring the good agricultural and environmental condition of agricultural land (GAEC) as defined in Annex IV of the Regulation. The SMRs are all pre-existing EU Directives and Regulations such as for example the Birds and Habitat Directives and the Nitrates Directive. In Figure 1.1. the complete cross compliance package, including the sanctioning and monitoring mechanism, the selected SMR standards subject to this mechanism and the newly introduced GAEC conditions, is indicated by the dashed line. With respect to these SMR standards CC acts as an additional incentive to stimulate enforcement of existing legislation (see *Figure 1.1*; Jongeneel and Brouwer, 2007)[1].

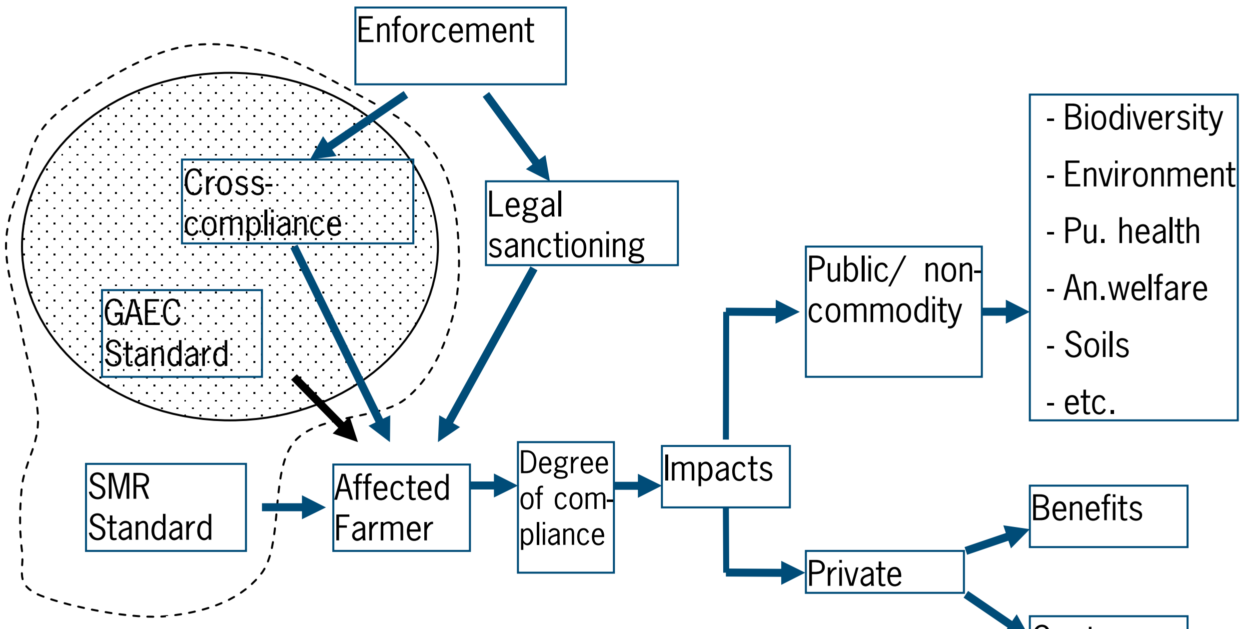


Figure 1.1: Standards, enforcement, compliance, benefits and costs related to CC policy

[1] Because the GAEC standards were newly introduced together with cross-compliance they are generally considered to be part of the CC-package (we follow that convention). However, following Figure 1.1. also here a distinction could be made between standard and standard-enforcement mechanisms just like with the SMRs.

The GAEC framework represents a new set of regulations introduced as part of the CC package. Roughly, it consists of a total of 11 standards relating to the protection of soils and maintenance of habitats. In addition, each Member State must ensure that the area of permanent pasture is maintained at the same magnitude as in 2003. The latter clause was also newly introduced with CC and aimed at avoiding the abandonment of land and associated environmental degradation. Abandonment of land was feared as a potential by-effect of the introduced decoupling, which delinked support from production activities. As such the GAEC requirements can be seen as a precautionary policy to prevent potential problems which might occur in the future.

With respect to the GAEC standards, Member States have introduced a wide range of measures to implement the standards as set out in Annex IV. The majority of Member States have implemented measures for some, but not all of the Annex IV standards. The implemented requirements vary from very basic, simple and already required or satisfied measures to more complex measures (See CCAT Deliverable 2.1/2.2 for further details). The result is a highly variable approach to Annex IV standards. Given the aim of implementing conditions taking into account the specific characteristics of areas concerned, including soil and climatic conditions, existing farming systems, land use, crop rotation, farming practices and farming structures, the variability is not surprising. Member States do not have an obligation to justify their choice of GAEC standards[2].

As Figure 1.1 illustrates standards aim to adjust the farmers behaviour in a desired direction, with the enforcement mechanism (monitoring, inspection and punishment in the form of either a legal fine and/or a deduction of direct payments) encouraging compliance. The adjusted or standard-satisfying behaviour of the regulated generates several impacts. Part of these impacts will have a private character and affect the regulated party. Examples are the cost a farmer has to make to comply with the standard. Standards might also generate private benefits (e.g. an increased organic matter content of the soil might improve soil fertility, increase yields and thus increase a farmer's revenues) or influence private benefits in a negative way (e.g. generate a yield loss). Alongside these there are also other impacts, having a public or/and non-commodity character. Often these are related to the policy aims associated with the standards (e.g. preserved habitats, minimum levels of animal welfare, ensured food safety, traceable animals, etc.).

From the above reasoning and the distinction between standards and enforcement of standards as conceptualized in Figure 1.1 a number of conclusions can be drawn with respect to issues of impacts, costs and benefits:

- Impacts associated with satisfying an SMR standard should be attributed to this standard rather than to cross-compliance (or enforcement mechanisms in general);
- Derived from this it follows that costs associated with satisfying an SMR standard should be attributed to this standard and not CC;

[2] Detailed rules for the implementation of cross-compliance are set down in Regulation 796/2004. The implementation started in year 2005 with the SMRs on environment, public and animal health, and the identification and registration of animals. Also the GAEC standards were imposed in 2005. In 2006 additional SMRs related to food safety (public health) and notification of diseases are implemented. The last part, regarding animal welfare was implemented in 2007

- Similarly benefits following from keeping up to SMR standards should be contributed to these standards, rather than to cross compliance;
- The main benefit of CC as an enforcement mechanism is an improvement of the degree of compliance[3];
- The main cost of CC are the cost related to (additional) inspection and monitoring costs public administrations make, as well as additional costs that have to be made by the regulated in terms of record keeping, registration, etc. which are directly related to cross-compliance;
- Since the GAECs are newly introduced standards and considered as being a part of the CC package, both the cost associated with complying to these standards, as well as all the benefits following from these standards can be attributed to the cross-compliance instrument;
- By definition new or additional costs from CC can only arise as far as standards are newly introduced and not refer or replace pre-existing legislation either at Community or national MS level. As a consequence of this only a limited part of the GAECs can lead to additional cost and/or benefits.

In terms of impact assessment, the primary focus in this project is on standards. How is this than linked to CC?

Firstly, as the dashed lines of Figure 1.1. try to express, the set of standards taken into account is not an arbitrary one, but includes those that are in the CC package (which might be labelled as the CC-standards). Secondly, the GAECs are considered to be a part of cross compliance and their impacts can thus be directly attributed to cross compliance. Thirdly, there is an indirect effect: cross compliance might improve the degree of compliance to standards because it acts as a leverage to the enforcement system. As far as this is the case the changes in impacts can be said to be cross compliance-induced.

1.2.2 Focus and scope of assessment

Given the need to focus, prototype 1 will include impact assessments of a selection of standards while for prototype 2 practically all standards will be included. In Table 1.1 an overview is given of the standards and the selected impact fields they will be assessed for in prototype 1 and prototype 2. From this overview it becomes clear that assessments in prototype 1 will only be done at national or Nuts 2 level, while in prototype 2 the assessment will also be done at below administrative boundary levels, such as within bio-physical entities (e.g. environmental zones, altitude areas), sensitive areas (e.g. High Nature Value farmland areas) either EU wide or within

[3] Cross-compliance is evaluated here within the context of its role to create a leverage to compliance with standards. When seen in a wider policy perspective there might be other benefits, such as the legitimization (and justification) of 'decoupled' direct payments to farmers, the flexibility it opens to rely more on a responsive regulation approach rather than to follow only the deterrence route, and the benefit of the Commission to increase its power to urge Member States to properly implement and monitor common regulations (Jongeneel and Brouwer, 2007). These wider issues are beyond the scope of this research. However, these 'neglected aspects' might be important from a political economy perspective and as such it is good to be aware of them when assessing the implementation, application and deliberation of future adjustments of the cross-compliance instrument.

Table 1.1 Scope and assessments in relation to standards and impacts fields in Prototype 1 and 2

SMRs and GAECs	**Prototype 1**			**Prototype 2**		
	Assessment level	***Impact field***		***EU wide assessment of impacts***	***Assessment in case studies***	***Impact field***
Nitrates Directive	NUTS2	MWALBL_U		Yes, spatially detailed assessment	Yes	MWALBL_U
Wild birds Directive	NUTS2	LB			Yes	MLB
Habitats Directive	NUTS2	LB			Yes	MLB
Sewage Sludge Directive	NO			Yes, spatially detailed assessment	Yes	MWSABL_U
Ground water Directive	NO			Yes, spatially detailed assessment	Yes	MWSABL_U
Animal Registration Directive	NATIONAL, NUTS2	MP		Yes, only markets and producers income and public health	Yes	MA_WP
Bovine, Ovine and Caprine Animal Registration Regulation	NUTS2	MP		Yes, only markets and producers income	Yes	MA_WP
Plant Protection Product Directive	NO			Yes, spatially detailed assessment	Yes	MW
Hormones Directive	NO			Yes, only markets and producers income	NO	
Food Law Regulation	NATIONAL	P		Yes	Yes	MP
Regulation (EC) 999/2001 on prevention, control and eradication transmissible spongiform encephalopathies	NO			Yes	Yes	MA_WP
Foot-and-Mouth Disease Regulation	NO			Yes	NO	M
Calves directive	NO			Yes, only markets and producers income	NO	M
Pigs Directive	NO			Yes, only markets and producers income	Yes	MA_W

Animal welfare Directive	NO			Yes, only markets and producers income	Yes	MA_W
Regulations on the hygiene of foodstuffs and food of animal origin	NATIONAL	P		Yes	Yes	MP
Regulation on requirements for feed hygiene	NATIONAL	P		Yes	Yes	MP
Soil erosion-minimum coverage	NUTS2	MWAL_ULB		Yes, spatially detailed assessment	Yes	MWASL_ULB
Soil erosion-minimum land management	NUTS2	MWAL_ULB		Yes, spatially detailed assessment	Yes	MWASL_ULB
Soil erosion-retain terraces	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	MSL_ULB
Soil organic matter-standards for crop rotation	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	MSL_ULB
Soil organic matter-appropriate stubble management	NO			Yes, spatially detailed assessment	Yes	MWAS
Soil organic matter-appropriate machinery use	NO			Yes, spatially detailed assessment	Yes	S
Minimum level of maintenance-minimum livestock stocking density and appropriate regimes	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	MWASL_ULB
Minimum level of maintenance-Protection of permanent grassland	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	MWASL_ULB
Minimum level of maintenance-retention of landscape features	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	ML_ULB
Minimum level of maintenance-Avoiding the encroachment of unwanted vegetation	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	ML_ULB
Minimum level of maintenance-Maintenance of olive groves	NUTS2	ML_ULB		Yes, spatially detailed assessment	Yes	ML_ULB

M=market & producer income; W=water quality; A=air and climate; B=biodiversity; L=landscape; S=soil quality; A_W=animal welfare, P=public health, L_U=land use.

selected case studies. It also becomes clear from the Table 1.1 that not all standards will be linked to all impact fields. In the following chapters it will be specified per impact field which standards will be assessed in prototype 1 and how this is done.

Prototype 2 will basically be an extended version of Prototype 1; where we will refine the assessments both spatially and scientifically and we will concentrate on several case study assessments which allow the incorporation of more detailed information. This will especially enable the estimation of impacts in the fields of animal welfare, public health, landscape and biodiversity for which detailed EU wide information is not available. Case studies will also be used for fine-tuning, calibrating and testing the plausibility of the assessments on other impact fields, especially the ones on water, soil, air and climate.

1.2.3 Compliance levels and baseline

As regards compliance levels two considerations might play a role. As regards the evaluation of impacts of standards different degrees of compliance starting with 0% compliance (i.e. not having the standard), and increasing degrees of compliance (increasing intensity of effective regulation), up till full compliance, 100%. However, 0% compliance can not be assumed in most cases because it is clear that even before any SMR or GAEC was in place many farmers already complied with them (or were not really affected, for example because of their free choice for a non-intensive production system). Moreover, when standards are pre-existing and enforced for already some time, this will affect the current degree of compliance and create an initial degree of compliance which is far beyond zero.

When evaluating different degrees of compliance it does not make much sense to analyse the case of 0% compliance, whereas most farmers already comply at a much higher rate. Most likely it is simply impossible to enforce a zero degree of compliance as no data are available on such a theoretical situation. Instead it is proposed that the starting point of all assessments should be a 2005 compliance level, which is the baseline year against which all other compliance levels can be compared. This level will entail a very varied situation in which different regions and different farm types have different baseline compliance levels.

Estimates of these 2005 compliance levels can partly be derived from other studies (e.g. the IEEP evaluation study and the Cross Compliance project estimates). However, where this information is missing, which is most strongly the case for all animal welfare and public health related SMRs, own estimates will need to be made.

A first point for further discussion is the determination of the best estimates of compliance. Now several sources are available (CC project and IEEP inventory study), which need to be analysed and complemented to create our own best estimates.

A second point for discussion is the level of detail of the analysis. Within the Nitrate Directive for example there are different requirements, such as not to over fertilize and to have a proper record keeping. A farmer can comply with the first but not with the second requirement. So non-compliance with the directive can come from various sources (violation of sub requirements), which may differ in perceived seriousness (likely to be related to the linkage of the sub requirement to the final policy aim) as well as cost impacts. For CCAT it is expected that is will be very difficult to make reliable estimates of compliance with all different standards and sub-standards for all regions in the EU. However, we will base the estimates on the best sources we have access to. The CCAT assessment tool however will provide the possibility for users to adjust the best estimates of compliance levels to their own best knowledge and let the tool calculate the effects on the indicators (see also CCAT Deliverable 2.5).

