seamless

System for Environmental and Agricultural Modelling; Linking European Science and Society

A restricted package of definitions of indicators and operational methodologies to assess them- to be implemented in Prototype no. 1 and suggestions for the future developments of indicators in SEAMLESS

Alkan Olsson, J., Theesfeld, I., Schleyer, C., Cairol, D., Turpin, N. et al.

Partners involved: LU, UBER, Cemagref, LEI, UNEW, INRA, UNIABDN, VUZE, UEVORA

LUND UNIVERSITY

HUMBOLDT-UNIVERSITÄT ZU BERLIN

Cemagref

Logo's main partners involved in this publication

Sixth Framework Programme

SEAMLESS integrated project aims at developing an integrated framework that allows ex-ante assessment of agricultural and environmental policies and technological innovations. The framework will have multi-scale capabilities ranging from field and farm to the EU25 and globe; it will be generic, modular and open and using state-of-the art software. The project is carried out by a consortium of 30 partners, led by Wageningen University (NL).

Email: seamless.office@wur.nl
Internet: www.seamless-ip.org

Authors of this report and contact details

Name: Johanna Alkan Olsson,   Partner acronym: LU
Address: LUCSUS Box 170 221 00 Lund, Sweden
E-mail: Johanna.Alkan_Olsson@lucsus.lu.se

Name: Insa Theesfeld,   Partner acronym: UBER
Address: Chair of Resource Economics, Department of Agricultural Science and Social Sciences, Humboldt University of Berlin, Luisenstrassse 56, 10099 Berlin
E-mail: insa.theesfeld@agrar.hu-berlin.de

Name: Christian Schleyer   Partner acronym: UBER
Address: Chair of Resource Economics, Department of Agricultural Science and Social Sciences, Humboldt University of Berlin, Luisenstrassse 56, 10099 Berlin

Name: Dominique Cairol,   Partner acronym: Cemagref
Address: DGGT Parc de Tourvoie, BP44
92163 Antony cedex, France
E-mail: dominique.cairol@cemagref.fr

Name: Nadine Turpin,   Partner acronym: Cemagref
Address: UMR Métafort Campus universitaire des Cézeaux
24, avenue des Landais - BP 50085, 63172 AUBIERE CEDEX France
E-mail : nadine.turpin@cemagref.fr

Name: Jean-Marc Callois,   Partner acronym: Cemagref
Address: UMR Métafort Campus universitaire des Cézeaux
24, avenue des Landais - BP 50085, 63172 AUBIERE CEDEX France
jean-marc.callois@cemagref.fr

Name Floor Brouwer   Partner acronym: LEI
Landbouw-Economisch Instituut,
29703 2502 LS 's-Gravenhage, The Netherlands
E-mail: floor.brouwer@wur.nl

Name: Martijn van der Heide,   Partner acronym: LEI
Address: Landbouw Economisch Instituut,
29703 2502 LS 's-Gravenhage, The Netherlands
E-mail: martijn.vanderheide@wur.nl

Name: Guy Garrod,   Partner acronym: UNEW
Address: Centre for Rural Economy, School of Agriculture, Food and Rural Development, The University of Newcastle-upon-Tyne, NE1 7RU, United Kingdom.
E-mail: Guy.Garrod@ncl.ac.uk

Name: Lee Stapleton,   Partner acronym: UNEW
Address: Centre for Rural Economy, School of Agriculture, Food and Rural Development,
The University of Newcastle-upon-Tyne, NE1 7RU, United Kingdom.
E-mail: L.M.Stapleton@ncl.ac.uk

Name: Christian Bockstaller,   Partner acronym: INRA
Address: UMR INPL-(ENSAIA)-INRA Agronomie et Environnement Nancy-Colmar
BP 20507 68021 Colmar Cedex, France
E-mail: bockstal@colmar.inra.fr

Name: Emmanuelle Weinzaepflen,   Partner acronym: INRA
Address: UMR INPL-(ENSAIA)-INRA Agronomie et Environnement Nancy-Colmar
BP 20507 68021 Colmar Cedex, France
E-mail: weinzaep@colmar.inra.fr

Name: Stéphane Bellon   Partner acronym: INRA
Address: INRA Ecodéveloppement, Site Agroparc, Domaine St Paul,
84914 Avignon Cedex 9, FRANCE
E-mail: bellon@avignon.inra.fr

Name: Chengyi Zhang   Partner acronym: UNIABDN
Address: School of Biological Sciences, University of Aberdeen, Cruickshank Building, St
Machar Drive, Aberdeen, AB24 3UU, UK
E-mail: c.zhang@abdn.ac.uk

Name: Pia Gottschalk   Partner acronym: UNIABDN
Address: School of Biological Sciences, University of Aberdeen, Cruickshank Building, St
Machar Drive, Aberdeen, AB24 3UU, UK
E-mail: pia.gottschalk@abdn.ac.uk

Name: Pete Smith   Partner acronym: UNIABDN
Address: School of Biological Sciences, University of Aberdeen, Cruickshank Building, St
Machar Drive, Aberdeen, AB24 3UU, UK
E-mail: pete.smith@abdn.ac.uk

Václav Voltr   Partner Acronym: VUZE
Address: Research Institute of Agricultural Economics (VUZE),
Manesova 75, 120 58 Praha 2 – Vinohrady, Czech Republic
E-mail: voltr@vuze.cz

Name: Teresa Pinto   Partner acronym: UEVORA
Address: University of Évora
Largo dos Colegiais 2, 7000 Évora
E-mail: mtpc@uevora.pt

Rosario Oliveira   Partner acronym: UEVORA
Address: University of Évora
Largo dos Colegiais 2, 7000 Évora
E-mail: mrgo@uevora.pt

Disclaimer 1:

Disclaimer 2:

Table of contents

General information

Task(s) and Activity code(s):   Task 2.1 Activity 2.1.1-3

Input from (Task and Activity codes):   Task 2.2 Activity 2.2.2-5, Task 2.3 Activity 2.3.1-3, Task 2.4 Activity 2.4.1-2, Task 2.5 Activity 2.5.1-3, Task 2.6 Activity 2.6.1-3.

Output to (Task and Activity codes):   A2.2.2-5, A2.3.1-3, A2.4.1-2, A2.5.1-3, A2.6.1-3

Related milestones: M2.1.2

Executive summary

This Deliverable consists of two parts. The first and consists of the definition and presentation of the restricted package of indicators and operational methodologies to assess them- to be implemented in Prototype number 1. This packages and methodologies for assessment have been agreed upon within the WP. The second part develops strategies for how this restricted package can be further developed in Prototype 2 and 3 of SEAMLESS-IF. Part two is an addition to the initial aim of D 2.1.1. The reason is that when developing the restricted package WP 2 deemed it important to also look forward and put the restricted package of indicators into the larger context of the development of indicators for SEAMLESS. This section sets the roadmap for the future development of indicators. Further efforts are needed to make them operational. In addition the indicators needs to be tested against further modelling work (WP3), data availability (WP4), implementation in the software framework (WP5) and assessment against user involvement (WP7).

The restricted package of indicators constitutes the basis for the initial operationalisation of indicators in Prototype 1 of SEAMLESS-IF. The basis for selecting indicators to the restricted list is to create routines for the integration of different types of indicators in the SEAMLESS-IF software structure.

To ensure an efficient and structured approach to indicator development and to facilitate the communication with other WPs, WP2 has deemed it important to develop a strategy for how to ensure a stable and efficient development of indicators. The basis for this strategy is to divide the indicators in three categories.

1) Indicators that can be assessed today by the SEAMLESS-IF (indicators in the restricted package)[1]

2) Indicators that most likely will be assessed by SEAMLESS-IF (Indicators which are planned to be assessed but for which not yet running models are available)

3) Indicators which are less likely to be assessed through models of WP3 (indicators for which WP 2 may need to develop simple models). This category could in turn be divided into two sub categories.

   a. Indicators where there is a possibility to produce a simple model and where necessary data exist or is possible to produce.

   b. Indicators, for which there is a lack of knowledge, lack of data or both.

---

[1] Only 9 indicators from this list are made operational in Prototype 1.

By producing the restricted package of indicators, necessary information to operationalise indicators has been identified and systematised. This work has resulted in an indicator fact sheet on which all relevant information about an indicator is collected. On the fact sheet different information about indicator is provided related to for example its scope and limitations, possibilities to set target levels and visualisation.

The restricted list consists of 41 different indicators covering all three dimensions of sustainable development and all geographical levels targeted by the SEAMLESS project. All indicators can not yet be produced at all scales but several of the indicators on the restricted list can be produced at multiple levels. 16 indicators on the restricted list are environmental indicators, 11 are economic and 14 are social indicators. For all the environmental and economic indicators indicator fact sheets have been prepared. Of this list only a sub set of 10 indicators will be possible to assess in Prototype 1, three environmental indicators and 7 economic indicators. No social indicator will be implemented in prototype 1.

Regarding the future development of the SEAMLESS indicator packages it can be concluded that both the environmental and economic package of indicators will be relatively easy to increase as the model output is there. There is however a few areas where new innovative approaches are needed to produce indicators that can be used in an ex-ante impact assessment. To be able to create a balanced package of social indicators several challenges have been identified as well as possible ways to affront these challenges in the SEAMLESS project, the invention of simple social models, the analysis of the sensitivity of ex-post social indicators to scenarios and the role of expert or stakeholder groups to assess social indicators.

The development of indicators of multifunctionality have also taken a few concrete steps by focussing on; 1) indicators describing the degree of multifunctionality and rank that into classes (a negative value when only negative externalities are provided or a positive value when positive externalities compensate the negative ones). 2) Indicators that points out whether a commodity/non-commodity outputs supplied are binomial i.e. related to two aspects of sustainable development or trinominal related to three aspects of sustainable development, includes the economic, the environmental and the social functions.

The development of a process for institutional compatibility assessment (PICA) has identified 5 steps which will be taken towards the assessment of institutional compatibility. The first step consist of screening the type of policy that is assessed, the second step is the definition of crucial institutional aspects which are required by distinct policy types. The third step includes criteria to select and develop relevant institutional indicators. The forth step is to develop indicators or assessment of institutional constraints. To illustrate how such an assessment can be used an example based on the policy options selected for Test Case 1 is prepared.

In the restricted list of indicators several target levels are presented. However in general the development of the use of reference levels for the indicators selected in the SEAMLESS project is not yet very developed. The same is valid for the aggregation of indicators. The development of target levels and the aggregation of indicators will increase in speed and depths when the package of indicator increases.

1 Introduction

The major part of indicators developed in SEAMLESS will be based on some kind of model output produced by the models used in SEAMLESS. The development of the restricted package of indicators is therefore strongly influenced by the present availability of model output. In prototype 1 of SEAMLESS-IF there are a few areas were there are no running models e.g. the rural labour model and the terrestrial model is not yet available. From the perspective of indicator development it means that several indicators in especially the social areas but also related to changes of the landscape can not yet be assessed. Moreover due to the present status of the model linking some model output is not yet available to serve as input in an indicator calculation.

Moreover there are several areas which could be relevant when assessing sustainable development, where the models included in SEAMLESS will not produce any output that can serve as a basis for indicator production. To be able to create a well balanced set of indicators across all dimensions of sustainable development it is important that WP2 develops alternative strategies. Therefore this deliverable have grew from solely present a restricted package of indicators to be used in Prototype 1 to also include strategies and suggestions for the future development of indicators in Seamless.

As a result the deliverable consists of two parts;

Part I: The first part includes the definition and presentation of the restricted package of indicators as well as operational methodologies to assess as well as the indicator frameworks developed within WP2. This package of indicators constitutes the basis for the initial implementation of indicators in Prototype 1 i.e. to create routines for the integration of different types of indicators in the SEAMLESS-IF software structure. This restricted package of indicators has been discussed and agreed upon within the work package.

Part II: This part look forward and put the restricted package of indicators into the larger context of developing indicators for SEAMLESS. It discusses strategies for how the restricted package can be further developed in Prototype 2 and 3 of SEAMLESS-IF. The second part could be seen as a roadmap for Prototype 2 and consist of suggestions and propositions but no formal decisions to how to proceed.

To ensure an efficient and structured approach to indicator development and to facilitate the communication with other WPs, WP2 has deemed it important to develop strategy for how to ensure a stable and efficient development of indicators and to indicate future areas of research where more data or knowledge has to be collected and models can be developed.

The basis for this strategy is to divide the indicators in three categories.

1. Indicators that can be assessed today by the SEAMLESS-IF (indicators in the restricted package)[2]

2. Indicators that most likely will be assessed by SEAMLESS-IF (Indicators which are planned to be assessed but for which not yet running models are available)

3. Indicators which are less likely to be assessed through models of WP3 (indicators for which WP 2 may need to develop simple models). This category could in turn be divided into two sub categories.

---

[2] Only 9 indicators from this list are made operational in Prototype 1.

    a. Indicators where there is a possibility to produce a simple model and where necessary data exist or is possible to produce.

    b. Indicators, for which there is a lack of knowledge, lack of data or both.

WP 2 has also developed indicator frameworks. An indicator framework is a way to sort indicators based on a specific logic. SEAMLESS have developing framework which can assist in the assessment of sustainable development and of sustainability. Frameworks consequently aim to guide users in their selection of indicators, which areas may be important to take into consideration if sustainable development and sustainability is in focus of the assessment. An indicator framework may also be helpful in creating a basis for different types of aggregation of indicators. Another important role of these frameworks is to assist indicator developers in the development of an indicator package that is relevant to the aim of SEAMLESS and the assessment of impacts on Sustainable Development and Sustainability.

During the first year of the project WP 2 has developed two indicator frameworks, A Goal-Oriented indicator Framework (GOF) and a System-Property Oriented Framework (SPOF). This part of the use of an indicator framework will be further developed in D 2.1.2.

WP 2 has decided to use the GOF in Prototype 1. The major reason is that GOF is easier to make operational. However, in the future the SEAMLESS project envisages employing several types of indicator frameworks which can be selected depending on the users' preferences or needs.

1.1 Aim with the deliverable

The aim of this deliverable is fourfold:

➢ To ensure an efficient indicator development through a systematic approach on how to structure information on indicators to facilitate the communication with other WPs and provide relevant information on indicators to the users.

➢ To present a restricted list of indicators and methodologies for their assessment to be implemented in Prototype 1.

➢ To describe the goal oriented indicator framework (GOF) and how it can be used as a basis for the users' selection of indicator in Prototype 1.

➢ To initiate the description of a road map for the future indicator development and to initiate the development of strategies for how to assess which indicators that will be possible to assess and how.

1.2 Objective within the project

There are three major objectives with this deliverable within the project all closely linked to the aims of the deliverable:

➢ The restricted package of indicators constitutes the basis for the initial implementation of indicators in Prototype 1. By providing the "receipt" for a set of indicators WP5 may develop routines and structures for the integration of different types of indicators in the SEAMLESS-IF software structure.

➢ The indicators that are made functional in Prototype 1 will be tested by WP 6 in test case 1.

> ➤ In the so called Demo Version of the SEAMLESS-IF several aspects related to the indicator selection and calculation is rudimentarily developed. This deliverable also provides the basis for how the indicator selection can be improved in Prototype 2 as well as which functionalities and new types of indicators that will be included when increasing the complexity of the operational package of indicators.

To make sure that the concepts Demo Version, Prototype 1 and Test Case 1 are well understood a brief explication will be given below.

1.2.1 The Demo Version

The Demo version is an operational user interface of the SEAMLESS- IF. The Demo Version offers a blue-print on the specification, interaction and integration of indicators, quantitative models, knowledge base and software architecture (SeamFrame). It also offers a procedure for the use of SEAMLESS-IF for real world problems by demonstrating for a selected example problem how SEAMLESS-IF can be applied to assess the impacts of policy change on agricultural sustainability and sustainable development.

The Demo Version gives a comprehensive picture of what the SEAMLESS-IF will look like and what it will be able to do. The different steps of an integrated impact assessment procedure and the role of users and stakeholders in such process will become evident. Methods for problem specification, scenario development, indicators selection, and model linkages to enable complex assessment of impact across disciplines and scales are demonstrated in a non-operational fashion together with approaches for data handling, post model analysis and presentation of results.

The Demo Version will be developed as Graphical User Interface (GUI) and enable users of different classes (e.g. linker, viewer) to explore the range of features planed for SEAMLESS-IF. Different options of this GUI will be made operational step by step so that the framework will start to "live". While the Demo Version attempts to capture the full range of features in a non-operational fashion the Prototype 1 will be operational for only a selected set of these features (Fig. 1).
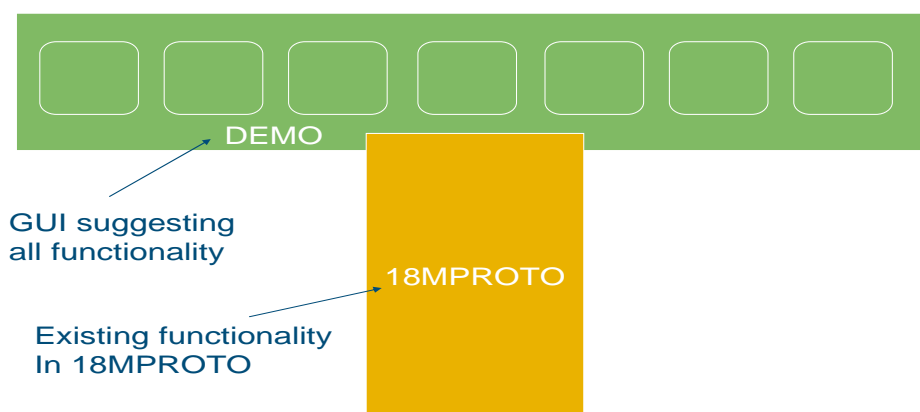
Figure 1: Relationship between DEMO and Prototype 1 of SEAMLESS-IF.

1.2.2 Prototype 1

The first prototype of SEAMLESS-IF contains selected global operational features (Fig. 2). Its purpose is to serve as a base for the initial and restricted testing and evaluation of its components. Prototype 1 comprises an initial set of indicators. First attempts are made to link the micro and macro level simulation tools. The prototype will allow for micro- and macro-

analysis for the arable sector, with simple linkage rules for different spatial dimensions from farm level to EU scale. The functionality of prototype 1 will be demonstrated and assessed in Test Case 1 for a selected example related to the impacts of trade liberalization for selected test case regions.
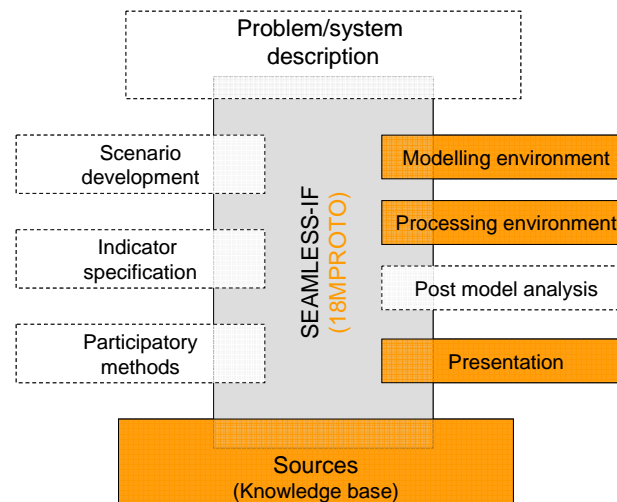
Figure 2: Representation of SEAMLESS-IF features provided by prototype 1 (in yellow boxes). Features in other boxes (dashed lines) will not be provided as integrated parts of prototype 1.

1.2.3   Test Case 1

In SEAMLESS-IF, two test cases have been planned to "test the validity and functionality" of the system tools (models, indicators and databases). Test case 1 (TC1) has been designed to analyse the effects of market policies in European Agriculture. With this purpose a 'policy scenario' focusing the latest WTO liberalisation proposals and their medium-term effect on the European agricultural markets has been selected as the topic of analysis for Prototype 1.

In Test Case 1 the changes in the systems come from the "market level", i.e. in terms of changed EU- trade policies. However, impact assessment of these changes will be performed a different levels, using indicators such as price changes and trade effects at the market level, production quantities, land use, and environmental indicators at regional and farm level. Test case 1 will consequently be run at two different geographical levels with a EU coverage (probably at NUTS 2 level) and with a limited set of indicators (especially in the social domain) because lack of data and model calibration. Tests will also be run at the test case region (a typical agricultural region) with a larger set of indicators.

The main objective of test case 1 in Prototype 1 is to test the validity and functionality of prototype 1 to learn for future prototypes. The objective for prototype 1 is therefore not to have all features of SEAMLESS-IF operational but to consistently include them in the overall software architecture.

The combination of test case 1 and prototype 1 should address the real possibilities of SEAMLESS-IF in the future. Its operational components should allow: linkages between bio-physical and economic models, central and structured storage of data, editable scenario-building, and analysis of information (through indicators) at various levels.

1.2.4 Outline

Part I consists of chapter two and three.

Chapter 2 gives an account of the 2 indicator frameworks developed within SEAMLESS. The main focus is given to the so called Goal Oriented Framework (GOF) that to a limited extent will be implemented in Prototype 1. Advantages and disadvantages with the two frameworks are also discussed.

Chapter 3 gives a background to the selections of indicators to the restricted list. This Chapter proposes a selection of indicators for the environmental, economic as well as social aspects of sustainable development. In Appendix 1 and 2 indicator fact sheets are presented for the environmental and economic indicators.

Part II consists of chapter four to eight

Chapter 4 explores the future possibilities of developing environmental, economic and social indicators in the project.

Chapter 5 Discuss and suggests possibilities for developing indicators of multi functionality

Chapter 6 Describes the Process of Institutional Compatibility Assessment that can be used in both a pre modelling and post modelling context to assess the feasibility of implementing a suggested policy.

Chapter 7 and 8 are two very short chapters that briefly explains the further work on reference levels and aggregation of indicators that will be explored deeper in relation to the indicators developed for Prototype 2.

Chapter 9 is the conclusion of both part I and II.

Chapter 10 consist of the glossary and define a few central terms used in the report.

PART I

2 Indicator frameworks

An indicator framework is a way to structure and categorise indicators in that they take into consideration the general attributes of the systems that are assessed. In that sense an indicator framework indirectly gives an idea for how these attributes are linked to each other. Some indicator frameworks have stronger ideas of the character of these linkages where as other frameworks are more similar to a structured list. The roles and functions of an indicator framework may be multiple. Generally their aim is to ensure that important issues are not forgotten i.e. it ensures that relevant indicators are selected in relation to the assessed issue. This means that depending of the purpose for assessment different types of indicator framework could and should be used. As the aim of SEAMLESS is to produce a tool that is able to assist in the assessment of the impacts of agri- environmental policies on the sustainability of the agricultural sector and their effects on sustainable development on the society as whole. A SEAMLESS indicator framework should consequently help a user at translating a vision of sustainability and sustainable development to a solid basis for the selection of indicators. An indicator framework may also assist the developer of indicators in visualising which areas the indicator development needs to be improved.

2.1 The roles and function of an indicator framework

An indicator framework may have several roles of function all depending on the type of framework and the needs of the user. An indicator framework may help the users of a set of indicators to;

1. Ensure that a balanced approach is taken to each of the sustainability dimensions (the environmental, economic and social dimensions).

2. Create a basis for the "translation" of users' policy questions into something that the SEAMLESS-IF tool can handle, i.e. the indicator framework serves as the link between user questions and the SEAMLESS-IF.

3. Assist the users in their selection of indicators.

An indicator framework may also be useful in assisting the developers of an indicator package to ensure the production of a balanced indicator package. An indicator framework may help the developers to;

1. Make sure that indicators are produced for relevant phenomena and attributes of the targeted system or systems.

2. Assist in the structuring of the indicators and their relations to each other into meaningful information.

3. Create the basis for a systematic approach on how indicators can be weighted and aggregated.

2.2 Developing an Indicator Framework to be used in SEAMLESS-IF

Initially, WP2 saw the adoption of one framework as essential to be able to select, define and sort relevant indicators. During the production of PD 1.2.1 it became clear that we were not

only dealing with one agricultural system but several and SEAMLESS has to address them all. Moreover in the Description of Work of the SEAMLESS project it has been made clear that the SEAMLESS-IF should be capable of assessing not only the impacts of a policy on the agricultural sector, but it should also be capable of assessing the impact of the agricultural sector on society as a whole. This increases complexity of an indicator framework that would be useful for the SEAMLESS project. A conclusion that was made was that an indicator framework has to be something that is developed and coordinated in parallel with the development of the indicators as well as with users and their need of assistance when selecting indicators to assess the impacts of a policy option.

WP2 therefore sees the development of the indicator framework as an interactive process where users (stakeholders), SEAMLESS experts and technical restrictions such as model-, time- and data availability will influence the end product.

As mentioned earlier the type of framework that may seem convenient depends on the reason for using it, the approach to sustainable development that is adopted as well as, the ambition and understanding of the role of indicators as a tool in impact assessment.

PD 2.2.1 has distinguished between four different types of indicator frameworks. Frameworks structured by components of the system (ex: water, air, soil ...), by problems (water, pollution, erosion ...), by Pressure/State/Impact/Response (DPSIR, PSR ...) and indicator frameworks categorised by systemic properties.

It is frequent that the composition by components of the system or by problem is combined with variables of state, impact and response (PD 2.2.1). These frameworks are seen as easy to understand because of their very concrete link to the problems at stake. PD 2.2.1 concludes that a major problem with these indicator frameworks is that they have a weak or shallow idea about the interrelations of the different categories, something that is crucial when aiming to assess the impacts on sustainable development or the sustainability of a sector. As a way to compensate this weakness these frameworks, often contain a list of criteria for indicator selection, well organized or not, which may give a certain, at least apparent, freedom to the users. However, such a framework is not clearly capable to assist in the weighting and aggregation of indicators as such routines are deeply depending on how you understand the relations between the different categories in the framework.

On the other hand a major problem with the forth type of frameworks based on a systemic approach is that due to their abstract concepts and high demand on integration; it has been difficult to make them operational i.e. to link indicators to the systemic properties.

In WP 2 the already known weaknesses and strengths of already existing frameworks combined with the type of impact assessment that the SEAMLESS-IF should be capable if has lead to the development of two indicator frameworks. The Goal Oriented Indicator Framework (GOF) and the System Property Oriented indicator Framework (SPOF) developed in PD 2.2.2 respectively PD 2.2.1. In Prototype 1 only the GOF will be used as an example for how an indicator framework can assist users in the selection of indicators.

2.3   The Goal Oriented Indicator Framework (GOF)

The Goal Oriented Indicator Framework (GOF) has its origin in a pragmatic need to structure WP2s assessments of areas where the development of indicators has been weak so far (PD 2.2.2). The development of the GOF was an attempt to take into account the main criticism addressed to the first three categories of indicator frameworks briefly described in section 2.2. Some principles of a systemic approach are introduced in this framework though avoiding the abstraction of a systemic approach.

The framework divides the assessed system into three aspects, the environmental, the economic, and the social, referring to the three pillars or dimensions of sustainable development. Each of these aspects is in turn divided into two domains. The first domain hosts indicators that assess impacts of agriculture on society as a whole. These could be named the external effects of agriculture. The second domain hosts indicators that assess impact on the agricultural sector itself (Table 1).

Table 1. General structure of the goal-oriented indicator framework (GOF)

Domain 1 Impacts on the agricultural sector			Domain 2 Impacts on the rest of the world		
Aspects of sustainable development			**Aspects of sustainable development**		
Environmental	Economic	Social	Environmental	Economic	Social

This division into two domains is based on two related considerations: 1) In rural areas there are today a range of processes that are not dependent on agriculture, and thus the rural can be sustainable in economic and social terms also besides agriculture, and 2) but even so agriculture still has a fundamental role in shaping the rural space and in influencing its character, and has impacts on the functions that can be supported and thus on the way society considers the rural space. There is thus a need, for the sustainability of agriculture, to understand impacts on the rural area in relation to the multiple functions that are supported and expected, and to understand how agriculture contribute to these functions and to their potential development as well as to sustainable development in general. This division has as already mentioned its basis in the ultimate goal of the SEAMLESS project: to produce tools for an impact assessment of policy options on the sustainability of the agricultural sector as well as the impacts on and contribution of agriculture to Sustainable Development.

The agriculture sector is the core of the SEAMLESS project. It is therefore important to assess both positive and negative impacts of agriculture on sustainable development of a society as a whole. For example, eutrophication caused by nitrogen leaching from agriculture is a negative influence of agriculture on our society's water resources. One solution could be to drastically reduce the use of fertilizer. However, below a certain level of reduction, the environmental impact will be still improved but the fertility of soil will be threatened. To assess the impacts on sustainability of the agricultural sector and sustainable development of society as a whole it may be important to understand the relation between reduction of nitrogen surplus and soil fertility.

The goal based indicator framework (GOF) has, as its name indicates a goal based approach. This framework is inspired by the idea that each action is motivated by an ultimate goal. To achieve this ultimate goal we need means as well as a method or process to achieve it. This causal relation between goals means and method is understood as generic for achieving any goals related to the three dimensions of sustainability. Rather than providing a list of themes related to problems which can be transformed in goals as in many frameworks, this framework has tried to categorize and qualify those "goals". The ultimate goal of a cropping system may be harvesting an acceptable yield but to do that the farmer needs seeds, machines and fertilizer which should be used according to technical recommendations. Accordingly each aspect of Sustainable development is divided into three generic themes; *ultimate goal, processes of achievement and means*. The logic behind that is that if assessing sustainability, defined goals could be achieved if they preserve the integrity of the means, i.e. the resources, and if they are based on appropriate and non disturbed processes which sustain the whole

system. Moreover the framework helps the user to avoid solely focusing on the ultimate goal without addressing and assessing the possible ways to achieve it. The GOF does not require a goal oriented approach in the policy analysis but it may help to illuminate important aspects of policy implementation which may be useful when doing ex-ante policy assessments, building on what if approach. The framework may also help the user to set priorities and identify possible ways (means) to achieve them and to develop or strengthen appropriate strategies (methods or processes).

For each of the aspects of sustainability, the generic theme is named slightly different. This categorisation and naming of themes is shown in Table 2. By using the same logic for the categorisation of the three aspects of Sustainable development, it may also serve as a basis for the aggregation of indicators.

Table 2. Themes of the goal-oriented framework (GOF)

	Environmental	**Economic**	**Social**
Ultimate goal	*Protection of human health and welfare, living beings and habitats*	*Viability*	*Quality of life individual, in society*
Methods for achievement	*Maintenance of environmental balances and functions*	*Performance*	*Population (demographics)*
Means	*Protection of Environmental compartments and non-renewable resources*	*Financial and productive capital*	*Social and human capital*

Each theme is divided into sub-themes and within each sub-theme there can be lists of indicators. These lists of indicators are closely related to impact issues, which are used in the EU system to categorise indicators (ECO1, 2, 3 etc ENV 1, 2, 3 etc and SOC 1, 2, 3). These sub-themes are a way to ensure the representation of topics or problems, such as eutrophication, climate change, farm income employment rate, gender and behavioural changes of farmers. As an example of how the division of sub-themes may look like the list if environmental indicators is given as an example (Table 3). (For an account of the sub-themes of all three aspects of sustainable development see PD 2.2.2)

The list of sub-themes may evolve over time when new problems or concerns enter the agri environmental agenda. The present list of sub themes is however based on current knowledge and concern in relation to each aspect of Sustainable development.

Each aspect, theme and sub-theme is filled with indicators for each assessed geographical level; farm, regional/local, national, EU 25 and Global. Some indicators will be possible to use on several geographical levels, depending on which levels it is possible to produce indicators on and for which levels a specific indicator is relevant. An indicator of nutrient leaching per year is for example not relevant to produce at the EU 25 level.

Table 3. Themes and sub-themes used in the goal oriented Framework for the environmental aspect of sustainable development.

Themes	Sub-themes
Ultimate goal Protection of human health and welfare	Air: pollution (pesticides) Water: Quality of groundwater (NO3, pesticide) Water: Quality of surface water pollution (NO3, pesticide, P) Landscape: Heterogeneity Landscape: Ecological structure and habitats Landscape: Biophysical aspects
Preservation of living being and habitats	Biodiversity: Species diversity Biodiversity: Ecosystem diversity
Methods for achievement Maintenance of environmental balances and functions	Climate: Greenhouse gases emissions (CO2, CH4, N2O) Soil acidification: NH3 emissions Soil fertility (Organic matter, N, P, K) Surface water eutrophisation: P runoff Groundwater eutrophisation: P leaching Ecological regulation of agrosystems: Crop rotation *Ecological regulation of agrosystems: Beneficials*
Means Protection of environmental compartments	Soil erosion Soil compaction Soil pollution (heavy metals, salinisation, etc.) Water quantity (depletion of resource)
Preservation of non-renewable resource	Minerals (P, K) Energy (oil) Use of renewable resources (e.g. biofuel)

Each indicator framework has its advantages and limitations. The indicator package implemented in Prototype 1 is still relatively simple. It is therefore too early to assess the whole functionality of the GOF and its advantages or limitations. However, based on literature studies of other frameworks and assessment within WP2 a record of advantages and disadvantages can be listed (Table 4).