1.3 Selection of indicators for prototype 1

The outcome of the exercise to focus on a subset of the regulations and standards included in the cross-compliance package, is further extended in this section. In particular the linkage of impacts and standards is further expelled and translated into modelling requirements or proposed modifications of existing models if there appears to be a need to further adapt them for the current purpose.

1.3.1 Selected economic impact indicators

The selected economic indicators are provided in Table 1.2. As Table 1.2 shows it is expected now that most indicators could be implemented within the CAPRI modelling framework. 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 per region.

Table 1.2 Final selection of economic indicators

Indicator	**Model available**				
		group of farms (e.g. types)	**region**	**country**	**EU**
Gross Margin/hectare[4]	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
Costs of controlling CC[5]	CAPRI			X	X

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

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

1.3.2 Selected environmental indicators

The final environmental impact indicator set includes all indicators on emissions of ammonia and greenhouse gases, soil erosion, gross balances of carbon (including the change of soil organic carbon content in the topsoil), the nutrients N and P and the heavy metals Cd, Cu, Pb and Zn and nitrates in leachate/runoff to ground water and surface water. The list of indicators to be specified in the first stage of the project is specified in Table 1.3 together with the main models used to calculate them. There are two additional environmental indicators for which it is not yet clear whether they can be covered by the models, i.e phosphate and metal accumulation (change in soil contents) and phosphate and metal leaching (occurrence in leachate and runoff water). For more details, we refer to Section 3.2 (Table 3.1) and to Deliverable number 4.2.1 'Development and application methodology of environmental impact tool to evaluate cross compliance measures' (De Vries et al, 2008).

Table 1.3 Final selection of main environmental indicators

Environ-mental field of impact	**Indicator**	**Model used**	**Level of calculation**			
			group of farms (e.g. types)	region	country	EU
Air/ climate	Atmospheric emissions of ammonia (NH_3), methane (CH_4) and nitrous oxide (N_2O) from agriculture	MITERRA Europe Ext. DNDC (EPIC)		X	X	X
Physical soil quality	Soil erosion by water	EPIC		X	X	X
Chemical soil quality	Gross balances for carbon, nitrogen, phosphorous and metals (Cd, Cu, Pb and Zn)	MITERRA Europe Ext. EPIC		X	X	X
Ground and surface water quality	Nitrate leaching to ground water and runoff to surface water from agriculture	MITERRA Europe Ext. DNDC EPIC		X	X	X

[5] 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.

1.3.3 Selected land use, landscape and biodiversity indicators

In Deliverable 2.1-2.2 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 remained indicative. Further criteria which will orient the selection of indicators include that:

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, and predicted situations can be computed with the tools and data available in the project.

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 1.4 it is indicated in a first step how these first 4 criteria work out on the initial indicators selected in Deliverable 2.1-2.2.

From Table 1.4 it becomes clear that at this moment the indicators to be operationalised for assessing the impacts on **land use** are the cropping pattern indicator (trend in *share of UAA of major intensive/extensive crops*) and the indicator of *livestock density*. Both indicators will be produced by the CAPRI/Miterra models at NUTS 2 level. How this will be done is further described in Chapters 2, 3 and 4.

As for **biodiversity**, four of the considered indicators cannot be adequately operationalised. The indicator *changes in the share of semi-natural habitats* can not be used mainly because in the CAPRI model it is not yet feasible to distinguish between improved grassland and semi-natural grassland. As for the indicators *Share of High Nature Value farmland of UAA* and *Spatial complexity/corridors and linkages between habitats*, there is not adequate output from the models to operationalise them, apart from that there is not a clear link between them and the CC measures. The indicator *Species richness/species population trends (farmland birds),* cannot be used because of lack of data at adequate scale/detail and with sufficient replication in time.

The indicator on *Change in habitat quality* can be derived from the output produced by the environmental models in relation to water, air and soil quality. For the first prototype the output of the environmental model MITERRA (in the form of environmental indicator values) will be used as input for a qualitative assessment of effects on farmland biodiversity within regions.

Table 1.4: 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.

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	No
	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 (change semi-natural grassland)	Yes, indirectly	Yes	Yes	maybe later
	Share of High Nature Value farmland of UAA	CAPRI, post model (change semi-natural grassland)	No, not directly	Yes	Yes	maybe later
	Spatial complexity/corridors and linkages between habitats	-	Yes, but limited	Yes	Yes	No
	Species richness/species population trends (farmland birds)	-	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	Extra data needed	Yes, possibly	Yes	No	Maybe rough estimate
	Agricultural land use diversity change	Capri, (better + post model disaggregation)	Yes, possibly	Yes	Yes	Yes, but rough estimate
	Change area/share of land recognized for its scenic/scientific value	-	Yes, possibly	Yes	Yes	No

* 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, and predicted situations can be computed with the tools and data available in the project.

Further, we will also use under the same approach. i.e. as pressure indicators on biodiversity, the indicators on land use change mentioned above. Apart from livestock density, the *Share of intensive and extensive livestock* will probably be used as an extra biodiversity indicator. Agricultural intensification is one of the main drivers of biodiversity loss in the European agricultural habitat as well as loss of landscape diversity (see e.g. EEA, 2005; Baillie et. Al, 2001 ; Buckwell & Armstrong-Brown 2004; Wadsworth et al. 2003; Boatman et al., 1999; Birdlife International, 2004; Vickery et al., 2004; Asher et al., 2001; Donald et al. 2001; Heath et al. (2000) and Wadsworth, et al., 2003).

For **landscape** the indicator *Change in openness versus closedness* cannot be used yet. The current openness/closedness of the landscape might be roughly estimated from the Corine Land Cover data base, but future changes in openness will be very difficult to predict on the basis of the CAPRI model output (however we might try in a later stage through post model disaggregation). Also, the relationship between openness/ closedness and biodiversity is very complex and difficult to assess in a general sense (e.g. more openness is positive for meadow birds, but negative for forest animals), so only a detailed assessment might be meaningful, which will not be possible in prototype 1. The indicator *Change area/share of land recognized for its scenic/scientific value* cannot be used yet either. There is spatial information available on current tourist attendance and protected landscapes like world heritage sites, which can be used as proxy variables for this, but we cannot predict any changes in them with the used models. We might however consider (in a later stage) to overlay this information on the current situation with more detailed predicted changes in land use and habitat quality, to give an indication that these sites might coincide with expected habitat/landscape changes.

The indicator *Agricultural land use diversity change* will be estimated by computing the evenness of agricultural land uses per Nuts2 region on groupings of the land use types of the CAPRI model. From literature it is well known that landscape diversity has a positive influence on biodiversity in general (see Deliverable 4.3.1).

Preceding the assessments described above, an expert qualitative judgment of the **effectiveness of the standards** related to the Birds and Habitats Directives and habitat/landscape directed GEACs will be estimated (see chapter 4). In this way a direct link between the Cross Compliance measures and their targets will be established.

Because the mentioned land use and landscape indicators are also important for biodiversity, the assessments for land use, landscape and biodiversity will be performed together.

Concluding: for prototype 1 we will probably be able to perform the following assessments:

- An expert qualitative estimate of the effectiveness of standards for biodiversity and landscape;
- Assessments of impacts induced by predicted land use changes as a consequence of Cross Compliance:
    - share of intensive/extensive land use
    - density and share of intensive/extensive livestock

- land use diversity (evenness)
- Impact assessments on habitat quality derived from environmental indicators.

In prototype 1 no distinction will be made between different impact fields, so the impacts will be assessed for land use/landscape/biodiversity together and as a whole.
In Chapter 4 and D 4.3.1 these assessments will be described in more detail.

In a later stage, for **prototype 2**, it is envisaged that:

1) the environmental models will be applied to environmental regions which are smaller then NUTS2 regions and which are characterised by a more homogeneous environment. Model calculations will then deliver a better picture of the CC effects taking account of the larger variation in combinations of farming practices with very localised bio-physical environmental factors.
2) more detailed combinations between the qualitative assessment of pressures on different impact fields of biodiversity/landscape and the present state of biodiversity will be made. This can however only be done where state data are available as this will enable us to make a prediction of changes in certain species groups (such prediction can be made with e.g. the LARCH model or we use quantitative relationships between farming practices and species numbers derived from e.g. countryside survey elaborated in SEAMLESS). This will only be possible for case studies for which we have information on the state of certain species groups.

1.3.4 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.

It was decided to carry out a selection of indicators 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 areas facing limitations regarding existing indicators, i.e. landscape and biodiversity. Direct indicators are those indicators which directly address final impacts whereas indirect ones are derived from models of this project and serve as proxies. In the following an overview is given of the criteria used to make a final selection of SMRs and indicators for operationalisation in prototype 1:

1. Clear relationship between the SMR standards and the 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 (an extensive desk study will be done to further explore the information available in member state specific studies). For these selected SMR the existence of direct or indirect indicators will be identified as explained in Table 1.5 (points 2 and 3 or new ones will be developed as explained under 4).

2. Identification of existing direct indicators for selected SMRs

The selection of indicators should takes the following into consideration:

- EU-wide dimension

As a first step indicators that are directly and regularly surveyed at European level will be identified. For Public Health and Animal Welfare existing SMRs are practically not addressed by any existing indicators, therefore mainly response indicators will be used such as the “effectiveness of control system”.

- 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 a large number of Member States is covered and that those countries are covered in which the CCAT case studies will be located.

- Regular survey before and after starting Cross Compliance

Ideally those indicators are selected for which information is available that was measured before and after implementation of CC standards and will also continue to be measured in the future. In some very limited cases some relevant data is available that fits this requirement.

3. Identification of indirect indicators produced by the models used in this project (e.g. CAPRI)

Some results of CAPRI can be used to identify how and where compliance with animal welfare and public health standards change.

4. Additionally needed indicators

For some of the relevant SMRs additional indicators will be developed which are addressed in a targeted CCAT survey to be executed in case study. 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 assessing impacts of standards on Public Health and Animal Welfare. How these indicators will be assessed is explained in Chapter 5.

Table 1.5: 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)		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)	response to SMR	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 (1993-2000, 2003-05)	1993-2005	Annual
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)	Some member states running a monitoring programme: Belgium, Denmark, Finland, Sweden, Norway	2001-2005	Annual

	No 183/2005			
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, other projects and own collection			
Membership in certification schemes	Cross Compliance project (LEI)			
Animal Welfare and Health				
1. Direct 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 by SMR standards as indicated by modelled changes in animal numbers	response to SMRs	EU-25 (CAPRI)	Annual	Annual
3. Own development				
Compliance level	Data need, other projects and own collection			
Farm-attributes	Survey in case regions			
Physical stress indicators at slaughterhouses	Survey in case regions			

1.4 Conceptual approach linking SMRs and GAECs to impact indicators

Cross compliance measures may cause effects in a direct and an indirect way. How direct and indirect effects on the different fields of impact are assessed and translated into impact indicators is described in further detail in next chapters. But the overall concept is explained here.

The economic model, CAPRI, models farmers response to CC-standards and translates this in economic indicators on producer's income and economic markets but also in changes in land use and livestock patterns. It simulates how the relative costs of SMRs and GAECs, estimated in a pre-modelling step outside CAPRI, lead to changes in cropping patterns (land use), shifts in animal herd composition and eventual output quantities which lead to changes in income and agricultural markets. Costs determine farmers' response and these responses may also involve changes in land use and livestock population numbers and composition. This is why economic effects and responses are the starting point of the operationalisation of not only the economic but also the environmental indicators. An important outcome of the economic assessments is therefore input for the assessment of effect indicators for environment, land use, landscape, biodiversity and sometimes also for animal welfare and public health.

However, it is also possible that certain CC standards lead to changes in practices first e.g. changes in fertiliser inputs which are quantified first by the environmental model (MITERRA). These changes in fertiliser inputs have an effect on production costs and these need to be fed back to the CAPRI model.

Beside the modelled response by Capri on land use and livestock patterns the direct impacts of implementing certain SMRs and GAECs on farming practices also need to be taken into account to model the environmental effects. Both CAPRI indicators on land use and livestock patterns and the changes in practices are the input for the environmental models. Especially in relation to the changes in practices a translation is required in indicators which can be input for the models. How this is done and from which SMRs and GAECs effects on farming practices are most likely to have an environmental impact is discussed in further detail in chapters 3 and 4.

For the assessment of the impacts on landscape the output data from CAPRI on land use is important, since predicted changes in land use might lead to changes of land use diversity and intensity. But also good implementation of SMRs and GAECs that prescribe the maintenance and preservation of landscape features (such as hedges and terraces), permanent grassland, olive groves, minimal soil cover etc.are relevant. The level of compliance of these standards and the area they are (or will be) applied will influence the effectiveness of the measures and their (positive) effects on landscape quality.

The assessment of impacts on biodiversity will be based on: (i) the CAPRI output on land use and livestock patterns, (ii) implementation rates of different types of SMRs, especially in relation to Wild Birds and Habitat Directive, (iii) the output of the landscape assessment specifying the effectiveness of measures preservation of landscape features and changes in agricultural lands use diversity, (iv) the output of the environmental impact assessment.

How the assessment of the impacts will be done and translated into the impact indicators and from which SMRs and GAECS different impacts can be expected and assessed is discussed in the next chapters.

1.5 Structure of this report

The next chapter will discuss the operationalisation of CC indicators in the field of producer's income and economic markets. It explains how the relative costs of a selection of SMRs and GAECs can be estimated at different compliance levels and how these may effect agricultural markets. In chapter 3 the operationalisation of environmental indicators is given. Chapter 4 describes the operationalisation of indicators of land use change, changes in landscape and biodiversity. The fifth chapter discusses the animal welfare and public health assessment and the report is finished with conclusions. Chapters 2,3 and 5 are set up according to the same structure. First a characterisation of effect indicators for prototype 1 is described. This is followed by a more detailed description of the theoretical link between the selected SMRs and GAECs and the effect indicators. After this the method of the assessment of the effect indicators is discussed, followed by main conclusions. Chapter 4, assessing effects of CC on land use, landscape and biodiversity, has a different structure; here the emphasis lies on describing the different assessment methods, of which a large part is based on the results of the economic and environmental impact assessments.