Table 4. Advantages and limitations with GOF

Advantages	Limitations
Relative simple and easy to understand by stakeholders.	**Specific to situation and scale.**
The structure refers to relatively well known lists used in other indicator initiatives.	**Do not incorporate a systematic approach to links aspects of the system as well as time and change**
Produce information for those who make decisions as it focuses on their domain of action.	**Can easily lead to very long lists of indicators because the framework implicitly aims at completeness without a clear definition of essential and universal properties of SD.**
Can be adapted to various scales and contexts.	**May create subjectivity and lacks transparency in the selection of indicators.**
Makes it relatively easy to identify gaps.	**Time aspects are not explicitly taken into consideration.**
The selection of indicators can be made rather flexible.	**May leave too much latitude in the users' indicator selection, without ensuring that all attributes of the system are accounted for and that redundancy is avoided.**

2.3.1 To make use of GOF in Prototype 1 and the testing GOF in Test case 1

From interactions with users both inside and outside the project it is clear that the indicator framework should not be presented as a limiting factor but rather a help in ensuring a balanced selection of indicators in relation to the assessment of sustainability and sustainable development. It is therefore important that the indicator framework is presented as a helping tool rather than a compulsory step in the indicator selection. Therefore WP 2 recommends that the indicator framework should be presented as a separate tool in the later Prototypes of SEAMLESS-IF, which may increase the feeling of flexibility for the user.

It is also important that the support for the user's selection of indicators is seen as a process composed of several steps, from the definition of which policy option/s to assess to the definition of impacts of interests over the definition of scenarios and to the very selection of indicators. Interactions with end users has indicated that this process needs to be iterative as well flexible as there are several factors defining which indicators or issues that may be deemed to be relevant or important in an impact assessment. In Prototype 1 the above mentioned steps are still rudimentary connected. An important work towards Prototype 2 will be to increase the interconnection and relations between these steps.

The use of GOF in Prototype 1 will be limited mainly because only a limited amount of indicators are implemented. However as to the testing of the indicator framework the conceptual aspect of the framework may be tested based on the information on the framework presented in PDs and Ds produced by WP2.

2.4 The System-Property Oriented Indicator Framework (SPOF)

The system-property oriented indicator framework has as it names suggests a systematic approach. This means that it is based on generic properties. The structure of this framework is to some extent similar to the previous one. It focuses on the three aspects of the system (environmental economic and social) it also aims to cover the same geographical scales as GOF. The framework is also separating impacts of a policy option in two domains but is seeing them as a system and a subsystem; the agricultural system is a subsystem of the global system.

The major difference between the two frameworks is that each of these systems and subsystems are described by generic properties*: productivity, existence, effectiveness, freedom of action, security, adaptability, self–reliance coexistence, psychological needs.* The focus on generic properties is a way to avoid repetition and is limited by the number of included systems. When filling the framework it is seen that each property would only need to host one or several indicators which as in the previous framework can be related to impact issues as defined in the EU institutions. The general structure of the framework is shown in Table 5. For each specific policy option and project one indicator is defined for each property of each system or sub system. In a second step, a composite indicator can be calculated. Beside the set of "systemic" indicators, there is also given the possibility for the users to define a new indicator, which the user may find important for a specific impact assessment.

Table 5. General structure of the system-property oriented indicator framework (SPOF).
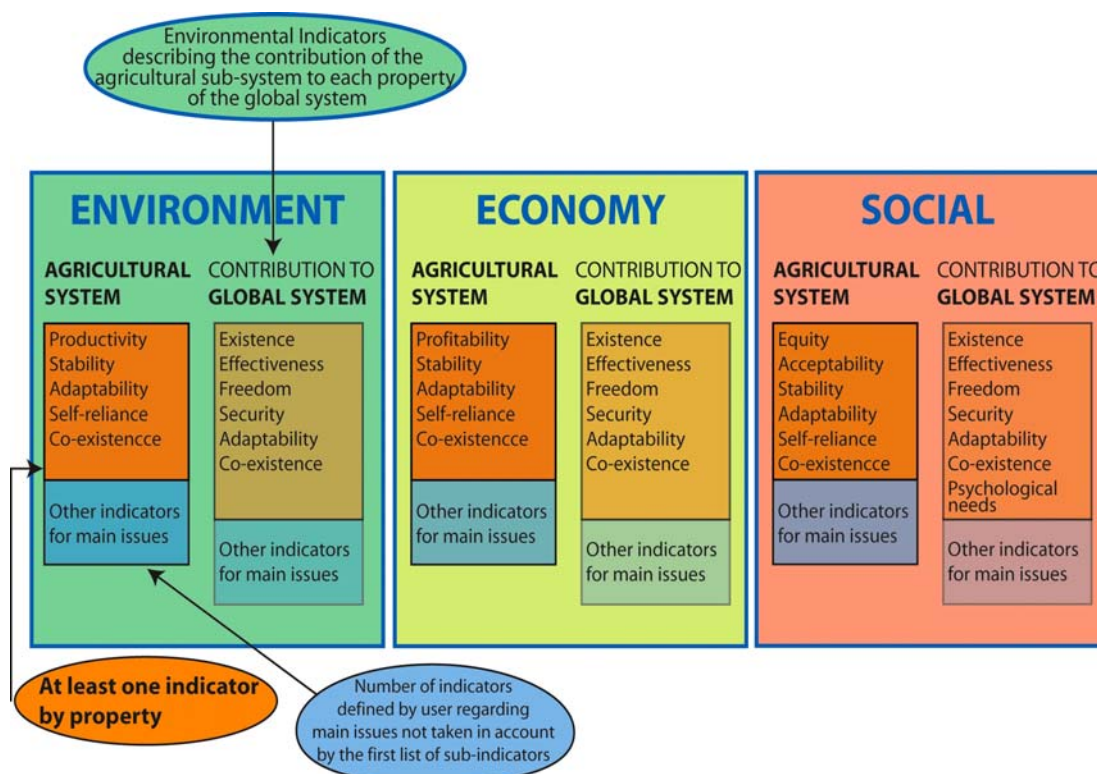
The major challenge with this framework is to ensure that the defined set of properties is possible to fill with indicators. As with the GOF the SPOF have its advantages and limitations. For a general overview of these advantages and limitations (see Table 6).

The SPOF will be further developed and implemented in Prototype 2.

Table 6 Advantages and limitations with SPOF

Advantages	Limitations
It is universal and generic.	**Relatively complex.**
It is transparent in relation to the addressed properties.	**Not well known.**
It take into consideration relations between the attributes of the system.	**Uncertainty about the possibility to identify indicator linked to each property.**
There is no redundancy between properties (and indicators).	**The link between proposed indicators and properties is not always easy to establish.**
No compensation possible between the aspects of the system	**The selection of indicators is not flexible**

3   The restricted package of Indicators

3.1   Introduction

The development of the restricted list of indicators work has been guided by a general recommendation within the project that the number of indicators should be around 30, 10 for each aspect of SD. The role or WP 2 is to provide the theoretical thinking based on the need within the project and scientific result produced outside the project. WP 5 will thereafter for prototype 1 produce the initial software that will handle the indicators and their assessment. WP6 will thereafter run test case 1 at two levels: one at EU coverage (NUTS2) with a *limited set of indicators*, and one at the test case region with *a much longer list* of indicators.

Indicators in SEAMLESS will essentially be based on the output of the models developed in WP3. This because a major point SEAMLESS-IF is to produce ex ante assessments answering questions such as what will happened (which will be the effects) if a certain policy is implemented. To be able to produce ex ante assessment models are generally needed. Ex ante assessments could also be based on trends for example assuming that a specific development such as decrease in the agricultural sector will continue. The SEAMLESS- IF will also always produce ex post indicators that either will be based on existing data or on a base line scenario. This latter category of indicators will serve as the basis of comparison The restricted list is based on the list of model outputs for Prototype 1 that have been prepared for PD 6.2.1.

From WP 2 perspective we have combined our creativity with available data and model output bearing in mind the two needs of WP6.

For each aspects of sustainable development the restricted list of indicators will be developed. Before we get to the lists of environmental, economic and social indicators, a brief word on criteria for the selection of indicators is included below.

From a general point of view, the selection of indicators should be guided by three main criteria:

- The scientific soundness
- The feasibility
- The usefulness

As a basis for the selection of indicators for prototype I WP2 has in co-operation with WP 6 defined a set of sub-criteria applicable to the context of Prototype I (Table 7).

Table 7 Criteria for selection of a restricted package of indicators

Group of criteria	Criteria
scientific soundness	➢ Indicators should cover the three dimensions of SD ➢ Indicators should be relevant for test-case one. ➢ Indicators should be consistent with and cover the themes and geographical scales that have been defined in the simple framework developed in PD 2.2.2 and in the DEMO (Table 1 in Annex) ➢ An indicator should capture the essence of the problem and have a clear and acceptable normative interpretation. ➢ An indicator should be robust and statistically validated ➢ Redundant indicator (correlated) should be avoided to restrict the number
feasibility	➢ Indicators will be essentially based on the output of the models developed in WP3. ➢ Indicators should take into consideration the technical restrictions that may exist for certain models in prototype 1. ➢ An indicator should be measurable and in a sufficiently comparable across member states. ➢ Provide examples of how indicators can be aggregated (systems for aggregation will thereafter be developed in Prototype 2 and 3)
Usefulness	➢ The indicators should also reflect the desire and need of the users ➢ The indicators should be policy relevant to the user asking the policy question (The fictive DG environment or agriculture official).

3.2   Environmental indicators

3.2.1   Comment on the proposed list in PD 6.2.1

The list in PD6.2.1 (Table 8) provides the outputs of the models CAPRI, FSSIM and APES that may be relevant for the production of environmental indicators. These model outputs need in most cases some recalculation as stated by (Riley, 2001) who defined indicators as "raw observations relative to their respective reference points". Thus, the calculation of an indicator should include the calculation (or observation) of a raw value (in this case outputs of the set of models) which can be then expressed relative to a reference value. These reference points are important and can be based on relevant scientific limits, on guidelines drawn from the legislation for water or air quality or targets decided by stakeholders (see PD2.6.1). These target or reference levels have consequences on the choice of indicator and the unit used for calculation of indicators.

The outputs from CAPRI and FSSIM in Table 8 (PD6.2.1) mainly deal with nutrient balances (including NH_3 emissions) and greenhouse gases emissions. To fulfill the criteria for indicator development that were defined in Table 7, the following indicators have been removed:

- K balance (and all related model output shown in the tables), because of low environmental and policy relevance.
- N balance, because indicators of N losses, which have a better scientific grounding are available.
- The model output from "N fixation" to "Nitrous oxide emissions from soils", (except "NPK import in mineral fertilization" which can be an indicator of energy use), are removed because those outputs are all linked to "NPK balances" or "Global warming potential".
- The "GHG emissions", because of it overlap with the "global warming potential". However, we propose to modify the calculation of the "global warming potential" (see section 3.2.2.2). The aggregation of the single indicators of GHG emission allows reducing the number of indicators, but it does not exclude a detailed analysis of each component of the global warming potential indicator.
- The "water drainage" is not an environmental issue per se. It is a factor of nutrient and chemical leaching, so that it can be added to a "hidden list" of drivers which explains indicators which can be explored more in detail later in the project.

Table 8   List of outputs provided by WP6 (see PD6.2.1)

Environmental Indicators	Model Name	Data Name of data base	Provided information	Global (main trade blocks)	EU	MS	Nuts 2	Farm Type	HRU	
NPK balance	CAPRI	(composite indicator)	Tonnes and t/ha		x	x	x	x	x	
. N fixation	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
. NPK import in atmospheric deposition	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
. NPK import in mineral fertiliser	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
. NPK import in organic fertiliser	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
. NPK export in crop harvesting	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
. N export in ammonia losses	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
. NPK export in crop harvesting	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	
Methane emissions	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	Based on IPCC rules
. Methane emissions from rice fields	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	Based on IPCC rules
. Methane emissions from animal production	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	Based on IPCC rules
Nitrous oxide emissions	CAPRI, FSSIM/APES	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	Based on IPCC rules
. Nitrous oxide emissions from manure handling	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	Based on IPCC rules
. Nitroux oxide emissions from soils	CAPRI	CAPREG, …	Tonnes and t/ha		x	x	x	x	x	Based on IPCC rules
Global warming potential	CAPRI	CAPREG, …	CO2 equivalents		x	x	x	x	x	Based on IPCC rules
Soil eroded (yearly cumulated	APES-FSSIM		t/ha					x		Calculated at field levels. The upscaling to regions requires the development of modelling procedures
N leaching (yearly cumulated)	APES-FSSIM		kg/ha					x		
N leaching (variability)	APES-FSSIM		kg/ha					x		
Soil organic matter trend	APES-FSSIM		t/ha*year					x		
Ammonia volatilization (yearly cumulated)	APES-FSSIM		kg/ha					x		
GHG emissions (yearly cumulated)	APES-FSSIM		kg/ha					x		
Water drainage (yearly cumulated)	APES-FSSIM		m3/ha					x		
Water drainage (variability)	APES-FSSIM		m3/ha					x		
Water surface runoff (yearly cumulated)	APES-FSSIM		m3/ha					x		
Chemical leaching (yearly cumulated)	APES-FSSIM		kg/ha					x		
Chemical leaching (variability)	APES-FSSIM		kg/ha					x		
Water use (yearly cumulated mean accross PE)	APES-FSSIM		m3/ha					x		
Water user (yearly variaibility mean across PE)	APES-FSSIM		m3/ha					x		
Landscape attributes	APES-FSSIM (via post-model analysis T3.7)						x			
Biodiversity	APES-FSSIM (via post-model analysis T3.7)						x			

3.2.2 The restricted list of environmental indicators (see table 9)

3.2.2.1 General considerations

For the restricted list of environmental indicators 16 indicators are proposed. For some environmental themes in the goal oriented indicator framework, two indicators are proposed, one average or cumulated value and one indicator expressing variability. The aim with these two indicators is to increase the user relevance. The variability based on a standard deviation remains for example more abstract for a user than an indicator of exceeding a target level for a specific time span expressed in for example months. For indicators assessing instantaneous events like erosion and runoff, the maximum value is more relevant than variability.

A reference value is proposed for some indicators. For the ones, for which no reference value is currently available according to our knowledge, we propose the value of the baseline scenario and an expression in % of the baseline scenario related to the policy scenario.

3.2.2.2 Details on some indicators

N leaching:

We propose to express the indicator using concentration because it allows the use of a European guideline value of water quality as a reference point. However, it may be useful to ask stakeholders which one they prefer: "yearly cumulated N leaching in kg N/ha" or "average NO_3 concentration per year". If they prefer the second indicator of nitrate leaching "Number of month with NO_3 concentration>50mg/L" has to be replaced by "N leaching variability".

Pesticide (chemical) leaching

This indicator refers to the main "chemicals" which can be modeled by APES according to our knowledge. The indicator allows the use of a European guideline value of water quality as reference point. This is also something that could be discussed with users:

- the expression of the indicator by mean of a risk ratio has been used by several authors of pesticides indicators (Reus et al., 2002): This is the ratio between the concentration in a certain compartment (here groundwater assessed by concentration in drainage water calculated by APES) and toxicity for relevant organisms (which could be here Admissible Daily Ingestion, ADI). To develop this indicators would need a database on ADI for each active ingredient.

Global warming potential

This indicator is based on the emission of each GHG weighted by a factor that represents is radiative force in relation to a molecule of CO_2 over a specified time period. (IPCC, 2001). However, the indicator is based on the estimation of GHG emissions (nitrous oxide and

methane) which is calculated by the CAPRI model.[3] For nitrous oxide emissions from soils we propose to replace the calculation of CAPRI based on IPCC tier 1 default emission factors, by the output of APES. For methane, the emission can be based on emissions factors and management data from FSSIM (number of cows, etc.). Moreover a term for CO_2 should be added. It can be assessed by the energetic consumption, soil CO_2 emissions and carbon sequestration. Those two latter terms may be calculated through the organic matter module of APES.

Water surface runoff

This indicator is relevant for assessing the problem with floods but also for a form of erosion. In Northern-Western of Europe, there is an erosion problem which is not due to heavy rains, slope, lack of soil cover, etc. but to the concentration of runoff from fields (Auzet et al., 1993). Furthermore, it can be an indicator of pesticides losses and PO_4 losses, especially when the P balance shows surplus.

P balance

This indicator shows surplus or deficit of Phosphor. In case of continual surplus, P content of soil will increase which will lead to leaching problem Surplus will hence be an indicator of excess. In case of deficit, the soil fertility is threatened on long term. Reference values are taken from German assessment methods KUL/USL and REPRO (Eckert et al., 2000; Hülsbergen, 2003).

Soil erosion

For this indicator, reference levels can be found in (Delbaere and Serradilla, 2004). Values of tolerable soil loss according to soil depth are proposed.

Water use

The use of water by irrigation (and not the total consumption of water by crops) is environmentally relevant because of possible water resource depletion.

Energy use due to mineral fertilizer

The main part in energy consumption for arable farming system is due to the use of mineral fertilizer (Pervanchon et al., 2002). This indicator can be expressed in total kg N, P, K/ha or in MJ/ha if database of energetic factor is added to the base. A mean value can be proposed.

Crop diversity

---

[3] To improve this indicator we should include CO_2 emissions from soil otherwise the balance is incomplete. For projects such as CarboEurope IP to use our results, the CO_2 emissions from soil is essential. Perhaps it could be calculated from soil organic matter trend.

We must also specify a time horizon: IPCC standard is 100 years which gives GWPs for methane of 21 and for nitrous oxide of 296 relative to CO_2.

The use of a Shanon index for diversity of crop or soil cover was proposed by several authors (Geoghegan et al., (1997) Delbaere and Serra). The former proposed the eveness Shanon index

$$Eveness = \sum_{i=1\ to\ S} piLnpi/LnS,$$

where pi the proportion of cover class i and S the number of cover class. The evenness varies between 0 and 1 (total evenness).

At farm level, the different crops (and soil cover like different fallow or meadow types) can replace the cover class. We propose to calculate an index which is equal to the number of crops (or soil cover) when their distribution is even (all are represented by the same proportion) and decreases when the unevenness increases. A first proposal is:

Crop diversity index = Number of crops (and the soil cover types) * Evenness

Another one is the Simpson'reciprocal index:

Crop diversity index = $1/\Sigma pi^2$

After a comparative sensitivity analysis, we will propose the second one which is more sensitive to variation of the distribution of crops.

Further, and more detailed information, on each of these indicators is provided in the Appendix 1 of this document.

Table 9 Restricted list of environmental indicators

Environmental indicator	Output of the model ***	Proposed reference point	subthemes	Unit	EU	MS	Nuts 2	Farm Type	HRU
							Scale/level		
NO3 leaching* (average concentration during the year)	N leaching (yearly cumulated)/ Water drainage (yearly cumulated)	EU guideline	Water: Quality of groundwater	mg /L*ha				x	
Number of month with NO3 concentration>50mg/L	N leaching (average per month)/ Water drainage (average per month)	EU guideline	Water: Quality of groundwater					x	
Pesticide leaching*	Chemical leaching (yearly cumulated)	EU guideline	Pesticide: Quality of groundwater	μg/L				x	
Pesticide leaching*: number of month with concentration>0,1 μmg/L	Chemical leaching (variability)	EU guideline	Pesticide: Quality of groundwater					x	
Global warming potential	Global warming potential (N2O*GHGfactor+CH4 emission*GHGfactor)	relative (% baseline scenario)	Climate: Greenhouse gases emissions (CH4, N2O)	CO2 equivalents	x	x	x	x	x
Ammonia volatilization (yearly cumulated)	Ammonia volatilization (yearly cumulated)	Critical load	Soil acidification: NH3	kg/ha				x	
Soil organic matter trend	Soil organic matter trend	relative (% baseline scenario)	Soil fertility (Organic matter)/Climat (carbon sequestration)	t/ha*year				x	
Water surface runoff (yearly cumulated)	Water surface runoff (yearly cumulated)	relative (% baseline scenario)	soil erosion/surface (and ground) water eutrophisation/water quality (pesticides)	m3/ha				x	
Water surface runoff (yearly cumulated)	Water surface runoff (daily peak)	relative (% baseline scenario)	soil erosion/surface (and ground) water eutrophisation/water quality (pesticides)	m3/ha				x	
P balance	P balance	-15 to +15 kg P/ha	surface (and ground) water eutrophisation/Preservation of non-renewable resource (P)	kg P/ha	x	x	x	x	x
yearly soil erosion	Soil eroded (yearly cumulated)	tolerable soil loss	Soil erosion	t/ha				x	
Peak of soil erosion	Soil eroded (daily peak)	tolerable soil loss	Soil erosion	t/ha				x	
Water use by irrigation (yearly cumulated)	Water use (yearly cumulated mean accross PE)	relative (% baseline scenario)	Water quantity (depletion of resource)	m3/ha				x	
N use in mineral fertiliser	N import in mineral fertiliser	relative (% baseline scenario)	Preservation of non-renewable resource (oil)	kg/ha	x	x	x	x	x
*Crop diversity index (mean value per farm and variability among farms)**	*Surface of crops*	*see text*	Landscape: Heterogeneity				*x*	*x*	
*Crop diversity index (variability among farms)**	*Surface of crops*	*see text*	Landscape: Heterogeneity						

* Another indicator is proposed, see discussion in text

** A new indicator + post-model analysis of landscape attributes

*** Model outputs come from APES (simulates yield, emissions from FSSIM outputs) and FSSIM (simulates farmers decisions)

3.2.3 Concluding remarks on the restricted list of environmental indicators

The proposed restricted list for environmental indicators is mainly based on the output of models developed by WP3. Some additional calculations are proposed and initial suggestions for reference values are proposed although they have still to be discussed and improved within WP2. It should be noticed that this is a restricted list and therefore not every theme or subtheme in the indicator framework is addressed. Further efforts would be required to aggregate these environmental indicators to cover all relevant geographical scales.

3.3 Economic indicators

3.3.1 General considerations

This list is based on the model output presented in PD 6.2.1. The main criteria underlying the production of this list can be found in table 7. The restricted list of economic indicators consists of 11 indicators (see Table 10)

3.3.2 Details on some indicators

The text below details those indicators which are on the current restricted list of economic indicators. This list has been selected based on what is currently operational from a SEAMLESS modelling perspective and what indicators are pertinent from a Test Case 1 perspective whilst recognising that the chosen indicators should cover as broad a range of themes (Goal Oriented Framework) and properties (System Property Oriented Framework) as possible.

(i) Production of main agricultural products

Agriculture production is the main source of farm income. This indicator gives a basic overview about agricultural productivity and farm structure. Agricultural production, for production comparison of particular countries, is divided into group and sub-groups. Main world comparable products are wheat, crops, livestock and poultry, dairy production, oilseeds, sugar.

(ii) Net value of capital

A measure of the value of capital stocks, useful in exploring fluctuations and substitutions across different types of capital. Net value of capital is used to evaluate risk and financial progress

(iii) Land factor price

Land factor prices identify income effects, risk related effects and dynamic effects of agricultural production and policy. Into land factor prices is integrated agricultural support, that affect incentive prices giving rise to price and cross-subsidation effects. If prices are changed on commodities that are substitutes in production or in input use, then the allocation of land and other inputs can be changed. The price effect of output subsidies is induced by the gap between producer and consumer prices. A subsidy to producers that gives the producer the same price as in the case of price support would increase the net welfare of the producer, while the taxpayers bear the cost. Land factor prices could be expressed as a result of land rental markets and land sale markets

(iv) Gross Margin

Gross margin is the difference between revenue and variable costs (EuroCARE 2003) where revenues incorporate premiums. A higher gross margin can reflect greater efficiency in turning raw materials into income. The European Commission defines the commercial viability of farms based on European Size Units particular to each Member State (European Commission, 2004) which is important when defining a threshold for acceptability for this indicator

(v) Export/Import ratios of main agricultural products

Exports of percentage imports. Ratio of the volume of selected agricultural products exported to the volume of selected agricultural products imported. If referring to the value, instead of the volume, we must examine the following indicator, terms of trade. There are differences between trade in raw materials, semi-finished products and processed products (animal production and crop production).

(vi) Terms of trade

Terms of trade is used for measurement of the import/export prices ratio. An improvement in a nation's terms of trade is good for that country in the sense that it has to pay less for the products it imports, that is, it has to give up less export for the imports it receives

(vii) Profits of the processing industry

This indicator focuses on secondary production at the industry level. The actual scope of the indicator depends on how 'profits' are defined. In economic terms, if revenue exceeds the *total opportunity costs* of the inputs then the firm is making an economic profit. In accounting terms, if revenue exceeds the *total costs* of the inputs the firm is making an accounting profit. This consideration is important when defining appropriate thresholds for this indicator. Economic profit is also known as supernormal profit; theoretically it should not occur in a perfect-market scenario and is thus an inefficiency indicative of one or more market failings. It is also undesirable from an equity standpoint. There is no equivalent determination in the literature of an acceptable threshold for profits described in accounting terms because positive accounting profits do not imply positive economic profits. However, a reasonable threshold in this case would be the minimum opportunity cost of capital which is the rate at which a firm borrows funds since one alternative to a production activity is to pay back borrowed money.

(viii) Budgetary expenditure

Budgetary expenditure refers to an array of monetary support provided to farmers under the first pillar of the Common Agricultural Policy. Expenditure under the second pillar of the CAP is not included. The dynamics of this indicator over time are limited by the decision of the European Commission to fix expenditure on the first pillar of the CAP until 2013.

(ix) Tariff revenues

Tariff revenues result from the application of import tariffs which are simply taxes on imported goods. The specified aim of such tariffs in a European agricultural context is to raise the World market price up to the EU target price. Tariffs can be distinguished as either specific or ad-valorem: the former is a levy per physical unit of the imported good whereas the latter is a levy which is proportional to the value of the imported good. In a World Trade Organisation context, tariffs can also be distinguished as either bound or applied: the former is the tariff level for a product which a country or group of countries commits not to exceed whereas the latter is the operational tariff which may or may not equal the bound tariff. The current tariff baseline can be traced back to the Uruguay round of the General Agreement on Tariffs and Trade (GATT) which came into force on 1st January 1995, committing developed countries to a shortening of bound tariffs by 36%. More recent negotiations suggest that the long-term existence of these tariffs is unlikely; although no agreement was reached at the 6th World Trade Organisation Ministerial meeting in Hong Kong (December, 2005) this issue is likely to remain on the international political agenda with phasing out of tariffs possible in the medium-term (perhaps after the completion of the phasing out of export subsidies, timetabled for 2013)..

(x) Total welfare

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

Further, and more detailed information, on each of these indicators is provided in the Appendix 2 of this document.

Table 10 The Restricted List of Economic Indicators

Indicator	Model	Database	Theme	Sub-theme	Property	Unit	Scale				
							Farm	Regional	National	EU-25	Global
Budgetary Expenditure	CAPRI	EU Commission Services (DG-AGRI)	Performance	Government Intervention	Self-reliance, Adaptability	Euros			x	x	
Export/Import Ratios of Main Agricultural Products	CAPRI	CAPREG	Performance	Trade	Self-reliance, Freedom, Security	Ratio/,%			x	x	
Gross Margin	CAPRI, FSSIM	CAPREG, FADN-FSSIM_DB	Performance	Profitability	Profitability	Euro, Euro/ha, Euro/head	x	x	x	x	X
Land Factor Price	GTAP	GTAP	Performance	Profitability, Government Intervention, Non-farm Activities	Profitability, Existence	% change			x	x	x
Net Value of Capital	GTAP	GTAP	Viability	Stability	Stability	Euros			x	x	x
Production of Main	CAPRI,	CAPREG, FADN	Performance	Productivity	Stability, Self-reliance	Tonnes, Tonnes/ha	x	x	x	x	x

Agricultural Products	FSSIM											
Profits of Processing Industry	CAPRI	CAPREG	Performance	Profitability	Profitability, Existence	Euros			x	x	x
Tariff Revenues	CAPRI	AMAD	Performance	Trade	Effectiveness	Euros/tonne, %			x	x	x
Terms of Trade	CAPRI	CAPREG	Performance	Trade	Co-existence	Ratio, %			x	x	x
Total Welfare	CAPRI	CAPREG, FADN-FSSIM_DB, AMAD, EU Commission Services (DG-AGRI)	Capital	Capital stocks	Profitability, Existence	Euros			x	x	

3.3.3 Concluding remarks and questions on the restricted list of economic indicators

The above is a restricted list and excludes some of the more problematic indicators. The emphasis is more on performance indicators and relatively few of the above are indicators of capital and viability. Indicators of the latter are particularly problematic and as identified in PD2.2.2 indicators of public preferences for environmental capital and the distribution of capital are not always available. Several indicators were selected specifically to match Test case 1 and would not be on a similar restricted list for other policy-scenarios.

In the next step it would be crucial to examine the importance of putting one indicator onto a theme in the indicator framework GOF (see Table 2). Net Farm Income for example could be an indicator showing the performance of the agricultural sector but it could also be interpreted as the capital to organise agriculture towards a more sustainable development. As for the environmental indicators this categorisation will be even more important to focus when developing different methods for aggregation of indicators.

3.4 Social indicators

3.4.1 General considerations

Based on the criteria defined in table 7 three issues seems to be important to produce social indicators for. In the Goal oriented framework these issues are related to the theme means and methods of achievements. These three types of indicators are related to the capacity of resistance and innovation of farming sector to changes in tariffs. This capacity is determined by human capital (e.g. education and age of farmers) and social capital (e.g. access to the Internet). They are also related to the adaptation to changes; i.e., farm specialization and typology as well as the changing role of the farming sector in rural areas, which is influenced by the population (e.g. share of population working in agriculture, gender) and quality of life (e.g. poverty, income per capita, land use, and landscape diversity).

Based of these three i types fourteen social indicators can be listed. Few of these indicators have however model support at this point.

1. Number of persons employed in agriculture as a share of total population
2. Gender distribution in agriculture (male / female farmers)
3. Number of farm types, or number of farms in each type, or area occupied by each farm type
4. Specialization of farms
5. Off-farm income
6. Percentage of agricultural population in rural population
7. Education level of farmers
8. Age of farmers
9. Population density (persons per km[2)]
10. Access to the Internet
11. Distance of farm to main service center
12. Income per capita in rural areas
13. Diversity of land uses per land unit
14. Rate of area under specific management

Model output and data availability is a key factor in developing a restricted package of social indicators. Presumably, data on 'access to the Internet' or 'distance of farm to main service centre is hard to obtain. It could be interesting to include indicators on income, poverty, and spatial dimension and management. Unfortunately, however, PD 6.2.1 notes that the ambitions for social indicators, are limited, as only a limited amount of model outputs are included in Prototype 1. The PD6.2.1 document continues that "the estimation of social indicators in SEAMLESS is mainly based on econometric approaches (e.g. cohort analysis for employment and gender indicators)" (page 19). For Prototype 1, therefore only some scattered indicators will be calculated. This information is presented in table 11, which summarises the model output for social indicators.

Table 11   Model output for social indicators

Social indicators	Name	Name of database	Unit	Global (main trade blocks)	EU	MS	Nuts 2	Sample regions	Farm type	HRU	Comments
Food availability	GTAP	GTAP		X	X						For developing countries
Food access*	GTAP	GTAP		X	X						For developing countries
Labour	APES-FSSIM (via post-processing)		Months/man						X		

* = Food purchasing power

3.4.2 Concluding remarks and questions to the resticted list of social indicators

The restricted package of social indicators is still weak mainly due to the lack of model output. In other words, at this moment there is a gap between what is ideally required and the available output of models developed by WP3. For some of the relevant issues, there is a need for developing new approaches that will lead to the construction of adapted social indicators, reflecting the more subjective type of information, as preferences, uses, functions, etc.

With respect to the indicators the 14 indicators listed in chapter 3 of this document, the following remarks can be made.

- The education level of farmers can be a determinant factor for knowledge gathering and entrepreneurship. However, this indicator only allows to relate education to human capital – although it is also fundamental for social capital: (e.g. illiterate farmers have probably more problems in obtaining relevant information and reacting in an innovative way if needed). The question is however whether there is a clear relationship between the implementation of new agricultural policy measures and sustainability. This question can, by the way, also be posed for other social indicators. It is expected that data on the education level is available.

- Being a member of active associations and organizations within the agricultural sector is fundamental for the formations of networks from where the social capital can emerge. However, data on this topic are not available, but can be collected for specific cases.

- It is suggested that poverty should be included as a criteria, for example as measured by income per capita. A clear definition of poverty is, however, needed, as the economic and social definitions of this concept are quite different in various parts of Europe. It is expected that data on income per capita are available. The social indicator of poverty is however closely related to economic aspects and it is important not to create indicators with conflicting approaches.

To conclude, there is a need to work further, within SEAMLESS and particularly within WP2, on the production of specific models for social indicators. For the shorter term, we need to clarify with WP3 which model outputs will be available soon or relatively soon, from the labour model or other models that may be interesting from the social perspective. In addition to the exploration of which model output is available, it is also necessary to have insight into the available data that will help us to define which areas are most important or realistic with respect to the development of social models.