2 Assessing effects of CC on producer's income and agricultural markets

2.1 Introduction

This section discusses how the economics indicators as presented in the previous section will be operationalized. Section 2.2. gives a characterization of the indicators and the dimension in terms of which they are measured. Section 2.3 discusses the links of the SMRs and GAECs and the selected economic indicators. For each of the indicators a reference or baseline level is needed. How this is done is discussed in section 2.4. It will appear that not all steps are necessary to arrive at the final economic indicators as some can directly come from the CAPRI modelling tool. Section 2.5. will focus therefore on the steps necessary to calculate suitable input data for the CAPRI model. To overcome scale problems a pre-model calculation is developed, which is the subject of Section 2.5. Section 2.6 ends with main conclusions.

2.2 Characterisation of economic effect indicators

The economic indicators were already briefly introduced before. In this section it is more precisely indicated at what dimension each indicator is measured (see Table 2.1).

Table 2.1 Final selection of economic indicators

Indicator	**Unit**	**Spatial resolution**	**details**	**Comments**
Gross margin/hectare[6]	euro/ha	Nuts2	Production activity	Crop specific, hectare-specific for missed crop rotations?
Land price	euro/ha	Nuts2	Arable- and Grassland	Arable- and grassland
Production of main agricultural products	ton	Nuts2	Production activity (output)	
Land allocation	Ha	Nuts2	Production activities	Absolute, can also be presented in share from
Export/Import ratio of main Agricultural Products	ratio	Member States	Production activity (output)	What level of aggregation?
Budgetary expenditure	thousand euro	Nuts2	Agricultural sector	Direct payments may be provided separately per hectare for certain regions/activity types?

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

				Exp.subs etc calculated at EU level
Costs of controlling CC[7]	thousand euro	Nuts2	CC measure	
Welfare changes related to agricultural production	thousand euro	Nuts2	Agricultural sector	Producer surplus
Agricultural Income (sectoral)	thousand euro	Nuts2	Production Activity	Calculated profits (short-run) and long-run (accounting for imputed land costs?)
Costs of compliance	Euro/ha	Nuts2	Production activity	Per hectare, or per activity level? E.g eartag costs per cow rather than per ha?
Competitiveness: change market share	Percentag e shares	Member States	Production activity (output)	Shares in national and EU production?

The economic activities in the agricultural sector are broken down conceptually into ‘production activities’ (e.g. cropping; a hectare of wheat or fattening a pig). CAPRI models 44 core production activities. Most of them are specific production activities (e.g. soft wheat), sometimes similar activities are merged (e.g. rye and meslin). Remaining minor activities are summarized in heterogeneous aggregates (e.g. other cereals).

Table 2.2 Production activities in CAPRI

Arable land
Soft wheat, durum wheat, barley, rye and meslin, oats, grain maize, paddy rice, other cereals
Rape, sunflowers, soya, olives (for oil), other oil seeds
Pulses, potatoes, sugar beet, flax and hemp, tobacco, other industrial crops
Tomatoes, other vegetables
Apples pears and peaches, other fruits, citrus fruits, table grapes, table olives, wine
Nurseries, flowers, other crop production
Fodder maize, fodder root crops, other fodder on arable land
Set aside, Non food production on set aside, fallow land
Grassland
Grass and grazings (intensive)
Grass and grazings (extensive)
Animal production
Dairy cows, suckler cows, bull fattening, heifers fattening, calves fattening (male and female)
Heifers raising, calves raising (male and female)
Sows, pig fattening
Sheep and goat for milk, sheep and goat fattening,
Hens, poultry fattening
Other animals

CAPRI basically distinguishes two types of land (arable- and grassland). While 36 crops are competing for the arable land, grassland is only divided in an intensive and

[7] 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.

extensive variant. Within simulation arable- and grassland are static and serve as constraints in the optimization of the production program. The dual value of these constraints can be interpreted as land rent.

With respect to the requirements of CCAT the list of production activities on arable land and the definition of animal production activities seem to be adequate. However some shortcomings are evident in the representation of grassland. First the definition of extensive and intensive grassland is done for technical reasons[8] and does not necessarily reflect actual farming habitats. Secondly the assumption of static grassland area at Nuts2 is a simplified representation of policies hindering the conversion of permanent grassland.

As different qualities of grassland are important with respect to landscape and biodiversity (high natural value areas) the definition of extensive and intensive grassland will be revised, probably based on additional information from land cover maps[9] and point observations[10]. Natural conditions in combination with expert knowledge could be taken into account as well.

The permanent pasture directive regulates in detail conversion of permanent grassland. This measure will be implemented in more detail. It can be assumed that part of the grassland is not suitable for arable farming because of natural limitation (e.g. soil depth, slope, water logging or tree coverage). This area can be determined based on expert knowledge. The remaining area, basically suitable for arable farming, might be affected by changes in economic conditions. However the exact methodology will be developed when the availability of raw data regarding different grassland qualities becomes clear, in a later stage of the project (not in prototype 1).

2.3 Links between SMRs and GAECs and selected economic effect indicators

The SMRs and GAECs are aimed at furthering a sustainable agriculture. As they impose restrictions on farmers' behaviour or add new obligations, as such they are not likely to directly contribute to the economic sustainability (viability) of agriculture. Additional restrictive requirements without special compensations, as they are typical for cross-compliance, will lower rather than increase farm profitability. Improvements on sustainability should be mainly realized at other impact fields and for those it makes more sense to come up with a detailed discussion of linkages.

As was explored in Deliverable 2.1-2.2 there is, however, an important linkage between the farm economics and the cross-compliance requirements. There it was argued that the decision to comply to the regulation involves cost and benefits. Although compliance is legally enforced and therefore not a deliberate economic decision farmers will face costs in complying to some regulations and standards, which they can and probably also will weigh against the benefits (expected avoidance of penalty payments or reductions on the single farm payment). So economic

[8] CAPRI needs extensive and intensive grassland activities to model changes in input consumption and yields, as input and output coefficients are fixed for each activity
[9] The CORINE land cover map distinguishes e.g. pasture and natural grassland
[10] The LUCAS survey gives different types of pastures e.g. with or without trees

considerations are likely co-influence the compliance decision. Therewith there is a linkage between economic indicators like profits, costs of compliance and direct payments and the expected degree of compliance. Note that at the same time there is a simultaneity. Economic variables are likely to have an impact on the degree of compliance chosen, whereas at the same time this choice affects variables like costs of compliance, profits, etc. and will thus impact economic indicators.

Since changes in the degree of compliance will also impact on the impacts obtained in all other fields, this economic-behavioural linkage is crucial. It is for this reason that further work is done to develop a procedure which links the degree of compliance, at least for some of the most significant CC requirements to the economic indicators. See for more details Subsection 2.5 about the pre-model calculation tool.

2.4 Baseline situation against which economic effects can be measured

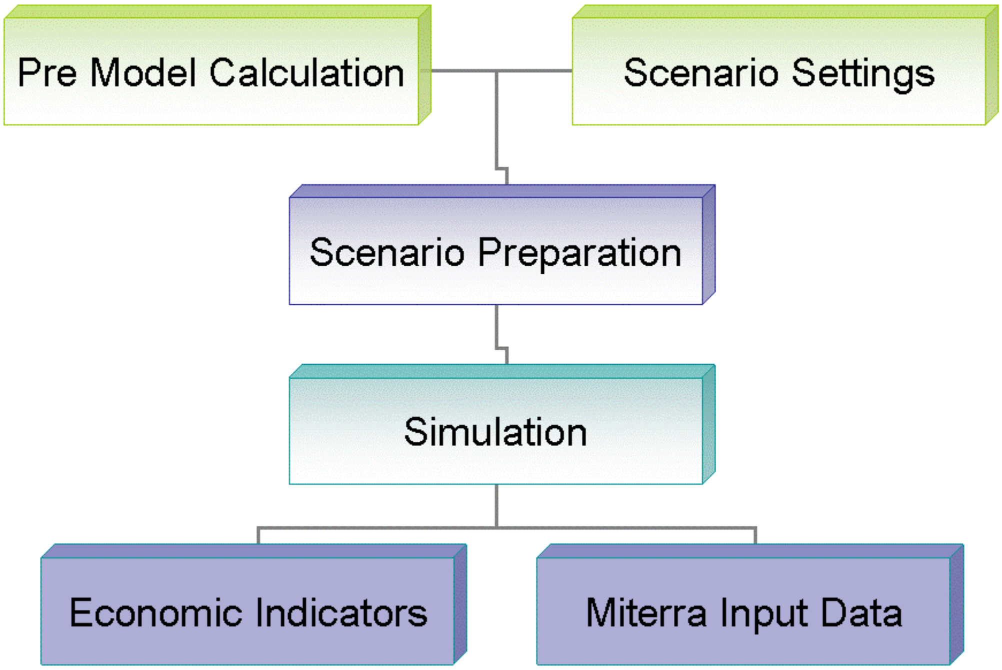
The baseline may be interpreted as a projection in time covering the most probable future development or the European agricultural sector under the status-quo policy and including all future changes already foreseen in the current legislation, except for CC measures.

Conceptually, the baseline should capture the complex interrelations between technological, structural and preference changes for agricultural products world-wide in combination with changes in policies, population and non-agricultural markets. Given the complexity of these highly interrelated developments, baselines are in most cases not a straight outcome from a model but developed in conjunction of trend analysis, model runs and expert consultations, especially DG-AGRI.

The CAPRI baseline is generated on a yearly basis in close collaboration of University Bonn, IPTS Seville and DG-AGRI. Actually projections are made for the year 2013. During the lifetime of CCAT this might be shifted to 2015, starting from the baseline year 2005. The actual reference scenario assumes continuation of the 2003 Luxembourg agreements and takes the sugar market reform into account. Potential effects of a liberalization of the dairy market and increasing demand for bio-fuels are in preparation and might be implemented in forthcoming CCAT applications.

2.5 Simulation of economic effects

Since CC standards are supposed to cause activity specific additional cost there is potential impact on agricultural production and income that can be simulated with CAPRI. The basic objective of the CAPRI supply model is profit maximization at a regional (Nuts2) level. The ultimate value needed in the CAPRI modelling system is the average additional cost per activity and region cumulated over all of CC measures.



A scenario preparation tool will derive additional costs based on results of pre model calculations and specific scenario settings. After simulation with the core CAPRI model results regarding economic indicators and data needed as input for the MITERRA model will be stored. The calculation and data requirements are explained in the following subsections.

2.5.1 Pre-model calculation tool

The pre-model calculation step will also be used to determine the per unit (hectare/animal) cost of compliance for various regulations. The CAPRI model will need input from a data base that has to be filled with information during the CCAT project. The pre-model calculation tool will create a table containing information on:

- Additional cost (comparing non compliance / full compliance)
- Share of (voluntary) compliance in reference situation (without CC measures) with respect to production level
- Production level of activity

Input data will be differentiated by Region, farm type, measure and activity. As it seems nearly impossible to get all data at the most detailed level, data gaps will be filled with values from a higher aggregated level. It is proposed to use the hierarchy shown in Table 2.3.

Table 2.3. Level of aggregation for data input

	High		**Level of aggregation**		**Low**
Region	EU27	EU15/EU12	Member state	Nuts1	Nuts2
Farm type	All farms	Specific farm type			
CC measures	Specific GAEC and SMR				
Activity	All activities	agricultural area / animals	Arable land / grassland / animals	specific activities	

In the following sub sections a number of pre-model calculation steps are discussed, with a particular focus on estimating the degree of compliance to regulations and derived measures (like for example the manure surplus), which are later used as inputs in the CAPRI model.

Degree of compliance

The degree of compliance to SMR and GAEC regulations differs over regulations (see discussion and Annex I of Deliverable 2.1-2.2) and over countries. In particular the Identification and Registration and Nitrate Directive requirements appear to create difficulties for farmers to satisfy. These regulations will be analysed in a more detailed way.

Before coming to an assessment of the *degree of compliance of farmers* an estimate will have to be made of the number of farms, animal heads and hectares which will be potentially affected by the specific Directive or Regulation (see below for more details for with respect to the specific regulations considered). Evidently the degree of compliance of farmers will refer to this latter number of farms. Moreover, farms do not only face costs, but in some cases may also receive compensations or premiums associated with producing to a certain standard. However, it are not only farms, but also Member States which can be non-compliant (cf the infringement cases of the Commission with some member states with respect to the Nitrate Directive).

Taking into account the considerations the general calculation formula for the national estimate of the additional costs of cross compliance will then be:

$$\text{additional cost of compliance} = (100-x)/100 * (100-x')/100 * (\alpha - \beta) * y$$

where x = degree of compliance (in percentage terms) at Member State level

x' = degree of compliance of farmers (in percentage terms)

α = unitary costs to comply with SMR/farm

β = compensation payments/farm

y = number of farms/country affected by the Directive or Regulation

A first step in the analysis of the cost of cross-compliance will be the assessment of the degree of compliance of Member States (application of legislation). Subsequently, the degree of compliance of farmers with cross compliance standards has to be determined. See further details for the Identification and Registration of Animals and Nitrate Directives below.

Identification and Registration

Given the current state of data availability, it does not make sense to differentiate over farms and regions in order to assess the degree of compliance to the Identification and Registration requirement.

Nitrate Directive

The level of regional detail within this project is much more refined than that of the CC-project, where the Annex I results come from. Rather than using previously obtained country-level estimates, an alternative procedure is followed to refine the degree of compliance estimates. For dairy this procedure consists of the following steps:

1. Relying on the FADN data an estimate is made of the fraction f_i of the number of (specialized) dairy farms in region *i* having a higher stocking density than 2 livestock units per hectare.
2. It is assumed that all specialized dairy farms have a lower stocking density than 2 LU/ha do not face a binding restriction from the Nitrate Directive requirement of a maximum application of 170 kgN/ha. Their degree of compliance is estimated to be 100%.
3. It is assumed that the degree of compliance for farms having a higher stocking density than 2 LU/ha follows the best estimate, say $\hat{c}_{Nitrate}^{country\ j}$ as obtained from the CC project. The final estimate of the degree of compliance of the region I in country j is subsequently determined as $\hat{c}_{Nitrate}^{region\ i} = (1 - f_i) * 100 + f_i \hat{c}_{Nitrate}^{country\ j}$.
4. For each farm *h* in region *i* having a stocking density higher than 2 LU/ha the actual stocking density S_{hi} and the number of hectares H_{hi} the farm has are determined. The number of surplus livestock units for such a farm SLU_{hi} can than be derived as $SLU_{hi} = (S_{hi} - 2) * H_{hi}$.
5. The dairy manure surplus S_i of region *i* can than be determined by multiplying the number of surplus livestock aggregated over farms by a manure excretion coefficient α, or as $S_i = \alpha \sum_h SLU_{hi}$.