PART II

4 Strategies for the future development of the SEAMLESS indicator package – towards Prototype 2

The list of indicators that are possible to assess will increase for each prototype. Also, the quality of indicators is expected to improve with the further improvements made in the prototypes. In prototype 1 only a restricted list of indicators will be possible to assess. The list is restricted by a limited model output as well as accessibility of data on relevant issues and scales. As pointed out in the introduction the aim of WP 2 is to overcome these difficulties and ensure a rich and varied development of indicators that could be relevant for potential future users of SEAMLESS-IF.

To do this it is important to develop strategies for indicator development for the indicators that cannot yet be assessed. To create a basis for this strategy indicators have as mentioned in the introduction been categorised in two groups, indicators that most likely can be assessed supported by model output in WP3 and indicators that are less likely to be supported by model output. The first category will mainly include indicators that can be assessed by models which are not yet operational in SEAMLESS such as the territorial models and the agric. employment models. The second category consists of indicators for which there could be lack of knowledge which means that there are not yet any models and frequently very scarce data availability. The aim of this chapter is to list these two groups of potential indicators and develop strategies for how they can be assessed or reasons for why it will be difficult to assess them. This will be a basis for further work in WP2, in co-operation with other workpackages.

4.1 Strategies for developing the package of Environmental Indicators

There are three directions to work for the development of environmental indicators within the framework of the prototype 2.

Firstly, the environmental indicators to be developed in Prototype 2 are indicators which aim to complete those already defined for Prototype 1. These indicators are going to bring precision at the level of processes involved or will allow calculations at supplementary spatial scales.

For example, with the functionality of the component related to livestock of the FSSIM model in Prototype 2, environmental indicators will be developed to also include CH_4 emissions. This indicator will be able to complete the Global Warming Potential indicator developed for the Prototype 1 which included only emissions of CO_2 and N_2O. It is the same case for NH_3 emissions for which, the emissions linked to the livestock buildings, will be able to be estimated with the FSSIM model.

Secondly, the development of new environmental indicators in Prototype 2 should cover in a complete as possible way the themes of the Goal Oriented Indicator Framework established in SEAMLESS project (see table 2). Indeed, in the Prototype 1 only some indicators in different themes have been developed for reasons of not available data or not functional models. In Prototype 2, WP 2 will give more attention to the theme "protection of the environmental compartments" and will try to develop indicators of soil compaction and soil pollution (heavy metals), for the theme of "preservation of living being and habitats" WP 2 will work to develop indicators measuring biodiversity (species and ecosystem diversity).

Finally, a third direction is the addition of simple indicators of which reliability as impact indicator is limited. But this type of indicators are present in many lists as those of the EU or OECD (e.g. ELISA, IRENA) and may by asked by the users of SEAMLESS in EC. Furthermore, they can be use to better understand or interpret already selected indicators (e.g.: % soil cover, pesticide uses).

4.1.1 Environmental indicators that most likely will be possible assessed through model output from WP 3.

Several environmental indicators which are not on the restricted list of indicators developed for Prototype 1 will be assessed by models which are operational in Prototype 2. These potential indicators are based on GOF (see table 2) presented by themes in tables 12-14.

Table 12 Protection of human health and welfare

Sub-themes	Indicators related to the		Domains of interest		Elementary scale		
	Means	Effects	Agriculture	Beyond agriculture	HSMU	Farm	Regio.
Air: pollution (pesticides)	Rate of volatile pesticides			X		X	
		Pesticides emissions to air		X		X	
Water: quality of groundwater	N balances			X	X		
	Soil cover in autumn-winter			X		X	
Water: quality of surface water		Pesticides in runoff*		X		X	
	% yearly soil cover			X		X	

* With outputs at field scale for the indicator: "Pesticides in runoff", it will be necessary to associate this indicator a landscape component which is the "distance between parcels and rivers". These landscape indicators (cf. 4.1.2.) are essential to assess the impact on the quality of surface water.

Table 13 Maintenance of environmental balances & functions

Sub-themes	Indicators related to the		Domains of interest		Elementary scale		
	Means	Effects	Agriculture	Beyond agriculture	HSMU	Farm	Regio.
Climate: greenhouse gases emissions		CH$_4$ emissions (livestock)	X	X		X	
		N$_2$O emissions (field + livestock)	X	X		X	
Soil acidification: NH3 emissions		NH$_3$ emissions from livestock buildings		X		X	
Soil fertility: organic matter, N	Fertilizers consumption		X			X	
		OM, N contents in soils	X		X		
Ecological regulation of agrosystems: crop rotation		Crop sequence indicator	X			X	

Table 14. Protection of environment compartments

Sub-themes	Indicators related to the		Domains of interest		Elementary scale		
	Means	Effects	Agriculture	Beyond agriculture	HSMU	Farm	Regio.
Soil compaction	% harvested crops in wet season		X			X	
Soil pollution: Heavy metals	Amount of heavy metal by organic fertilizer		X			X	

4.1.1.1 Comments

The calculation of environmental indicators in Prototype 2 (defined in the previous tables) will increase with the added functionality of new model components of APES and FSSIM:

- The indicators of air pollution (pesticides) will for example be calculated with the output of the "Pesticides component" of the APES model. This pesticides component simulates the movements of the pesticides into the soil profile and over the soil surface (volatilisation, runoff loss, etc…).
- The indicators linked with environmental impacts form livestock (CH$_4$ and NH$_3$ emissions from livestock building, etc...) will be calculated with the new "Livestock" of the FSSIM model.

The calculation of some indicators for Prototype 2 may also be based on already existing methodologies. This could be the case for a "crop sequence indicator" (Bockstaller et al., 1996 and 2000) developed at INRA Colmar and applied in other countries (Leteinturier et al, 2006).

4.1.2 Environmental indicators that are less likely to be supported by model output from WP 3

Some environmental indicators which could be important to develop are indicators of the sustainability of systems policies and innovations in agriculture. However these indicators are often hard to develop for different reasons. These indicators are presented by theme of the Goal Oriented Framework (table 2) in the following tables:

In the theme protection of human health and welfare there is one sub theme called landscape and within this sub theme there are a few indicators could be important for seamless to consider.

Even if landscape indicators may be seen as important for SEAMLESS as they could reflect important attributes of spatial pattern, they have some limitations (Harbin and Jianguo, 2004). One problem is that landscape indicators may not differentiate between different types of landscapes with qualitative changes in landscapes because of their insensitivity. The reason is that if evenness of a landscape is calculated with proportions it would for example be unaffected when forest landscapes change into urban landscapes.

Table 15. Protection of human health and welfare

Sub-themes	Indicators related to the		Domains of interest		Elementary scale		
	Means	**Effects**	**Agriculture**	**Beyond agriculture**	**HSMU**	**Farm**	**Regio.**
Landscape: -Heterogeneity		Landscape indices		X		X	
-Ecological structure and habitats	Parcels size		X			X	
	Elements with linear features			X			X
-Biophysical aspects	Distance between parcel and river			X	X		

Another important area is linked to the theme preservation of living beings and habitats. From the perspective of the user it could be important to separate between species diversity and ecosystem diversity as these may be related in different ways to possible policy options.

Table 16 Preservation of living being and habitat

Sub-themes	Indicators related to the		Domains of interest		Elementary scale		
	Means	Effects	Agriculture	Beyond agriculture	HSMU	Farm	Regio.
Biodiversity: species diversity	% non cropped surface			X		X	
	Shannon Index for crop diversity and ecological structures on farm			X		X	
Biodiversity: Ecosystem diversity	% of grassy strips			X		X	
		% natural ecosystem with high ecological value		X		X	

4.1.2.1 Strategies to ensure the assessment of these environmental indicators

One of main problem for the development of landscape and biodiversity indicators is the lack of data. These indicators need precise location of field, hedges, etc…with a fine resolution analysis (below 1 km*1km). At the moment the spatial precision of landscape data (e.g. CORINE Land Cover 1:10 000) does not cover small-scale landscape elements.

As a consequence to be able to assess these types of indicators it would be essential to find other data sources like national level surveys of habitat and landscape features or to use results of research projects such as (e.g. IRENA) and projects going on within the OECD. For landscape indicators this data could for example be such as parcel size the data could be extracted from the Integrated Administration and Control System - Land Parcel Identification System data sets on a case study.

Moreover, the FSSIM outputs for modelling landscape/biodiversity are not spatially explicit. Supplementary model developments by WP3 will be necessary; mainly through Task 3.7. This effort could be combined with exploring the possibilities to use the environmental typologies developed in WP4.

4.2   Strategies for developing the package of Economic Indicators

As mentioned in the introduction the development of indicators will follow a three step approach starting by indicators that can be assessed by models. These indicators, the restricted list was presented in chapter 2. The second and third categories of indicators are indicators that are more likely to be assessed and indicators that are less likely to be assessed. In the following subsections economic indicators of the two latter categories will be discussed. The basis for this discussion is the list of economic indicators developed in PD 2.2.2. The discussion will also follow the two domains division introduced by the General structure of the Goal Oriented indicator Framework; Impacts on the agricultural sector and impacts on the rest of the world (see Table 1).

4.2.1   Economic indicators that most likely can be produced supported by model output from WP 3

4.2.1.1   *Domain I: Impacts on the agricultural sector*

This category of indicator can be further divided into two sub categories. Indicators that can be produced by model output accounted for in PD 6.2.1 but which have been excluded from the restricted list of indicators. The second subcategory is more open and needs more open cooperation, negotiation and discussion with modellers in WP3.

Possible indicators of the first sub category are:

i) Share of agriculture in the global economy; ii) Total factor productivity indices; iii) Activity level of agricultural activities; iv) Yields for agricultural activities; v) Production variability; vi) Human consumption of main agricultural products; vii) Processing of sugar, rice, oils and dairy products; viii) Feed demand; ix) Producer and consumer prices of main agricultural products; x) Labour factor price; xi) Land factor price; xii) Money metric; xiii) Total revenues; xiv) Total costs; xv) Gross margins; xvi) Outlays on domestic support; xvii) Outlays on CAP premiums (direct payments); xviii) Export subsidy outlays; xix) Intervention stock costs.

This list of indicators is exhaustive in the sense that it does not discount those indicators which are included in an aggregated form on the current restricted list. For example, *budgetary outlays* on the current restricted list (see chapter 3) is composed of export subsidy outlays, intervention stock costs and (most significantly) direct payments.

The next step to make these indicators operational is to define their calculation routine on the indicator fact sheets as well as support this calculation in the software in the so called indicator calculator.

The indicators of the second sub category are indicators identified in the economical indicator matrices of PD2.2.2 but which do not appear on the list of model output presented in PD6.2.1. However the indicators that can be accounted for here are indicators have support in the FADN documentation from 2002 and 2005. It is therefore more likely these indicators will be possible to assess at least as ex post indicators, i.e. indicators that are based on data and which evaluate a present state. For the further development of the package of indicators for prototype 2 it is consequently crucial to assess which of theses suggestions that will or could be supported by the WP3 models.

The following list of possible ex-post indicators will therefore serve as a basis of this communication with WP 3.

i)   *Proportion of farm income from state support;*

This indicator could be calculable using *budgetary outlays / Agricultural income.* To make this indicator relevant it is important to include spending on the second pillar of the CAP. However CAPRI does not incorporate spending in the second pillar of the CAP which means that the project would need to find another solution to calculate this type of indicators. *Total insurance/asset ratio;*

ii)   *Level of assets insured;*

Insurance data is contained within the following FADN variables:

SE340	machinery & building current costs	Costs of current upkeep of equipment (and purchase of minor equipment), car expenses, current upkeep of buildings and land improvements, insurance of buildings. Major repairs are considered as investments.
SE370	wages paid	Wages and social security charges (and insurance) of wage earners. Amounts received by workers considered as unpaid
SE356	other direct inputs	Water, insurance (except for buildings and accidents at work) and other farming overheads (accountants' fees, telephone charges, etc.).

However, a later document states that building insurance data is optional which could result in incomplete data:

87. Insurance for farm buildings	Insurance premiums (e. g fire, flood) for the buildings in owner-occupation, which in the case of tenant farming are normally paid by the landlord. In the case of insurance payments covering buildings shared by the farm business, the business share should be estimated.	*This information is optional*

Source: European Commission (2002)

Asset data is contained within the following FADN variables:

SE436	Total assets	Only assets in ownership are taken into account. Capital indicators are based on the value of the various assets at closing valuation. = Fixed assets + current assets.
SE441	Total fixed assets	= Agricultural land and farm buildings and forest capital + buildings + Machinery and equipment + Breeding livestock.
SE465	Total current assets	= Non-breeding livestock + Circulating capital (Stocks of agricultural products + Other circulating capital).

Source: European Commission (2002)

iii)   *Intermediate consumption / Total production;*

Intermediate Consumption is measured and defined by the FADN as the sum of total specific costs (including inputs produced on the holding) and overheads arising from production in the accounting year: = Specific costs + Overheads. *Total production* is given by: Sales and use of

(crop and livestock) products and livestock + change in stocks of (Crop and livestock) products + change in valuation of livestock - purchases of livestock + various non-exceptional products (European Commission, 2002).

iv)   *Net value added growth;*

Farm net value added is calculated by the FADN (European Commission, 2002). *Farm net value added growth* could be calculated using this indicator:

$$\frac{Farm\ Net\ Value\ Added_{t2}}{Farm\ Net\ Value\ Added_{t1}} \cdot 100 = Farm\ Net\ Value\ Added\ Growth$$

v)   *% land under statutory environmental designation;*

Accounted for by the FADN as follows:

Areas with environmental restrictions	45	Codes indicating the location of the *majority* of the UAA of the holding: (► R. (EC) No. 1257/1999) 1 = the majority of the utilised agricultural area of the holding is not situated in an area with environmental restrictions 2 = the majority of the utilised agricultural area of the holding is situated in an area with environmental restrictions Areas with environmental restrictions in the meaning of this heading are those indicated in the rural development programs.

Source: European Commission (2002)

vi)   *% area of energy crops;*

Area devoted to energy crops is differentiated from area devoted to other crop types by the FADN (European Commission, 2002).

vii)   *Average productive life of capital;*

Calculable as the quotient of *Average farm capital* and *Depreciation:*

SE510	Average farm capital	Average value (= [opening + closing] / 2) of Working capital = Livestock + Permanent crops + Land improvements + Buildings + Machinery and equipment + Circulating capital. Not included is the value of quotas and other prescribed rights as it cannot always be dissociated from the value of land. Is calculated only if land capital is recorded separately from the value of buildings.	{ [D22(2)..50(2)] + [D22(4)..50(4)] + #312 + #320 + #328 + #352+ #360 + #317 + #325 + #333 + #357 + #365} / 2
SE360	Depreciation	Depreciation of capital assets estimated at replacement value. Entry in the accounts of depreciation of capital assets over the accounting year. It is determined on the basis of the replacement value. Concerns plantations of permanent crops, farm buildings and fixed equipment, land improvements, machinery and equipment and forest plantations. There is no depreciation of land and circulating capital.	#300 + #348 + #356

Source: European Commission (2002)

However, it should be noted that data for *Average farm capital* might be incomplete and patchy because "A correct estimate of this result can only be obtained if the value of land is recorded separately of other fixed assets. If all fixed assets are recorded together […] a missing data code (1) should be entered. Only farms with a value not equal to one […] are then taken into account in the calculation" (European Commission, 2002):

viii)   *Capital generation;*

Calculated by the FADN as follows:

| SE506 | Change in net worth | =[(Total assets - Liabilities) at closing valuation]
 - [(Total assets - Liabilities) at opening valuation]. | SE501 - {#296 + #344 + #352 + #360 + [D22(2)..50(2)] - #390} |

Where *Total assets* and *Liabilities* have the following functional forms:

| SE436 | Total assets | Only assets in ownership are taken into account.
 Capital indicators are based on the value of the various assets at closing valuation.
 = Fixed assets + current assets. | SE441 + SE465 |
| SE485 | Total liabilities | Value at closing valuation of total of (long-, medium- or short-term) loans still to be repaid. | #394 |

Source: European Commission (2002)

The advantage of the FADN methodology in terms of this indicator is that *Total assets* include both fixed and current forms; economists often wrongly use capital generation (or capital formation) synonymously with Gross Fixed Capital Generation (Formation) which is erroneous. However, a disadvantage of the FADN methodology (perhaps) is that this indicator is calculated net of *Liabilities* but not net of *Depreciation*. Nevertheless, this is easily incorporated as follows:

Change in net worth =   [(Total assets – Liabilities - Depreciation) at closing valuation]

[(Total assets – Liabilities - Depreciation) at opening valuation]

> *ix)*   *Capital consumption;*

This is synonymous with depreciation of fixed capital assets which is calculated as follows in the FADN:

| SE360 | Depreciation | Depreciation of capital assets estimated at replacement value.
 Entry in the accounts of depreciation of capital assets over the accounting year. It is determined on the basis of the replacement value.
 Concerns plantations of permanent crops, farm buildings and fixed equipment, land improvements, machinery and equipment and forest plantations. There is no depreciation of land and circulating capital. | #300 + #348 + #356 |

Source: European Commission (2002)

> *x)*   *% of farms below or above average capital level;*

The FADN calculates a farm's average capital (i.e. difference between opening and closing valuation); if this farm level data is summed and divided by the number of farms then we get the average capital level from which the proportion of farms either side of this average can be determined. If the distribution of farm income is skewed then the median, as opposed to the mean might be a more accurate measure of central tendency for the calculation of this indicator.

> *xi)*   *Investment ratios;*

| SE516 | Gross Investment | = Purchases - Sales of Fixed assets. |
| SE521 | Net Investment | = Gross Investment - Depreciation. |

Source: European Commission (2002)

> *xii)*   *Investment into land improvement;*

Calculated by and mentioned in FADN documentation but not tabulated separately with explanatory notes.

xiii)   *Mean farm household savings;*

Two FADN Cash Flow indicators measure capacity for saving and self-financing:

SE526	Cash Flow (1)	" = The holding's capacity for saving and self-financing.
		= Receipts - Expenditure for the accounting year, not taking into account operations on capital and on debts and loans. This indicator is close to that used by EUROSTAT on the basis of Macro-economic accounts.
		= Net Receipts of Agricultural activity and Other Receipts
		+ Balance farm subsidies & taxes
		+ Balance subsidies & taxes on investments
		= Sales of products + Other Receipts + Sales of livestock
		- all costs paid - purchases of livestock
		= Receipts - Expenditure for the accounting year
		= Net Receipts of Agricultural activity and Other Receipts
		+ Balance farm subsidies & taxes
		+ Balance subsidies & taxes on investments
SE530	Cash Flow (2)	= The holding's capacity for saving and self-financing
		= Receipts - Expenditure for the accounting year
		= Net receipts of agricultural activity and other receipts
		+ Balance farm subsidies & taxes
		+ Balance subsidies & taxes on investments
		+ Balance of operations on capital
		+ Balance of operations on debts and loans
		= Sales of products + other receipts + sales of livestock
		- all costs paid - purchases of livestock
		+ Farm subsidies - farm taxes
		+ VAT balance
		+ Subsidies on investments - taxes on investments
		+ Sales of capital - Investments
		+ Closing valuation of debts - opening valuation of debts.

Source: European Commission (2002)

xiv)   *Agricultural debt / equity ratio;*

SE480	other circulating capital	value of crops, holdings of agricultural shares, amounts receivable in the short-term, cash balances in hand or at the bank (assets necessary for running the holding).
SE485	Total liabilities	Value at closing valuation of total of (long- , medium- or short-term) loans still to be repaid.
SE490	long & medium-term loans	Loans contracted for a period of more than one year.
SE495	short-term loans	Loans contracted for less than one year and outstanding cash payments.
SE501	Net worth	= Total assets - Liabilities.

Source: European Commission (2002)

xv)   *Productive area;*

| | SE025 | Total Utilised Agricultural Area | Total utilised agricultural area of holding. Does not include areas used for mushrooms, land rented for less than one year on an occasitional basis, woodland and other farm areas (roads, ponds, non-farmed areas, etc.). It consists of land in owner occupation, rented land, land in share-cropping (remuneration linked to output from land made available). It includes agricultural land temporarily not under cultivation for agricultural reasons or being withdrawn from production as part of agricultural policy measures. |

Source: European Commission (2002)

xvii) *Ratio of leased land;*

Calculable based on the following classification of land:

| 10 UAA in owner-occupation | 48 | Land of which the holder is owner, lifelong tenant or leaseholder. Includes land leased to others for sowing (► heading K149). UAA in owner occupation implies value of land (heading G95) |
| 11 Rented UAA | 49 | Land not belonging to the holding (nor satisfying the conditions of owner-occupation in heading 10), and for which a fixed rent in paid in cash or kind. Rented UAA implies usually the recording of "rent paid" (heading F85) **Does not include**: • Land on which the harvest is bought as a standing crop or • Land rented for a period of less than one year on an occasional basis. However, if the renting is renewed from year to year this area can be included also in Table B (► tables F and K). |

Source: European Commission (2004)

xviii) *% growth in income derived from specialised activities;*

xix) *Proportion of income from specialised or diversification activities;*

The FADN description of how its results are weighted is relevant here and indicates how these indicators are calculated:

"[…] holdings in the sample and in the population are stratified (i.e. formed into groups) according to region, type of specialisation and economic size. […]. The FADN weighting system has been optimised with a view to providing good averages for groups (average family farm income on Italian wine holdings, for example)". (European Commission, 2002).

xx) *Structure of agri-environmental support;*

The following grants/subsidies are listed by the FADN:

Table J - Detail of heading 113 (Grants and subsidies <u>except</u> those on costs and purchase of animals) (► see also RI/CC 1314)	
Grants and subsidies	**Code**
Direct aids to agricultural production methods designed to protect the environment, maintain the countryside or improve animal welfare (Council Regulation (EC) No1257/99, Art,22-24) .	800
Payments to farmers who are subject to restrictions on agricultural use in areas with environmental restrictions (► Council Regulation (EC) No 1257/99, Art. 16).	810

| Support granted for the afforestation of agricultural land. | 900 |
| Other support to forestry | 910 |

Source: European Commission (2004)

xxi)   Fertility measure;

xxii)   Soil depth;

xxii)   Rainfall or climatic index;

These last three examples of indicators clearly affect economic variables but are they are probably more appropriate for consideration as part of the environmental dimension of sustainable development. However, as these indicators are not clearly taken into account in the environmental list of indicators they will still be mentioned here and may even serve as a basis for indicators of multifunctionality or as a basis for an aggregated economic indicator.

4.2.1.2   Domain 2: Impacts on society as a whole

The following indicators identified in the matrices of PD2.2.2, for the impacts on society as a whole, do not appear on list presented in PD6.2.1. These indicators are:

i)   Land use structure;

The FADN delineates land based on size of holdings, type of crops grown, area set-aside and area under woodland. However, some of the FSSIM output and the typologies developed by WP 4 could be a possibility to assess this indicator.

ii)   Sectoral multipliers;

Social Accounting Matrices (SAMs) can be used to analyse the interactions between a particular sector and the rest of the economy at different spatial scales.

4.2.1.3   Comments

The first step to develop the indicators for which there is already model output available would be to define these indicators in the indicator fact sheet for the other group of indicators the first step would be to initiate a discussion negotiation with WP 3 as to the possiblility to assess these indicators by the models.

4.2.2   Economic indicators that are less likely to be supported by model output from WP 3

4.2.2.1   Impacts on the agricultural sector

The following indicators identified in the matrices of PD2.2.2, for the impacts on the agricultural domain may be hard to quantify:

i)   Frequency of crop failure;

ii)   Transaction costs for agri-environment participation;

iii)   Per unit expenditure on expert advice;

In terms of iii) The Wye Group (2005) identified a related indicator, recommended for data collection by Hay (2002) based on an assessment of what was currently unavailable in EUROSTAT:

Research and Development Expenditure	% GDP Spent on Research and Development – Government Sector % GDP Spent on Research and Development – Business Sector % GDP Spent on Research and Development – Higher Education Sector

    iv)   *Proportion of income from non-farm activities;*

"Non-farming activities of the holder and family are not included (pensions, private bank accounts, property external to the agricultural holding, personal taxation, private insurance, inheritance" (European Commission, 2005). However, The Wye Group (2005) identifies non-farm income as an area of interest highlighted by EUROSTAT's Proposal on Agri-Environmental Indicators (PAIS).

4.2.2.2   Impacts on society as a whole

The following indicators identified in the matrices of PD2.2.2. for the societal domain may be hard to quantify:

    i)   *Participation in community/environmental groups;*

    ii)   *Mean travel distance from designated areas;*

    iii)   *Day visit rates to AESs/designated areas*

    iv)   *Per visit expenditure at AESs/designated areas*

These four indicators are difficult to assess because of a lack of data.

    v)   *Level of non-farm investments*

"Non-farming activities of the holder and family are not included (pensions, private bank accounts, property external to the agricultural holding, personal taxation, private insurance, inheritance" (European Commission, 2005). However, The Wye Group (2005) identifies non-farm income as an area of interest highlighted by EUROSTAT's Proposal on Agri-Environmental Indicators (PAIS).

    vi)   *Mean proportion of rural income from state support;*

    vii)   *Socio-economic index of rural tourists;*

    viii)   *Per visit expenditure at AESs/designated areas;*

    ix)   *Rural Unemployment Rate*

There are also a number of indicators that may not be possible to make operational from a SEAMLESS perspective but the Wye Group (2005) identifies *Dependence of Rural Areas on State Aid* (% income from social transfers); *Number of Tourist Beds* and *Rural*

Unemployment Rate as recommendations for data collection made in Hay (2002) based on an assessment of what was currently unavailable in EUROSTAT.

    x)   *Investment in flood/soil erosion control/infrastructure;*

In terms of investment into rural transport infrastructure the Wye Group (2005) identifies the following from EUROSTAT-ESTAT although it may not be operational from a SEAMLESS perspective:

Issue	*Indicator*	*Variable*
Development of transport infrastructure	Investments in transport network last 5 years	EU and national subsidies spent in millions of Euros

    xi)   *Food miles;*

Smith *et al* (2005) in a study commissioned by the UK's Department for Environment, Food and Rural Affairs report on the compilation of a food miles dataset covering the supply chain from farmer (either in the UK or abroad) to consumer (in the UK) for 1992, 1997 and 2002. For such an indicator to be operational from a SEAMLESS perspective then data on distance travelled would need to be available for all forms of transport from farmers to consumers in different Member States in order to properly assess the social and environmental costs associated with food mile calculations; for example CO_2 emissions for 1 km travelled by air are greater than CO_2 emissions for 1 km travelled by any alternative form of transport which means that a simple food mile indicator based simply on distance without acknowledging the differential social and environmental costs associated with different forms of transport would be inadequate from a policy point of view – a decrease in food miles over time would not be an indicator of sustainable development if it were associated with a shift toward more environmentally malign forms of transport.

    xii)   *Public WTP for landscape or biodiversity;*

Willingness to pay (WTP) is known as an *expressed preference* technique because it involves surveying people in order to find out (ask them to express) their willingness to pay for ecosystem goods services, see for example Garrod and Willis, 1999. This methodology however has received a high level of criticism over time and as a result has become more sophisticated to improve the reliability of the results obtained, see for example, Powe *et al* (2005). It is however unlikely that sufficient WTP data could be made available to make such and indicator operational from a SEAMLESS perspective.

    xiii)   *Mean travel distance from designated areas;*

    xiv)   *Day visit rates to AESs/designated areas;*

These two indicators are related to *xii) Public WTP for landscape or biodiversity* in the sense that they could be used to infer the monetary value placed on ecological goods and services via a methodology known as the travel cost technique, after Hotelling (1931), which infers environmental values based on how much people pay (in terms of travel and time) to visit a site for recreation and/or sightseeing. If data were available for these two indicators as well as for the WTP indicator above then the inference of environmental value based on two different methodologies (i.e. by taking the mean of the two methods) would offer a more reliable value estimate than the use of one method in isolation.

Three other indicators discussed in PD2.2.2 are perhaps least likely to be assessed because they are problematic from a conceptual point of view:

i.   Genuine Savings (Solow, 1974)

ii. Index of Sustainable Economic Welfare also known as the Genuine Progress Indicator

iii. Adjusted Green National Product;

The inherent appeal of such indicators, particularly from a SEAMLESS perspective is that they amalgamate the economic with the social and environmental dimensions of sustainable development, potentially reducing the number of indicators required by end-users in order to fully appreciate the implications of a given policy scenario on sustainable development. *Genuine Savings (GS)* can be defined by the following functional form: GS = investment in man-made capital – net foreign borrowing + net official transfers – depreciation of man-made capital – net depreciation of natural capital + current education expenditures. Problems with this potential indicator are conceptual rather than data availability. The World Bank (1997, 2000) has made comprehensive calculations of GS for individual countries. The sustainability of countries using GS is measured against a threshold value of zero i.e. *GS > 0 = Weak sustainability*. However, commentators who have analysed the GS approach have concluded that positive GS is no real indication as to whether a country is sustainable or not (e.g. Asheim, 1994). This casts serious doubt as to whether GS is an indicator of sustainable development, making its use in SEAMLESS is therefore difficult to defend. The *Index of Sustainable Economic Welfare (ISEW)* also known as the *Genuine Progress Indicator (GPI)* is mathematically similar to GS discussed above and therefore suffers from similar problems. Lawn (2003) notes how the reliability and thus policy guiding value of this indicator can be improved by a combinatorial approach, for example "[…] ISEW, when combined with ecological footprint/biocapacity comparisons can provide policy-makers with substantial insight as to whether a country is approaching or has exceeded its optimal macroeconomic scale, or […] its maximum sustainable scale". Others have argued that examining simple, separate indicators is more reliable from a methodological point of view (Lintott, 2006) and arguably are more readily understandable to the non-specialist future user of the SEAMLESS-IF. Finally, the Adjusted Green National Product evolved from the idea that traditional net national product should be adjusted to account for the cost of environmental damages (Hartwick, 1990) but, has also received significant criticism in terms of the methodology used, the nature of the results obtained and the difficulty of interpreting a useful policy response from the results (Aaheim and Nyborg, 1995).

4.2.2.3   Strategies to ensure the assessment of these economic indicators

There are several possible ways of making operational economic indicators which cannot directly be assessed based on the model output. One way is to develop simple models or to base some of the ex-post indicators on trends or scenario assumptions. Another way could be to assess the indicators by experts of stakeholder groups. Here a joint effort between the different domains of sustainability will be taken to ensure an as broad indicator package as possible if referring to the developed indicator frameworks.

4.3 Strategies for developing the package of Social Indicators

4.3.1 What can social indicators indicate?

Social indicators are frequently seen as an assessment that should measure progress towards the policy objectives designed for promoting employment, combating poverty, improving living and working conditions, combating exclusion, developing human resources. OECD uses social indicators for two purposes: to describe social development and to determine how effective society and government are in altering social outcomes (OECD 2001a). Indicators of social development require (OECD 2001a) "a broad coverage of social issues; insofar as social life requires health, education, freedom to develop, resources and a stable basis of social interactions, so must the indicators reflect these various dimensions".

Early attempts to use indicators to evaluate the impact of government programmes, or policies, were of limited value because the produced indicators were not closely linked to the activities of the programmes they were intended to evaluate (Armstrong and Francis 2002).

After the first attempts to measure policy impacts, evaluators first turned to map the logic of governmental programmes and then to measuring their performance in terms of outputs and targets. Although outputs showed what the programme was delivering, this measurement still did not demonstrate whether the programmes were having an impact, i.e., what were the outcomes for society (Armstrong and Francis 2002). Social indicators then again emerged as the means of measuring, not individual programmes, but social outcomes to which programme activities could be linked.

Social indicator should thus be considered as those that are used to assess whether and how the broad thrust of policy is addressing important social issues (OECD 2001a). They address complex questions that have to be seen in an integrated way, and allow the assessment of larger societal goals (Innes 1990). They are thus of a different nature than economic and environmental indicators, as they often refer to matters of human satisfaction which are more subjective than those within the other two dimensions.

4.3.2 The SEAMLESS social indicator wish list

Within the aim of the SEAMLESS project the aim of the social indicators is to assess to what extent any suggested agricultural or agri- environmental policy may influence the social aspect of the sustainability of the agricultural sector and to which extent this policy targeting the agricultural sector may influence the social aspect of the sustainable development of society as a whole. As explored earlier in chapter 3 there are no social indicators that have been implemented in the SEAMLESS-IF at this point in the project but there are several model outputs especially related to employment and landscape aspects that will be available in a near future.

To develop a package of social indicators that may grasp the two aims of the project a so called wish list of social indicators have been produced in PD 2.2.2. This so called wish list has been reproduced in Table 17 (representing the local and regional and national levels).