For beef a similar procedure can be followed. Also for pigs the calculation procedure is rather similar. The only difference being the livestock density variable, which is set at 17 pig equivalents per hectare.

Per unit costs of compliance

The pre-model calculation step also includes a module determining the per-unit costs of compliance to various regulations. Being a combination of exogenous per unit costs and endogenous activity levels, the final costs of compliance will be endogenous and can only be derived from CAPRI.

Identification and Registration

As regards the per unit costs of compliance associated with the Identification and Registration of Animals Directive the calculation procedure as developed in the CC project will be followed (see De Roest et al, 2006). Essentially a farm in order to comply with the Directives will have *to update register and ear tag* continuously otherwise he will either be fined (ordinary compliance) and/or his single farm payment will be cut (cross compliance).

The costs generated by the mandatory part of these directives have essentially an administrative nature. They are related to the time necessary to update the registers and to the purchase of ear tags for new born calves and imported calves. Much more incisive for the farm balance are the voluntary certification schemes foreseen by the meat quality labelling systems. A large number of beef product specifications have been approved and recognised in accordance with Directive 1760/2000, which provide for special feeding regimes and the use of pure cattle breeds. These label systems have however a voluntary basis and as such are out of scope of the present cost analysis which interests only mandatory standards.

As the annual national costs of cattle registration is concerned the following variables have to be collected:

Table 2.4: Specific data requirements I&R costs calculation

Variable	**Unit**	**Data source[11]**
Dairy cow population	N.	National Census
Calf birth index	%	Herd book organisations
Imported calves and cows	N	Import-export statistics
Beef cow population	N	National census
Calf birth index	%	Herd book organisations
Cost of ear tags	€	Farmers' associations
Loss of ear tags	%	Farmers' associations
Time dedicated to animal registration on the farm	Hours/animal	Sample survey

[11] Part of the required data may be based on other EU projects on cross compliance, notably the CC project and the IEEP evaluation study.

Dairy sector

The following algorithm for the cost of compliance in the beef sector can be used (De Roest et al, 2006)

*Costs of ear tags of new born female calves = dairy cow population * birth index* 0,5 * cost of ear tag (1)*

*Costs of ear tags of imported calves = imported calves * cost of ear tag (2)*

*Cost of loss of ear tags(dairy) = dairy cattle population * % loss of ear tags * cost of ear tag (3)*

*Labour costs of registration = dairy cattle population * hours/animal * labour costs/hour (4)*

Cost of compliance :((1) + (2) + (3) + (4))/kg milk

The result will be the total national cost of dairy cattle identification and registration. Relating the total cost for the dairy sector to the national (or regional) cow milk production one obtains the cost of identification and registration per kg milk.

The same calculation procedure is to be followed for the beef cattle population (see below)[12].

Beef sector

The following algorithm for the cost of compliance in the beef sector can be used (De Roest et al, 2006)

*Costs of ear tags of new born male calves = dairy cow population * birth index* 0,5 * cost of ear tag (1)*

*Costs of ear tags of new born calves = beef cow population * birth index * cost of ear tag (1)*

*Costs of eartags of imported calves = imported calves * cost of ear tag (2)*

*Cost of loss of ear tags(beef) = beef cattle population * % loss of ear tags * cost of ear tag (3)*

*Labour costs of registration = beef cattle population * hours/animal * labour costs/hour (4)*

Cost of compliance :((1) + (2) + (3) + (4))/kg beef and veal

The result will be the total national cost of dairy cattle identification and registration. Relating the total cost to the national (or regional) production of beef and veal one obtains the cost per kg meat.

[12] Note that the I&R costs associated with the male calves which go from dairy sector to the beef sector and are used for beef are attributed to the beef sector.

Nitrate Directive[13]

The potential costs associated with the Nitrate Directive range from (De Roest et al, 2006):

1. investment and running costs for manure storage equipment and/or manure treatment plants
2. transport cost of excess manure outside nitrate vulnerable areas
3. the purchase of extra farm land or the acquisition of manure spreading rights on extra farm land
4. the reduction of nitrogen content in feed and the inherent decrease of the lean meat percentage, which determines a reduction of farm receipts
5. the reduction of crop yield due to the decrease of manure spreading
6. the costs of an Agronomic Utilisation Plan (AUP) of manure

By law all countries have defined the *nitrogen excretion figures per animal* to be used to calculate the maximum number of animals per ha which correspond to the limit of 170 kg N per ha[14]. A first step in the cost analysis will be to determine these maximum threshold values for the relevant animal species (cows, pigs and beef cattle).

Table 2.5 Data requirements associated with N-Directive cost calculation

Variable	**Unit**	**Data source**
Investment costs per m3 of manure storage tanks or reservoirs	€/m3	Literature
Transport cost of manure per km/m3	€/km/m3	Literature
Average land price in vulnerable areas	€/ha	National statistics
Cost of manure spreading rights	€/ha	Local statistics
Interest rate	%	National statistics
Fixed investment depreciation rate	%	Literature
Production of manure per animal	m3/fattening pig m3/dairy cow	Literature /Table of manure production per animal species and category

[13] Cost calculation for Nitrate Directive standard follow procedure as developed in CC project (see De Roest, 2007).
[14] As far as countries got a derogation they are allowed to higher applications per hectare. Where relevant this should be taken into account.

In order to assess how many livestock farms will be affected by the Nitrate Directive within the vulnerable zones the number of farms should be counted which exceed these limits as these farms will have to face to extra costs to comply with the Directive (see Table 2.5). The time period of prohibition of manure spreading defines the capacity of the manure storage tanks, which may imply an expansion of the existing capacity. Extra investments may become necessary.

The cost calculation necessarily should be based on the analysis of a series of case studies of intensive livestock farm types in vulnerable areas. Basically two farm situations may occur:

1. farms which exceed the 170 kg N/ha located in a nitrate vulnerable area which as whole does not exceed this limit
2. farms which exceed the 170 kg N/ha located in a nitrate vulnerable area which produce entirely more than 170 kg N/ha.

In order to establish if a nitrate vulnerable zone produces an excess of manure a calculation should be made of the total quantity of manure related to the 170 kg N limit. By means of the agricultural census animal population data multiplied with nitrogen excretion figures at municipality level are used to calculate the ratio between manure and UAA hectares within the vulnerable area.

In both situations extra investment in manure storage and the costs of a manure disposal plan have to carried out by the affected intensive livestock farms. However, a significant difference in costs emerges between the two situations as to the transport or treatment of manure. In the first situation transport of excess manure will be sufficient, in the second farmers will have to treat their manure to reduce the N content. Another option open to all farmers is the reduction of the protein content of concentrate feed, which will reduce the feed conversion rate and reduce the lean meat percentage in the meat. For the cost calculations this latter option can be discarded as experimental data concerning this strategy are not available at EU scale.

For the case studies an average farm size of intensive pig, dairy and beef farm has to be chosen. For each farm type at first the quantity of excess manure has to be calculated by means of the same methodology used to calculate excess manure in a vulnerable area.

The costs of compliance with the Nitrate Directive in the two described situations can be then synthesised by the following formula (De Roest et al, 2006):

1st situation:

*Δ investment in storage * annuity % + transport costs of*

excess manure + spreading cost manure +costs of rights to spread
--- = *costs/kg*

kg meat or milk produced

2nd situation:
*Δ investment in storage * annuity % + manure treatment costs*
-- = *costs per kg*

kg meat or milk produced

Activity level per farm type

Farm type specific activity levels and regional shares can be calculated from FADN data. As FADN data is mostly reported at a level higher than Nuts2 some CAPRI model components already enable estimation of farm type information at NUTS2 combining FADN, FSS and EUROSTAT data.

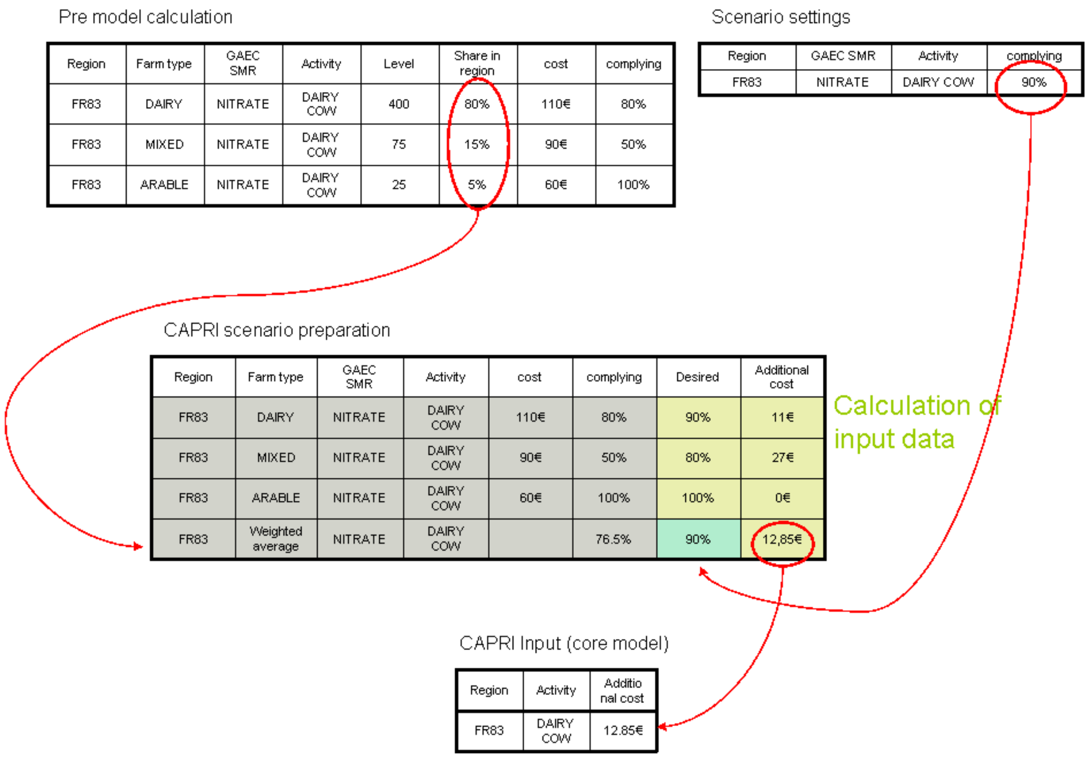
2.5.2 Scenario specific settings

The user will be able to set a desired degree of compliance in the graphical user interface. By definition this value has to be higher than the voluntary degree of compliance in the reverence situation. The setting can be done at different levels of aggregation as shown in Table 2.3. Missing settings on the lowest level will be filled by values entered at a more aggregated level.

2.5.3 CAPRI scenario preparation

The value of interest in the CAPRI modelling system is the average additional cost per activity and region cumulated over all of CC measures. Figure 2.1. illustrates the way of calculating the specific value based on results from pre model calculations and scenario specific settings.

Figure 2.1. Calculation of additional cost



Pre model calculation

Region	Farm type	GAEC SMR	Activity	Level	Share in region	cost	complying
FR83	DAIRY	NITRATE	DAIRY COW	400	80%	110€	80%
FR83	MIXED	NITRATE	DAIRY COW	75	15%	90€	50%
FR83	ARABLE	NITRATE	DAIRY COW	25	5%	60€	100%

Scenario settings

Region	GAEC SMR	Activity	complying
FR83	NITRATE	DAIRY COW	90%

CAPRI scenario preparation

Region	Farm type	GAEC SMR	Activity	cost	complying	Desired	Additional cost
FR83	DAIRY	NITRATE	DAIRY COW	110€	80%	90%	11€
FR83	MIXED	NITRATE	DAIRY COW	90€	50%	80%	27€
FR83	ARABLE	NITRATE	DAIRY COW	60€	100%	100%	0€
FR83	Weighted average	NITRATE	DAIRY COW		76.5%	90%	12,85€

CAPRI Input (core model)

Region	Activity	Additional cost
FR83	DAIRY COW	12.85€

Following the numerical example in Figure 2.1. 76.5% of the dairy cows in a specific region are anyway kept under conditions conform to the Nitrate directive. However this differs among different farm types from 50% to 100%. As in the scenario the desired degree of compliance is set to 90% the habitats of the farmers would have change what causes additional costs. The exact rules how to translate this regional value to specific farm types are subject to further discussion[15]. Assuming the values shown in Figure 2.1. are suitable, additional cost per farm type are calculated by multiplying the percentage increase in complying with the total cost, e.g. for transporting manure of one dairy cow. The weighted average of those additional cost (12.85€) is then used in the CAPRI simulation.

2.5.4 Assessing effects of CC with CAPRI model

The basic components of the CAPRI modelling system are supply and market model. The supply model is based on positive mathematical programming:

[15] Possible rules would be “lowest cost farms first” or linear increase over all farm types

$$\max_{x_j \geq 0} z = \sum_{j=1}^{n} \left(r_j - c_j \right) x_j - \sum_j x_j \left(\alpha_j + \tfrac{1}{2} \sum_k \left(\beta_{jk} x_k \right) \right)$$

$$s.t. \sum_{j=1}^{n} a_{ij} x_j \leq b_i \quad \left[\lambda_i \right]$$

j activities

r revenu

c variable cost

x production level

a input coefficients

b ressouce availabilty

α and β parameter from calbration

λ dual value of contraints

We assume that CC measures only influence variable cost, i.e. some additional cost c^* calculated in the scenario preparation tool enter the objective function.

$$\max_{x_j \geq 0} z = \sum_{j=1}^{n} \left(r_j - c_j - c_j^* \right) x_j - \sum_j x_j \left(\alpha_j + \tfrac{1}{2} \sum_k \left(\beta_{jk} x_k \right) \right)$$

$$s.t. \sum_{j=1}^{n} a_{ij} x_j \leq b_i \quad \left[\lambda_i \right]$$

c^* additional variable cost (CC measures)

As a consequence of introducing additional costs the optimal production level and hence the supply of agricultural goods will change. Following the market model determines demand and prices based on changed supply. This again alters the revenues in the supply part. Iterative solutions of market and supply model finally lead to equilibrium.

2.5.5 Economic Indicators

Most of the indicators discussed in 2.2 are already calculated by the CAPRI modelling system. The remaining can be added easily since raw data for their calculation is available in the model.

2.5.6 MITERRA Input Data

The exchange of data between the CAPRI and MITERRA model was already established in former projects. The main information passed to MITERRA are activity levels and fertilizer (mineral and manure) application rates.

2.6 Conclusions

The operational CAPRI model allows calculation of all selected economic indicators. The major challenge in this field is the suitable implementation of measures. Since cost estimations are available from previous studies we opted to focus on additional cost and neglected potential effects on input/output coefficients. Once the first results based on the methodology described before are available, sensitivity of model results against the assumptions will be tested and potential improvements will be discussed.

3 Assessing effects of CC on water, soil, air and climate

3.1 Introduction

This section discusses how the environmental indicators as presented in Section 1.3.2 (see Table 1.2) will be made operational. Section 3.2. gives a characterization of the environmental indicators and the dimensions in which the results will be presented. Section 3.3 discusses the links of the SMRs and GAECs and the selected environmental indicators. For each of the indicators a reference or baseline level is needed. How this is done is discussed in Section 3.4. The input data that are needed by the environmental models used in CCAT (MITERRA Europe, EPIC and DNDC) for the calculation of environmental effect indicator are presented in Section 3.5, together with the interaction with the CAPRI model. Section 3.6 summarizes the status of the environmental modelling approach in some conclusions.

3.2 Characterisation of environmental effect indicators

In assessing the impacts of cross compliance measures on air-, soil-, and water quality, a choice has to be made which environmental indicators we aim to address. In the analytical tool, we include all aspects that can be quantified in a reasonable way on a European wide scale. This includes:

- Atmospheric emission of ammonia and green house gases (air quality and climate).
- Soil erosion (physical soil quality).
- Soil accumulation or release of carbon (organic matter), phosphorous and heavy metals (chemical 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. The impact of cross-compliance measures on pesticides is not included in the integrated environmental modelling framework because: (i) pesticides are not under cross compliance measures, (ii) the information on pesticide use on a European wide scale is inadequate and (iii) the complexity of modelling pesticide behaviour makes it difficult to make adequate predictions of pesticide accumulation and leaching in response to measures at a large scale. A more precise characterization of the indicators used, the models with which they will be calculated and the spatial resolution with which the results will be presented is given in Table 3.1.

Table 3.1 Selection of environmental indicators, models used to assess these indicators in response to CC measures and spatial resolution of calculation and presentation.

Environ-mental field of impact	**Indicator and units**	**Model used**	**Spatial resolution level**		
			HSMU	NUTS2	Country
Air/ climate	Total atmospheric emissions of ammonia (NH_3) from agriculture in kg NH_3-N/ha/yr [1]	MITERRA Europe DNDC EPIC	X	X	X
	Emissions of methane by agriculture in kg CH_4/ha/yr	MITERRA Europe DNDC	X	X	X
	Emissions of nitrous oxide by agriculture in kg N2O-N/ha/yr	MITERRA Europe DNDC	X	X	X
	Gross total GHG emission from agriculture in kg CO_2 equivalents	MITERRA Europe 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	Gross carbon balance in kg C/ha/yr and change in top soil organic carbon content in g/kg	MITERRA Europe (Ext) EPIC	X	X	X
	Gross nitrogen balance in kg N/ha/yr	MITERRA Europe DNDC EPIC	X	X	X
	Gross phosphorous balance in kg P/ha/yr	EPIC	X	X	X
	Gross metal balance for Cd, Cu, Pb and Zn in g /ha/yr	MITERRA Europe (Ext)	X	X	X
Ground and surface water quality	Nitrate leaching to ground water and runoff to surface water from agriculture in kg N/ha/yr and concentrations in water in mg/l [3]	MITERRA Europe DNDC EPIC	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"

The major model involved is MITERRA-Europe that focuses on N fluxes and will be extended in the context of CCAT with carbon and metal balances. The spatial resolution with which the environmental targets relevant to agriculture will be calculated are ultimately at the level of Homogeneous Spatial Mapping Units

(HSMUs) whereas results will be presented at regional level (NUTS2), country level (at which targets have been set) and EU level.

3.3 Links between SMRs and GAECs and selected environmental effect indicators

A summarized overview of the Statutory Management Requirements (SMRs) to be met by the farmer in the: (i) Nitrate Directive (Council Directive 91/676/EEC), (ii) Sewage Sludge Directive (Council Directive 86/278/EEC) and (iii) Directive on the protection of groundwater (Council Directive 80/68/EEC), that will be evaluated by the CCAT environmental impact tool is given in Table 3.2. Measures in the Habitat directive can not be evaluated with the set of available models, since thy all focus on agricultural soils. Details of all the measures defined in these three directives and the possibility to evaluate them with the set of available models is further elaborated in the Deliverable on the Environmental Impact Tool, including an overview of (Chapter 4.2 and Annex 2 in De Vries et al., 2008):

- selected measures in SMRs
- the effect indicators that will be calculated in view of the measures
- the models included in doing such a calculation (MITERRA, DNDC and/or EPIC)
- the way in which the measures will be evaluated.

Table 3.2 The Cross Compliance requirements according to the Statutory Management Requirements (SMRs) in the three EC directives included in the CCAT tool for environmental impacts

EC Directive / Regulation	What will be the Cross Compliance requirements to be met by the farmer and included in the CCAT tool?
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.
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.
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.

A summarized overview of the Good Agricultural and Environmental Condition (GAECs) to be met by the farmer, to warrant appropriate soil protection (prevent soil erosion, avoid loss of soil organic matter and protect soil structure), ensure a minimum level of maintenance of land and avoid the deterioration of habitats, that will be evaluated by the CCAT environmental impact tool is given in Table 3.3.

As with the SMRs, details of all the measures defined by the GAECs and the possibility to evaluate them with the set of available models is further elaborated in the Deliverable on the Environmental Impact Tool, including an overview of (Chapter 4.3 and Annex 4 in De Vries et al., 2008):

- selected measures in GAECs
- the effect indicators that will be calculated in view of the measures
- the models included in doing such a calculation (MITERRA, DNDC and/or EPIC)
- the way in which the measures will be evaluated.

Table 3.3 The Cross Compliance requirements according to the Good Agricultural and Environmental Conditions (GAECs) included in the CCAT tool for environmental impacts

GAEC	What will be the Cross Compliance requirements to be met by the farmer and included in the CCAT tool?
Soil erosion	Protect soil through appropriate measures Minimum soil cover Minimum land management reflecting site-specific conditions
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	Minimum livestock stocking rates or/and appropriate regimes Protection of permanent pasture Avoiding the encroachment of unwanted vegetation on agricultural land

3.4 Baseline against which environmental effects can be measured

The baseline against which the effects of CC measures are evaluated is the year 2005. CC measures are only related to the implementation of GAECs while the effects of SMRs are not part of CC as they are based on already existing Directives (no additional compliance since 2005!). In the context of CCAT, the effects of SMRs will only be evaluated by comparing the impacts of complying versus not complying with them. In this context, it will not be done measure by measure but as a group of measures related to one directive.

3.5 Input data for the calculation of environmental effect indicators

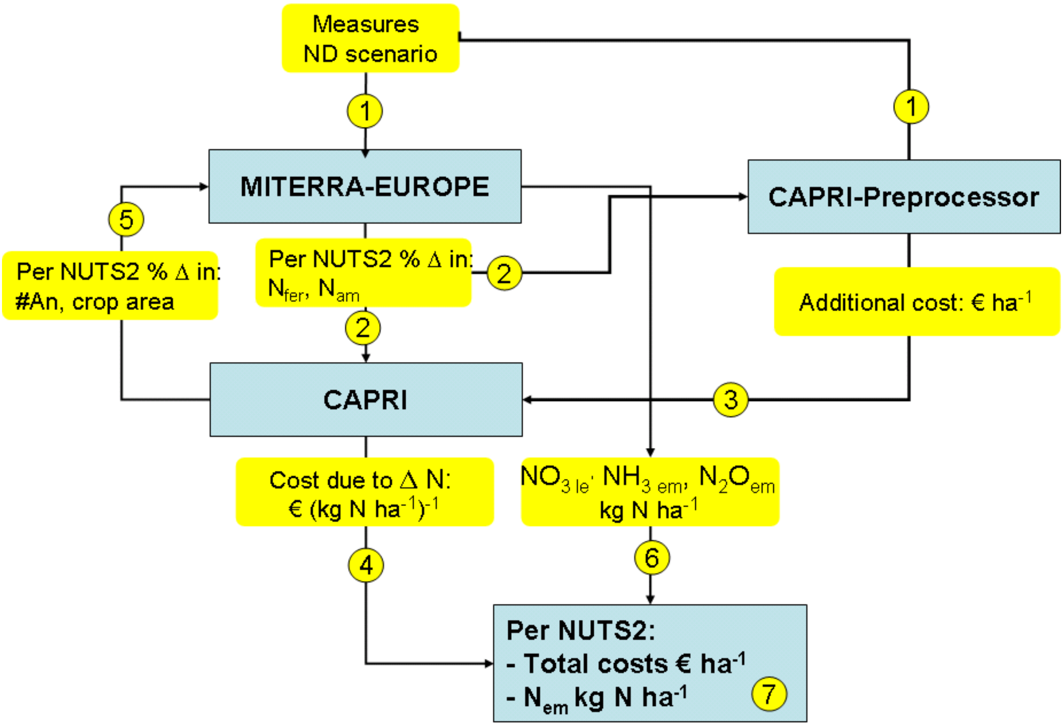
3.5.1 Input data for MITERRA Europe, EPIC and DNDC

The environmental effect indicators calculated with MITERRA, EPIC and/or DNDC focus on balances (inputs, net uptake by crops and leaching) of C, N, P and metals, including atmospheric emissions of N compounds (NH_3 and N_2O) and of CH_4. In view of these calculations, all models require at least the annual inputs of one or more of these elements by fertilizers, animal manure and biosolids (sewage sludge, compost etc). It thus implies that we always need to know the application rates and types of fertilizers (nitrogenous, phosphatic, potassic etc), animal manure (cows, pig, poultry etc) and biosolids (sewage sludge, compost etc) to assess the annual inputs of C, N, P and metals. Furthermore, information is needed on inputs by atmospheric deposition and N2 fixation in case of N. Element outputs always include net crop removal, being the product of harvested crop yield and element contents in the harvested crop, and leaching from the root zone being the product of water flux and element concentration in the water. An overview of major input data in relation to the use of the various models is given in Table 3.2.

3.5.2 Input data from CAPRI

Animal manure application rates are determined by the number of livestock and their excretion rates. Element uptake by crops is determined by the type of crop. Information on the change in livestock type and livestock numbers and also on the change in cropping patters has to come from CAPRI, based on the calculated change in fertilizer and animal manure by MITERRA Europe. A schematic overview of the interaction between MITERRA Europe and CAPRI within the CCAT prototype is presented in Figure 3.1.

Figure 3.1 Schematic presentation of the interaction between MITERRA Europe and CAPRI



Scenarios are defined, i.e. which measures are implemented and at which degree of implementation (number 1 in Figure 3.1). The implementation implies that measures are assigned to the NUTS2 regions for which they are applicable and they are parameterized in terms of changes of model parameters and/or model inputs. The degree of implementation implies the fraction of the area or farm animal share of a NUTS2 region for which the measure is applicable. Based on the selected scenario and degree of implementation, the changes in fertilizer use and manure use in %-change as compared to the reference year will be derived for all NUTS 2 regions and disaggregated at specific activity levels (number 2 in Figure 3.1). These results will be used in the CAPRI_Pre-Processor that calculates all the additional costs related the applied measures (number 3 in Figure 3.1). Given the percentage cost increases as estimated in the pre-model calculation tool, CAPRI calculates the economical effects and changes in agricultural structure (change in animal numbers and in crop area per crop type; number 4 and 5 in Figure 3.1). These are given to MITERRA-Europe, which calculates the various N fluxes, including NH_3 and N_2O emissions and nitrate leaching in kg N per ha agricultural land (number 6 in Figure 3.1)

Table 3.4 Major input data needed by MITERRA Europe (extended), DNDC and EPIC.

Indicator	Inputs needed	Unit	Models involved
General for all balances	Application rates and types of - fertilizers - animal manure - biosolids Yields of harvested crops	 kg /ha/yr ton/ha/yr ton/ha/yr ton/ha/yr	 MITERRA Europe DNDC EPIC
Nitrogen balance	N2 fixation Atmospheric N deposition N contents in fertilizers, animal manure, biosolids and crops	kg N/ha/yr kg N/ha/yr mgN/kg	MITERRA Europe DNDC EPIC
NH3 emission	NH3 emission factors/parameters	Depends on model (e.g. % of N excreted)	MITERRA Europe DNDC EPIC
N2O emission	N2O emission factors/parameters	Depends on model (e.g. % of N excreted)	MITERRA Europe DNDC
Nitrogen leaching[1]	N leaching fractions	Depends on model (e.g. % of N applied)	MITERRA Europe DNDC EPIC
Nitrogen runoff[2]	N runoff fractions	Depends on model (e.g. % of N applied)	MITERRA Europe EPIC
Carbon balance	C/N ratios in animal manure and biosolids (sewage sludge, compost etc)	-	MITERRA Europe DNDC EPIC
CH_4 emission	CH_4 emission factors per animal category	kg CH4/ha/yr	MITERRA Europe DNDC
Phosphorous balance	atmospheric P deposition P contents in fertilizers, animal manure, biosolids and crops	kg P/ha/yr mgP/kg	MITERRA Europe EPIC
Phosphorous leaching[1]	P adsorption parameters	Depends on model	MITERRA Europe EPIC
Metal balance	atmospheric Cd, Cu, Pb and Zn deposition Cd, Cu, Pb and Zn contents in fertilizers, animal manure, biosolids and crops	g/ha/yr mg/kg	MITERRA Europe
Metal leaching[1]	Metal adsorption parameters	Depends on model	MITERRA Europe
Erosion	Erosion parameters	Depends on model	EPIC

3.6 Conclusions

The models that will be used to calculate selected environmental effect indicators are MITERRA Europe, EPIC and DNDC, coupled to the economic CAPRI model. The model results will include:

- Air: Emissions of (i) ammonia in kg NH_3-N/ha/yr and (ii) greenhouse gases (GHG) N_2O and CH_4 in kg N_2O-N/ha/yr and kg CH_4/ha/yr

- Soil: Soil erosion in m3 soil/ha/yr and gross balance of: (i) C allowing to calculate the change in soil organic carbon content in the topsoil in g/kg (ii) the nutrients N in kg N/ha/yr and P in kg P/ha/yr and (iii) the metals Cd, Cu and Zn in g/ha/yr, including inputs of these metals to soil by fertilizer, manure and sewage sludge and the output by crop removal.
- Water: Nitrates in water, including leaching in kg N/ha/yr and concentrations in mg NO_3/l and possibly concentrations of metals and phosphate in water.