The numbers between brackets in the column named sub-theme in table 17, refer to the fourteen social indicators presented in section 3.4.1- This whish list will serve as a basis for the development of different strategies for the development of indicators in the project.

seamless

Table 17   Framework for social indicators

Themes	Sub-themes	Impacts on the agricultural sector itself	Impact of agriculture on society as a whole
POPULATION	Age (8)	Age of farmers	Age distribution % young farmers (< 40 years old)
	Sex ratio (2)	Male / female farmers	Sex ratio (men per 100 women)
	Migration		Net migration rate
	Population growth rate (6)	Agricultural population growth rate	% of agricultural population on the population growth rate
HUMAN CAPITAL	Health		Life expectancy at birth
	Education (7)	Education level of farmer % of illiterate farmers	Education level of adult population % of illiterates
	Employment (1)	Off-farm employment % hobby farmers (main income outside the farm)	Number of persons employed in agriculture as a share of total population
SOCIAL CAPITAL	Membership and participation	Active associations and organizations Participation of farmers in social/cultural/environmental associations	Number of active social/cultural/environmental local associations
	Information accessibility (10)	Internet connection Subscription of specialised magazines Number of professional events	Internet access
	Innovation and research	Diversity of activities in farm Funds invested in research	Diversity of enterprise types % new enterprises
	Services infrastructures	Distance of farm to public transport	Diversity of services in rural areas
QUALITY OF LIFE	Poverty/wealth (5,12)	Income per capita Off-farm income	Social exclusion
	Accessibility and mobility (11)	Distance of farm to main service centre	Number of road vehicles per 1,000 inhabitants Distance to large urban centre
	Housing and settlement (9)	Persons per km^2	Population distribution per rural residence % population living in farms
	Leisure and sport		Arrivals of non-resident tourists staying in 'rural hotels' and similar establishments
	Cultural activity		Number of events
	Landscape multifunctionality (3,4 13, 14)	Specialisation of farms Number of farm types Number of farms in each type	% classified area Diversity land cover in farm Rate of area under special landscape management contract Number of classified sites and buildings Rate of change in land cover Recreation activities based on landscape Hunting and fishing activities Number of tourist beds in farms

4.3.3 Challenges with developing social indicators in SEAMLESS

As discussed in PD 2.2.2 and as recognised by other researchers in the area (Hueting 2004) the environment and economic dimensions are almost always emphasised in indicator initiatives despite of the repeated acknowledgement of the relevance of the social and human dimension of sustainable development. There are several reasons which could explain this unbalance and they therefore deserve being mentioned. In the following sections, six challenges related to the creation of social indicators will be mentioned combined with ideas how SEAMLESS could tackle them,

4.3.3.1 Challenge 1 – Social indicators to be used in ex-ante impact assessment

Some social indicators are very difficult to produce for an ex-ante impact assessment, especially if considering the speed of change of social values nowadays. How could we for example predict what will be the concept of quality of live in ten years time? Most existing social indicators that have been developed are based on existing data and built for ex-post evaluations.

SEAMLESS has therefore to explore how the ex ante aspect could be added to social indicators through adding ideas how peoples behaviour may change in the future. This could be done by;

1. Basing existing ex-post indicators on current trends which would need to develop a deepened scenario analysis/understanding and make sure that the assumptions made in the scenarios are in close relations to the assumptions that are made or used in the developed social indicators that will be used in ex ante impact assessment.

2. By combining variables that are assumed to be roughly stable in time, with outputs of the models. This, of course, depends of what exactly can be extracted from the models. Here are a few examples:

   a. Assuming the models give the evolution of labour in agriculture, if we have data on the structure of employment, we can build a simple model (inspired by base theory) to compute the effect of the policy on **total employment** in the area.

   b. If we assume that migration trends are stable in time, and if we have data on past migrations, broken down by economic sector, then we can compute the effect on **migration**.

   c. If we get sufficiently detailed data on membership in associations and combine that with a hypothesis on the stability of the number of associations per inhabitant, we can deduce its effect on **social capital**. For instance, if an estimation predicts that population density will fall, involvement in associations will be more difficult, this could imply a decrease in social capital.

   d. Another aspect of **social capital** that is not currently dealt with in the restricted package of indicators is the social acceptance of the effects of the policy option. If we compare data (e.g. from Eurobarometer) about how people see rural areas with the predictions of the models in terms of rural population, we can probably get contrasted situations across Europe. For example, in countries which value rural areas a lot (like France for instance),

a sharp decrease of rural employment could be seen as detrimental to social capital.

e. A more elaborate indicator of **social capital** could be constructed if we get access to a migration matrix. This information, combined with outputs of the model could allow us to compute an indicator of outer opportunities, which would be certainly relevant to assess sustainability issues.

3. Another approach could be to develop specific social models. Ideas that have been developed for such of models, in different applied contexts and relating broadly to quality of life, could be used as a starting point (Calvert and Henderson 2005; U.S. Working Group on Sustainable Development Indicators, 1998).

There have been a number of initiatives to model social outcomes using multivariate methods aiming to establish causal relations. In most cases, policy-relevant variables are introduced as one independent or predictor variable, among many others, contributing to the social outcome in question. The outcome is ordinarily represented by variables which can be termed social indicators. This involves using social indicators derived from conceptual models in relation to consensually derived social benchmarks or goals. Under this approach, a set of social benchmarks and the respective inputs are first selected on the basis of consultation with all relevant stakeholders, including representatives of the general public and potential clients of the programs in question, as well as policy makers, and analysts. For the indices to be useful for program evaluation and monitoring, the program evaluation perspective must be represented in the process of selecting and constructing indicators. And, over a longer period, the conceptual model can be validated on the basis of expert opinion and microsimulation or econometric analysis and supported by data gathering through a longitudinal (panel) survey of beneficiaries and through case studies (Ekos Research Associates 1998).

This approach is costly in terms of the resources required, both in terms of costs and of time frame - the whole set of processes demand some time. But it has quite some advantages: first, simulation models are ordinarily based on some kind of conceptual or causal model where the link between inputs and the outputs (represented by social indicators) are clearly specified, along with the external control variables affecting these outcomes; second, because the simulation model is based on a conceptual or theoretical model, coherence and efficiency are lent to data collection and research (Wolfson 1994); third, because policy measures can be included as explanatory variables, it is possible to measure the contribution of policies to final social outcomes; fourth, the simulation models have the further flexibility of posing and rigorously answering "what if" questions such as the implications of a change in welfare expenditures.

In SEAMLESS it is clear that the emphasis on models that may grasp social impacts is weak. The approach to create social indicators has therefore to be innovative. One conclusion from chapter three is that to develop the package of social indicators to be used in SEAMLESS-IF WP 2 has to explore how the existing and forthcoming model output could be used to compute social indicators The main focus of this exploration is the agricultural labour model developed in task 3.9, the terrestrial model developed in task 3.7 and the structural change models developed in task 3.6. For these models it seems to be plausible that at least some indicator could be estimated directly. Another way could be to combine some of model output from CAPRI, FSSIM or

APES with data or to develop social models or calculation rules that would be handled by the indicator calculator.

4.3.3.2 *Challenge 2 – The subjectivity of the social domain*

Several aspects of the social dimension of the sustainability are not definable in an objective way either because of the subjectivity of the concepts or due to the methodology required to collect data (survey involving opinions and feelings, for example). Nevertheless, during the last few years the importance of developing qualitative indicators to measure the sustainability has been recognized (OECD, 2003). Both quantitative and qualitative indicators are needed: quantitative says "what" is happening, qualitative says "why" it is happening (Armstrong and Francis 2002). But the question of how to measure remains: how to measure social phenomena beyond the ones, which are easily quantified through statistics. The individual and social well-being has to be taken into account, but they are extremely difficult to quantify.

Social aspects are also very much dependent on cultural and legal contexts and general goals of social sustainability like progress and enhancement of individual and collective well being. These goals can be achieved or satisfied very differently depending on the ideas behind for example intragenerational equity, satisfaction of basic needs and quality of life – they therefore require a certain form of contextualization.

SEAMLESS would need to in a consistent and methodological way incorporate the subjective aspects of social indicators in the tool. This could be done through contextualising each indicator either through the PICA compatibility assessment tool (see chapter 6) or through methodologies related to each social indicator. Such methodologies could be the definition of thresholds which are context specific, or by using stakeholder or expert groups to contextualise each indicator.

4.3.3.3 *Challenge 3 – Interrelations with the environmental and economic domains*

Most social indicators are able to evaluate the consequence of environment and economic interrelationship in society, rather than evaluate how social aspects could influence the environment or the economy (Spangenberg, 2002; Perret, 2002). More and more frequently aspects of the sustainability can be explained looking at new possible interactions, as it is the case of the remote rural areas. Results are coming up on integrating different dimensions of sustainability and an indicator of "Social Utility" is a recent example, where environment and economical services are included (Wiggering et al, 2006). There should be paid attention to problems of overlapping.

The SEAMLESS project has to pay special attention in developing these cross-dimension indicators which needs special efforts in develop indicators on multi functionality as well as in the aggregation of indicators between the domains of sustainable development.

4.3.3.4 *Challenge 4 The context dependence of social indicators*

Agricultural and rural landscapes are often judged from the perspectives that in part mirror the view of urban consumers. When local stakeholder look at their rurality it is probable that some of the social indicators can be considered as pressure or state instead of response.

SEAMLESS therefore has to make sure that the social indicators are assessed and evaluated by stakeholders in the Test Cases.

4.3.3.5   Challenge 5- Handling incomplete data at multiple scales

Regarding space and time scales, the complexity is very high when crossing from the individual/community to the society level. The spatial dimension of social indicators therefore has to be carefully interpreted since the same indicator can have different meanings depending on if it is considered at a local level or upper levels, for instance. The local level is seen as the fundamental level where local communities interact.

Some methodologies of defining sustainability indicators locally are gaining importance (Fraser, et al, 2005). Despite the relevance of such an approach it is important to keep in mind that indicators have to be defined so that different regions can be compared and that is still not clear how to deal with higher levels of aggregation from the methodological point of view. Besides, some impacts are only measurable in a long period, while others should be detected in a short or medium time frame.

Moreover there are often inconsistencies in data collection between member states. A slight variation in the definition and collection of data may change the possibilities to consistent indicators over a pan European scale considerably. For example, the measurement of membership in associations greatly differs from a country to another, so that figures cannot be compared.

To use data collected on a multi-national level, except for very basic variables (such as age or sex-ratio) could be problematic. Eurobarometer, World Values Survey and European Values Studies provide many interesting variables, sometimes at an infra-national (NUTS I or NUTS II) level. As a way forward SEAMLESS may try to develop the conceptual ideas behind the indicators and then implement them in the scales and regions where there are available data starting with the test case regions and maybe even some sample region.

4.3.3.6   Challenge 6 – Grasping complexity through composite social indicators

Creating social indicators can be achieved by collecting statistical data. But, despite this being the most simple option, it has quite some limitations: arbitrariness in deciding what statistics should be included in the collection - the inclusion or exclusion of certain indicators may reflect values and ideologies that are not made explicit; such collections of indicators rarely include measures of how satisfied individuals are in their activities, i.e., of the subjective value placed on objective conditions; finally, such efforts are rarely based on an explicit conceptual social framework and modelling nor do they include socially desirable goals to which current conditions may be compared. Thus, from an evaluation perspective, they have limited value (Ekos Researh Associates 1998).

A more sophisticated approach to social indicators is the construction of composite social indices based on a number of social indicators. By summarizing a number of measures, such indices overcome the difficulty in detecting trends based on a plethora of singular social statistics. Such measures would be used to provide social intelligence on changes in various input and output areas such as social expenditures, physical health, and child poverty. The strengths of such an approach lie in its relative simplicity and public acceptability, and in the relatively low investment required to produce indicators from a wide array of existing data. The main weakness of social composites relates to a lesson not learned from the previous social indicators movement: there is little or no connection to either an explanatory causal model of the social states in question, or to explicit goals or benchmarks against which progress can be measured; this approach does not permit causal attribution of changes in outputs to changes in inputs (Ekos Researh Associates 1998).

This approach does not solve the problem that these data based indicators can not directly be used in an ex ante assessment. However the scenario dependence of an indicator is another difficulty with social indicators that have been commented elsewhere.

5 Methodologies and strategies for the development of Indicators of multi-functionality

The aim of this chapter is to give a brief account on indicators of multifunctionality and how they can be used in SEAMLESS. The chapter will also outline strategies for how such indicators can be developed and give some examples of what type of multifunctionality indicators that could be developed in SEAMLESS.

5.1 The Multifunctionality concept: which is the interest for SEAMLESS-IF?

The notion of multifunctionality increasingly gained attention during the nineties in discussions about agricultural policy changes and the future of agriculture, both at national and international levels, particularly within the framework of OECD works and in the WTO multilateral negotiations on agricultural trade. Since the term "Multifunctionality of Agriculture" (MFA) has rapidly emerged into common use in environmental, agricultural and international trade discussions, the multifunctionality concept carries different meanings for various actors at several scales (see Appendix 3).

For SEAMLESS-IF, we choose to adopt the EU's understanding of MFA: the term multifunctional agriculture relates to the fact that agriculture, beyond the production of food and fibers (= commodities) also provides important social, environmental and economic functions to society that manifest themselves in products that are up to now not marketable (= non-commodities). This understanding refers to three main interrogations:

- does the evaluated policy improve sustainability through a development of multifunctional features of agriculture in the targeted areas ? In other words is the *ex-ante* impact of policies positive along the three dimensions of sustainable development (economy, environment, social)?

- does the **degree** of multifunctionality increases? A regulator may whish to sustain the development of her spatial units through the increase of "multifunctional" agriculture. Thus we have estimate the extent to which this multifunctionality increases, or to provide measures: in places where the multifunction increases (or simply develops) is it possible to determine the extend of this increase (i.e. can we at least rank different policies according to their multifunctionality improvement ?).

- does the **nature** of multifunctionality evolves through the evaluated policy ? The non-commodity outputs of agriculture are non conventional products, but most of them result of specific aspects of the agricultural production process. Some of these outputs are closely tied to agricultural production and others[4] compete with agricultural production for land or other resources. In this sense, any policy dealing with agricultural production is likely to modify the nature of the multifunctional features in a region.

The first point refers to the identification of multifunctional features, the second to their quantitative assessment, and the last to their qualitative description. Thus, indicators of

---

[4] like the establishment or restoration of wetlands, or the creation of wildlife habitat on farmland.

sustainability could be and approach to indicators have the capacity to make sustainable development operational by exploring the relation between different dimensions.

The key issue concerning the nature and degree of jointness in the production of commodity and non commodity outputs for Prototype 1 is that jointness will induce correlation effects in the statistical analysis of the indicator sets. This correlation can be assessed with appropriate statistical manipulations, provided that a policy supporting a sustainable development is expected maintaining or increasing the degree of jointness between the commodity and non commodity outputs supplied. The rational is that increasing the joint supply of commodity and non-commodity outputs will lead to lower costs than when these outputs are supplied separately (OECD, 2001b).

5.2   Examples of indicators of multi-functionality to be used in SEAMLESS

This section will give two examples of indicators that could be operational in the SEAMLESS-IF. The first indicator will bring to light spatial units where sustainable development is improved through multifunctional features, the second will provide a simple measurement of the extent to which multifunctionality increases.

MFA.1 indicator focuses on spatial units where the *ex-ante* impact of a specific policy is positive along the three dimensions of sustainable development (economy, environment, social). Regions can develop multifunctional features in case the impact of a policy is positive for the long-term viability of agriculture (economic indicator), a strong improvement of water and soil conservation (environmental dimension) and if the policy is also improving the quality of labour conditions (social dimensions).

The design of MFA.1 indicator requires some expertise to aggregate the indicators developed in the previous Sections (economic, environmental and social indicators) to assess whether the policy will have a positive long-term impact on:

- the viability of agriculture,

- the environment quality,

- the quality of labour conditions.

MFA.1 is a binary indicator: in the spatial units where the ex-ante assessed impact is positive along the three dimensions, its value will be assessed to 1, and 0 otherwise.

MFA.2 indicator is a simple measure of the degree of multifunctionality, designed to rank different policies according to their capacity of improving multifunctionality. Gillette *et al*. (2005) presented a first pragmatic attempt to qualify the degree of multifunctionality at farm and regional scale. They identify external functions of agriculture, grouped them into 3 sets (food security/quality, social, environment) and propose to count the number of function that a farm fulfils. At the regional scale, they propose to aggregate the functions weighted by the size of the farms which fulfil them.

MFA.2 will focus at the farm and regional scales and will be rather simple. Farms and regions may produce (or not) economic, environmental and social functions (see PD2.3.1 for details), namely:

- economic functions: quality of products, diversity of products, non-farming activities, services.

- environmental functions: water conservation, soil conservation, agricultural landscape, contribution to air quality, use of renewable energies, supply of renewable energies, biodiversity.

- social functions: contribution to employment, contribution to rural viability, animal welfare, cultural heritage, provision of recreational areas.

Depending on the thresholds and targets designed for indicators of each function, this function can be considered as fulfilled (and coded 1) or not (and coded 0). Up to now, as no consensus exists on operational ways to aggregate the different functions, a simple way to present this type of indicator of multifunctionality is a Table, assessing which functions are fulfilled (see Table 18). Once again, there is a need to aggregate the indicators designed in the previous sections, to asses whether the referred function is fulfilled or not (for example, water quality function is connected to nitrate and pesticide leaching, phosphorus balance and soil erosion). The SEAMLESS-IF can propose some sets of aggregation rules than the user can choose. Another option is to let the user build his own rules. The representation suggested in Table 18 allows SEAMLESS-IF users to select the functions that are of interest for them and/or weight the proposed functions according to their own objectives (see PD2.6.1).

Table 18 Examples of indicators of multifunctionality

	economy				environment							social				
	quality of products	diversity of products	non-farming activities	services	water conservation	soil conservation	agricultural landscape	contribution to air quality	use of renewable energies	supply of renewable energies	biodiversity	contribution to employment	contribution to rural viability	animal welfare	cultural heritage	provision of recreational areas
farm1	1	1	0	1	1	1	1	0	0	0	0	1	0	0	0	0
farm1																
farm2	0	0	0	0	0	0	1	1	0	1	1	0	1	1	1	1
farm2																

5.3 Strategies to develop future indicators of multifunctionality

The previous indicators can be made operational at farm and regional scales. A further step would be to improve MFA.1 and MFA.2 indicators at the national scale and develop indicators of the nature of multifunctionality.

The nature of multifunctionality is evolving following past and current policies. This evolution is related to the trade-off that farmers make between scale and scope economies, depending on the economic context to which they are subject. The border between farms where scope economies are more profitable and those where scale economies are clearly the best way to improve the farmer's revenue is rather soft, and in most farms both economies are exploited, depending on the production and farmer's skills. But because the border is soft, any policy that subsidizes the farms in any way is likely to select among the population of farms

that develop scale or scope economies, and thus modify the nature of multifunctionality in a region.

Recent work provides promising analysis of the jointness of commodity and non-commodity outputs supply. This work focus on the description of the heterogeneity of the farms regarding the jointness between commodity and non-commodity outputs supply (Bontems *et al.,* 2005) and on the potential evolution of this jointness along production possibility curves (Wiggering *et al.,* 2006).

A policy will modify the repartition of farms according to their multifunctional degree. 3 as an example depicts two policies that both increase the multifunctional features of a given region to roughly the same extent, but in very different ways: policy A favours the development of farms having medium multifunctional features and policy B favours farms which are highly multifunctional.
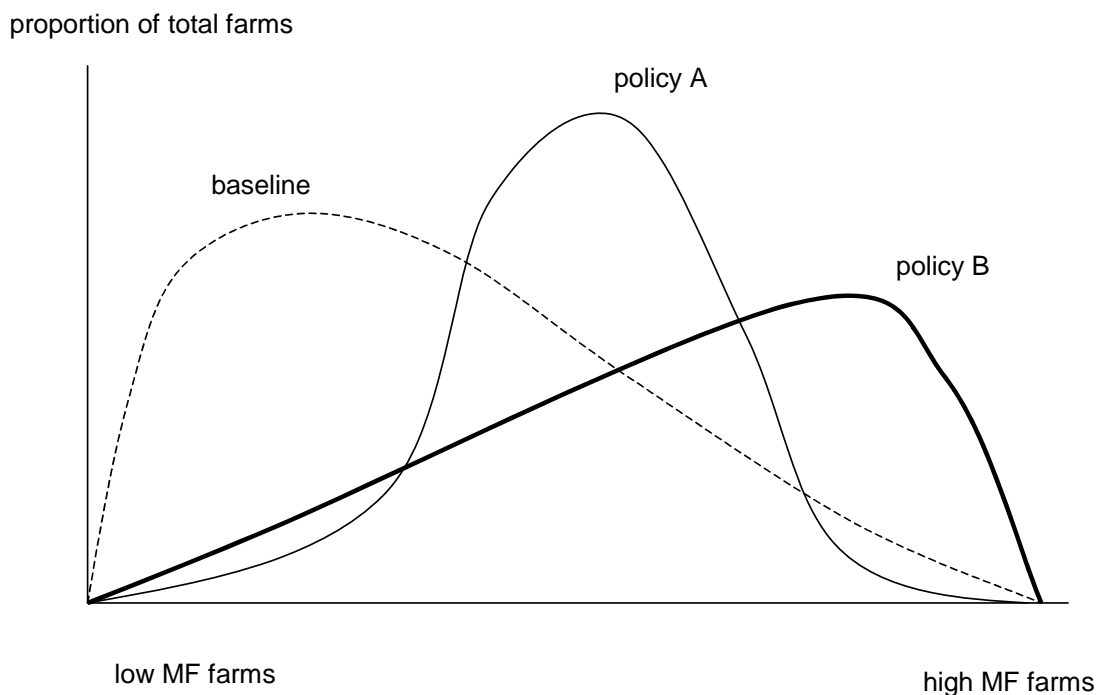
Figure 3 Example of two policies that modify the multifunctional features in a region in two different ways.

Moreover, qualitative assessment of jointness would involve an assessment as to whether a given commodity and non-commodity output are positively or negatively correlated, or a combination of the two in a quadratic function. Furthermore, qualitative assessment of jointness could indicate whether that jointness is strong or weak. The final, and most difficult stage is to develop a quantitative assessment of jointness which would involve specifying the magnitude of the coefficient(s) in the jointness function. Graphical examples of these different types of jointness are given below in Figures 4 a-c (see also appendix 4).

(a) Positive jointness:
NCO = a*CO

(b) Positive and negative (quadratic) jointness:
NCO=a*CO+(-b*CO^2)
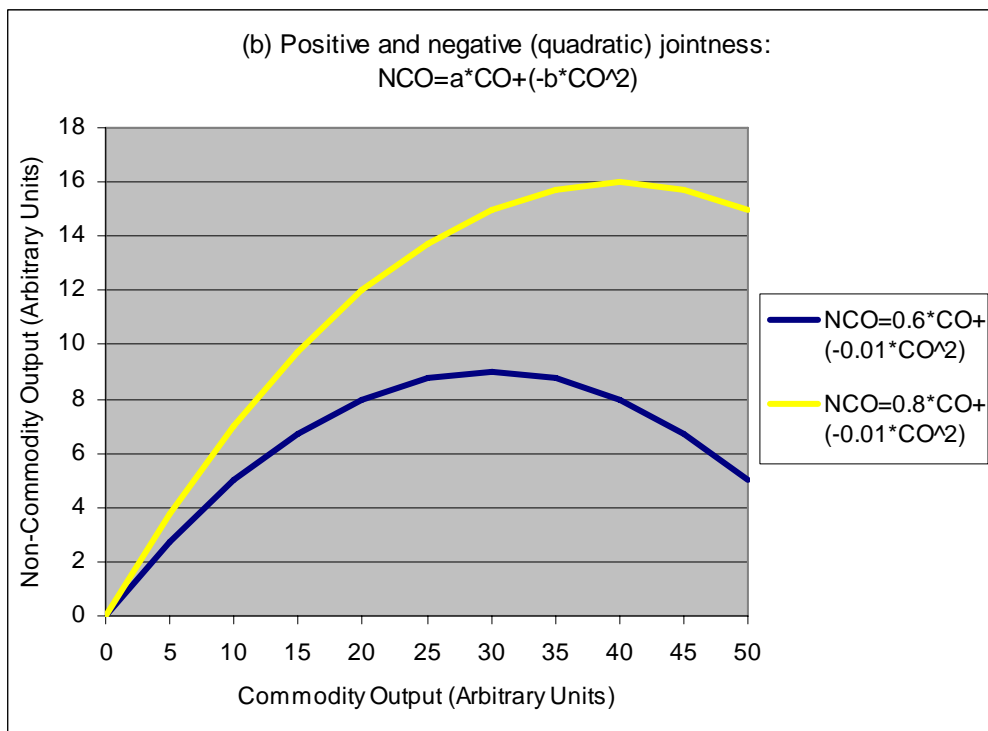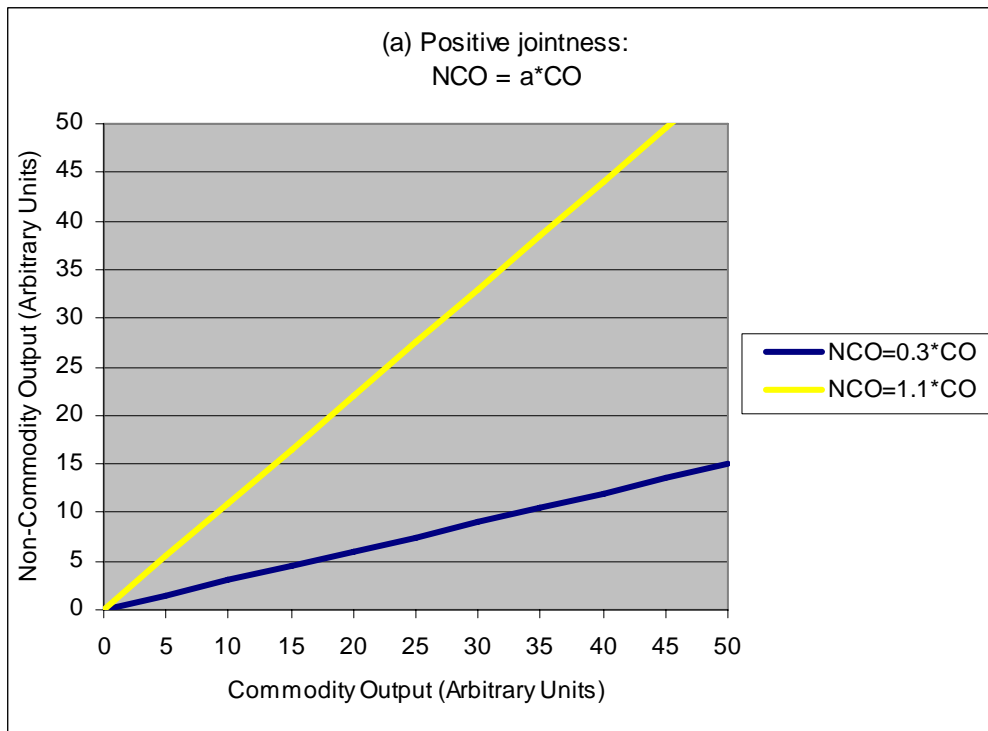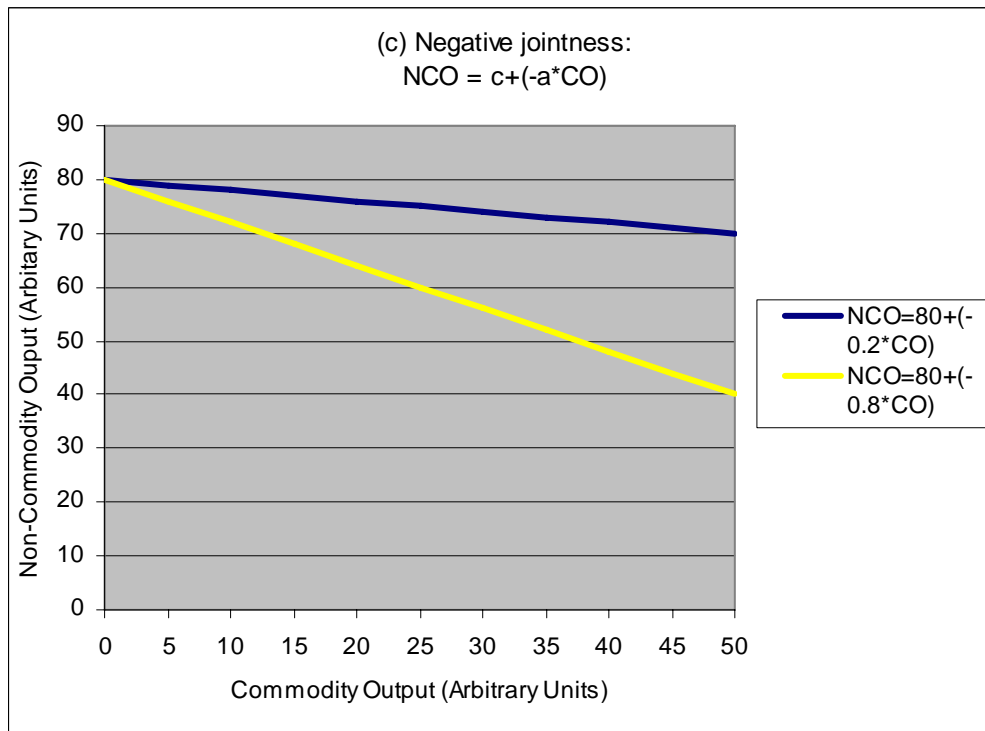
Figure 4 a –c. Strong and weak jointness for (a) positive (b) positive and negative (quadratic) and (c) negative cases

In the following Prototypes, we will design indicators that capture both:

- the nature of jointness (positive, negative, both, strong or weak),
- the density parameters of the farms when ranked according to their multifunctionality degrees.

These indicators will be developed using databases and modelling results from the project.

6 Process for Institutional Compatibility Assessment (PICA)

The aim of this chapter is to give a brief explanation of the underlying ideas of the Process for Institutional Cpmpatibility Assessment (PICA). The aim is also to explain how it can be used in SEAMLESS-IF e.g. providing explanatory content and context to the model results. To enlighten this explanation one example how the PICA methodology may work will be given in relation to the policy options relevant for Test Case 1.

A correct understanding of the institutional context in which a policy is to be implemented is a necessary condition for assessing the balance between the intended and unintended consequences of that policy. A better understanding of the institutional context could also be important to interpret the output from the models or result of indicators. The institutional analysis in SEAMLESS will consequently fulfil a twofold role. It can both be used in a pre- and post-model analysis.

The Procedure for Institutional Compatibility Assessment (PICA) is based on the idea of compatibility. The compatibility between policy options and institutions is one way to assess if a suggested policy will be implemented or not. The difficulty in assessing institutional compatibility is that the concept institution is complex and relate to long range of situations (see PD 2.4.1), but a formalized methodology to assess the possibilities to implement of optional policies could be important to improve the efficiency of an impact assessment. In order to assess the compatibility we follow a process in four subsequent steps.

6.1.1 Pre model analysis

The pre-model analysis refers to the conceptualisation phase of an impact assessment. The division between pre-model analysis and modelling is to some extent artificial, as pre-model analysis can also be understood as the first step of a model run. The PICA assessment tool may in the pre modelling phase assist the users of the SEAMLESS – IF in assessing the possibilities to implement the chosen policy option in different institutional context (countries regions). Using the institutional analysis as a pre-model analysis will hence assess whether it will be possible to implement a certain policy or whether institutional constraints will cause prohibitive transaction costs resulting in the fact that the policy hardly will reach its objective. The result of such an assessment may give the indication that there might be no need to run, e.g., bio-physical farm models assessing the policy impact on the production function. The pre-model analysis can be made both from a quantitative and qualitative perspective.

> From a quantitative perspective, data and variables need to be tested if they fulfil certain criteria required by modelling statistics. Likewise, model assumptions need to be explicitly considered, in order to decide whether the model could be run with the given data. This is something that will be handled by the tool itself and where the user definition and refinement of the assessed impacts will be continuously controlled against availability of data in the knowledge base. This is an assessment that will be jointly developed by WP3 and 4 and the PICA does not deal with this assessment.

> From a qualitative perspective, it needs to be decided if the model can produce outputs that are relevant for the issue under scrutiny. The focus of the assessment will be narrowed down to certain resource and environmental issues or geographical scales depending on the policy-option. This type of pre-model analysis facilitates the

selection of appropriate models from a pool of models possible to be handled within SEAMLESS. Here PICA may be of assistance.

6.1.2   Post model analysis

The post-model analysis also follows a twofold methodology.

- First, it comprises further testing of the model outputs in terms of their robustness and sensitivity. This is mainly done in a quantitative way with sensitivity analyses or uncertainty analyses. Such kind of post-model analyses are referred to in SEAMLESS as advanced model chain analyses. Tools for this type of uncertainty analysis should be provided by the modellers and the developers of indicators.

- Second, it relates the model outputs to a context, by relating quantitative model to its context and guiding the interpretation of the results e.g. a decrease in employment in the agricultural sector does not mean the same in a region where a large part of the population is employed in the agricultural sector if compared which a decrease in a region where few are employed in the agricultural sector. This can be done by comparing a set of indicators to context specific thresholds. Participatory methods are one way of validating quantitative model outputs by stakeholders.

The post-model analysis facilitates the interpretation of other, mainly quantitative, model results and relates them to the institutional context. This provides hints on the probabilities of the model assumptions and predictions.

6.2   Procedure to Make the Conceptual model PICA Applicable

PICA will be developed in four steps.

Step 1

First, we elaborate a screening to cluster policy types according to their type of intervention (regulatory, economic, and advisory), their area of intervention (governance structures), the possibly involved property rights change and the nature of the problem addressed (attributes of resources). This screening will result in a classification system to identify the generic structure of policy options (see Figure 5). In this table we can see the type of intervention on the x axis, the area of intervention on the y axis. The possibly involved property rights are shown as the two coloured boxes. The nature of the problems addressed is mentioned on the diagram as soil, water biodiversity and forest.

These *Policy Types* are introduced to offer a systematic way to classify every future policy option according to four dimensions. For instance, establishing an EU Food Safety Agency (with branches in every Member State) to monitor the quality of particular agricultural products can be considered as a regulatory type of policy adding a (bureaucratic) element to a hierarchically organized governance structure (to ensure product quality) that might be already in place in a particular country.

The objective of the specification of policy types is to provide a suitable formalized structure as a basis for the assessment of crucial institutional aspects of policy implementation (Step 2). We assume that the assessment of different policy types will lead to distinct different institutional requirements for institutional compatibility of the particular policy type.
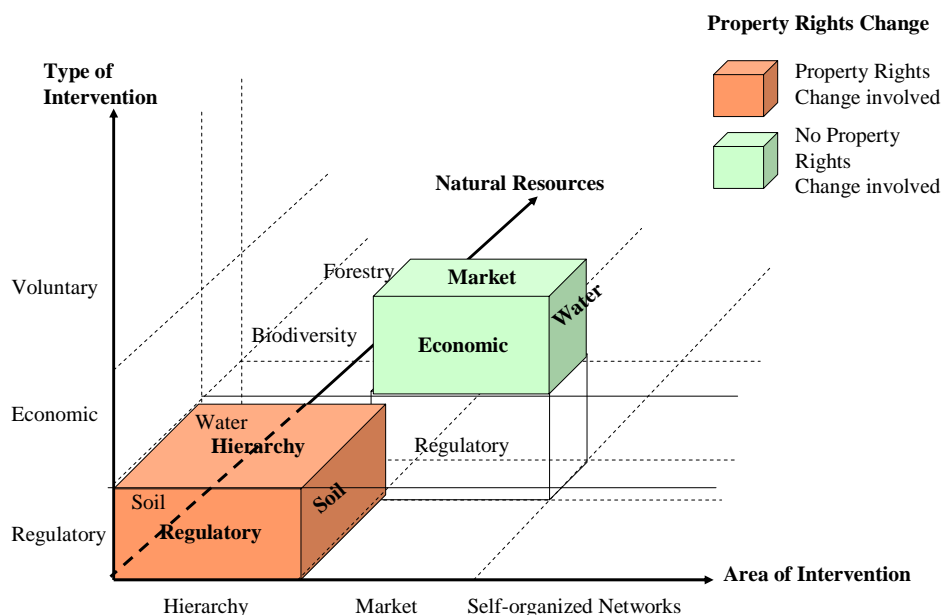
Figure 5 Four Dimensions of a Policy Type (Step 1)

Step 2

Second, crucial institutional aspects which are required by distinct policy types are defined. For instance, the European LEADER+ - initiative to support innovative projects in rural areas can be considered as an economic type of intervention encouraging local initiatives, based on participation of local communities. It therefore requires local cooperation and communication and well functioning local institutional network to lead to the desired outcome.

Step 3

Third, we will develop criteria to select and develop relevant institutional indicators. These indicators will be used as proxies or variables in the PICA model. Examples of such indicators could be members in associations, or density of sociability places to measure the possibilities and abilities to communicate and collaborate. These indicators which for example can be produced within SEAMLESS work on social indicators are seen as proxies and will be used as inputs into the PICA. These proxies will give information on crucial institutional aspects according to the policy type under scrutiny. Likewise, we need to specify linkages and causalities between the indicators, which will be based on assumptions regarding the behaviour and interests of actors under different institutional settings, and the effect of the characteristics of ecological systems and the environmental problem tackled by the policy option.

Step 4

In a *forth step*, we will elaborate on indications for institutional constraints which are regarded as outputs of the PICA model. These indications will have a qualitative character and will consist of thematic issues of institutional compatibility rather than single indicators. The composition of relevant issues will lead us to statements about the effectiveness of the assessed policy options from an institutional perspective. These thematic issues will allow us to draw conclusions about an institutional fit or misfit for different institutional settings.

6.3 Example of Institutional Assessment related to Test Case 1 and prototype 1

In the first (PICA) step, the screening of the policy option the type of policy is screened according to the screening categories developed in step one. In Test Case 1 the policy option which is assessed is trade liberalisation. This policy option can be categorized as a policy type aiming to intervene at markets (here, for 12 raw commodities and 8 intermediates) using economic instruments (here, tariff cuts, reduction in subsidies) as type of intervention.

In the *second step*, we identify required institutional elements. According to the reviewed literature there are a number of (institutional) reasons why the implementation of tariff cuts and reductions in subsidies have not been successful and / or why the actual effects (e.g., a negative trade balance and/or a decreasing domestic production) of those policy instruments differ (in some countries/regions) from the predictions of economic models, such as GTAP and CAPRI. Five kinds of institutional constraints can be identified.

1) Consumer- or environmental-based implementation of quality standards or environmental regulations by the member states (non-tariff barriers) (Kerr 2004):

For example, for a given product, say milk, there might be very high state-sanctioned quality / hygienic standards in place (in a particular region or country). Assuming a positive relation between quality and marginal production costs, fulfilling this particular standard might not be possible for every potential foreign milk producer (alternatively, his marginal production costs increase and he can not (longer) offer the milk at a (comparatively) low price).

2) Shrinking consumer demand:

Consumers in a particular country or region might have a strong preference for buying products that are produced in an environmentally friendly fashion (e.g. dolphin friendly tuna) or products that are not produced using genetically modified organisms (e.g., maize) or growth hormones (e.g., BST beef). If this is the case, there might be no markets (or smaller ones than predicted) for those products bearing the risk of being produced in a way not preferred by the consumers in this country.

3) Farmers' lobbying for compensation:

Another institutional aspect for a possible implementation failure of e.g., tariff cuts might be the existence of strong interest groups, e.g., farmer associations who might lobby successfully for some sort of subsidies for their clientele, thus, reducing the domestic farmers' marginal production costs. In addition there is a strong resistance towards adaptations in farms structure and a delay of structural changes in the agricultural sector.

4) Failed-economy based opposition (Kerr 2004):

The existence of some/powerful domestic actors who profit from trade regulations in place - since they help them to extract corruption rents – might also hinder a successful implementation.

5) Contradicting regulations due to joint production

Another strand of institutional constraints might stem from the fact that agricultural production is usually marked by joint production of commodities (e.g., meat or milk) and non-commodities (e.g., landscapes attractive for tourists). For example, lifting import tariffs for milk (meat) might cause a decrease in domestic prices for milk (meat) which can lead to a decrease in domestic milk (meat) production. Thus, less grassland is needed; farmers in some (marginal) regions might stop farming at all and / or using their land for other purposes (fallow land; housing). However, there are special support programs in place in some

countries and regions that encourage farmers to use their land in a particular way (e.g., using grassland as pastures) because it 'produces' a landscape attractive for tourists, thus, preventing the predicted change in land use. Such financial support might come from the state but also from the regional tourist council; eventually 'buying a particular landscape from the farmer'. There might even be formal laws preventing the use of land other than 'the traditional way' in some regions. One could also think of international agreements a particular country has signed that serve as institutional constraints. For example, a country might have agreed to reduce their emission of climate gases by creating appropriate 'sinks'. Here, certain types of land cover (e.g., grasslands) might serve this purpose better than others (e.g., arable or housing). Thus, there might be financial incentive programs in place - or even formal restrictions - for changing land use, again, preventing the predicted decrease in e.g., milk (meat) production.

In the *third step*, we need to *decide on institutional indicators which can be utilized as proxies for the crucial institutional aspects*. The interlinkages between the crucial institutional aspects and the indicators used are based on theoretical and empirical knowledge. In our example, the number of quality standards for a particular product might serve as a proxy for the existence of non-trade barriers. Data form the European Value Study or the Eurobarometer give indications on the level of environmental awareness and health concerns among populations that either lead to environmental regulations implemented by the state or to a shrinking demand for products produced in a particular way. Furthermore, proxies for the likelihood of farmers getting subsidies compensating them for the effects of tariff cuts (for imports) can be: the share of people in one economic sector being organized in associations, the number of appointments of lobbying groups with politicians, the current share of subsidies concerning a particular product, and the number of exemptions from the law in the agricultural sector. The Corruption Perception Index (Transparency International) or the Quality of Governments Services Index (World Development Report) can provide proxies for the effectiveness of the general market mechanism in the respective country or region.

The presented indicators should help to illustrate the procedure; they are not considered to be the most sophisticated ones. In the starting phase of devising the PICA approach, we will favour proxies which have already been used and operationalised in other studies and evaluations.

In the *forth step*, we have to decide whether these links and available indicators are sufficient to come to conclusions about the institutional fit or misfit of a policy option or whether meaningful institutional indicators are missing and have to be supplemented. The output of the PICA will have a qualitative character and will rather be thematic issues of institutional compatibility than single indicators. The composition of relevant issues will lead us to statements about the effectiveness of policy options from an institutional perspective.

7 Methodologies and strategies for assessing thresholds, critical values critical ranges and target values

The aim of this chapter is to give a brief account on the assessment of thresholds, critical ranges and target values and how they can be used in SEAMLESS. The chapter will also briefly outline strategies for how these methodologies will be developed in the project as well as give a few examples of thresholds, critical ranges and target levels.

7.1 Reference values – thresholds, critical values, critical ranges and target values

The notion reference value is here seen as the general concept which includes several types of reference values; thresholds, critical values, critical ranges and target values.

The word thresholds refer to margins, or ranges, beyond which changes are likely to happen. They refer to the forcing that a driver can maximally exert on a given resource while maintaining acceptable levels of environmental, social and economic quality. As such, this category of reference levels is closely related to the ecological-economic approach to resilience, which is directed at the magnitude of disturbance that can be absorbed before an ecosystem is displaced from one state to another (Holling, 1973). Points of no return are central to the assessment of thresholds. After all, these points lay the basis for sustainable policies, because when such a point is reached, changes are practically irreversible. In the social and economic domain a threshold could instead mean a level above which certain indicators are relevant.

Critical values and critical ranges reflect instead prevailing sets of norms and social values, particularly regarding issues of risk and uncertainty. These two issues – risk and uncertainty – are inextricably linked with the concept of irreversibility. The issue of climate change is often mentioned in this context. Natural scientists have emphasised the irreversibility, or at least the extremely long duration, of many of the hypothesised impacts of emissions. At the same time, however, there is always almost uncertainty about the future costs and benefits of adopting policies to reduce emissions of greenhouse gasses. We simply do not know how much average temperatures will rise, with or without reduced CO_2 emissions, nor do we know the economic impact of higher temperatures (Pindyck, 2000).

Target values or reference levels refers to policy objectives and priorities. These values are set up pragmatically in the light of what is actually achievable. They indicate what is necessary to achieve defined goals. In general, target values and reference levels are based on a wide range of expertise and best available data.

7.2 Reference levels to be used in SEAMLESS-IF

There is currently a lack of knowledge on scientifically based thresholds. For some mainly environmental indicators, there are critical ranges and target values, sometimes set according to environmental impact assessment (e.g. eutrophication) and sometimes through direct measures of adverse impact (e.g. safe levels derived by applying safety factors to ecotoxicologically-derived LC50 values). In some cases, for example for air and water quality, there are limits enshrined within the relevant EU and national legislation (e.g. the Water Framework Directive).

In addition to the challenges regarding the assessment of reference values for the environmental indicators, there are also challenges to be met with respect to the economic and social indicators. For example, how could a reference value for poverty be defined? In the European Union a widely used reference value for poverty is 60 percent of median income. However, if we define a reference value for poverty as the amounts of euros used to determine poverty status, then these values vary according to the size of the family and ages of members. And what, for example, is an relevant reference value for the level for education? The current literature seems to suggest that it is not yet evident if education make a significant difference to living standards and brings about substantial reduction of poverty.

7.2.1 Strategies on and working plan for how to develop reference levels

Based on the restricted list defined in chapter 3 different types of reference levels should be defined. It is clear that each domain of sustainable development have has developed its own specific ideas on the concepts and characteristics of reference levels, so that the same words have different meanings mainly due to the fact that different scientific disciplines are involved in defining these reference levels. Put differently, some terms are defined and treated in different ways in different disciplines. Besides, some terms are more common, or more firmly rooted, in one discipline than in another.

The first step should therefore be the formalisation of the various concepts to make it suitable for application and implementation. Formalisation facilitates the consensual agreement about these concepts. As such, it represents the (scientific) consensus on the concept of reference level and other related terms. This step is largely based on a review of existing approaches in the literature.

The second step is to collect scientifically based threshold values critical values, critical ranges, and target values for environmental, economic and social indicators relating to farming practices. Here, we will not only make use of available research results, but also of other sources, such as expert judgement, national and European legislation (in relation to policy priorities) and information provided by governmental and non-governmental organisations.

Expert or stakeholder knowledge is needed to assess and validate several types of reference levels, Methodologies for this validation has to be developed.

8 Methodologies for aggregating and weighting indicators

Assessing of sustainability and sustainable development implies in all cases a multidimensional approach. Even within each dimension (e.g. economic, environmental or social), the assessment will address different themes (see chapter 2 on the framework). Practically, this will lead a list of assessed indicators, whose result in many cases will be difficult interpret as a totality. With such list it will be difficult to compare the two scenarios (baseline- and policy scenario) and to come to a general conclusion in a transparent and scientific way. To avoid the trap of an unconscious weighting (focusing on one or two indicators without calculation) or of a rough calculation of a mean (based on adding apples and oranges), the user need an appropriate aggregation method. The aggregation will help the user to derive synthetic information, essential to compare, rank, select and classify different policy options.

One major criticism made in relation to aggregation is the loss of information (Nardo et al., 2005). Loss of information is however and to a certain extent unavoidable. The solution which will be adopted in SEAMLESS is to work on two levels as a way to help the future users:

- By using the set of individual indicators assess difference between each scenario.

- By using a method of aggregation compare scenarios.

8.1 Methodological considerations in aggregating and weighting indicators

8.1.1 Different level of aggregation

Several different types of aggregation can be distinguished:

- Spatial and/or temporal aggregation of indicators for the same theme or property of an indicator framework. This type of aggregation raises discussions about the possibility of up scaling, which can be of two orders, the need to involve new processes and statistical procedures (Stein et al., 2001).

- The aggregation of a set of indicators within a given theme (Girardin et al., 2000). This level of aggregation is in a quantitative way used in Life Cycle Analysis by applying the so called the factor impact (see the environmental indicator global warming potential indicator in chapter 3).

- Aggregation of a set of indicators within or between the dimensions of sustainable development. This certainly is the most challenging work and will be the core task of the work on aggregation within SEAMLESS. The term 'composite indicator' is generally applied here.

8.1.2 Different approaches possible for aggregation

It is not the purpose of this section to present a detailed methodological review on aggregation. Based on the work done in PD2.2.1, different methodologies for aggregation are available:

- *The aggregation* of single indicators such as the indicator global warning potential.

- *Normalisation*: This can be based on different mathematical approach (see PD 2.2.1, Nardo et al., 2005). The idea of normalization is to use a unique unit of measurement (monetary as in valuation approaches, land surface needed as in the Ecological Footprint).

- Another approach of aggregation is to use the methodology of the *"law of the minimum"* as a way to compare indicators.

- *The multicriteria analysis*: in this aggregation approach, no single indicator will be calculated but the method will allow to rank, select the best option and to classify the action (scenarios). Within this approach it is frequent to distinguish between compensatory methods (allowing compensation between attributes) and non compensatory methods (Hayashi, 1998).

- A qualitative approach leading to the development of dashboards as presented by Girardin et al., (2005). Such dashboard rests on qualitative decision rules close to what is done in qualitative multi-attribute decision modelling (Bohanec et al., 2000).

8.2   Example of aggregated indicator to be used in Prototype 1

Restricted list of indicators in chapter 3 contains no aggregated indicators at the highest level.

A first example of an aggregated indicator on the intermediate level is the Global warming potential based on the aggregation of GHG emissions by means of impact factor as those used in Life Cycle Analysis (Brentrup et al., 2004).

9 Conclusion

By producing the restricted package of indicators, necessary information to operationalise indicators has been identified and systematised. This work has resulted in an indicator fact sheet on which all relevant information about an indicator can be collected. On the fact sheet different information about indicator is provided related to for example its scope and limitations, possibilities to set target levels as well as suggestions for visualisation.

The restricted package of indicator consists of 41 different indicators covering all three dimensions of sustainable development and all geographical levels targeted by the SEAMLESS project. All indicators can not yet be produced at all scales but several of the indicators on the restricted list can be produced at multiple levels. 16 indicators on the restricted list are environmental indicators, 11 are economic and 14 are social indicators. For all the environmental and economic indicators indicator fact sheets have been prepared. Of this list only a sub set of 9 indicators will be possible to assess in Prototype 1, three environmental indicators and 6 economic indicators. No social indicator will be implemented in prototype 1. These nine indicators are; Agricultural income, Budgetary expenditure, Tariff Revenues, Total welfare, Profits of processing industry, Net farm income, NO3 leaching Global warming potential, Energy consumption due to use of mineral fertilizers.

Regarding the future development of the SEAMLESS indicator packages it can be concluded that both for the environmental and economic package of indicators there are several indicators that will be relatively easy to make operational as the model output is there. However, there are a few themes in the Goal Oriented indicator Framework which are not covered with the existing model output. In these areas new innovative approaches are needed to produce indicators that can be used in an ex-ante impact assessment. The use of expert and stakeholder groups in assessing these indicators have been identified as one important possibility to come up with indicators which either are too context dependent or for which there are no available data or models This could for example be the methodological basis for economic indicators using evaluation methods. Another way is to explore the possibilities of transforming already existing ex - post indicators into indicators that can be used in ex-ante impact assessment. This could either be done creating simple causal models or by linking operational ex post indicators to trends that can be explored in the databases.

The development of a package of social indicators is much more of a challenge. As it is there is already few and undeveloped ex post indicators as pre indicators that can be used in ex-ante impact assessment there is very little. To be able to create a balanced package of social indicators several challenges have been identified as well as possible ways to affront these challenges in the SEAMLESS project. One identified possibility is the invention of simple social models, another is the analysis of the sensitivity of ex-post social indicators to scenarios and a third possibility is to explore the possibility to use expert or stakeholder groups to assess social indicators.

The development of indicators of multifunctionality have also taken a few concrete steps by focussing on; 1) indicators describing the degree of multifunctionality and rank that into classes (a negative value when only externalities are provided or a positive value when produced amenities compensate the potential externalities). 2) Indicators that points out whether a commodity/non-commodity outputs supplied are binomial i.e. related to two aspects of sustainable development or trinominal related to three aspects of sustainable development the economic functions plus environmental or social ones. To several extent indicators of multifunctionality are overlapping the social, environmental and economic

indicators. For the future development of the SEAMLESS indicator package it is important to be aware of this overlap and use it in the most efficient way.

The development of a process for institutional compatibility assessment (PICA) has identified 5 steps which will be taken towards the assessment of institutional compatibility. The first step consist of screening the type of policy that is assessed the second step is the definition of crucial institutional aspects which are required by distinct policy types. The third step criteria to select and develop relevant institutional indicators. The forth step is to develop indicators or assessment of institutional constraints. To illustrate how such an assessment can be used an example based on the policy options selected for Test Case 1 is prepared. The indicators used in step tree can on several occasions be both social and economic indicators, and a combination of these indicators and different types of data. To get the most out of the project it is crucial to coordinate the development and use of these indicators in the project.

In the restricted list of indicators several target levels are presented. However in general the development of the use of reference levels for the indicators selected in the SEAMLESS project is not yet very developed. The same is valid for the aggregation of indicators. This work will increase in speed and depths when the package of indicator increases.

10 Glossary

Aggregation of Indicators	Aggregation of indicators is a way to help the user to derive synthetic information, essential to compare, rank, select and classify different policy options. Aggregation can be made between the dimensions of sustainable development as well as within each domain.
Ex-ante indicator	An ex-ante indicator is an indicator that is based on models, scenarios or trends. It is capable of assessing future impacts.
Ex-post indicator	An ex-post indicator is an indicator that is based on existing data. It is capable of evaluating the present impacts.
Indicator	An indicator is a value that can be used to evaluate or assess different types of impacts. Indicators are in SEAMLESS values that have been assessed to be relevant for a specific context a specific policy or user group.
Indicator Fact Sheet	A document providing all relevant information of an indicator from position in an indicator framework, ways to assess it, reference values and reference to other literature.
Indicator Framework	An indicator framework is a way to structure and categorise indicators so that they take into consideration the general attributes of the systems that are assessed. An indicator framework also directly or indirectly gives an idea for how these attributes are linked to each other.
Indicators of Multifunctionality	The term Multifunctionality or Indicators of multifunctionality refers to indicators that are assessing the multifunctionality of agriculture. Multifunctional agriculture relates to the fact that agriculture, beyond the production of food and fibers (= commodities) also provides important social, environmental and economic functions to society that manifest themselves in products that are up to now not marketable (= non-commodities).
PICA	Process for Institutional Compatibility Assessment. This process can be used in a pre or post modelling perspective to assess the feasibility of the suggested policy option, i.e. will it be possible to implement or not at different geographical scales.
Reference values	The notion reference value is here seen as the general concept which includes several types of reference values; thresholds, critical values, critical ranges and target values. These values can be used to define the context for an indicator as well as the basis of reference to which the indicator should be compared

References

Aaheim, A. and Nyborg, K., 1995. On the interpretation and applicability of a "Green National Product". Review of Income and Wealth 41, 51.

Abler D., 2001. Multifunctionality: the question of jointness: applying the OECD framework - a review of literature in the United States, OECD, Paris.

Armstrong A. and Francis R., 2002. Difficulties of Developing and Using Social Indicators to Evaluate Government Programs: a critical review. Paper presented at the Australasian Evaluation Society International Conference, Wollogong.

Armstrong A., 1998. A comparative analysis: new public sector management – the way ahead. Australian Journal of Public Administration 57, 12-24.

Asheim, G.B., 1994. Net national product as an indicator of sustainability. Scandinavian Journal of Economics 96, 257–65.

Auzet, A. V., Boiffin, J., Papy, F., Ludwig, B. & Maucorps, J., 1993. Rill Erosion as a function of the caracteristics of cultivated catchments in the North of France. Catena, 20, 41-62.

Becker, B., 1997. Sustainability Assessment: A Review of Values, Concepts and Methodological Approaches. World Bank, Washington DC.

Bockstaller, C., Girardin, P., 1996. The crop sequence indicator: a tool to evaluate crop rotations in relation to the requirements of Integrated Arable Farming Systems. Aspects Appl. Biol. 47, 405-408.

Bockstaller, C., Girardin, P., 2000. Using a crop sequence indicator to evaluate crop rotations, 3rd International Crop Science Congres , Hamburg, 17-22 August 2000.

Bohanec, M., Zupan, B. & Rajkovic, V., 2000. Applications of qualitative multi-attribute decision models in health care. International Journal of Medical Informatics 58, 191-205.

Boller, E. F., Malavolta, C. and Jörg, E., 1997. Guidelines for integrated production of arable crops in Europe. Technical guidelines III. IOBC/WPRS Bulletin 20, 5-19.

Bossel, H., 1999. Indicators for sustainable dévelopment: Theory, method, applications. IISD International Institute of Sustainable Development.

Brentrup, F., Kusters, J., Kuhlmann, H. & Lammel, J., 2004. Environmental impact assessment of agricultural production systems using the life cycle assessment methodology - I. Theoretical concept of a LCA method tailored to crop production. European Journal of Agronomy 20, 247-264.

Bontems P., Rotillon G. and Turpin N., 2005, Self-selecting agri-environmental policies with an application to the Don watershed. Environmental and Resource Economics 31, 275-301.

Bontems, P., Rotillon, G., and Turpin, N., 2004. Improvement of water quality as a joint production of milk when dairy farms are heterogeneous. 90th EAAE Seminar - Multifunctional agriculture, policies and markets: understanding the critical linkage, Rennes, 7 p.

Calvert G. and Henderson H., 2005. Calvert-Henderson Quality of Life Indicators, USA.

Delbaere, B. and Serradilla, A. N. E., 2004. Environmental risks from agriculture in Europe: Locating environmental risk zones in Europe using agri-environmental indicators. EC NC-European Centre for Nature Conservation.

Eckert, H., Breitschuh, G. & Sauerbeck, D., 2000. Criteria and Standards for Sustainable Agriculture. Journal of Plant Nutrition and Soil Science (Zeitschrift für Pflanzenernährung und Bodenkunde) 163, 337-351.

Ekos Research Associates 1998. The Use of Social Indicators as Evaluation Instruments. Final Report. Canada.

European Commission 2002. Definition of variables used in FADN standard results. Community Committee For The Farm Accountancy Data Network.

European Commission 2005. Farm return data definitions. Community Committee For The Farm Accountancy Data Network. RI/CC 1256 Rev .3.

Fraser, E.D.G., Dougill, A.J., Mabee, W.E., Reed, Mark, MacAlpine, P., 2005. Bottom-up and top-down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environment management. Journal of Environment Management, article in press, 1-14.

Garrod, G.D., Willis, K.G. 1999. Economic Valuation of the Environment: Methods and Case Studies. Edward Elgar, Cheltenham.

Geoghegan, J., Wainger, L. A. & Bockstael, N. E., 1997. Spatial landscape indices in a hedonic framework: an ecological economics analysis using GIS. Ecologial Economics 23, 251-264.

Gillette C., Merchez L., Perret E., 2005, Indicateurs territoriaux de multifonctionnalité agricole pour un développement durable plus opérationnel, Colloque international indicateurs territoriaux de développement durable, Aix-en-Provence, 1-2 December, 12 p.

Girardin, P., Bockstaller, C. & van der Werf, H. M. G., 2000. Assessment of potential impacts of agricultural practices on the environment: the AGRO*ECO method. Environmental Impact Assessment Review 20, 227-239.

Girardin, P., Guichard, L. & Bockstaller, C. 2005. Indicateurs et tableaux de bord. Guide pratique pour l'évaluation. Lavoisier, Londres, Paris, New-York.

Harbin, L., Jianguo, W., 2004. Use and misuse of landscape indices. Landscape Ecology 19, 389-399.

Hartwick, J. M., 1990. Natural Resources, National Accounting and Economic Depreciation. Journal of Public Economics 43, 291-304.

Hay, K. 2002. Rural indicators and rural development. Final Report for the Department for Environment, Food and Rural Affairs, UK.

Hayashi, K., 1998. Multicriteria aid for agricultural decisions using preference relations: Methodology and application. Agricultural Systems, 58, 483-503.

Holling, C.S., 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4, 1-23.

Hotelling, H., 1931. The economics of exhaustible resources. Journal of Political Economy 39, 137-175.

Hueting R. and Reijnders L., 2004. Broad sustainability contra sustainability: the proper construction of sustainability indicators. Ecological Economics 50, 249-260.

Hülsbergen, K. J. 2003. Entwickluung und Anwendung eines Bilanzierungsmodells zur Bewertung der Nachhaltigkeit landwirtschaftlicher Systeme. Shaker Verlag (Halle, Univ., Habil.-Schr.), Aachen.

Innes, J.E. 1990. Knowledge and Public Policy: The Search for Meaningful Indicators, Second Expanded Edition, Transaction Publishers, New Brunswick, NJ.

IPCC 2001. Climate change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, UK.

Kerr, W.A., 2004. The Changing Nature of Protectionism: Are "Free Traders" Up to the Challenges It Presents? The Estey Centre Journal of International Law and Trade Policy 5, 91-101.

Lawn, P.A., 2003. A theoretical foundation to support the Index of Sustainable Ecnomic Welfare (ISEW), Genuine Progress Indicator (GPI), and other indexes. Ecoloigcal Economics 44, 105-118.

Leteinturier, B., Herman, J.L., de Longueville, F., Quintin, L. and Oger, R., 2006. Adaptation of a crop sequence indicator based on a land parcel management system. Agriculture, Ecosystems & Environment 112, 324-334.

Lintott, J., 2006. Environmental accounting and policy making. In Lawn P (ed.), Sustainable Development Indicators in Ecological Economics (ed.), Edward Elgar, Cheltenham. pp. 78-95.

Nardo, M., Saisana, M., Saltelli, A. & Tarantola, S. 2005. Tools for composite indicators building. Joint Research Center, European Commission. EUR21682EN.

OECD 2001a. Society at a Glance. OECD Social Indicators, OECD, Paris.

OECD 2001b. Multifunctionality, towards an analytical framework, Paris.

OECD 2003. Quality framework and guidelines for OECD statistical activities, OECD, Paris.

Perret B. 2002 Indicateurs sociaux, état des lieux et perspectives. Rapport du Conseil de l'émploi, des Revenus et de la Cohésion Sociale.

Pervanchon, F., Bockstaller, C. & Girardin, P., 2002. Assessment of energy use in arable farming systems by means of an agro-ecological indicator: the *energy* indicator. Agricultural Systems 72, 149-172.

Pindyck, R.S., 2000. Irreversibilies and the timing of environmental policy. Resource and Energy Economics 22, 233-259.

Powe, N.A., Garrod, G.D. and McMahon, P.L., 2005. Mixing methods within stated preference environmental valuation: choice experiments and post-questionnaire qualitative analysis. Ecological Economics 52, 513-526.

Reus, J., Leenderste, P., Bockstaller, C., Fomsgaard, I., Gutsche, V., Lewis, K., Nilsson, C., Pussemier, L., Trevisan, M., van der Werf, H., Alfarroba, F., Blümel, S., Isart, J., McGrath, D. & Seppälä, T., 2002. Comparing and evaluating eight pesticide environmental risk indicators developed in Europe and recommendations for future use. Agriculture Ecosystems and Environment, 90, 177-187.

Riley, J., 2001. Multidisciplinary indicators of impact and change - Key issues for identification and summary. Agriculture Ecosystems and Environment, 87, 245-259.

Schmid E. and Sinabell F., 2004. Modelling multifunctionality of agriculture – concepts, challenges and an application, discussion Paper Institute for Sustainable Economic Development, Vienna.

Smith, A., Watkiss, P., Tweddle, G., McKinnon, A., Browne, M, Hunt, A., Treleven, C., Nash, C and Cross, S. 2005. The Validity of Food Miles as an Indicator of Sustainable Development. Final Report for the Department for Environment, Food and Rural Affairs, UK.

Solow, R.M., 1974. Intergenerational equity and exhaustible resources. Review of Economic Studies 41, 29-46.

Spangenberg J., 2002. Environmental space and the prism of sustainability:frameworks for indicators measuring sustainable development. Ecological indicators 2, 295-309.

Stein, A., Riley, J. & Halberg, N., 2001. Issues of scale for environmental indicators. Agriculture Ecosystems and Environment 87, 215-232.

US Working group on Sustainable development Indicators 1998. Sustainable Development in the United States: An Experimental Set of Indicators. Washington, DC.

Wiggering H., Dalchow C., Glemnitz M., Helming K., Müller K., Schultz A., Stachow U., Zander P., 2006. Indicators for multifunctional land use - Linking socio-economic requirements with landscape potentials. Ecological Indicators 6, 238-249.

Wolfson, M.C., 1994. POHEM a framework for understanding and modelling the health of human populations, World Health Statistical Quarterly 47, 157-176.

The Wye Group 2005. Handbook on rural households' livelihood and well-being: statistics on rural development and agricultural household income, United Nations. Economic Commission for Europe [online] Available from: *http://www.unece.org/stats/rural/*.

World Bank 1997. Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development. World Bank, Washington D.C.

World Bank 2002. Adjusted Net Savings Data [online]. Available from: http://lnweb18.worldbank.org/ESSD/essdext.nsf/44ByDocName/GreenAccountingAdjustedNetSavings World Bank, Washington D.C.

Appendices

Appendix 1   **Indicator fact sheets for the environmental indicators on the restricted list**

Appendix 2   **Indicator fact sheets for the economic indicators on the restricted list**

Appendix 3   **Multifunctionality main concepts for SEAMLESS-IF**

Appendix 4   **An example of jointness indicator for SEAMLESS**

seamless

FACT SHEETS OF ENVIRONMENTAL INDICATORS

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet : indicator ENV. 1

Name of indicator

Nitrate leaching: mean concentration per year

General scope of indicator [(1)]

This indicator aims to assess the nitrate leaching below crops and to detect therefore a potential groundwater pollution which has consequence on the water quality. It will assist farmers in selecting the best nitrogen management option (fertilizer application, intercropping management) and policymakers in setting policy to minimise nitrate leaching.