In the first prototype of the environmental impact tool, there is a clear emphasis on an evaluation of CC measures related to the Nitrates Directive and of selected GAECs coupled with the CAPRI-MITERRA model chain. This means that for prototype 1 all nitrogen, phosphate and carbon balances are calculated and only emission and concentrations of nitrogen in water and GHG and ammonia emission to air will be calculated. The calculations of CC effects on metal and phosphate emissions will be postponed to prototype 2. The same applies to the calculation of erosion effects and effects on soil organic carbon content of CC.

Calculations with EPC and DNDC model will be implemented for prototype 2. The selected measures in SMRs and GAECs, including the way in which effect indicators will be calculated with one or more models in the final CCAT tool, are presented in annexes of the report on the Environmental Impact Tool (De Vries et al., 2008).

4 Assessing effects of CC on land use, landscape and biodiversity

4.1 Introduction

As already stated in par. 1.3.3, we are planning to perform the following assessments for prototype1:

- An expert qualitative estimate of the effectiveness of standards for biodiversity and landscape;
- Assessments of impacts induced by predicted land use changes as a consequence of Cross Compliance;
- Impact assessments on habitat quality derived from environmental indicators.

For prototype 1, no distinction will be made between different impact fields, so the impacts will be assessed for landscape and biodiversity as a whole.

The expert qualitative estimate of the standards' effectiveness will concentrate on the standards under the selected SMRs and GAECs as specified in Section 1.2.2 (Table 1.1), and will focus on those that target the preservation of landscapes and biodiversity (Birds and Habitats Directives, and GAECs targeted on habitat/landscape preservation, including e.g. measures against soil erosion).

For the other two impact assessment types only the effects of the standards addressed by the CAPRI/MITERRA prototype 1 models can be taken into account, since these form the input for these assessments. In relation to the SMRs this will only include the effects of the Nitrate Directive and for GAECs all standards will be included for as far as assessed with the CAPRI and MITERRA models in prototype 1 (see also Chapters 2 and 3 and Deliverables 4.1.1 and 4.2.1).

The scientific state-of-play underpinning the interpretation of the land use and environmental indicators in terms of pressures on biodiversity and landscape is given in D 4.3.1

How these assessments are performed is discussed briefly in the next sections and in more detail in Deliverable 4.3.1.

4.2 Approach to estimate the effectiveness of standards for biodiversity and landscape

The effectiveness of standards for biodiversity and landscape will be estimated through an analysis on the basis of expert knowledge. First the intrinsic potential effectiveness of standards will be specified in the following qualitative way:

+++: Standards targeting explicitly species or landscape features.
++: Standards targeting elements related to habitat/landscape quality
+: Targeting to preserve habitats/landscape in a general or subtle way

0: No expected impact (not a probable relationship).
-: Negative impact expected on biodiversity (not a probable relationship).
?: No clear relationship.

This qualitative analysis of the standards will be done based on the short names contained in the CCAT/CIFAS database. These short names synthesise the detailed standards implemented in the surveyed MS/Regions on the basis of their similarities (see Schramek et al., 2007 for further details).

The next step will be to use the *regional share of UAA, or the share of a specific land use to which the standard is targeted (e.g. olive groves)* to weight the potential effectiveness per NUTS2. The logic is that the greater the UAA, where the standards are to be implemented, the higher their potential effect on biodiversity will be. Both, share of UAA and absolute hectares of UAA at NUTS2 level will be used as weighting factors, reflecting respectively the magnitude and the extend of the potential effects.

To come from a *potential* effectiveness to an estimate of the *expected* effectiveness the *level of compliance* is introduced in the analysis. This is done by using the data delivered by WP3 on the land use share per NUTS 2 region estimated to be compliant with different standards under 3 different scenarios of compliance. If it turns out to be problematic to estimate shares of compliance for certain standards per land use category we will work with the regional average compliance levels for all land uses.

4.3 Approach of the land use based assessments

In prototype 1 we will perform the following assessments of impacts induced by predicted land use changes as a consequence of Cross Compliance:

- change in share of intensive/extensive land use
- change in density and share of intensive/extensive livestock
- change in land use diversity (evenness)

These indicators will be calculated at NUTS 2 level using the output of CAPRI/MITERRA models (see Chapters 2 and 3). They will be used as pressure indicators on biodiversity and landscape. Agricultural intensification is one of the main drivers of biodiversity loss in the European agricultural habitats and loss of landscape features and diversity (see D 4.3.1). In this sense, the interpretation of changes in the value of the land use indicators will be based on the idea that the higher the share of extensive land uses, extensive livestock densities or land use evenness, the better for biodiversity and landscape.

Contrary to the case of the potential effectiveness approach, compliance levels are already internalised in the calculation of the land change by the CAPRI/MITERRA models.

The procedure for calculating these indicators will be described in short below and further detailed in D4.3.1.

Change in share of intensive/extensive land uses

To assess the impacts the present share of intensive/extensive land uses (the situation for the baseline year (2005) needs to be compared with (modelled) future patterns after e.g. an expected level of increase in Cross Compliance. Then it can also be derived where and in what degree an increase in extensive land use can be expected, leading to an expected improvement in habitat quality and landscape structure.

The input data for this assessment comes from the CAPRI database, which specifies 35 different land use categories (for the base line situation which is 2005) and the CAPRI model output for the future situations. CAPRI assesses the response of farmers in relation to CC standards and translates this response in a change in land use per NUTS 2. CAPRI works with the same land use classes as in FSS which includes 34 different crops and permanent grassland.

These land use classes will be classified in intensive and extensive categories, taking ecological principles into account. Certain crops are intensive per definition, in the sense that they are always managed under high levels of chemical inputs, including fertilisers, herbicides, plant protection products and irrigation (e.g. maize, potatoes, sugar beet, most vegetables). Some others nevertheless can be managed under intensive or extensive practices (e.g. wheat, rye, rice). Therefore, a previous assessment needs to be made to determine whether a particular crop belongs to the intensive or the extensive modality. Information on other input levels can be derived from the pre-model CAPRI input data which include estimates on input levels for different crops both in terms of artificial fertilisers, agro-chemicals and irrigation since such information is needed to make realistic estimates of the production costs per crop, per region. The information on fertiliser input levels per crop type per region are delivered by MITERRA to CAPRI as is explained in Chapter 2 and 3. .

Change in density and share of intensive/extensive livestock

For assessing the effects on the livestock density indicator the input comes from the present livestock patterns and the by the CAPRI model predicted changes in livestock mix and numbers.

The indicator LU/ha UAA will be directly used for certain livestock types (LU) considered always intensively managed, such as pigs and poultry. Therefore figures of LU of pigs and poultry per ha UAA at NUTS2 will be added directly to the "intensive pool".

But other types of livestock, such as dairy, beef, sheep and goat, can be managed either in an intensive or extensive way and therefore an estimation of their intensity needs to be made in advance. A decision on which indicators will be used for this estimation is still to be made. Potential indicators considered are LU/ha UAA, LU/ha of fodder and milk yield per cow which can again be derived from the pre-model input data from CAPRI (see Chapter 2).

Change in land use diversity (evenness)

For this assessment the land use classes used in the CAPRI model will be classified according to similarity of structure and appearance. We are considering the following three classes on the basis of EUROSTAT definitions: arable crops, permanent crops, grasslands/set aside/fallow land.

First the share of CAPRI agricultural land uses will be computed at NUTS2 level for the baseline situation and the scenarios. Then these will be aggregated per NUTS2 into the 3 classes mentioned above and the evenness will be calculated of these 3 classes for each scenario (see D4.3.1). The evenness of the compliance scenarios will be compared with the baseline evenness. From this it can be derived where and in what degree an increase in land use diversity can be expected, assuming this will lead to an higher landscape diversity, and an higher biodiversity.

Since CAPRI only predicts changes in agricultural land, this indicator relates exclusively to the agricultural components of the landscape, independently of the quantitative and spatial contribution that other landscape components (e.g. forest, shrubs, unproductive, water, marshes, etc.) might have to the entire picture.

4.4 Approach to assess impacts on habitat quality derived from environmental indicators

The following environmental indicators will be used for this prototype 1 impact assessment:

- Air: Emissions of (i) ammonia in kg NH_3-N/ha/yr
- Water: Nitrates in water, including leaching in kg N/ha/yr and concentrations in mg NO_3/l

It will be assumed that the higher the modelled quality, the better for biodiversity. The interpretation of changes in the environmental qualities will be based on the idea that an increase in environmental quality (above a certain level, which still needs to be defined), will lead to an improvement of biodiversity.

Contrary to the case of the potential effectiveness approach, compliance levels are already internalised in the calculation of environmental indicators in the CAPRI/MITERRA models who’s output is used here.

The way these indicators will be computed has been further outlined in Chapter 3

5 Assessing effects of CC on animal welfare and public health

5.1 Introduction

In area of public health and animal welfare some specific problems are faced: for public health the impact of the relevant standards 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. A combination of desk research and case-study should help to at least recover part of the desired information

5.2 Characterisation of selected indicators of animal welfare and public health

In the first prototype of the tool only EU-wide indicators (at European scale) will be involved. Therefore only 6 of the already selected indicators will be implemented :

- **WHO:** Environment and health indicators: Incidence rate for all type of food-borne illness, food-borne infections & intoxications per 100000 population: The indicator data is available on European level (EU 15 and EU 25) and on national level (NUTS0: 25 Member states with few data gaps).
- **Eurostat:** Indicators of public health: Occurrence of salmonellosis: The indicator data is available on European level (EU 15 & EU 25) and national level (member states EU 25).
- **Eurostat:** Indicators of public health: Government investments in food safety measures: The indicator data is available in most Member states (NUTS0) of the EU 15. They can be aggregated on European Level.
- **Own developed indicator data:**
    - **Number of offspring per sow/cow per year:** Reliable indicator data on NUTS0-level is available in the CAPRI data base up to the year 2004. On NUTS2-level the CAPRI data is not reliable. Moreover there is Eurostat data available up to the year 2007.
    - **Average milk yield per cow per year (l/cow):** Reliable indicator data is available in the CAPRI data based on NUTS0, NUTS1 and NUTS2

level until the year 2004. Further data is available in the Eurostat database up to the year 2006.

- **Degree of compliance**: Data from the IEEP-Project „Evaluation of the application of cross compliance as foreseen under regulation 1782/2003“ can be used. This data includes in addition to the total numbers of SMR inspections and breaches the proportions of breaches by SMR on NUTS0 level.

A more detailed description of the survey specifications of the indicators to be used in the first prototype of the tool is given in the following table 5.1:

Table 5.1: Survey specifications of the indicators to be used in the first prototype

Area	Indicator framework	Indicator	Survey	Spatial level	MS /regions	Data source	URL for data source
Public health	WHO: Environment and health indicators	Incidence rate of food-borne illness, infections and intoxications	Annual (1987-2005)	NUTS 0	EU 15 / EU 25 (with few data gaps)	WHO	http://data.euro.who.int/hfadb/
	Eurostat: Indicators of public health	Government investments in food safety measures	Annual (1991-2006)	NUTS 0	EU 15 (few exceptions)	Eurostat	http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=EU_MASTER_food_safety&depth=2
		Occurence of salmonellosis	Annual (1995-2005)	NUTS 0	EU 15 & 25		http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=de&product=sdi_ph&root=sdi_ph/sdi_ph/sdi_ph_foo/sdi_ph1300
	Own development	Degree of compliance	Annual (2005-06)	EU 25 (few gaps), NUTS 0	Austria, Belgium (Flanders, Wallonia), Germany, Denmark, Greece, Spain, Finland, France, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Sweden, SI, England, Scotland, Slovakia, Hungary, Latvia, Estonia, Cyprus, Northern Ireland, Wales	IEEP	http://www.ccat.nl/UK/
Animal welfare	Own development	Degree of compliance	See above	See above	See above	See above	http://www.ccat.nl/UK/
		Milk yield	Annual CAPRI	CAPRI: NUTS0-2 /	EU 25	CAPRI / Eurostat	http://epp.eurostat.ec.europa.eu/por

			(-2004) Eurostat (2005.06)	Eurostat: NUTS0			tal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/E/E1/E12&language=de&product=Yearlies_new_agriculture&root=Yearlies_new_agriculture&scrollto=0
		Number of offspring	Annual CAPRI (-2004) Eurostat (2005-07)	CAPRI: NUTS0-2 / Eurostat: NUTS0	EU 25	CAPRI / Eurostat	http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/E/E1/E12&language=de&product=Yearlies_new_agriculture&root=Yearlies_new_agriculture&scrollto=0

Given that the indicator “degree of compliance” which specifies the proportions of breaches by SMR only refers to the legal acts No. 1-8a (environmental issues, registration of farm animals), it is necessary to translate its values into the SMRs of the legal acts No. 9-18 as well as the Regulation (EC) No. 852/2004 that are focussed on the issues of public health or animal welfare.

The “degree of compliance” with legal acts / SMRs depends among others on the existing costs of compliance, the quality of the monitoring system (first of all the control frequencies) and the probability to uncover breaches respectively. It will be tried to gather in an indirect way some information that could be helpful in making a best estimate of compliance, be it necessarily a tentative one. For example, we will estimate the cost implications for compliant farms in several EU countries based on secondary information (desk study review of existing literature and grey reports) as well as a case study. When this information is available, and relying on an economic approach to compliance, legal acts / SMRs that have the same or similar cost implications could for example be assumed to lead to a similar “degree of compliance” with the mandatory standards and thus to similar proportions of breaches by SMR.