This indicator can be expressed on different scales (crop farm type, regional scale) in yearly average NO_3 concentration, which allows the use of the European guideline value of water quality as reference point.

[(1)] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

mg NO_3 L^{-1}

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of human health and welfare
Sub-theme : Water (quality of groundwater)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[X] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effects on agriculture: Productivity	Effects beyond agriculture: Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[X] HSMU[(3)]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[(3)] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

> Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level. For this last scale, the assumption should be made that point-source pollution from farm does not happen.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

> Yes

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Yearly nitrate leached	kg NO_3 ha^{-1} yr^{-1}	APES	
Yearly water drainage	mm ha^{-1} yr^{-1}	APES	

Brief description of the calculation :

> Nitrate leaching = (Yearly nitrate leached / Yearly water drainage) * 100

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Local / Regional National EU World (global)	European guideline value of water quality (50 mg NO_3 L^{-1})	Defined by stakeholders	The relevance of the threshold can be discussed on lower scale (field, farm)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

> Per agri-environmental region; mean value.

Type of visualisation (number, graphical visualisation):

> Number (one value per year) or possibility of a graphical visualisation (evolution of the average NO_3 concentration).

Additional data/indicators needed to interpret the results:

> Nitrogen fertilizer applications, Nitrogen balance, soil cover in winter.

Relation with other indicator(s)

> N leaching variation
> Number of days (weeks) when there is a risk of nitrate leaching
> Pesticides leached (quality of groundwater)

Aggregation possibilities with other indicator(s)

Aggregation of three indicators linked with nitrogen:
- N leaching
- Ammoniac volatilization
- N_2O emissions

to develop a "Nitrogen loss indicator".

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The indicator is derived from model output and based on a model which addresses mechanism of losses (climate and soil factors, fertilization practices, cropping system). By this way, the user has the possibility to identify causes of nitrate leaching;
- Useful for the users (definition a quantified objective, possibility of comparison) and for the public (correspondence with a centre of interest of the public).

If the feasibility of the model implementation is solved, there is no difficulty to use the indicator.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Smith, J.U., Gottschalk, P., 2006. Model components: Soil Carbon and Nitrogen Prototypes and Revised Data types, Seamless project (contract no. 010036), PD 3.2.2., 24 p.

Smith, J.U., Smith, P., Dailey A.G., 2004. The SUNDIAL model, 12th Nitrogen Workshop, University of Exeter, UK, 21-24 September 2003.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)
Chengyi Zhang (c.zhang@abdn.ac.uk)
Pete Smith (pete.smith@abdn.zc.uk)
Jo Smith (jo.smith@abdn.ac.uk)

Fact sheet: indicator ENV. 2

Name of indicator

Nitrate leaching variation

General scope of indicator [1]

This indicator aims to assess the temporal variation in nitrate leaching below the crop and to measure the uncertainty due to climate fluctuation, fertilizer applications on ground water quality. It will assist farmers in selecting the best nitrogen management option (fertilizer application, intercropping management) and policymakers in setting policy to minimise nitrate leaching.

This indicator can be expressed on different scales (crop farm type, regional scale) as the percentage of yearly NO_3 concentration in the drainage water to the European guideline value of water quality (50 mg NO_3 L^{-1}).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

%

Type of indicator

X Environmental ☐ Economic ☐ Social ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

☐ Effects on agricultural sector on it self   **X** Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of human health and welfare
Sub-theme : Water (quality of groundwater)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

☐ Effects on agriculture   **X** Effects beyond agriculture

Property to which the indicator is related:

Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

X HSMU[3] ☐ farm ☐ regional ☐ national ☐ European ☐ world
[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level. For this last scale, the assumption should be made that point-source pollution from farm does not happen.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Yes

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Yearly nitrate leaching	kg NO_3 ha^{-1} yr^{-1}	APES	
Yearly water drainage	mm ha^{-1} yr^{-1}	APES	

Brief description of the calculation:

Nitrate leaching variation = 50 - ((Yearly nitrate leached / Yearly water drainage) * 100)   The positive value of the variation indicates that there is no risk for groundwater quality and vice versa.

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Local / Regional National EU World (global)	European guideline value of water quality (50 mg NO_3 L^{-1})	Defined by stakeholders	The relevance of the threshold can be discussed on lower scale (field, farm)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per crop type; minimum and maximum percent values.

Type of visualisation (number, graphical visualisation):

Numbers (minimum and maximum values per year) and/or the possibility of a graphical visualisation (evolution of NO_3 concentration variation from its minimum to maximum values) with climate fluctuation and nitrogen fertiliser applications.

Additional data/indicators needed to interpret the results:

Nitrogen fertilizer applications, Nitrogen balance, Soil cover in winter.

Relation with other indicator(s)

Nitrate leaching: mean concentration per year   Number of days (weeks) where there is a risk of nitrate leaching   Pesticides leached (quality of groundwater)   Variation in pesticide leaching

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The indicator is derived from model output and based on a model which addresses mechanism of losses (climate and soil factors, fertiliser applications, cropping system). The user has a high possibility to identify causes of nitrate leaching and select a specific fertiliser application to minimise the nitrate leaching for a crop relevant to the climate and soil;
- Useful for the users (definition a quantified objective, possibility of comparison) and for the public (correspondence with a centre of interest of the public).

If the feasibility of the model implementation is solved, there is no difficulty to use the indicator.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Smith, J.U., Gottschalk, P., 2006. Model components: Soil Carbon and Nitrogen Prototypes and Revised Data types, Seamless project (contract no. 010036), PD 3.2.2., 24 p.

Smith, J.U., Smith, P., Dailey A.G., 2004. The SUNDIAL model, 12th Nitrogen Workshop, University of Exeter, UK, 21-24 September 2003.

Smith, J.U., Bradbury N.J., Addiscott T.M., 1996. SUNDIAL: A PC-Based System for Simulating Nitrogen Dynamics in Arable Land. Agronomy Journal, 88 : 38-43.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)
Chengyi Zhang (c.zhang@abdn.ac.uk)
Pete Smith (pete.smith@abdn.ac.uk)
Jo Smith (jo.smith@abdn.ac.uk)

Fact sheet: indicator ENV. 3

Name of indicator

> Number of days (weeks, months, years) when there is a risk of nitrate leaching

General scope of indicator [1]

> This indicator aims to assess the days (weeks, months, years) when there is a risk of nitrate leaching below crops and to detect potential groundwater pollution, which has consequences for the water supply.
> This indicator can be expressed on different scales (crop farm type, regional scale) in number of days (weeks, months) per year or number of years with a NO_3 concentration in the drained groundwater above to the European guideline value of water quality (50 mg NO_3 L^{-1}).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

> Dimensionless

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

> Theme : Protection of human health and welfare
> Sub-theme : Water (quality of groundwater)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

> Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level. For this last scale, the assumption should be made that point-source pollution from farm does not happen.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☒ day   ☒ week   ☒ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Yes

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Daily (weekly, monthly, yearly) nitrate leaching	kg NO_3 ha^{-1} d^{-1}	APES	
Daily (weekly, monthly, yearly) water drainage	mm ha^{-1} d^{-1}	APES	

Brief description of the calculation:

Number of days (weeks, months) per year or number of years with nitrate concentration in the drained water > 50 mg L^{-1} with: nitrate concentration in the drained water = (daily (weekly, monthly, yearly) nitrate leaching / daily (weekly, monthly, yearly) water drainage) * 100

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Local / Regional National EU World (global)	European guideline value of water quality (50 mg NO_3 L^{-1})	Defined by stakeholders	The relevance of the threshold can be discussed on lower scale (field, farm)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per farm type.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation to determine the number of days (weeks, months, years) in which nitrate concentration is above the 50 mg NO_3 L^{-1}.

Additional data/indicators needed to interpret the results:

Nitrogen fertilizer applications, Nitrogen balance, Soil cover in winter.

Relation with other indicator(s)

Nitrate leaching: mean concentration per year
Nitrate leaching variation
Number of days (weeks, months, years) when there is a risk of pesticide leaching (quality of groundwater).

Aggregation possibilities with other indicator(s)

Aggregation with the indicator "Number of days (weeks, months, years) when there is a risk of pesticide leaching" to develop a "Days (weeks, months, years) of drained groundwater pollution".

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The indicator is derived from model output and based on a model which addresses mechanism of losses (climate and soil factors, fertilization practices, cropping system). By this way, the user has the possibility to identify causes of nitrate leaching;
- Useful for the users (definition a quantified objective, possibility of comparison) and for the public (correspondence with a centre of interest of the public).

If the feasibility of the model implementation is solved, there is no difficulty to use the indicator.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Smith, J.U., Gottschalk, P., 2006. Model components: Soil Carbon and Nitrogen Prototypes and Revised Data types, Seamless project (contract no. 010036), PD 3.2.2., 24 p.

Smith, J.U., Smith, P., Dailey A.G., 2004. The SUNDIAL model, 12th Nitrogen Workshop, University of Exeter, UK, 21-24 September 2003.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 4

Name of indicator

Pesticide leaching : risk ratio for groundwater

General scope of indicator [1]

This indicator aims to assess because of pesticide leaching the potential risk of groundwater pollution, which can have consequence of human health.

This indicator used a risk ratio approach, i.e. the ratio between the exposure (the concentration in groundwater) and toxicity for relevant organisms (expressed in concentration, in case of groundwater EU guidelines).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

%

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of human health and welfare
Sub-theme : Water (quality of groundwater)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[X] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effects on agriculture: Productivity	Effects beyond agriculture: Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [(4)]:

Calculation of a weighted mean by HSMU surface at higher scales, crop, farm and regional level.

[(4)] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☒ day ☐ week ☐ month ☐ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Quantity of pesticides in groundwater	mg ha^{-1}	APES	
Water drainage	mm ha^{-1}	APES	
Admissible legal pesticide concentration in drinking water	µg L^{-1}	EU guidelines	

Brief description of the calculation:

Pesticide leaching risk ratio for groundwater = (predicted pesticide concentration in groundwater / 0,1) * 100 with: predicted pesticide concentration in groundwater = quantity of pesticides in groundwater / water drainage 0,1 µg L^{-1} (admissible pesticide concentration in drinking water, EU guidelines) NB: the calculation can also be run for the sum of active ingredient using then the EU guideline of 0,5 µg L^{-1}

Threshold/target at different scales

Scale	Threshold	Target	Remark
Farm Local / Regional (water catchment)	European guideline value of water quality (0,1 µg L^{-1} for each active ingredient or 0,5 µg L^{-1} for the sum of active ingredient)	Defined by stakeholders	The relevance of the threshold can be discussed

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per agri-environmental region.

Type of visualisation (number, graphical visualisation):

Number (one value per day) with the possibility of a graphical visualisation to determine the days of which there is a risk of pesticide groundwater contamination.

Additional data/indicators needed to interpret the results:

Pesticide use, amount of leachable pesticides.

Relation with other indicator(s)

Number of days (weeks) when there is a risk of pesticides leaching.

Aggregation possibilities with other indicator(s)

N leaching (quality of groundwater)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The indicator is derived from model output and based on a model which addresses mechanism of losses (climate and soil factors, fertilization practices, cropping system). By this way, the user has the possibility to identify causes of pesticides leaching;
- Useful for the users (indication if pesticides groundwater pollution is increasing or decreasing and if the number of water bodies affected are changing, possibility of comparison of various agri-environmental regions) and for the public (correspondence with a centre of interest of the public: human health).

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Padovani, L., Trevisan, M., Capri, E., 2004. A calculation procedure to assess potential environmental risk of pesticides at the farm level. Ecological Indicators 4, 111-123.

Reus, J., Leendertse, P., Bockstaller, C., Fomsgaard, I., Gutsche, V., Lewis, K., Nilsson, C., Pussemier, L., Trevisan, M., Van der Werf, H., Alfarroba, F., Blümel, S., Isart, J., McGrath, D., Seppäla, T., 2002. Comparaison and evalution of eight pesticide environmental risk indicators developped in Europe and recommandations for future use. Agriculture, Ecosystems and Environmment 90, 177-187.

Trevisan, M., Balderacchi, M., 2005. Model components: Pesticides, data types, Seamless project (contract no 010036), PD 3.2.9.1., 12 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)
Chengyi Zhang (c.zhang@abdn.ac.uk)

Fact sheet: indicator ENV. 5

Name of indicator

> Number of days (weeks, months, years) when there is a risk of pesticide leaching

General scope of indicator [1]

> This indicator aims to assess the days (weeks, months, years) when there is a risk of pesticide leaching below crops and to detect potential groundwater contamination, which has consequence for the water supply.
> This indicator can be expressed on different scales (crop farm type, regional scale) in number of days (weeks, months) per year or number of years with a pesticide concentration in the drained groundwater above to the European guideline value of water quality (0,1 µg L^{-1} per individualized substance).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

> Dimensionless

Type of indicator

X Environmental ☐ Economic ☐ Social ☐ Institutional

Position of the indicator on framework

> **on the goal-oriented frameworks (see D 2.1.1) :**

☐ Effects on agricultural sector on it self **X** Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

> Theme : Protection of human health and welfare
> Sub-theme : Water (quality of groundwater)

> **on the system property-oriented frameworks (see D 2.1.1) :**

☐ Effects on agriculture **X** Effects beyond agriculture

Property to which the indicator is related:

> Security

Scales for elementary calculation and up scaling possibilities

> **spatial scales :**

Elementary calculation:

X HSMU[3] ☐ farm ☐ regional ☐ national ☐ European ☐ world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level. For this last scale, the assumption should be made that point-source pollution from farm does not happen.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☒ day   ☒ week   ☒ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Yes

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Daily (weekly, monthly, yearly) pesticide leaching	mg ha^{-}1 d^{-1}	APES	
Daily (weekly, monthly, yearly) water drainage	mm ha^{-1} d^{-1}	APES	

Brief description of the calculation:

Number of days (weeks, months) per year or number of years with pesticide concentration in the drained water > 0,1 µg L^{-1} with: pesticide concentration in the drained water = (daily (weekly, monthly, yearly) pesticide leaching / daily (weekly, monthly, yearly) water drainage) * 100   0,1 µg L^{-1} (admissible pesticide concentration in drinking water, EU guidelines)   NB: the calculation can also be run for the sum of active ingredient using then the EU guideline of 0,5 µg L^{-1}

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Local / Regional National EU World (global)	European guideline value of water quality (0,1 µg L^{-1}, per individualised substance)	Defined by stakeholders	The relevance of the threshold can be discussed on lower scale (field, farm)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per farm type.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation to determine the number of days (weeks, months, years) in which pesticides concentration is above the 0,1 µg L^{-1}.

Additional data/indicators needed to interpret the results:

Amount of leachable pesticides.

Relation with other indicator(s)

Pesticides leaching: risk ratio for groundwater.

Aggregation possibilities with other indicator(s)

Aggregation with the indicator "Number of days (weeks, months, years) when there is a risk of nitrate leaching" to develop a "Days (weeks, months, years) of drained groundwater pollution".

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The indicator is derived from model output and based on a model which addresses mechanism of losses (climate and soil factors, fertilization practices, cropping system). By this way, the user has the possibility to identify causes of pesticides leaching;
- Useful for the users (indication if pesticides groundwater pollution is increasing or decreasing and if the number of water bodies affected are changing, possibility of comparison of various agri-environmental regions) and for the public (correspondence with a centre of interest of the public: human health).

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Padovani, L., Trevisan, M., Capri, E., 2004. A calculation procedure to assess potential environmental risk of pesticides at the farm level. Ecological Indicators 4, 111-123.

Reus, J., Leendertse, P., Bockstaller, C., Fomsgaard, I., Gutsche, V., Lewis, K., Nilsson, C., Pussemier, L., Trevisan, M., Van der Werf, H., Alfarroba, F., Blümel, S., Isart, J., McGrath, D., Seppäla, T., 2002. Comparaison and evalution of eight pesticide environmental risk indicators developped in Europe and recommandations for future use. Agriculture, Ecosystems and Environmment 90, 177-187.

Trevisan, M., Balderacchi, M., 2005. Model components: Pesticides, data types, Seamless project (contract no 010036), PD 3.2.9.1., 12 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Pete Smith (pete.smith@abdn.ac.uk)
Jo Smith (jo.smith@abdn.ac.uk)
Chengyi Zhang (c.zhang@abdn.ac.uk)

Fact sheet: indicator ENV. 6

Name of indicator

Net greenhouse gases emission

General scope of indicator [(1)]

The net greenhouse gases (GHGs) emission is a means of assessing the complete radiative forcing produced by greenhouse gases. The emission of non-CO_2 GHGs are usually expressed relative to CO_2 by a mol. Since different GHGs has different atmospheric liftimes, the Global warming potential (GWP) of GHGs will change depending upon the time period over which GHG is assessed. The convention is now to assess the GWP over a 100 year time frame. Over 100 years, the GWP of CO_2, by definition, is 1. The GWP of N_2O (nitrous oxide) is 296 and the GWP of CH_4 (methane) 23 (IPCC, 2001). Using these GWPs, the full impact of net GHG emission on radiative forcing can be expressed in terms of CO_2 equivalents (CO_2-eq.) by adding up the combined impact.

[(1)] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Net GHG emission itself is dimensionless (i.e. the relative radiative forcing over 100 years of non-CO_2 GHG relative to CO_2). The full radiative forcing of all GHGs combined, calculated using the GWPs, is often expressed in tonnes CO_2-equivalents (t CO_2-eq.).

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Maintenance of environmental balances & functions
Sub-theme : Climate (greenhouse gases emission)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effectiveness

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[X] HSMU[(3)]   [X] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[(3)] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Applicable at all scales.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Applicable at all scales (up to 100 years).

Calculation of the indicator

☐ Simple   ☒ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
CO_2 emission	kg CO_2 ha^{-1} yr^{-1}	APES	
N_2O emission	kg N_2O-N ha^{-1} yr^{-1}	APES	
CH_4 emission	*kg CH_4 ha^{-1} yr^{-1}*	*FSSIM*	*No relevant for prototype 1 (no livestock)*

Brief description of the calculation:

Net emission of GHG = N_2O * GWP $_{N2O}$ + CO_2
 	
with: N_2O :emissions of N_2O = N_2O-N *.3,143
     CO_2 : emissions of CO_2
     GWP $_{N2O}$ = 296
If the farm has livestock (ruminants), CH_4 emissions should be added (= CH_4 * GWP $_{CH4}$ with GWP $_{CH4}$ = 23)

Threshold/target at different scales

Scale	Threshold	Target	Remark
Regional / National / EU	None	As low as possible	In terms of UNFCCC
Regional / National / EU	1990 GHG emissions	Reduction relative to 1990 emissions	For Kyoto Protocol accounting
Regional / National / EU	GHG emission under previous management	Reduction relative to emissions before mitigation put in place	To assess GHG mitigation potential of changed practice

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Could be per crop, per farm, per region or per country. Most comparable with targets at country / EU level.

Type of visualisation (number, graphical visualisation):

Graphical, numerical or as GIS map if spatially generated.

Additional data/indicators needed to interpret the results:

CO_2 , N_2O emissions, N fertilizer rate, carbon sequestration.

Relation with other indicator(s)

> Losses of C and N from the system can be compared to other system losses – e.g. N loss through leaching, C lost through dissolved organic carbon (DOC).

Aggregation possibilities with other indicator(s)

> It is already an aggregated measure and should not be aggregated further.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

> Advantages:
> - Commonly used in the climate change community and understood by policy makers. Allows different gases to be compared on a common basis.
>
> Disadvantages:
> - Aggregated measure so can cloud interpretation of the mechanism / gas upon which the management has its impact, for example some management practices affect N_2O more than CO_2 whilst others do the opposite. Should therefore be interpreted in light of the component gas fluxes.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

> IPCC 2001. Climate change 2001: The scientific basis (Contribution of Working Group I to the third assessment report of the Intergovernmental Panel on Climate Change). Cambridge: Cambridge University Press.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 7

Name of indicator

Ammonia volatilization of fertilizer: yearly cumulated

General scope of indicator [1]

This indicator aims to assess the cumulated quantity of gaseous ammonia emissions from agricultural origin. The relevance of this indicator is due to the return of ammonia compounds to the biosphere (through dry and wet deposition) which has effects on soil and water ecosystems lead to eutrophication (nitrogen enrichment) and/or acidification with the disappearance of fauna and flora in the extreme situation.
This indicator can be expressed on different scales (farm type, regional scale) in yearly cumulated ammonia volatilization.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

kg ha^{-1}

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

  ➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Maintenance of environmental balances & functions
Sub-theme : Soil acidification (NH_3 emissions)

  ➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[X] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effects on agriculture: Productivity	Effects beyond agriculture: Security

Scales for elementary calculation and up scaling possibilities

  ➢ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ☒ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Total NH_4-N lost	kg N ha^{-1} mo.$^{-1}$	APES	

Brief description of the calculation:

Yearly ammonia volatilization = $\sum$ total NH_4-N lost over a year

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Local / Regional National	Critical load	% reduction by stakeholders	This critical load can be found in: Bobbink et al., (1996), Freibauer, A. & Kaltschmitt, M. e. (2000) and Skeffington R. (2006)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per farm type.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation (distribution of yearly cumulated ammoniac volatilisation per farm type for a given region, evolution of cumulated ammoniac volatilisation over years per regions or countries).

Additional data/indicators needed to interpret the results:

Nitrogen fertilization (amount of NH3), technique of application, characteristics of soil (moisture, temperature).

Relation with other indicator(s)

NH_3 volatilization from livestock building and grazing.

Aggregation possibilities with other indicator(s)

> Aggregation of three indicators linked with nitrogen:
> - N leaching
> - Ammoniac volatilization
> - N_2O emissions
>
> to develop a "Nitrogen loss indicator".

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

> Advantages:
> - Useful for the users (indication on the importance of evolution of ammoniac volatilisation, possibility of comparison of various farm type) and for the public (correspondence with a centre of interest of the public: soil and water ecosystems preservation;
> - Allows to address trade-off between losses to water and to air.
> If the feasibility of the model implementation is solved, there is no difficulty to use the indicator.
> Disadvantages:
> - The indicator does not tackle losses to livestock which can be important.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Bobbink, R., Hornug, M. & Roelofs, J. G. M., 1996. Empirical nitrogen critical loads for natural and semi-natural ecosystems. In Manual on methodologies for mapping critical loads/levels and geographical areas where they are exceeded, eds. B. Werner & T. Sprenger, Umweltbundesamt (UBA). Berlin, pp. (Annex III 1-54).

Freibauer, A. and Kaltschmitt, M. E., 2000. Emissions rates and emissions factors of greenhouse gas fluxes in arable and animal agriculture. University of Stuttgart. Concerted Action FAIR3-CT96-1877, 192 p.

Skeffington, R., 2006. Quantifying uncertainly in critical loads: (A) literature review. Water Air and Soil Pollution, 169 (1-4).

Smith, J.U., Gottschalk, P., 2006. Model components: Soil Carbon and Nitrogen Prototypes and Revised Data types, Seamless project (contract no. 010036), PD 3.2.2., 24 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 8

Name of indicator

Soil organic matter trend

General scope of indicator [1]

This indicator aims to assess the soil organic matter which is a relevant factor in soil quality. Decrease of soil organic matter results in the breakdown of soil structure, greater vulnerability of the soil to erosion and reduced fertility, all leading to reductions in yield and sustainability of the soil resource.

Most of the carbon lost from the soil is released as CO_2 so organic matter trend is also a measure of soil CO_2 emissions, for inclusion in the Global Warming Potential calculation with N_2O and CH_4 fluxes.

This indicator can be expressed in different scales (farm, regions, country) in yearly average of tons equivalent CO_2.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

t equivalent CO_2 ha^{-1} yr^{-1} or in % of variation

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[X] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Maintenance of environmental balances & functions Sub-theme : Soil fertility	Sub-theme: Climate (carbon sequestration)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[X] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effects on agriculture: Productivity	Effects beyond agriculture: Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales (farm, regional or national level).

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➤ **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Soil organic carbon	equivalent CO_2 ha^{-1}	APES	

Brief description of the calculation:

Soil organic matter trend = variation of soil organic carbon on calculation period / number of years It can also be expressed in a relative way to the first year in % of variation.

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Farm Local / Regional National	Relative (% baseline scenario)	Defined by stakeholders	

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per farm type; mean value (max, min. over a year).

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation (distribution of yearly soil organic matter per farm type or per agri-environmental region for a given country, evolution of cumulated soil organic matter over years per regions or countries).

Additional data/indicators needed to interpret the results:

Nitrogen fertilisation, soil cover during the year, area with exported crop residues, amount of organic fertilizers.

Relation with other indicator(s)

Organic matter balance Soil erosion: yearly cumulated Part of the calculation of Global Warming Potential (GWP)

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The indicator is derived from model output and based on a model which addresses mechanism of losses (climate and soil factors, cropping system). By this way, the user has the possibility to identify causes of soil organic losses;
- Useful for the users (indication on the change in soil organic matter in agricultural soils, possibility of comparison of various agri-environmental regions or countries) and for the public (correspondence with a centre of interest of the public: link with erosion, reduction of fertility).

If the feasibility of the model implementation is solved, there is no difficulty to use the indicator.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Smith, P., 2004. Soils as carbon sinks - the global context. Soil Use and Management 20: 212-218.

Smith, P., 2004. Carbon sequestration in croplands: the potential in Europe and the global context. European Journal of Agronomy 20: 229-236.

Smith, J.U., Gottschalk, P., 2006. Model components: Soil Carbon and Nitrogen Prototypes and Revised Data types, Seamless project (contract no. 010036), PD 3.2.2., 24 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 9

Name of indicator

Water surface runoff : yearly cumulated

General scope of indicator [1]

This indicator aims to assess the water surface runoff which is relevant for hydrological problems of floods, especially against a background of climate change, but also an important factor involved in the formation of concentrated erosion in Northern-Western of Europe and losses of pollutants from fields (pesticides, P losses, etc..).

This indicator can be expressed in different scales (farm type, regional or national scale) in yearly cumulated water surface runoff.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

mm ha^{-1}

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[X] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme: Protection of environment compartments Sub-theme: Soil erosion	Theme: Protection of human health and welfare Sub-theme: Water (quality of surface water pollution)	Theme: Protection of environmental balances and functions Sub-theme: Surface water eutrophication (P runoff)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[X] Effects on agriculture   [ ] Effects beyond agriculture

Property to which the indicator is related:

Productivity

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales (farm, regional or national level).

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Water surface runoff cumulated	mm	APES	

Brief description of the calculation:

Yearly water surface runoff = water surface runoff cumulated (over a year)

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Farm Local / Regional National	Relative (% baseline scenario)	% reduction by stakeholders	

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per agri-environmental region or per country.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation (distribution of yearly cumulated eroded soil per agri-environmental region for a given country, evolution of cumulated eroded soil over years per regions or countries).

Additional data/indicators needed to interpret the results:

Land management (soil cover by crops during the year, system of soil tillage), soils characteristics (e.g. low clay content, OM content), topography data (e.g. slope) and climate data (precipitation), % of area with grassy strips, amount of pesticides on sensitive soils to runoff.

Relation with other indicator(s)

Surface water runoff: daily peak Soil erosion: daily peak Soil erosion: yearly cumulated Soil erosion risk Pesticides in runoff

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- Easy calculation when data for model are available;
- Useful for the users (indication on the importance of evolution of water surface runoff, possibility of comparison of various agri-environmental regions or countries) and for the public (correspondence with a centre of interest of the public: problems such as soil degradation, flood risk, pollutant losses etc...).

Disadvantages:
- The yearly cumulated amount does not express the catastrophic aspect of such events but is relevant for the assessment of pollution risk;
- This indicator assesses the runoff at field level without integrating hydrological processes at water catchment level.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Acutis, M., Gentile, A., 2005. Model components: Water and Runoff-Erosion data types, Seamless project (contract no. 010036), PD 3.2.1., 15 p.

Auzet, A. V., Boiffin, J., Papy, F., Maucorps, J. & Ouvry, J. F. (1990). An approach to the assessment of erosion forms and erosion risk on agricultural land in the northern Paris Basin, France. In Soil erosion on agricultural land, eds. J. Boardman, I. D. L. Foster & J. A. Dearing, John Wiley & Sons Ltd, pp. 383-400.

Braudeau, E., Martin, P., 2005. Model components: Soil Structure and water data types, Seamless project (contract no. 010036), PD 3.2.3, 12 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 10

Name of indicator

Water surface runoff: daily peak

General scope of indicator [1]

This indicator aims to assess the water surface runoff variation in the time which is relevant for hydrological problems of floods, especially against a background of climate change, but also for a form of erosion in Northern-Western of Europe which is due to the heavy rains, slope, lack of cover, etc...but to the concentration of runoff from fields (pesticides, P losses, etc..).
This indicator can be expressed in different scales (farm type, regional scale) in daily peak of water surface runoff.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

$m^3 \, ha^{-1}$

Type of indicator

[X] Environmental [ ] Economic [ ] Social [ ] Institutional

Position of the indicator on framework

➤ **on the goal-oriented frameworks (see D 2.1.1) :**

[X] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme: Protection of environment compartments Sub-theme: Soil erosion	Theme: Protection of human health and welfare Sub-theme: Water (quality of surface water pollution)	Theme: Protection of environmental balances and functions Sub-theme: Surface water eutrophication (P runoff)

➤ **on the system property-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Security

Scales for elementary calculation and up scaling possibilities

➤ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☒ day ☐ week ☐ month ☐ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Runoff	$mm\ d^{-1}$	APES	

Brief description of the calculation:

Daily peak of water surface runoff = water surface runoff predicted by model (max value per day)

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field (HSMU) Farm Local / Regional National	Relative (% baseline scenario)	% reduction by stakeholders	

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Maximum value per day; expression per farm type.

Type of visualisation (number, graphical visualisation):

Number (one value per day) and/or the possibility of a graphical visualisation (distribution of daily peak of soil erosion per farm type for a given region, evolution of daily peak of soil erosion over year per farm type).

Additional data/indicators needed to interpret the results:

Soil cover by crop during the year, soils characteristics (e.g. low clay content, OM content), topography data (e.g. slope) and climate data (precipitation), % of area with grassy strips, amount of pesticides on sensitive soil to runoff.

Relation with other indicator(s)

Surface water runoff: yearly cumulated Soil erosion: daily peak Soil erosion: yearly cumulated Soil erosion risk Pesticides in runoff

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- Easy calculation when the data are available;
- Useful for the users (indication on the importance of water surface runoff per day and consequently to explain catastrophic events like floods, possibility of comparison of various regions) and for the public (correspondence with a centre of interest of the public: problems such as soil degradation, flood risk, pollutant losses, etc...);
- This indicator based on daily peak of water surface runoff shows the intensity of the events like floods.

Disadvantages:
- This indicator assesses the runoff at field level without integrating hydrological processes at water catchment level.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Acutis, M., Gentile, A., 2005. Model components: Water and Runoff-Erosion data types, Seamless project (contract no. 010036), PD 3.2.1., 15 p.

Auzet, A. V., Boiffin, J., Papy, F., Maucorps, J. & Ouvry, J. F. ,1990. An approach to the assessment of erosion forms and erosion risk on agricultural land in the northern Paris Basin, France. In Soil erosion on agricultural land, eds. J. Boardman, I. D. L. Foster & J. A. Dearing, John Wiley & Sons Ltd, pp. 383-400.

Braudeau, E., Martin, P., 2005. Model components: Soil Structure and water data types, Seamless project (contract no. 010036), PD 3.2.3, 12 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 11

Name of indicator

Phosphorus balance

General scope of indicator [1]

This indicator aims to assess the phosphorus balance in soil under crops and consequently a surplus or deficit of P. In case of continual surplus, P content in soil is going to increase and can lead to runoff or leaching which has an impact on water eutrophisation. In case of deficit, the chemical soil fertility is threatened on long term.
This indicator can be expressed per farm type.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

kg P ha^{-1}

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➤ **on the goal-oriented frameworks (see D 2.1.1) :**

[X] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Maintenance of environmental balances & functions		
Sub-theme : Surface water eutrophisation (P runoff)	Sub-theme: Groundwater eutrophisation (P leaching)	Sub-theme: Soil fertility (organic matter, N, P, K)

➤ **on the system property-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effectiveness

Scales for elementary calculation and up scaling possibilities

➤ **spatial scales :**

Elementary calculation:

[X] HSMU[3]   [ ] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

[ ]

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ☒ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

[ ]

Calculation of the indicator

☐ Simple ☒ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
P import in mineral fertilizers: - amount of mineral fertilizers - P contents in mineral fertilizers	kg P ha^{-1} kg ha^{-1} %	 FSSIM External database	
P import in organic fertilizers: - amount of organic fertilizers - P contents in organic fertilizers	kg P ha^{-1} kg ha^{-1} %	 FSSIM External database	Animal manure coefficients are difficult to determine and to regionalise according to the feeding regime (raw fodder, feedstuff, etc...)
P export in crop harvesting: - yield - P contents in crop harvesting	kg P ha^{-1} kg ha^{-1} %	 APES External database	
P in exported residues	kg P ha^{-1}	External database	
P export in animal products	kg P ha^{-1}	External database	

Brief description of the calculation:

P balance = $(P_{minfert} + P_{orgfert}) - (P_{crop} + P_{res} + P_{anim)}$

with:
$P_{minfert}$ = P import in mineral fertilizers (= amount of mineral fertilisers * P contents in mineral fertilizers)
$P_{orgfert}$ = P import in organic fertilizers (= amount of organic fertilisers * P contents in organic fertilizers)
P_{crop} = P export in crop harvesting (= yield of a specific crop * P contents in this crop)
P_{res} = P in exported residues
P_{anim} = P export in animal products

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Farm Local / Regional National	-15 to +15 kg P ha^{-1}	Defined by stakeholders	Threshold proposed in German assessment methods KUL/USL (Eckert *et al.*, 2000).

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

> Per farm; mean value.

Type of visualisation (number, graphical visualisation):

> Number (one value per year) and/or the possibility of a graphical visualisation (distribution of yearly P balance per farm type for a given region, evolution of daily P balance over year per farm type).

Additional data/indicators needed to interpret the results:

> Amount of P (mineral and organic), P contents in mineral and organic fertilizers.

Relation with other indicator(s)

> P in runoff
> P leaching (Sharpley A.N. *et al.*, 2001)

Aggregation possibilities with other indicator(s)

> Yearly water surface runoff
> Yearly erosion (Lemunyon J.L. and Gilbert R.G., 1993)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

> Advantages:
> - Useful for the users (indication on the deficit of surplus of P in agricultural soils, possibility of comparison of various agri-environmental regions or countries) and for the public (correspondence with a centre of interest of the public: surface and groundwater quality).
>
> If the feasibility of the model implementation is solved, there is no difficulty to use this indicator.
> Disadvantages:
> - The impact of P excess on environment, due to P runoff or leaching, is not assessed directly by the indicator. It depends on a variety of factors: pedological, topographical, agronomic, temporal and climatic.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Eckert, H., Breitschuh, G., Sauerbeck, D., 2000. Criteria and Standards for Sustainable Agriculture. Journal of Plant Nutrition and Soil Science 163, 337-351.

Lemunyon, J.L. and Gilbert, R.G., 1993. The concept and need for a phosphorus assessment tool. Journal of Production Agriculture, 6 (4), 483-486.

Sharpley, A.N., McDowell, R.W., Weld, J.L., and Kleinman, P.J.A., 2001. Assessing Site Vulnerability to Phosphorus Loss in an Agricultural Watershed. Journal Environ. Qual. 30:2026-2036.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 12

Name of indicator

Soil erosion risk

General scope of indicator [1]

> This indicator aims to assess soil erosion by water, which reduces productivity of the land and degrades the performance and the effectiveness of the ecosystems in the shorter or longer term.
> This indicator use a risk ratio approach, i.e. the ratio between the predicted eroded soil and the value of tolerable soil loss which depends of situation and location.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

%

Type of indicator

☒ Environmental ☐ Economic ☐ Social ☐ Institutional

Position of the indicator on framework

> **on the goal-oriented frameworks (see D 2.1.1) :**

☒ Effects on agricultural sector on it self ☒ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of environment compartments Sub-theme : Soil erosion

> **on the system property-oriented frameworks (see D 2.1.1) :**

☐ Effects on agriculture ☒ Effects beyond agriculture

Property to which the indicator is related:

Security

Scales for elementary calculation and up scaling possibilities

> **spatial scales :**

Elementary calculation:

☒ HSMU[3] ☐ farm ☐ regional ☐ national ☐ European ☐ world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales (farm, regional or national level).

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Soil eroded	$t\ ha^{-1}\ yr^{-1}$	APES	
Tolerable soil loss according to soil depth	$t\ ha^{-1}\ yr^{-1}$	External database	Values of tolerable soil loss can be found in: Delbaere and Serradilla (2004) Schwertmann *et al.* (1987) Schertz (1983)

Brief description of the calculation:

Soil erosion risk = (soil eroded predicted by model / tolerable soil loss) * 100

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Farm Local / Regional National	Relative (depends on situation and location)	Defined by stakeholders	An example is given in Delbaere and Serradilla (2004)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per agri-environmental region or per country.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation (distribution of soil erosion risk per agri-environmental region for a given country, evolution of soil erosion risk over years per regions or countries).

Additional data/indicators needed to interpret the results:

Soil cover by crop during the year, soils characteristics (e.g. texture, OM content, depth), topography data (e.g. slope) and climate data (precipitation).

Relation with other indicator(s)

Peak of soil erosion Water surface runoff: yearly cumulated

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages: • Useful for the users (indication on the importance of soil erosion risk regarding soil protection, possibility of comparison of various agri-environmental regions or countries) and for the public (correspondence with a centre of interest of the public: risk of off-site damages, increasing the risk of desertification in most vulnerable areas, particulary in the Mediterranean region). Disadvantages: • This indicator estimates erosion risk but not the real impact of the phenomenon; • The model used tackles one form of erosion on hillslope. Risk of concentrated flow erosion die to runoff concentration is not assessed by this indicator (Auzet *et al.*, 1990); • Regarding soil protection, the cumulated soil loss is more relevant.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Acutis, M., Gentile, A., 2005. Model components: Water and Runoff-Erosion data types, Seamless project (contract no. 010036), PD 3.2.1., 15 p.

Auzet, A. V., Boiffin, J., Papy, F., Maucorps, J. & Ouvry, J. F., 1990. An approach to the assessment of erosion forms and erosion risk on agricultural land in the northern Paris Basin, France. In Soil erosion on agricultural land, eds. J. Boardman, I. D. L. Foster & J. A. Dearing, John Wiley & Sons Ltd, pp. 383-400.

Delbaere, B. and Serradilla, A. N. E. (eds), 2004. Environmental risks from agriculture in Europe: Locating environmental risk zones in Europe using agri-environmental indicators. EC NC-European Centre for Nature Conservation, Tilburg, the Netherlands, 184 p.

Montanarella L., 1999. Soil at the interface between agriculture and environment. In: Agriculture, environment, rural development: facts and figures – A challenge for Agriculture, 223-233 (http://europa.eu.int/comm/agriculture/envir/report/en/inter_en/report.htm).

Schertz, D.L., 1983. The basis for soil loss tolerances. Journal of Soil and Water Conservation. 38, 10-14.

Schwertmann, U., Vogl, W. and Kainz, M., 1987. Bodenerosion durch Wasser – Vorhersage des Abtrags und Bewertung von Gegenmassnahmen, Stuggart, Ulmer.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 13

Name of indicator

Soil erosion: daily peak

General scope of indicator [1]

This indicator aims to assess soil erosion by water, which reduces productivity of the land and degrades the performance and the effectiveness of the ecosystems in the shorter or longer term (Montanarella L.,1999). This indicator can be expressed in different scales (farm type, regional scale) in daily peak of soil eroded which can be compared with tolerable values of soil loss.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

t ha^{-1}

Type of indicator

☒ Environmental   ☐ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

☒ Effects on agricultural sector on it self   ☒ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of environment compartments
Sub-theme : Soil erosion

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

☐ Effects on agriculture   ☒ Effects beyond agriculture

Property to which the indicator is related:

Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☒ HSMU[3]   ☐ farm   ☐ regional   ☐ national   ☐ European   ☐ world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by HSMU surface at higher scales, crop and farm, regional level.

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☒ day   ☐ week   ☐ month   ☐ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Soil eroded	t ha^{-1}	APES	

Brief description of the calculation:

Daily peak of soil erosion = soil eroded predicted by model (max value per day)

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Farm Local / Regional National	Tolerable soil loss according to soil depth	Defined by stakeholders	Values of tolerable soil loss can be found in: Delbaere and Serradilla (2004) Schwertmann *et al.* (1987) Schertz (1983)

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Maximum value per day; expression per farm type.

Type of visualisation (number, graphical visualisation):

Number (one value per day) and/or the possibility of a graphical visualisation (distribution of daily peak of soil erosion per farm type for a given region, evolution of daily peak of soil erosion over year per farm type).

Additional data/indicators needed to interpret the results:

Soil cover by crop during the year, tillage, soils characteristics (e.g. low clay content, OM content), topography data(e.g. slope) and climate data (precipitation).

Relation with other indicator(s)

Yearly soil erosion Soil erosion risk Water surface runoff: daily peak

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- Useful for the users (indication on the importance of evolution of erosion regarding soil protection, possibility of comparison of various agri-environmental regions or countries) and for the public (correspondence with a centre of interest of the public: risk of off-site damages, increasing the risk of desertification in most vulnerable areas, particularity in the Mediterranean region);
- Erosion may be due to catastrophic events. This indicator based on the daily peak of soil loss gives an indication on the intensity of the events.

Disadvantages:
- The model used tackles one form of erosion on hillslope. Risk of concentrated flow erosion die to runoff concentration is not assessed by this indicator (Auzet *et al.*, 1990);
- Regarding soil protection, the cumulated soil loss is more relevant.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Acutis, M., Gentile, A., 2005. Model components: Water and Runoff-Erosion data types, Seamless project (contract no. 010036), PD 3.2.1., 15 p.

Auzet, A. V., Boiffin, J., Papy, F., Maucorps, J. & Ouvry, J. F., 1990. An approach to the assessment of erosion forms and erosion risk on agricultural land in te nothern Paris Basin, France. In Soil erosion on agricultural land, eds. J. Boardman, I. D. L. Foster & J. A. Dearing, John Wiley & Sons Ltd, pp. 383-400.

Delbaere, B. and Serradilla, A. N. E. (eds), 2004. Environmental risks from agriculture in Europe: Locating environmental risk zones in Europe using agri-environmental indicators. EC NC-European Centre for Nature Conservation, Tilburg, the Netherlands, 184 p.

Montanarella L., 1999. Soil at the interface between agriculture and environment. In: Agriculture, environment, rural development: facts and figures – A challenge for Agriculture, 223-233 (http://europa.eu.int/comm/agriculture/envir/report/en/inter_en/report.htm).

Schertz, D.L., 1983. The basis for soil loss tolerances. Journal of Soil and Water Conservation. 38, 10-14.

Schwertmann, U., Vogl, W. and Kainz, M., 1987. Bodenerosion durch Wasser – Vorhersage des Abtrags und Bewertung von Gegenmassnahmen, Stuggart, Ulmer, 60 p.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 14

Name of indicator

Water use by irrigation

General scope of indicator [1]

This indicator aims to assess the quantity of water used for irrigation of agricultural surfaces and consequently to detect a potential depletion of the water resource.
This indicator can be expressed on different scales (crop, farm type, regional scale) in yearly cumulated mean of water use for irrigation per ha (irrigated surface).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

$m^3\ ha^{-1}$

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[X] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of environment compartments
Sub-theme : Water quantity (depletion of resource)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effectiveness

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[ ] HSMU[3]   [X] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by farm types at higher scales (regional or national level).

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event　　☐ day　　☐ week　　☐ month　　☒ year　　☐ multi-annual　　☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple　　☐ Aggregated　　☐ Composite　　☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Water use	$m^3\ ha^{-1}$	APES	

Brief description of the calculation:

Yearly water use by irrigation = water use (yearly cumulated)

Threshold/target at different scales

Scale	Threshold	Target	Remark
Field Farm Local / Regional National	Relative (% baseline scenario) or regional guideline	Defined by stakeholders	

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Per crop or per farm type ; mean value.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation (distribution of yearly cumulated water use per agri-environmental region for a given country, evolution of cumulated water use over years per regions or countries).

Additional data/indicators needed to interpret the results:

% of irrigated surfaces, water use efficiency index.

Relation with other indicator(s)

% water used for irrigation / water available.

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

> Advantages:
> - Useful for the users (indication on the importance of evolution of water use for irrigation, possibility of comparison of various crops or farm types) and for the public (correspondence with a centre of interest of the public: risk of depletion of water resource).

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 15

Name of indicator

Energy consumption due to use of mineral fertilizers

General scope of indicator [1]

The aim of this indicator is to assess the consumption of non renewable resource. This estimation is made in indirect way by the evaluation of energy consumption due to the use of mineral fertilizers, main part in energy consumption for arable farming.
This indicator is expressed per crop which allows to distinguish crops with high and low energy consumption. It can also be expressed by farm type.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Equivalent liter oil ha^{-1}

Type of indicator

[X] Environmental   [ ] Economic   [ ] Social   [ ] Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

[X] Effects on agricultural sector on it self   [X] Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Preservation of non-renewable resource
Sub-theme : Energy (oil)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

[ ] Effects on agriculture   [X] Effects beyond agriculture

Property to which the indicator is related:

Effectiveness

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

[ ] HSMU[3]   [X] farm   [ ] regional   [ ] national   [ ] European   [ ] world

[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

Calculation of a weighted mean by crop surfaces at higher level (regional, national, etc.).

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Amount of mineral fertilisers	kg N, P_2O_5, K_2O^* ha^{-1}	FSSIM	
Type of fertiliser		FSSIM	Two options are possible: i) to differenciate the type within a category (N, P, K): e.g. ammonium nitrate, urea, etc. for N ii) to differenciate only at the level of nutrient (N, P, K).
Energetic coefficient of each type of fertiliser (table)	MJ kg^{-1}	External database	Those of Pervanchon *et al.* (2002) can be provided by INRA Colmar

* $P_2O_5 * 0,436 = P$
$K_2O * 0,83 = K$

Brief description of the calculation:

For each crop (farm type): Energy consumption = $C_{enN} * Q_{fertN} + C_{en P} * Q_{fertP} + C_{enK} * Q_{fertK}$ with: C_{enN}, C_{enP}, C_{enK} = energetic coefficient respectively for nitrogen, phosphate and potash Q_{fertN}, Q_{fertP}, Q_{fertK} = quantity respectively for nitrogen, phosphate and potash fertilisers

Threshold/target at different scales

Scale	Threshold	Target	Remark
Farm	Relative (% baseline scenario)	% reduction by stakeholders	
Region	Relative (% baseline scenario)		

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Mean (max. min.) per crops or farm type.

Type of visualisation (number, graphical visualisation):

Number (e.g. mean per crop and per year), distribution per crop or per farm type for a given region and evolution over years per crop.

Additional data/indicators needed to interpret the results:

Nutrient use (N, P_2O_5, K_2O. ha^{-1} per crop (or farm type).

Relation with other indicator(s)

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- Calculation method accepted by experts and used in many publications;
- Easy calculation when the data are available.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Pervanchon, F., Bockstaller, C. & Girardin, P., 2002. Assessment of energy use in arable farming systems by means of an agro-ecological indicator: the energy indicator. Agricultural Systems, 72, 149-172.

Remark on the operationality of this indicator in Prototype 1:

Authors:
Christian Bockstaller (bockstal@colmar.inra.fr)
Emmanuelle Weinzaepflen (weinzaep@colmar.inra.fr)

Fact sheet: indicator ENV. 16

Name of indicator

Crop diversity index : mean value per farm

General scope of indicator [1]

This indicator aims to assess the crop diversity index which is a relevant element to evaluate the impact of farm practices (e.g. changes in crop selection and rotations) on biodiversity. In fact, biodiversity represents a potential reserve of new compounds for medecine, interesting genes for plant breeding and services for agriculture.
This indicator can be expressed by mean value per farm type.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Dimensionless

Type of indicator

X Environmental ☐ Economic ☐ Social ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

☐ Effects on agricultural sector on it self   **X** Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related:

Theme : Protection of human health and welfare
Sub-theme : Landscape (heterogeneity)

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

☐ Effects on agriculture   **X** Effects beyond agriculture

Property to which the indicator is related:

Adaptability

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ HSMU[3]   **X** farm   **X** regional   ☐ national   ☐ European   ☐ world
[3] Homogeneous soil map unit (field)

Up scaling possibilities [4]:

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ☒ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

Calculation of the indicator

☒ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Different data needed for calculation:

Type of data	Unit	Origin	Remark (quality of data)
Surface of the cover	ha	FSSIM	
Total cropped surface	ha	FSSIM	

Brief description of the calculation:

The calculation is based on the reciprocal Simpson's index:

Crop diversity index = $1 / \sum p_i^2$ (mean value per farm)

with:

p_i : the proportion of cover class i (surface of the cover / total cropped surface)

This index is equal to the number of crops (or soil cover) when their distribution is even (all are represented by the same proportion) and decreases when the unevenness increases.

Threshold/target at different scales

Scale	Threshold	Target	Remark
Farm Local / Regional National	4	Defined by stakeholders	Based on the guideline in integrated farming of the International Organization for Biological and Integrated Control, IOBC (Boller et al., 1997).
	1.9	Defined by stakeholders	Based on cross-compliance guideline. The value meets the minimal requirement (3 crops with a minimal share of 15 % for two and 60 % for the last one.

Presentation of the results

Expression of the results (per crop/ per farm/ per region; mean/ max or min value):

Par farm type, mean value.

Type of visualisation (number, graphical visualisation):

Number (one value per year) and/or the possibility of a graphical visualisation (distribution of crop diversity index per farm type for a given agri-environmental region or country, evolution of crop diversity index over years per farm type).

Additional data/indicators needed to interpret the results:

Soil cover by crops during the year, crop rotations.

Relation with other indicator(s)

Crop diversity index : variability among farms
% natural ecosystems with high ecological value
Crop sequence indicator.

Aggregation possibilities with other indicator(s)

With an indicator which addresses ecological infrastructure and non-cropped area.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users:

Advantages:
- The meaning of the value is easy to understand in comparison with other diversity index (Shannon, etc.);
- Landscape indices can functionally link the dynamics of ecological processes to landscape structure (Wiens et al., 1993).

Disadvantages:
- This indicator does not take into account non cropped area and ecological infrastructure (hedges, etc.);
- Landscape indices may not differentiate landscapes with qualitative changes because of their insensitivity, e.g. evenness calculated with proportions is unaffected when forest landscapes change into urban landscapes (Li, 2004) or even by the type of crop.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Boller, E.F., Malavolta, C., Jörg, E., 1997. Guidelines for integrated Production of arable crops in Europe: Technical Guideline III, Organization for Biological and Integrated Control (IOBC), Wädenswill, Switzerland.

Li, H. and Wu, J., 2004. Use and misuse of landscape indices. Landscape Ecology 19, 389-399.

Wiens, J.A., Stenseth, N.C., Van Horne, B., and Ims R.A., 1993. Ecological mechanisms and landscape ecology. Oikos 66: 369-380.

Remark on the operationality of this indicator in Prototype 1:

**FACT SHEETS FOR ECONOMIC INDICATORS
OF SUSTAINABLE DEVELOPMENT**

Restricted List Indicators

ECON 1: BUDGETARY EXPENDITURE

ECON 2: EXPORT/IMPORT RATIOS OF AGRICULTURAL PRODUCTS

ECON 3: GROSS MARGIN

ECON 4: LAND FACTOR PRICE

ECON 5: NET VALUE OF CAPITAL

ECON 6: PRODUCTION OF MAIN AGRICULTURAL PRODUCTS

ECON 7: PROFITS OF THE PROCESSING INDUSTRY

ECON 8: TARIFF REVENUES

ECON 9: TERMS OF TRADE

ECON 10: TOTAL WELFARE

Other Indicators (Components of the Total Welfare Indicator which are not on the current Restricted List)

ECON 11: AGRICULTURAL INCOME

ECON 12: MONEY METRIC (CONSUMER SURPLUS)

For correct formatting: View > Print Layout

Author: Lee Stapleton   Implemented in Prototype 1? **YES/NO**
E-mail: L.M.Stapleton@ncl.ac.uk

Fact sheet: ECON 1

Name of indicator

BUDGETARY EXPENDITURE

General scope of indicator [1]

Budgetary expenditure refers to an array of monetary support provided to farmers under the first pillar of the Common Agricultural Policy (CAP). Expenditure under the second pillar of the CAP is not included. The dynamics of this indicator over time are limited by the decision of the European Commission to fix expenditure on the first pillar of the CAP until 2013.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euros

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Government Intervention

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Self-reliance / Adaptability

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU* [3]   ☐ farm   ☐ regional   ■ national   ■ European   ☐ world

Up scaling possibilities [4]:

No upscaling is possible; only define at national and European levels.

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ■ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. $X \euro$ expenditure over a ten year period) or a mean (i.e. annual expenditure was on average $X \euro$ over a ten year period).

Calculation of the indicator

☐ Simple ■ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Model output :

CAPRI

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Budgetary outlays	Euros	EU Commission services (DG-AGRI)	

Brief description of the calculation :

Budgetary expenditure comprises all direct payments for agricultural commodities (premiums included in the first pillar of the CAP), export subsidies, costs for intervention purchases, processing, feed industry, and consumption aid. This corresponds to the FEOGA budgetary costs included in the first pillar for each of the production programmes.

Threshold/target at different scales

Scale	Threshold	Target	Remark
Country EU	Based on Allocation [a] €45 Bio in 2006 (Ahner, 2004)[a]	Stakeholder defined Stakeholder defined	[a]See note above, under 'General Scope of Indicator'

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value) :

Euros

Type of visualisation (number, graphical visualisation) :

Number
Graphical

Additional data/indicators needed to interpret the results :

Direct payments; export subsidy outlays; intervention stock costs.

Relation with other indicator(s)

The components of this indicator – direct payments; export subsidy outlays; intervention stock costs – are defined as separate operational indicators in CAPRI.

Aggregation possibilities with other indicator(s)

This indicator is already an aggregation of smaller expenditure indicators.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

The advantages of this indicator include the fact that it aggregates export subsidy outlays with other support outlays; it is perhaps undesirable to separate these into distinct indicators because an agreement was reached at the 6th World Trade Organisation Ministerial meeting in Hong Kong (December, 2005) to phase out export subsidies by 2013; a separate indicator for export subsidies could, therefore, quickly become redundant if they are phased out as currently planned.

Disadvantages include the fact that this measure excludes budgetary expenditure on rural development (second pillar of the CAP); this clearly impinges on the environmental dimension of sustainable development and as such is perhaps worthy of being included as a separate indicator.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Ahner, D. (2004) CAP reform and EU enlargement : the future of European agricultural policy [online]. Available from: http://europa.eu.int/comm/agriculture/events/sofia/ahner.pdf

World Trade Organisation (2005) The Sixth WTO Ministerial Conference [online] Available from: http://www.wto.org/english/theWTO_e/minist_e/min05_e/min05_e.htm World Trade Organisation, Geneva

Author: Vaclav Voltr
E-mail: voltr@vuze.cz

Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 2

Name of indicator

EXPORT/IMPORT RATIOS OF AGRICULTURAL PRODUCTS

General scope of indicator [1]

Exports of percentage imports. Ratio of the volume of selected agricultural products exported to the volume of selected agricultural products imported. If referring to the value, instead of the volume, we must examine the following indicator, terms of trade. There are differences between trade in raw materials, semi-finished products and processed products (animal production and crop production).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Ratio, %

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Trade

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Self-reliance; Freedom; Security

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ☐ farm   ☐ regional   ■ national   ■ European   ☐ world

Up scaling possibilities [4]:

Upscaling not possible

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☑ year   ☑ multi-annual   ☑ long-term

Up scaling possibilities:

Upscaling possible.

Calculation of the indicator

☑ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Model output:

CAPRI

Different data needed for calculation:

Type of data	Unit	Origin	Remarks (quality of data)
Trade flows of main agricultural products	Tonnes	CAPREG	

Brief description of the calculation:

$$\frac{E}{I} * 100 \quad [\%]$$

Capri documentation: Equation 116, 117

$$\text{Imports}_{i,r} = \sum_{r1 \neq r} flows_{i,r,r1}$$

$$\text{Exports}_{i,r} = \sum_{r1 \neq r} flows_{i,r1,r}$$

E - volume and value of exported agriculture product
I - volume and value of imported agricultural product
ATPSM model (UNCTAD + FAO)

Threshold/target at different scales

Scale	Threshold	Target	Remark
National	??	Stakeholder defined	
EU	??	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

Ratio, %

Type of visualisation (number, graphical visualisation):

Number Graphical

Additional data/indicators needed to interpret the results:

Export/Import Prices

Relation with other indicator(s)

Production of Main Agricultural Products, Export/Import Prices

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Simple measurement applied, on a large scale, to external trade activity comparison. Disadvantage of the ratio is, when re-exports are included and/or in case, when product structure of an aggregate group is changed.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

FAO, Economic and Social Department (2003) *Commodity market review (2003-2004)* [online] Available from:
http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/006/Y5117E/Y5117E00.HTM

FAO (1995) *Agricultural trade: entering a new era?* [online] Available from:
http://www.fao.org/docrep/v6800e/v6800E0i.htm#Agricultural%20trade:%20entering%20a%20new%20era

OECD (2002) Basic Agricultural Indicators AGR-NME 2 [online] Available from:
http://www.ingentaconnect.com/content/oecd/16081056/0017/00000001/00000001/1cagrind#avail

Data set: EUROSTAT

Data set: FAOSTAT

seamless

Author: Lee Stapleton   Implemented in Prototype 1? **YES/NO**
E-mail: L.M.Stapleton@ncl.ac.uk

Fact sheet: ECON 3

Name of indicator

GROSS MARGIN

General scope of indicator [1]

Gross margin is the difference between revenue and variable costs (EuroCARE 2003) where revenues incorporate premiums. A higher gross margin can reflect greater efficiency in turning raw materials into income. The European Commission defines the commercial viability of farms based on European Size Units particular to each Member State (European Commission, 2004) which is important when defining a threshold for acceptability for this indicator.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euro; Euro/ha; Euro/head

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ☐ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Profitability

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ☐ Effects beyond agriculture

Property to which the indicator is related

Profitability

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ■ farm   ■ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Upscaling possible.

[3] Homogeneous soil map unit (field)
[4] if the up scaling is only based on the calculation of a weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☑ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. X € gross margin over a ten year period) or a mean (i.e. annual gross margin was on average X € over a ten year period).

Calculation of the indicator

☑ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Model output:

CAPRI; FSSIM (Only sample regions, only crop products 18MPROTO)

Different data needed for calculation:

Type of data	Unit	Origin	Remarks (quality of data)
Gross margins	Euro; Euro/ha; Euro/head	CAPREG	
Gross margins	Euro; Euro/ha	FADN-FSSIM_DB	

Brief description of the calculation:

Gross margin for an activity z is the difference between expected revenue per activity level (EREV) of that activity and the sum over all inputs used in that activity. The Set G1(CI,Z) allocates the inputs used to each activity and $X_{exo,Z}$ are inputs that are not estimated here, but cannot be neglected in defining gross margins (Britz, 2005):

$$GM_Z = EREV_Z - \sum_{Z \in G1(CI,Z)} X_{CI,Z} - X_{exo,Z}$$

Premiums are incorporated into revenue via a premium calculation module in CAPRI.

Threshold/target at different scales

Scale	Threshold	Target	Remark
Farm	€1200 per ESU[a]	Stakeholder defined	[a]The number of ESUs per Member State are available from European Commission (2004)
Regional	€1200 per ESU[a]	Stakeholder defined	
National	€1200 per ESU[a]	Stakeholder defined	
European	€1200 per ESU[a]	Stakeholder defined	
World	€1200 per ESU[a]	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

Euro; Euro/ha; Euro/head

Type of visualisation (number, graphical visualisation):

Number Graphical

Additional data/indicators needed to interpret the results:

Total revenues (CAPRI, CAPREG); Total costs (CAPRI, CAPREG)

Relation with other indicator(s)

Related to Consumer prices of main agricultural products (CAPRI, CAPREG) if Consumer price = Cost / (1 – Gross margin)

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Gross margin is an ambiguous phrase because, in the literature, it is sometimes expressed as a ratio, rather than in absolute terms. As an indicator, it fails to take into account fixed costs (such an indicator would be denoted as Net margins). However, some commentators do not see this as a disadvantage as Net margins can be misleading (Firth, 2002).

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Britz, W. (2005) CAPRI *Modelling System Documentation.* European Commission, J05/30/2004
EuroCARE (2003) *Mid-Term Review proposal impact analysis using the CAPRI modelling system* [online]. Available from: http://europa.eu.int/comm/agriculture/publi/reports/mtrimpact/rep4_en.pdf Directorate-General for Agriculture, European Commission.
European Commission (2004) *FADN Methodology* [online] Available from: http://europa.eu.int/comm/agriculture/rica/methodology1_en.cfm
Firth, C (2002) *The use of gross and net margins in the economic analysis of organic farms* [online] Available from: http://www.organic.aber.ac.uk/library/Gross%20and%20net%20margins%20for%20economic%20analysis.pdf Proceedings of the COR Conference, 26-28th March 2002, Aberystwyth, pp. 285-288.

Author: Vaclav Voltr
E-mail: voltr@vuze.cz

Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 4

Name of indicator

LAND FACTOR PRICE

General scope of indicator [1]

Land factor prices identify income effects, risk related effects and dynamic effects of agricultural production and policy. Into land factor prices is integrated agricultural support, that affect incentive prices giving rise to price and cross-subsidation effects. If prices are changed on commodities that are substitutes in production or in input use, then the allocation of land and other inputs can be changed. The price effect of output subsidies is induced by the gap between producer and consumer prices. A subsidy to producers that gives the producer the same price as in the case of price support would increase the net welfare of the producer, while the taxpayers bear the cost. Land factor prices could be expressed as a result of land rental markets and land sale markets.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

% change

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance Sub-themes: Profitability; Government intervention; Non-farm activities

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Profitability; Existence

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ☐ farm   ☐ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Upscaling not possible.

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of a weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ■ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. $X \, €$ price % change over a ten year period) or a mean (i.e. annual price % change was on average $X \, €$ over a ten year period).

Calculation of the indicator

■ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Model output:

GTAP

Different data needed for calculation:

Type of data	Unit	Origin	Remarks (quality of data)
Land factor price	% change	GTAP	

Brief description of the calculation:

GTAP documentation is unavailable in the public domain; guidance required from WP3.

Threshold/target at different scales

Scale	Threshold	Target	Remark
National	??	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

% change

Type of visualisation (number, graphical visualisation):

| Number
Graphical |
| --- |

Additional data/indicators needed to interpret the results:

Total factor productivity indices (GTAP; % change)

Relation with other indicator(s)

Labour factor price (GTAP; % change)

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Land factor price is a very complex indicator of agricultural and rural welfare; modelling land markets is not an easy task.

Modelling of land rental markets is likely to be easier than modelling land sale markets, the former being less concerned with difficult issues such as expectation of the future and dynamic processes. Land demand and land supply depend on farm production technology as well as farm output and input prices; they also depend on many other factors that relate to the presence or the absence of imperfections in labour, credit and insurance markets. Although such market imperfections are present in all economies to a greater or lesser extent, global models of agricultural sectors as well as many general equilibrium models most often rely on the perfect market assumption. This assumption probably leads to misrepresentation of the impact of shocks, in particular policy shocks, on the distribution of factors (i.e. land, labour, capital) within the agricultural sector (i.e. between agricultural activities) and between this sector and other sectors in the economy.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Andersson, FCA (2004) *Decoupling: The concept and past experiences* [online] Available from: http://www.sli.lu.se/eng/idema/WPs/IDEMA_deliverable_1.pdf IDEMA Deliverable No.1, European Commission.

Le Mouel, C. (2005) *The impact of decoupling and modulation in the enlarged Union: A sectoral and farm level assessment* [online] Available from: http://www.sli.lu.se/eng/idema/WPs/IDEMA_deliverable_2.pdf IDEMA Deliverable No.2, European Commission.

Author: Vaclav Voltr   Implemented in Prototype 1? **YES/NO**
E-mail: voltr@vuze.cz

Fact sheet: ECON 5

Name of indicator

NET VALUE OF CAPITAL

General scope of indicator [1]

A measure of the value of capital stocks, useful in exploring fluctuations and substitutions across different types of capital. Net value of capital is used to evaluate risk and financial progress.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

10^3 Euros

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ☐ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Viability
Sub-theme: Stability

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ☐ Effects beyond agriculture

Property to which the indicator is related

Stability

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ☐ farm   ☐ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Upscaling not possible.

[3] Homogeneous soil map unit (field)
[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event　　☐ day　　☐ week　　☐ month　　■ year　　☐ multi-annual　　☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. X € capital stocks a ten year period) or a mean (i.e. annual capital stock was on average X € over a ten year period).

Calculation of the indicator

■ Simple　　　　☐ Aggregated　　　　☐ Composite　　　　☐ Indicators of multifunctionality

Model output :

GTAP

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Net value of capital	% change	GTAP	

Brief description of the calculation :

Calculated as:
Total assets – Liabilities

For a public company, the excess of assets over liabilities consist of retained earnings, common stock and additional paid-in surplus; here also called owner's equity or shareholders' equity or net assets. For an individual, the excess of assets over liabilities is most likely to come from savings and any additional contributions to income that they have received. Some economists say net worth is not very useful, since financial statements value most assets and liabilities at historical cost, which is usually not a good indicator of true value. Also called capital net worth.