Clearly, this approach holds several problems. Because of the incompleteness of the existing data it is very difficult to estimate the proportions of breaches. For the regulation (EC) No. 852/2004 to be involved are even no figures available. Another problem is the use of the categories of evaluation (empty cell, - , +, ++) to describe the level of cost implications in the study, that leads due to a rough classification to a very limited comparability of the legal acts and SMRs respectively[16]. Another problem might be the weak statistical correlation between the “degree of compliance”

[16] The weighting of the “degree of compliance” data for the legal acts No. 9-18 as well as the regulation (EC) No. 852/2004 is described in more detail in the Annex II of the deliverable report 4.4.1.

data and the categorical cost implications. According to some first very provisional analysis, where a correlation coefficient of r=0.35 was found, this correlation is low. However, further research on this is needed before drawing conclusions. (For further details about an indicator approach to explain compliance see Deliverable 4.1.1.).

5.3 Links between SMRs and selected indicators

The relations between the SMRs to be assessed and the selected indicators of the first prototype are presented in the following Table 5.2:

Table 5.2 Links between the SMRs and the indicators of the first prototype

Selected indicators for prototype 1	Legal acts	SMRs
WHO: Incidence rate of food-borne illness, infections and intoxications	Regulation (EC) No 178/2002 of the European Parliament and of the Council	Forbidden to have, process or feed unhealthy feed
Eurostat: Government investments in food safety measures	Animal Registration Directive: Council Directive 92/102/EEC	Registration of farmers keeping animals
Eurostat: Occurence of salmonellosis	Regulation (EC) No 178/2002 of the European Parliament and of the Council	Forbidden to have, process or feed unhealthy feed
Own development: Degree of compliance	All selected legal acts	All selected SMRs
Own development: Milk yield	Regulation (EC) No 852/2004 of the European Parliament and of the Council	Correct use of feed additives, veterinarian drugs, pesticides
		Control contamination
Own development: Number of offspring	Regulation (EC) No 852/2004 of the European Parliament and of the Council	Correct use of feed additives, veterinarian drugs, pesticides
		Control contamination

Whereas the connections between the indicators and the SMRs appear to be rather vague or indirect, the selected indicators represent the only existing data that is available in the fields of animal welfare and public health.

The central issue of the indicator selection is their appropriateness to assess the impacts of the European CC-policy. In the case of the WHO-indicator "incidence rates of food-borne illness, infections and intoxications" and the Eurostat-indicator "occurrence of salmonellosis" it is difficult to establish a connection to the impacts of CC. Changes in incidences of infections diseases and salmonellosis rates depend among many other factors on the quality of the existing national monitoring system and the number of controls respectively. Better controls would therefore lower the incidence rates and the number of salmonellosis cases.

Thus we will involve the Eurostat-Indicators "Government investments in food safety measures" as well as "controls and inspections of food and feed" (data of this indicator will be published in beginning of 2008). Additional to the degree of compliance this data would give us a feedback of the quality of the national food monitoring systems, so that we will be able to separate the influence of the monitoring system from the potential impacts of Cross Compliance. This would mean that we are using the existing indicator data as reference for the state indicators ("cross check").

5.4 Assessment of effect indicators of animal welfare and public health

Whereas the indicator data for the first prototype of the tool is available on European level most of the indicator data for the second prototype will be assessed locally. The assessment specifications of the selected indicators for the first prototype are given in the following table 5.3.

Table 5.3: Assessment specifications of the selected indicators of the 1. prototype

Selected indicators for prototype 1	Dimension of indicators	Availability of data	Scientific significance
WHO: Incidence rate of food-borne illness, infections and intoxications	Number of cases per hundred thousand population and year	Digital	Significance for public health is obvious
Eurostat: Government investments in food safety measures	million € / year	Digital	Significance for public health is obvious
Eurostat: Occurence of salmonellosis	Occurrence per 100000 people and year	Digital	Significance for public health (KRÄMER, 2002; MÜLLER et al., 1996)
Own development: Degree of compliance	Proportion of breaches by SMR / Breaches as a percentage of inspected farms / Percentage of non-compliant farms per year	Paper	Significance for public health and animal welfare is obvious
Own development: Milk yield	Milk yield per cow per year (kg/cow)	Digital	Significance for animal welfare (ROUSING et al., 2000 & 2002; VON BORELL & VAN DEN WEGHE, 1999)
Own development: Number of offspring	Number of offspring per cow / sow per year	Digital	Significance for animal welfare (HÖRNING, 2004)

Where the first three indicators might be self-evident and not in need for further motivation, some additional remarks about the last two (milk yield and number of offspring) are appropriate.

As regards the inclusion of the milk yield per cow as an animal welfare indicator, the intuition is that the occurrence of udder diseases (e.g. mastitis) causes physical suffering of the cows and it also leads to a reduction of the milk yield in comparison to the potential yield under normalized or healthy conditions. Given that in most cases udder diseases are a result of poor hygienic conditions the annual milk yield of a cow can be used as performance and response indicator for animal welfare.

A final performance indicator that will be used in the Prototype 1 tool for assessing animal welfare is the number of offspring per cow / sow and year. Under poor animal welfare conditions the reproductive instinct of farm animals is reduced as compared to normalized conditions. It is realized that these 'normalized conditions' can vary over member states partly because of differences in farming practices, genetic quality, and entrepreneurship.

As regards the milk yield and number of offspring indicators further work will be done to check whether it is possible to construct meaningful indicators from this. An important issue will be whether a reliable proxy for the normalized conditions can be found, i.e. the baseline against which deviations have to be measured. More details and final conclusions will be discussed in Deliverable 4.1.1.

5.5 Baseline situation against which effects on animal welfare and public health can be measured

To assess the impacts of the European CC-Policy we have to select a reference year before the implementation of the CC-system in the area of public health and animal welfare. To define a time-referenced baseline of the study it is also important to compare the temporal data availability of the selected indicators with the quality of their figures. Moreover we should prefer newer data to older data. Considering these criteria the best choice would be 2005 as the reference year.

5.6 Case study research

5.6.1 General procedure

To get sufficient reliable information about the farmer´s behaviour in the fields of animal welfare and public health a desk study and an in-depth case study will be conducted. The desk study aims at surveying the existing literature and detail studies done in this field at member state level. It will include both officially published and grey literature. Based on this a general and systematized picture of the state of the research will be made. It is hoped for that this will provide further insight into the available data, as well as into the existing heterogeneity between member states. This latter info will be useful when attempts will be made to generalize assumptions based on case study information.

The desk study includes surveying the current literature on animal welfare and public health. This information will be scanned and be brought into a more general framework, allowing for a systematic comparison of results over member states. This study will also help to identify gaps in the information, which might be of use in further specifying the case study set-up.

Whereas the desk study aims at existing literature and studies at member state level, the in-depth case study to be conducted in Austria will provide the following specific types of information:

- **Standard of animal welfare:** Specific interview-based (interviews of the farmers and experts) and practical (e.g. the ANI) assessments of important animal welfare issues
- **Standard of public health**: Interview-based assessments of important public health issues (e.g. traceability of feed in all stages of production)
- **Memberships in certification schemes:** The membership in certification schemes (also used as an indicator for animal welfare and public health) gives relevant and detailed information about the quality of animal welfare and the applied measures to improve public health. This is an important criteria for the creation of the different scenarios
- **Farmer's level of knowledge of "Cross Compliance":** Interview-based assessments that will focus on the farmer's point of view. Its results will be used as criteria for the creation of the scenarios
- **Compliance behaviour of the farmers:** Interview-based assessments of the farmer's attitude and behaviour concerning the European "Cross Compliance" policy
- **Costs of compliance:** As the expected main influence of the farmer's compliance behaviour the determination of the costs of compliance is crucial for the project. Their assessment will be interview-based
- **Farming systems:** The type farming system plays an important role especially for the standard of animal welfare. It will be used as criteria for the creation of scenarios
- **Effectiveness of the monitoring system:** Assessments that base on interviews with the farmers on local experts
- **Animal welfare requirements:** Additional interview-based information from local voluntary certification standards
- **Other relevant farm conditions:** Interview-based assessments of farm conditions that will be used as criteria for the creation of scenarios (e.g. live stock, type of farm animal, animal density, …)

The general procedure to be applied in this case study is focussed on the development of farm scenarios. See for a further description of the working steps involved Table 5.4 below.

Table 5.4: Working stages of the case study

Stages of the case study research	Working steps
1. Design of the case study protocol	a) Determination of the required skills
	b) Determination of the analysis approach

	c) Develop and review of the protocol
2. Conduction of the case study	a) Preparation for the data collection
	b) Distribution of the questionnaire
	c) Conduction of the interviews
3. Analysis of the case study Evidence	a) Appliance of the analytic strategy
	b) Creation of different scenarios on the basis of existing and assessed indicators
4. Development of conclusions, and implications based on the evidence	a) Application of the different scenarios as a reference for the other case regions
	b) Desk research for the other case regions / member states

The collection of topic-related data is the basis of case studies. But it can also be a major source of error. Therefore it first has to be ensured that the used data is reliable. The case study in the fields of animal welfare and public health will be based on the following sources of information:

- **Pre-existing indicator data:** Especially in the field of public health existing indicator data is available (existing data on desk research and previous info on the case study)
- **Data of own developed indicators:** Most of them derive from indicator data gathered in the CAPRI model database
- **General, structural, country-specific and problem-based information:** Relevant case study information e.g. the rural development plans or the "costs of compliance" derived from the LEI-project
- **Interviews:** For the case study assessments the choice of the adequate interview type plays an important role. For this case study targeted, semi-standardised Interviews will be passed. By focussing on different topical priorities they provide a differentiated view of the topic. The interviews will base on tailor-made questionnaires which refer to the different points of view and the specific knowledge of the interviewed persons
- **Direct observations (e.g. ANI):** The investigator makes a site visit to gather data. The observations could be formal or casual activities, but the reliability of the observation is the main concern. Using at least two observers is one way to guard against this problem

Based on the detailed information coming from the case study it will also be tried to further explore the possibilities to assess the effectiveness of the animal welfare standards.

In order to gain additional as well as reliable information without becoming dependent on a single informant the case study will be passed on three different levels of measurement. In addition to the farm-level assessments, there will be interviews with experts of local food monitoring authorities and certification companies which have wide experience in controlling the compliance with certain standards in the fields of animal welfare and public health. By seeking the same data from other sources we can verify its authenticity. The following diagram provides an overview of the different measurement levels of the case study:

Diagram 5.1: Measurement levels of the case study

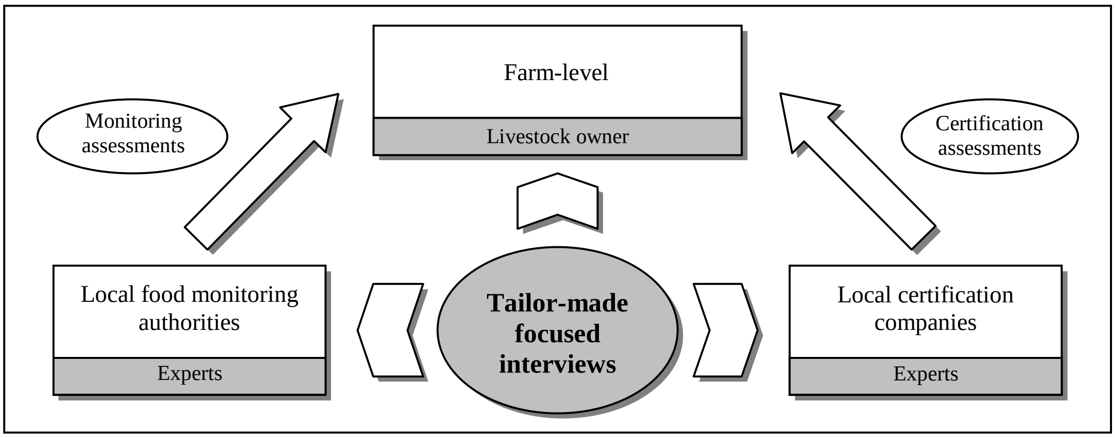
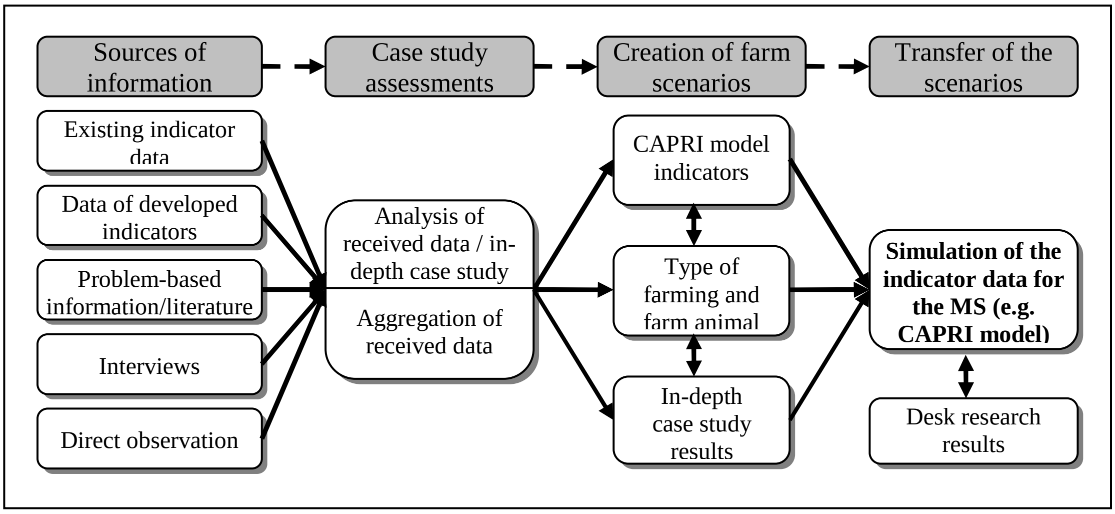


Diagram 5.2: Overview of the methodology of the case study



Whereas the interviews and interview-based assessments will be the most important sources for the case study information, existing and own developed (e.g. on the basis of the CAPRI model) indicator data as well as country-specific, general, structural and problem-based information will be used as cornerstones to create different scenarios which will be used as reference for the other case regions regarding their different conditions. This procedure enables a better comparability of the case study results with the help of the CAPRI model. In diagram 5.2 a short overview of the methodology to be applied for the case study is given.

The choice of farm scenarios to be used for the case study should be restricted to a total number of two to six scenarios. Whereas the scenarios should address to the different farm conditions, they base on the available indicator data.

5.6.2 Selection of Styria as case region

The choice of the member state in which the in-depth case study will be passed is a crucial point of the case study design. The main reasons for the selection of Austria are mentioned in the following:

- **High number of organic farms:** Austria has with 11.9 % the highest proportion of organic farms in agriculture in Europe (Lebensministerium, Austria, 2007). Because it is usually illegal for a non-certified farm to call itself or its product organic, the membership in certification schemes (also used as an indicator for animal welfare and public health) gives relevant and detailed information about the quality of animal welfare and the applied measures to improve public health.
- **High standard of animal welfare:** At international level Austria takes a unique position concerning animal welfare efforts. As cutting-edge especially in the field of animal welfare assessments it has already an animal welfare track record which makes it worthwhile to further explore it as a case region. There is also plenty information about relevant research projects available which can be used for the desk study part.
- **Region of intensive and extensive farming practices:** Austria offers a mixture of extensive and intensive animal husbandry. This allows an assessment of farms ranging from extensive to intensive farming practices.
- **Cooperation with the AREC Raumberg-Gumpenstein:** As the biggest agency of the Ministery for Agriculture and Forestry, Environment and Water Management of Austria the AREC Raumberg-Gumpenstein is the centre for research and education of the rural society. As developers (Prof. H. Bartussek) of the Animal Needs Index (ANI), which became in 1995 the official system for assessing housing conditions in terms of animal welfare for organic farms in Austria they have the right expertise, experience and contacts to local authorities and certification companies that are crucial for the case study assessments. They would conduct the surveys for us at least in the field of animal welfare and evaluate the assessments of the ANI.
- **Available indicator data:** Especially in the area of animal welfare the availability of indicators is very restricted. The selection of Austria allows the application of the ANI and its existing data without paying a license fee. In the field of public health Austria offers an above-average data availability for the respective indicators.

Within Austria there are several regions which are suitable as case regions. The choice of Styria offers many advantages. These are mentioned in the following:

- **Styria has the highest number of pig farms in Austria (Statistik Austria, 2007)**
- **Styria has the second highest number of cattle farms in Austria (Statistik Austria, 2007)**
- **Low travel expenses:** Because of the localisation of the AREC Raumberg-Gumpenstein in Styria, the expenses for travelling are reduced to a minimum.

- **Low survey expenses / personnel costs:** In addition to the travelling expenses the expenditure of time for the travelling and the survey assessments is minimised.

5.7 Conclusions

As final conclusions of this chapter we can point out the following aspects:

- For the first prototype of the tool we will select the following indicators:
  - **WHO:** Incidence rate of food-borne illness, infections and intoxications
  - **Eurostat:**
    - (1) Government investments in food safety measures
    - (2) Occurrence of salmonellosis
  - **Own development:**
    - (1) Degree of compliance
    - (2) Number of offspring
    - (3) Milk yield
- The existing “degree of compliance” data derived from the IEEP project “Evaluation of the application of Cross Compliance as foreseen under regulation 1782/2004” only refers to the legal acts 1-8a which are focussed on environmental and animal registration issues. Due to the existing requirement-specific data problems the best option is to weight the indicator data for the respective countries by calculating the arithmetic average of the proportions of breaches for several sub requirements. The results will be used as characteristic “degree of compliance”-values for the SMRs of the relevant legal acts.
- that the existing “degree of compliance” data of IEEP project “Evaluation of the application of Cross Compliance as foreseen under regulation 1782/2004” only refers to the legal acts 1-8a which are focussed on environmental and animal registration issues. Therefore the indicator data will be estimated for the legal acts / SMRs in the fields of animal welfare and public health. Reference points for the estimation will be the “costs of compliance” that have been assessed in the LEI project as well as existing studies.
- In the case of the WHO-indicator “incidence rates of food-borne illness, infections and intoxications” and the Eurostat-indicator “occurrence of salmonellosis” it is difficult to establish a connection to the impacts of CC. Because the indicators also depend on the quality of the monitoring we will involve the Eurostat-Indicators “Government investments in food safety measures” as well as “controls and inspections of food and feed” (data of this indicator will be published in beginning of 2008) and use them as a reference for the state-indicators.

- The year 2005 will be used as baseline situation
- An in-depth case study will be conducted that provides specific topic-related information and a desk study that aims at surveying the existing literature and detail studies done in this field at member state level. The latter will include both officially published and grey literature. Based on this a general and systematized picture of the state of the research will be made
- Styria in Austria will be selected as case region
- The case study assessments in Styria will be conducted on different measurement levels. In addition to the farm-level assessments, there will be interviews with experts of local food monitoring authorities and certification companies.
- Farm scenarios will be created (e.g. with the help of the CAPRI model) which will be used as reference for the other case regions regarding their different conditions.
- The time period of the case study assessments will be January and / or February 2009

6 Discussion

The objectives of the CCAT project should be broader then only assessing the effects of Cross Compliance. CC policy operates mainly as an additional enforcement mechanism for existing legislation and as such CC might improve the degree of compliance to standards because it acts as a leverage to the enforcement system. However, the GAECs were introduced with CC policy and their impacts can thus be directly attributed to CC. This project will therefore focus especially on identifying the changes in compliance with SMR and GEAC standards since the implementation of CC in 2005 and on assessing the impacts of additional compliance with both SMR and GEAC standards.

With the limited tools, data and knowledge it is clear that we cannot ensure that all effects of all standards can be assessed. Choices have therefore been made in this first year for those SMRs and GAECs and related effects of which real effects can be expected and measured with our tools and data available.

An important aim of the project is also to assess to what extend we are removed from reaching full implementation of all SMRs and GAECs and what would the impact be on the different impact fields to reach this full compliance.

Effects of CC are not only related to improved compliance (enforcement mechanism) with standards but also lead to improvement of quality (in relation to e.g. environment, biodiversity, landscape, animal welfare, public health).

Some standards directly address farmers (e.g. Nitrate Directive) while others have much wider target group (e.g. Birds and Habitats Directive). For the latter it is more difficult to estimate effects of the standard itself. More attention will therefore be paid within CCAT to assessing the effects of standards that directly address the farmer and farmland.

Given the need to focus, the outcome of the Cross Compliance project and other bilateral discussions with individual CCAT partners and WP leaders it was decided that the ambitions for assessment in the first prototype should be limited. The first prototype should be ready by October 2008 and the second and last prototype by month 34 (October 2009). Prototype 1 will include impact assessments of a selection of standards while for prototype 2 practically all standards will be included. In Table 1.1 an overview is given of the standards and the selected impact fields they will be assessed for in prototype 1 and prototype 2. From this overview it becomes clear that assessments in prototype 1 will only be done at national or Nuts 2 level, while in prototype 2 the assessment will also be done at below administrative boundary levels, such as within bio-physical entities such as environmental zones, sensitive areas such as High Nature Value (HNV) farmland either EU wide or within selected case studies.

For the calculation of environmental impacts this means that in prototype 1 only the MITERRA-Europe model will be integrated in the model component, while the assessments with the EPIC and DNDC models will be only integrated in the prototype 2. The reason for this is the scale of assessment which is at grid and Homogeneous Spatial Mapping Unit level. The exclusion of EPIC and DNDC assessments also explains why soil impacts (e.g. erosion, soil organic matter) will not be assessed in prototype 1. In spite of this, it does not imply that work on further adaptation and improvement of the EPIC and DNDC models for assessing the effects of CC standards has not started in the first year of the project.

Prototype 2 will basically be an extended form of prototype 1, where we will refine the assessments to a more spatially detailed scale (below Nuts 2 level) and we will concentrate on several case study assessments which allow the incorporation of more detailed information especially enabling the estimation of impacts in the fields of animal welfare, public health, landscape and biodiversity for which detailed EU wide information is not available. Case studies will also be used for fine-tuning and calibrating and/or testing the plausibility of the assessments on other impact fields, especially the ones on water, soil, air and climate.

As regards to compliance levels to be assessed it is clear that it does not make much sense to analyse the case of 0% compliance, whereas most farmers already comply at a much higher rate. Most likely it is simply impossible to enforce a zero degree of compliance as no data are available on such a theoretical situation. Instead it is proposed that the starting point of all assessments should be a 2005 compliance level, which is the baseline against which all other compliance levels can be compared. This level will entail a very varied situation in which different regions and different farm types have different baseline compliance levels. Other compliance levels to be assessed for prototype 1 are a 75% and a 100% Compliance level. In prototype 2 new compliance levels might be introduced.

Estimates of the 2005 compliance levels can partly be derived from other studies (e.g. the IEEP evaluation study and the Cross Compliance project estimates). However, where this information is missing, which is most strongly the case for all animal welfare and public health related SMRs, own estimates will need to be made.

The backbone of the prototype 1 is made up by the CAPRI and MITERRA models. These models, which are different in nature (economic/environmental) have to be linked. A procedure for this is generated and described which takes care of preserving behavioural consistency at one hand and at the best exploits the strong points of each of the models (e.g. CAPRI in explaining the behaviour of farmers with respect to input-output decisions as a response to market signals; MITERRA in explaining nutrient balances as a function of manure applications, animal activities, crop allocation and soil and groundwater table conditions) at the other hand.

As regards the **economic** indicators the CAPRI part of the tool is able to provide the necessary information, without the need to adjust the model (except for adding some derived calculation rules). A pre-model calculation tool has been developed which is argued to be able to supply this information. From a technical point of view an adequate solution is found and described to analyse the Nitrate Directive and Identification and Registration Directives. The main challenge is now at the empirical side, i.e. determining the costs of compliance as well as creating best-estimates of compliance for the base year. Because no information is currently available about observed improvements in compliance (for example as induced by the cross-compliance enforcement mechanism), improvements in compliance will be analysed scenario-wise by specifying different rates of improvements as compared to the base year 2005.

The MITERRA part of the CCAT-tool includes all **environmental** aspects that can be quantified in a reasonable way on a European wide scale. For prototype 1 all nitrogen and carbon balances and emission and concentrations of nitrogen in water and GHG and ammonia emissions to air will be calculated. The calculations of CC effects on emission of metal and phosphates will be postponed to prototype 2. The same applies to the calculation of erosion effects and effects on soil organic carbon contents of CC. The impact of cross-compliance measures on pesticides is not included in the integrated environmental modelling framework.

With respect to **biodiversity and landscape**, the Prototype 1 tool will contain an expert qualitative estimate of the effectiveness of standards for biodiversity and landscape, an assessments of impacts induced by predicted land use changes as a consequence of compliance to standards, and an impact analysis on habitat quality derived from environmental indicators. The impacts will be assessed for landscape/biodiversity as a whole. The expert qualitative estimate of the standards' effectiveness will concentrate on the standards under the selected SMRs and GAECs and will focus on those that target the preservation of landscapes and biodiversity (Birds and Habitats Directives, and GAECs targeted on habitat/landscape preservation).

Since **public health and animal welfare** are mainly related to the way the production processes are organized rather than to the amount of production factors used, applied input mix and produced output mix and output levels, their linkage to the CAPRI-MITERRA model is also rather indirect and often not existing. Therefore a more independent approach is proposed, which focuses on a selected number of aggregate indicators for which either their specification relies on already available data collected for whole EU (EUROSTAT or WHO) or for a selection of Member States, or which have the potential to be linked to the model-tool. In addition it was also decided to further extent the research on this theme according to two lines: a desk study of the existing literature as well as an in-depth case study.

References

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

Batie and Sappington (1986), Cross-Compliance and a soil conservation strategy: A case study. American Journal of Agricultural Economics. Vol 68, no.4, p. 880-886.

Boatman, N., Stoate, C., Gooch, R., Rio Carvalho, C., Borralho, R., Snoo, De G., Eden, P. (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.

Brouwer, F. & B.A. McCarl (Eds.) (2006), Agriculture and climate beyond 2015: a new perspective on future land use patterns. Dordrecht, Springer.

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

De Roest, K., E. Corradini and F. Brouwer, eds. (2006): D7: Framework for analysis of the cost of compliance. Reggio Emilia, CPRA (Deliverable 7 of Project no. SSPE-CT-2005-006489 CROSS-COMPLIANCE; Facilitating the CAP reform:Compliance and competitiveness of European agriculture; Specific Targeted Research or Innovation Project (STREP);Integrating and Strengthening the European Research Area).

De Vries, W., H. Kros, P. Kuikman, G. Velthof, J.C. Voogd, R. Wieggers, K. Butterbach Bahl, H. D. van der Gon & A. van Amstel (2005), 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, G. Velthof ,D. Oudendag, R. Jongeneel, A. Leip, M. van der Velde and M. Kempen, 2008. *Development and application methodology of environmental impact tool to evaluate cross compliance measures. EU Strep CCAT Deliverable 4.2.*

EEA (European Environment Agency) (2005). *Agriculture and environment in EU-15 – the IRENA indicator report*. European Environmental Agency, Copenhagen.

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.

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.

Heckelei T. & W. Britz (2001): "Concept and explorative application of an EU-wide regional agricultural sector model (CAPRI-Projekt). In: Heckelei, T., H.P. Witzke &

W. Henrichsmeyer (Eds.). Agricultural Sector Modelling and Policy Information Systems. Proceedings of the 65th EAAE Seminar, 29-31 March, 2000. Bonn University, Vauk Verlag Kiel, Germany, pp. 281-290.

Jongeneel R, and Elbersen B. (eds.) (2007) Deliverables 2.1 and 2.2: General approach to the assessment of the impacts of CC in the EU and list of indicators. CCAT project.

Jongeneel, R. and F. Brouwer (2007): Compliance with regulations and standards in European agriculture vis-à-vis its main competitors; a comparative overview and competitiveness impact assessment. Paper presented at the Conference on the Science and Education of Land Use: A transatlantic, multidisciplinary and comparative approach, September 24-26, 2007 Washington DC.

Primdahl, J., Peco, B., Schramek, J., Andersen, E. & J.J. Onate (2003), Environmental effects and effects measurement of agri-environmental policies. Journal of Environmental Management, 67: 129-138.

Schramek, J., Sommer J., Andersen, E., Mikk, M., Oñate Rubalcaba, J., Peepson, A. (2006): Study on Environmental Cross-compliance Indicators in the Context of the Farm Advisory System – CIFAS. Final report. Institute for Rural Development Research (IfLS) Frankfurt am Main.

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.

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.