Threshold/target at different scales

Scale	Threshold	Target	Remark
National	Positive	Stakeholder defined	
EU	Positive	Stakeholder defined	
World	Positive	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

% change

Type of visualisation (number, graphical visualisation):

Number
Graphical

Additional data/indicators needed to interpret the results:

N/A

Relation with other indicator(s)

N/A

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Total Assets refer to all economic resources, in monetary terms, that are owned or controlled by enterprises including properties, creditor's equity and other economic rights of all forms. Classified by the degree of equitability, total assets include circulating assets, long-term investment, fixed assets, intangible assets and deferred assets, and other assets. Data on this indicator can be obtained by the year-end figures of total assets in the Assets and Liability Table of accounting records of enterprises.

To calculate net worth, there are roughly two approaches. The first is to value all assets and liabilities at the value they were obtained, less depreciation or plus appreciation. This is typically done in accounting to produce companies' balance sheets. The disadvantage of this approach is that the value, at which an item is listed, might not be the amount that you receive when you try to sell it. To remedy this problem, assets are sometimes marked to market. This means, that the value that is used for an item is that at which you can sell it in the open market. Using this method net worth will vary, as prices on the open market vary. It is sometimes difficult to find a mark to market for illiquid assets, such as real estate and shares in unlisted companies. The estimate has to be made then based on readily available comparable valuations. Premise of sustainable agriculture from economic point of view: the family savings or net worth is consistently going up.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Sullivan, P. (2003) *Applying the Principles of Sustainable Farming: Fundamentals of Sustainable Agriculture* [online] Available from: http://attra.ncat.org/attra-pub/PDF/Transition.pdf ATTRA - National Sustainable Agriculture Information Service of USDA.

United Nations Economic Commission for Europe (2005) : *The Wye Group Handbook - RURAL HOUSEHOLDS' LIVELIHOOD AND WELL-BEING* [online]. Available from: http://www.unece.org/stats/rural/annex8.pdf

Author: Vaclav Voltr
E-mail: voltr@vuze.cz

Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 6

Name of indicator

PRODUCTION OF MAIN AGRICULTURAL PRODUCTS

General scope of indicator [1]

Agriculture production is the main source of farm income. This indicator gives a basic overview about agricultural productivity and farm structure. Agricultural production, for production comparison of particular countries, is divided into group and sub-groups. Main world comparable products are wheat, crops, livestock and poultry, dairy production, oilseeds, sugar

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Production – tonne; yield - tonne/ha; area of production – ha, piece

Type of indicator

☐ Environmental ■ Economic ☐ Social ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self ☐ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Productivity

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture ☐ Effects beyond agriculture

Property to which the indicator is related

Stability; Self-reliance

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU* [3] ■ farm ■ regional ■ national ■ European ■ world

Up scaling possibilities [4]:

Upscaling possible.

[3] Homogeneous soil map unit (field)
[4] if the up scaling is only based on the calculation of a weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ☑ year ☑ multi-annual ☑ long-term

Up scaling possibilities:

| Upscaling possible. |

Calculation of the indicator

☑ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Model output :

| CAPRI; FSSIM (only for current activities; FADN is a reference for calibration) |

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Production area	ha	statistic	
Yield	t/ha	statistic	
Total production	tonnes	statistic/computed	
Livestock units	tonnes, pieces	statistic	
Dairy production	kg, kg/head	statistic	

Brief description of the calculation :

| Statistical data, production functions in models |

Threshold/target at different scales

Scale	Threshold	Target	Remark
Farm	??	Stakeholder defined	Thresholds are defined via production conditions and vary across bright scale
Regional	??	Stakeholder defined	
National	??	Stakeholder defined	
EU	??	Stakeholder defined	
World	??	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value) :

| Quantity (1000 tonnes); Price (Euros); Yield (tonne per hectare). Per crop, per farm, per region, mean, min and max values all appropriate. |

Type of visualisation (number, graphical visualisation):

| Number Graphical |

Additional data/indicators needed to interpret the results:

| Total production (€), % of specified production from total production, year comparison |

Relation with other indicator(s)

| Export/Import Ratios of Agricultural Products; Human Consumption of Main Agricultural Products |

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Simple description of productivity, direct comparison of production possibility. From the model point of view this indicator could be described in terms of aggregation-disaggregation possibilities.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

USDA Foreign Agriculture Service (2006) *Current World Production, Market and Trade Reports* [online] Available from: http://www.fas.usda.gov/currwmt.asp

European Commission (1999) *CAP reform: The arable crops sector* [online] Available from: http://europa.eu.int/comm/agriculture/publi/fact/cereals/cereals_en.pdf Directorate-General of Agriculture.

European Commission, (2004) *The meat sector in the European Union.* Directorate-General of Agriculture.

Dataset: CAPREG, FADN-FSSIM_DB, Eurostat, FADN

seamless

Author: Lee Stapleton
E-mail: L.M.Stapleton@ncl.ac.uk
Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 7

Name of indicator

PROFITS OF THE PROCESSING INDUSTRY

General scope of indicator [(1)]

This indicator focuses on secondary production at the industry level. The actual scope of the indicator depends on how 'profits' are defined. In economic terms, if revenue exceeds the *total opportunity costs* of the inputs then the firm is making an economic profit. In accounting terms, if revenue exceeds the *total costs* of the inputs the firm is making an accounting profit. This consideration is important when defining appropriate thresholds for this indicator. Economic profit is also known as supernormal profit; theoretically it should not occur in a perfect-market scenario and is thus an inefficiency indicative of one or more market failings. It is also undesirable from an equity standpoint. There is no equivalent determination in the literature of an acceptable threshold for profits described in accounting terms because positive accounting profits do not imply positive economic profits. However, a reasonable threshold in this case would be the minimum opportunity cost of capital which is the rate at which a firm borrows funds since one alternative to a production activity is to pay back borrowed money.

[(1)] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euros

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ☐ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance Sub-theme: Profitability

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ☐ Effects beyond agriculture

Property to which the indicator is related

Profitability / Existence

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[(3)]   ☐ farm   ☐ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Upscaling not applicable.

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ☒ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. X € profits over a ten year period) or a mean (i.e. annual profits were on average X € over a ten year period).

Calculation of the indicator

☒ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Model output :

CAPRI

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Profits of the processing industry	Euros	CAPREG	

Brief description of the calculation :

Production of processed products in the diary and oilseed industry is evaluated with the derivative of the normalised quadratic profit function. As an exception, production of milled rice is calculated through fixed processing factors.

$$procM\,arg_{seed,r} = -\,ppri_{seed,r}$$

$$+\,ppri_{seed,r \to cak,r}\,\frac{sup\,ply_{seed \to cak,r}^{bas}}{sup\,ply_{seed,r}^{bas}}$$

$$+\,ppri_{seed,r \to oil,r}\,\frac{sup\,ply_{seed \to oil,r}^{bas}}{sup\,ply_{seed,r}^{bas}}$$

Defined from the producer prices *ppri* and crushing coefficients derived from observed supply quantities (Britz, 2005).

Threshold/target at different scales

Scale	Threshold	Target	Remark
Country	National interest rate / European Central Bank	Stakeholder defined	[a] Assuming that profits

| EU | (ECB) interest rate[a]
Average of national /
ECB interest rates[a] | Stakeholder defined | are determined in accounting terms; see discussion above under 'General Scope of Indicator' |
| World | Average of national /
ECB interest rates[a] | Stakeholder defined | |

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

Euros

Type of visualisation (number, graphical visualisation):

Number
Graphical

Additional data/indicators needed to interpret the results:

Profits of the processing industry depend upon the level of production of agricultural products

Relation with other indicator(s)

.Agricultural income and money metric are measures of producer and consumer surplus respectively.

Aggregation possibilities with other indicator(s)

Profits of the processing industry can be summed with agricultural income, money metric and tariff revenues minus budgetary expenditure to give an indicator of total welfare.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

The advantages of this indicator include the fact that it impacts on variables such as employment and investment in human capital thus impinging on the social dimension of sustainable development, as well as the economic dimension.

A disadvantage of this indicator might be narrowness of scope i.e. it focuses specifically on profits from secondary production.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Britz, W. (2005) CAPRI *Modelling System Documentation.* European Commission, J05/30/2004.

Author: Lee Stapleton
E-mail: L.M.Stapleton@ncl.ac.uk

Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 8

Name of indicator

TARIFF REVENUES

General scope of indicator [1]

Tariff revenues result from the application of import tariffs which are simply taxes on imported goods. The specified aim of such tariffs in a European agricultural context is to raise the World market price up to the EU target price. Tariffs can be distinguished as either specific or ad-valorem: the former is a levy per physical unit of the imported good whereas the latter is a levy which is proportional to the value of the imported good. In a World Trade Organisation context, tariffs can also be distinguished as either bound or applied: the former is the tariff level for a product which a country or group of countries commits not to exceed whereas the latter is the operational tariff which may or may not equal the bound tariff. The current tariff baseline can be traced back to the Uruguay round of the General Agreement on Tariffs and Trade (GATT) which came into force on 1st January 1995, committing developed countries to a shortening of bound tariffs by 36%. More recent negotiations suggest that the long-term existence of these tariffs is unlikely; although no agreement was reached at the 6th World Trade Organisation Ministerial meeting in Hong Kong (December, 2005) this issue is likely to remain on the international political agenda with phasing out of tariffs possible in the medium-term (perhaps after the completion of the phasing out of export subsidies, timetabled for 2013).

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euros/tonne (specific tariffs); % (ad valorem tariffs)

Type of indicator

☐ Environmental ■ Economic ☐ Social ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

| Theme: Performance
Sub-theme: Trade |
|---|

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Effectiveness

Scales for elementary calculation and up scaling possibilities

> **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ☐ farm   ☐ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Not applicable.

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ■ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. *X* € tariff-take over a ten year period) or a mean (i.e. annual tariff-take was on average *X* € over a ten year period).

Calculation of the indicator

■ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Model output :

CAPRI

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Tariff Revenues	Euros/tonne; %	AMAD	

Brief description of the calculation :

CAPRI works with applied, as opposed to bound tariffs and ad valorem, as opposed to specific tariffs in the medium-term at least. Results are aggregated for the CAPRI products (original data at HS6 to HS12 tariff line).

Threshold/target at different scales

Scale	Threshold	Target	Remark
Country	Zero[a]	Stakeholder defined	[a]See discussion above, under 'General Scope of Indicator'
EU	Zero[a]	Stakeholder defined	
World	Zero[a]	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value) :

Euros/tonne (specific tariffs); % (ad valorem tariffs)

Type of visualisation (number, graphical visualisation) :

Number
Graphical

Additional data/indicators needed to interpret the results :

N/A

Relation with other indicator(s)

This indicator is related to import prices and quantity of imports. It is also related to agricultural income (i.e. tariffs increase the producer surplus) and the money metric (i.e. tariffs decrease the consumer surplus).

Aggregation possibilities with other indicator(s)

Tariff revenues can be summed with agricultural income, money metric and profits of the processing industry minus budgetary expenditure to give an indicator of total welfare.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

The advantages of this indicator include the fact that it provides a measure of market openness and is a proxy for trade magnitude with the international community.

Disadvantages include the fact that administrative costs of the tariff system are not considered in the analysis i.e. it is a gross revenue measure. Also, due to the problems of developing schedules for specific tariffs (high uncertainty about the reference price used by the different parties: world price, domestic price, border price) in the medium-term at least, it will be easier and more reliable to operationalise the ad-valorem tariff measure.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

World Trade Organisation (2005) The Sixth WTO Ministerial Conference [online] Available from: http://www.wto.org/english/theWTO_e/minist_e/min05_e/min05_e.htm World Trade Organisation, Geneva.

Author: Vaclav Voltr
E-mail: voltr@vuze.cz

Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 9

Name of indicator

TERMS OF TRADE

General scope of indicator [1]

Terms of trade is used for measurement of the import/export prices ratio. An improvement in a nation's terms of trade is good for that country in the sense that it has to pay less for the products it imports, that is, it has to give up less export for the imports it receives. Terms of trade state a change of purchasing power of exported products, expressed in the volume of imported products, on conditions otherwise the same. Terms of trade describe only relation changes of imported and exported prices at the time interval.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

ratio, %

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Trade

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Co-existence

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ☐ farm   ☐ regional   ■ national   ■ European   ■ world

Up scaling possibilities [(4)]:

Upscaling not possible.

[(3)] Homogeneous soil map unit (field)

[(4)] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ■ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. $X \in$ prices over a ten year period) or a mean (i.e. annual prices were on average $X \in$ over a ten year period).

Calculation of the indicator

■ Simple ☐ Aggregated ☐ Composite ☐ Indicators of multifunctionality

Model output :

CAPRI

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Import and Export Prices	Euro per tonne	CAPREG	

Brief description of the calculation :

$$\frac{p_x^c \, q_x^0}{p_x^0 \, q_x^0} \Big/ \frac{p_m^c \, q_m^0}{p_m^0 \, q_m^0}$$

$p_x^c =$ price of exports in the current period (simulation scenario)

$q_x^0 =$ quantity of exports in the base period (reference/baseline scenario)

$p_x^0 =$ price of exports in the base period

$p_m^c =$ price of imports in the current period

$q_m^0 =$ quantity of imports in the base period

$p_m^0 =$ price of imports in the base period

Threshold/target at different scales

Scale	Threshold	Target	Remark
National	>=1	Stakeholder defined	Ratio > 1 signify active export balance in a period
EU	>=1	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

Ratio, %

Type of visualisation (number, graphical visualisation):

Number
Graphical

Additional data/indicators needed to interpret the results:

N/A

Relation with other indicator(s)

This indicator is related to export/import prices and quantity of exports/imports.

Aggregation possibilities with other indicator(s)

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

This is a simple measurement of external trade activity. Terms of trade calculations do not tell us about the volume of the countries´ exports, only relative changes between countries. By the product structure change, the predicative ability of the terms of trade declines.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Batabyal, A.A and Beladi, H. (2001) *The Economics of International Trade and the Environment.* CRC Press.

Gandolfo, G. (2002) International *Finance and Open-Economy Macroeconomics.* Springer.

Gandolfo, G. (2004) Elements *of International Economics.* Springer.

OECD (2006) *Glossary of Statistical terms.* [online] Available from:
http://stats.oecd.org/glossary/search.asp

Data set: Eurostat

seamless

Author: Lee Stapleton   Implemented in Prototype 1? **YES/NO**
E-mail: L.M.Stapleton@ncl.ac.uk

Fact sheet: ECON 10

Name of indicator

TOTAL WELFARE

General scope of indicator [1]

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

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euros

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Capital
Sub-theme: Capital stocks

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Profitability / Existence

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU*[3]   ☐ farm   ☐ regional   ■ national   ■ European   ☐ world

Up scaling possibilities [4]:

No upscaling is possible; only define at national and European levels.

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> ➤ **time scales :**

Elementary calculation:

☐ event   ☐ day   ☐ week   ☐ month   ■ year   ☐ multi-annual   ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. *X* € total welfare over a ten year period) or a mean (i.e. annual total welfare was on average *X* € over a ten year period).

Calculation of the indicator

☐ Simple   ☐ Aggregated   ■ Composite   ☐ Indicators of multifunctionality

Model output :

CAPRI

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Agricultural income	Euros	CAPREG ;FADN-FSSIM_DB	
Money metric	Euros	CAPREG	
Profits of the processing industries	Euros	CAPREG	
Tariff revenues	Euros/tonne; %	AMAD	
Budgetary Expenditure	Euros	EU Commission services (DG-AGRI)	

Brief description of the calculation :

Total welfare is decomposed into the sum of agricultural income (welfare gain of producers), money metric (welfare gain of consumers), profits by processing activities (welfare gain of the agro-industry) and tariff revenues (welfare gain of the public sector), minus budgetary expenditure (welfare loss from taxpayers).

Money metric is an indirect utility function after Varian (1992):
$ì (q;p.m) = e (p, v(q,m))$
ì (q;p.m) measures how much income the consumer would need at prices q to be as well off as he or she would be facing prices p and income m.

Production of processed products in the diary and oilseed industry is evaluated with the derivative of the normalised quadratic profit function. As an exception, production of milled rice is calculated through fixed processing factors.

$$procM\arg_{seed,r} = -ppri_{seed,r}$$
$$+ ppri_{seed,r\to cak,r} \frac{sup\,ply^{bas}_{seed\to cak,r}}{sup\,ply^{bas}_{seed,r}}$$
$$+ ppri_{seed,r\to oil,r} \frac{sup\,ply^{bas}_{seed\to oil,r}}{sup\,ply^{bas}_{seed,r}}$$

Defined from the producer prices ppri and crushing coefficients derived from observed supply quantities (Britz, 2005).

Threshold/target at different scales

Scale	Threshold	Target	Remark
Country	Positive	Stakeholder defined	
EU	Positive	Stakeholder defined	
World	Positive	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value) :

Euros

Type of visualisation (number, graphical visualisation) :

Number
Graphical

Additional data/indicators needed to interpret the results :

Agricultural income, money metric, profits of the processing industries, tariff revenues, budgetary expenditure.

Relation with other indicator(s)

The components of this indicator – agricultural income, money metric, profits by processing activities, tariff revenues and budgetary expenditure – are defined as separate operational indicators in CAPRI.

Aggregation possibilities with other indicator(s)

This indicator is already an aggregation of smaller utility indicators.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Advantages of this indicator include the fact that total welfare is a well-established concept in economics and it aggregates different variables into one measure.

Disadvantages include the fact that the concept may not be readily understandable to people without a background in economics who may understand welfare in terms of non-monetary well-being, social welfare (services to meet needs) or financial aid i.e. there is a semantic issue here for non-economists. Another important disadvantage with the use of total welfare as an indicator of sustainable development particularly in the context of developing countries is that it attaches equal importance to producer and consumer surpluses but "agricultural development requires producer surplus gains on a sustained basis […] it would thus seem that producer surpluses are much more valuable than consumer gains" (Poonyth and Sharma, 2003).

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Britz, W. (2005) CAPRI *Modelling System Documentation.* European Commission, J05/30/2004.

Poonyth, D and Sharma, R (2003) *The impact of the WTO negotiating modalities in the areas of domestic support, market access and export competition on developing countries: results from ATPSM* [online]. International conference - Agricultural policy reform and the WTO: Where are we heading? Capri, Italy, June 23-26, 2003. Available from: *http://www.ecostat.unical.it/2003agtradeconf/Contributed%20papers/Poonyth%20and%20Sharma.pdf*

Varian, H.R. (1992) *Microeconomic Analysis.* Norton & Company Inc, New York.

seamless

Author: Lee Stapleton   Implemented in Prototype 1? **YES/NO**
E-mail: L.M.Stapleton@ncl.ac.uk

Fact sheet: ECON 11

Name of indicator

AGRICULTURAL INCOME

General scope of indicator [1]

Agricultural income is the difference between the value of agricultural output and the value of intermediate consumption.

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euros

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➢ **on the goal-oriented frameworks (see D 2.1.1) :**

■ Effects on agricultural sector on it self   ☐ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Profitability

➢ **on the system property-oriented frameworks (see D 2.1.1) :**

■ Effects on agriculture   ☐ Effects beyond agriculture

Property to which the indicator is related

Profitability

Scales for elementary calculation and up scaling possibilities

➢ **spatial scales :**

Elementary calculation:

☐ *HSMU* [3]   ■ farm   ■ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Upscaling possible.

[3] Homogeneous soil map unit (field)
[4] if the up scaling is only based on the calculation of a weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

➢ **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ■ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. $X \, €$ income over a ten year period) or a mean (i.e. annual income was on average $X \, €$ over a ten year period).

Calculation of the indicator

■ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Model output :

CAPRI; FSSIM (Only sample regions; only crop products – 18MPROTO)

Different data needed for calculation :

Type of data	Unit	Origin	Remarks (quality of data)
Agricultural Income	Euro	CAPREG	
Agricultural Income	Euro	FADN-FSSIM_DB	

Brief description of the calculation :

Calculated according to the gross value added concept of the EAA. Costs for crop, animal, and other variable inputs, as reflected in the EAA, are deducted from the income of agricultural producers (agricultural gross value added at market prices). Income from premiums in a respective region is added to the producer' market income.

Threshold/target at different scales

Scale	Threshold	Target	Remark
Farm	Positive[a]	Stakeholder defined	
Regional	Positive[a]	Stakeholder defined	[a]See discussion under
National	Positive[a]	Stakeholder defined	'Evaluation of Indicator'
European	Positive[a]	Stakeholder defined	
World	Positive[a]	Stakeholder defined	

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value) :

Euros

Type of visualisation (number, graphical visualisation) :

Number Graphical

Additional data/indicators needed to interpret the results :

Production of agricultural products (CAPRI,CAPREG; FSSIM,FADN-FSSIM_DB (only for current activities)

Relation with other indicator(s)

Related to Gross Margin

Aggregation possibilities with other indicator(s)

Agricultural income can be summed with profits of the processing industry, money metric and tariff revenues minus budgetary expenditure to give an indicator of total welfare.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

An important indicator of agricultural economic viability given that it is a direct measure of producer income. However, the fact that it does not take into account fixed costs of production may be seen as a disadvantage. Additionally, because it is not defined on a per person basis it is difficult to assess appropriate thresholds for this indicator.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

N/A

Author: Lee Stapleton
E-mail: L.M.Stapleton@ncl.ac.uk

Implemented in Prototype 1? **YES/NO**

Fact sheet: ECON 12

Name of indicator

MONEY METRIC (CONSUMER SURPLUS)

General scope of indicator [1]

Consumer surplus is the difference between what a person would be willing to pay and what he/she actually has to pay to buy a certain amount of a good. Technically it is the area below the demand curve and above the price level. In CAPRI, the money metric measure is the minimal expenditure needed for consumers to reach the utility level of the simulation scenario at prices of the reference scenario. Therefore, it appears that the threshold for consumer surplus is determined endogenously; it does not require setting exogenously

[1] Brief description of the impact, process, scales treated by the indicator

Unit of indicator

Euro

Type of indicator

☐ Environmental   ■ Economic   ☐ Social   ☐ Institutional

Position of the indicator on framework

➤ **on the goal-oriented frameworks (see D 2.1.1) :**

☐ Effects on agricultural sector on it self   ■ Effects of agriculture on the rest of the world

Theme and sub-theme to which the indicator is related

Theme: Performance
Sub-theme: Profitability; Efficiency

➤ **on the system property-oriented frameworks (see D 2.1.1) :**

☐ Effects on agriculture   ■ Effects beyond agriculture

Property to which the indicator is related

Effectiveness

Scales for elementary calculation and up scaling possibilities

➤ **spatial scales :**

Elementary calculation:

☐ *HSMU* [3]   ☐ farm   ☐ regional   ■ national   ■ European   ■ world

Up scaling possibilities [4]:

Upscaling not appropriate.

[3] Homogeneous soil map unit (field)

[4] if the up scaling is only based on the calculation of an weighted mean, it can be written in this box. If not (up scaling needs the addition of new processes or component, e.g. NH3 from field to farm), a new fact sheet should be made.

> **time scales :**

Elementary calculation:

☐ event ☐ day ☐ week ☐ month ☑ year ☐ multi-annual ☐ long-term

Up scaling possibilities:

If described in real instead of nominal terms then this indicator can be expressed over longer timescales either as a summation (i.e. X € money metric over a ten year period) or a mean (i.e. annual gross money metric was on average X € over a ten year period).

Calculation of the indicator

☑ Simple   ☐ Aggregated   ☐ Composite   ☐ Indicators of multifunctionality

Model output:

CAPRI

Different data needed for calculation:

Type of data	Unit	Origin	Remarks (quality of data)
Money metric	Euro	CAPREG	

Brief description of the calculation:

Money metric is an indirect utility function after Varian (1992):
ì $(q;p.m) = e (p, v(q,m))$
ì $(q;p.m)$ measures how much income the consumer would need at prices q to be as well off as he or she would be facing prices p and income m.

Threshold/target at different scales

Scale	Threshold	Target	Remark
National	Set endogenously[a]	Stakeholder defined	See comment above
European	Set endogenously[a]	Stakeholder defined	under 'General Scope
World	Set endogenously[a]	Stakeholder defined	of Indicator'

Presentation of the results

Expression of the results (per crop/ per farm/ par region; mean/ max or min value):

Euro

Type of visualisation (number, graphical visualisation):

Number
Graphical

Additional data/indicators needed to interpret the results:

Consumer prices of main agricultural products (CAPRI, CAPREG)

Relation with other indicator(s)

Analogous to measures of producer surplus: Agricultural income; Profits of the processing industry.

Aggregation possibilities with other indicator(s)

Consumer surplus can be summed with profits of the processing industry, agricultural income and tariff revenues minus budgetary expenditure to give an indicator of total welfare.

Evaluation of the indicator [5]

Advantages - Disadvantages / Opinions from the users

Consumer surplus is a well-established concept in economics although may not be readily understandable to the non-specialist particularly if described in terms of the functional form used for its measurement.

[5] Based on specific validation work (on the design, on the output, on its usage) regarding the scientific soundness (reliability, robustness, transposability), the feasibility and usefulness

References

Varian, H.R. (1992) *Microeconomic Analysis*. Norton & Company Inc, New York.

Appendix 3: Multifunctionality main concepts for SEAMLESS-IF

The multifunctionality concept carries different meanings for various actors at several scales. Depending upon its different definitions, this concept can be associated with a long variety of policies and associated monitoring tools. The country reviews performed during the Multagri project show that evaluation perspectives and experiences are very diverse: they reflect different perceptions and cultures, institutional arrangements as well as differences in the relationship between scientific communities and policy (www.multiagri.net).

Although the multifunctionality concept is used in many different ways, we chose to restrain our analysis to the most relevant ones for modelling approaches. It refers to two different concept oriented research clusters (CORCs) identified in Multagri:

- CORC 1: A joint production of commodities and public goods
- CORC 2: Multiple impacts and contributions from agriculture to rural areas.

One also needs to take two viewpoints: from the producer of commodity outputs (COs) and non-commodity outputs (NCOs) or the 'supply side' view; or from the consumers' position whose needs and preferences count (and are considered), i.e. the 'demand side'.

On the *supply side*, the main issue concerns the nature and degree of jointness in the production of commodity and non commodity outputs, not the amount of non-commodity outputs supplied (which is analysed in section). First, any change in commodity production (market-led or policy driven) is liable to lead to a change in the levels of the non commodity outputs that are jointly produced. Early literature reviews suggest that for externalities the degree of jointness may be strong and the consequences of changes in the supply of commodity outputs may have important consequences on the externality levels (Abler, 2001). But the degree of jointness for the amenities supplied seemed to be weak in this study. Second, the OECD stresses that jointness can create the possibility of cost savings through the joint provision of several outputs compared to their separate provision.

The *demand side* considers the evolution of needs and demand of consumers and society. Considering that this demand may have a multidimensional nature, it could be of interest to consider the potential demand from future generations. However, this analysis is beyond the aims of this report.

Appendix 4: An example of jointness indicator for SEAMLESS

Bontems *et al.* (2004) observe first a large heterogeneity of the ratio of non-commodity and commodity outputs supplied by dairy farms in the western part of France. This ratio can be captured by a one-dimensional parameter: the type of the farm. They consider farmers who produce milk (*y*) from a quantity *s* of land devoted to feed crops and a polluting input such as fertilizers with a unit cost $c(y,\theta)$ per unit of land. The parameter θ belongs to the set $\Theta=[\theta_1,\theta_2]$ and represents the farmer's ability to transform feed crops into the production of milk. Parameter θ can be understood as a function of several on-farm characteristics (management skills, soil quality, genetic value of the herd...). This parameter reduces the heterogeneity of the farms. The authors also assume that the pollution can be represented by a pollution production function per hectare, denoted $g(y,\theta)$, that estimates well emissions using simulation models. Adequate statistical analysis of data collected on the studied watershed leads to the estimation of the profit and emissions functions: the ratio profit/emissions is not monotonous in θ for the *status quo* situation (see Figure 1), but the use of the θ parameter is sufficient enough to reduce the overall heterogeneity of this ratio profit/emissions for the surveyed farms (see Figure 2).

A similar analysis can be performed for SEAMLESS but requests considerable attention on the assumptions for the design of commodity and non commodity outputs supply functions.
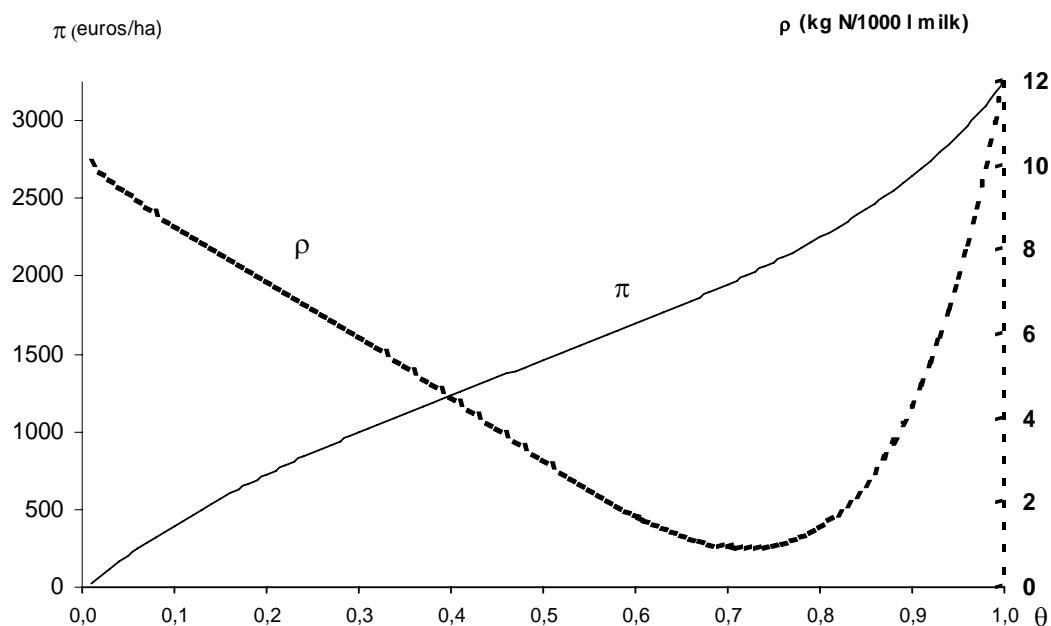

Figure 1: profit per amount of nitrogen emitted and ρ (ratio between the supply of non-commodity and commodity outputs) depending on the θ-type of the farm in the *laissez-faire* situation for the Don watershed (adapted from Bontems, *et al.*, 2004)
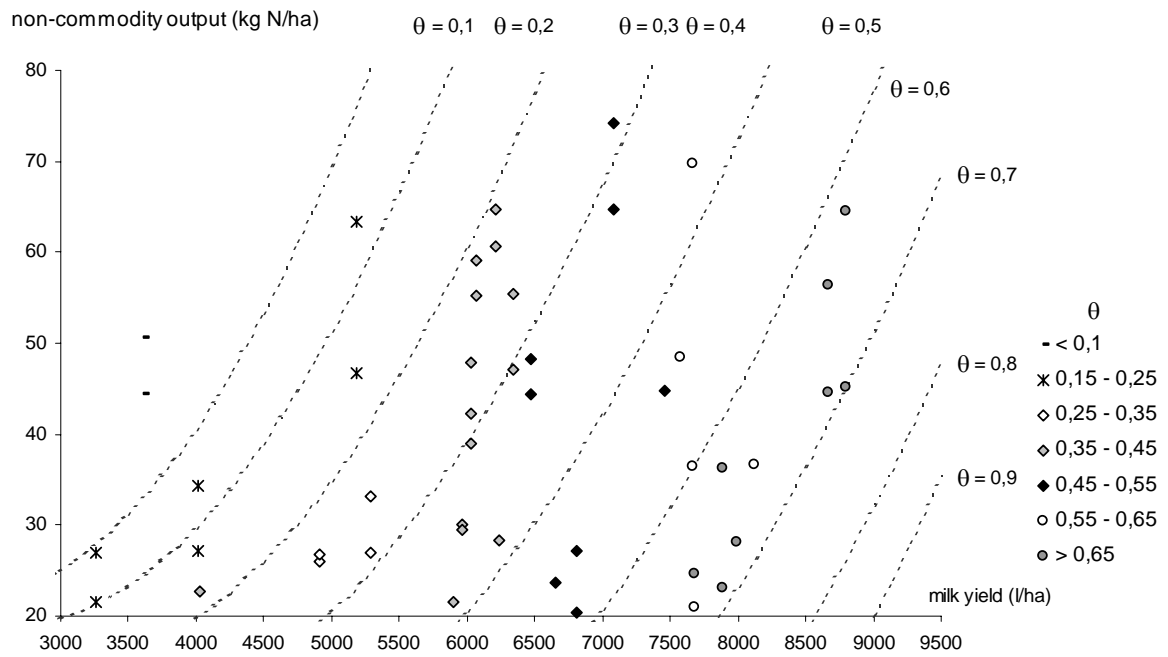
Figure 2: observed milk yield and non-commodity output (N leached/ha) for surveyed farms on the Don watershed, adapted from Bontems, *et al.* (2005)