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Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy

{COM(2006) 508 final}

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1. INTRODUCTION

This document accompanies the Commission's Communication "Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy" [COM(2006) 508 final]. It reviews the progress achieved to date in the development of agri-environmental indicators on the basis of the IRENA operation[1] and presents the main findings of the IRENA reports in relation to indicator development. It also identifies key challenges and future actions.

2. PROGRESS WITH THE DEVELOPMENT OF AGRI-ENVIRONMENTAL INDICATORS

2.1. Scope and outputs of the IRENA operation

In January 2000, the Commission adopted the Communication "Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy"[2], which identified a set of 35 agri-environmental indicators and presented an analytical framework for their development (see Figure 1). The Communication mentions the following reasons for developing agri-environmental indicators:

– to understand the linkages between agricultural practices and the environment;

– to identify environmental issues related to agriculture;

– to help target measures that address agri-environmental issues;

– to help monitor and assess agri-environmental policies; and

– to provide contextual information for rural development.

In March 2001, the Commission published a second Communication entitled "Statistical Information Needed for Indicators to Monitor the Integration of Environmental Concerns into the CAP"[3], which proposed definitions for each of the 35 indicators, and identified potential data sources and information needed to make the indicators operational.

These two Commission Communications provided the conceptual input for the launch of the IRENA operation in September 2002.

The IRENA operation was based on a grant agreement between the European Commission and the European Environment Agency (EEA)[4]. The operation was closely guided by a steering group involving representatives of DG Agriculture and Rural Development, DG Environment, Eurostat, the Joint Research Centre, and the EEA. While the indicator work was developed in partnership, the EEA co-ordinated and managed the project and was responsible for providing the deliverables set out in the agreement.

The purpose of the IRENA operation was to develop and compile, for the EU-15, the set of 35 agri-environmental indicators identified in the Commission Communications COM(2000) 20 and COM(2001) 144, at the appropriate geographical levels and, as far as possible, on the basis of existing data sources. The objectives also included regional analyses and an indicator-based

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1 **I**ndicator **R**eporting on the Integration of **EN**vironmental Concerns into **A**griculture Policy.

2 COM(2000) 20.

3 COM(2001) 144 final.

4 The amount of the grant – EUR 675 000 – was equally shared between DG AGRI and DG ENV.

assessment of the integration of environmental concerns into EU agricultural policy, as shaped by Agenda 2000.

The IRENA operation was finalised in December 2005. Its outputs are the following[5]

1. 40 ***indicator fact sheets*** and their corresponding data sets (in the form of Excel files), accompanied by an information manual for the indicator data sets,

2. an ***Indicator Report,*** which reviews the interactions between farming and the environment on the basis of the indicator results, and provides an assessment of the progress made in developing and compiling the set of agri-environmental indicators,

3. an ***Indicator-based Assessment Report*** on the integration of environmental concerns into the CAP, based on the indicators and the agri-environmental analysis developed in the context of the Indicator Report, and

4. an ***Evaluation Report***, which reports on the working procedures and resources of the IRENA operation, assesses the suitability of the data sources used, and makes proposals for future indicator work and development.

2.2. The analytical framework for agri-environmental indicators

The agricultural DPSIR framework (Driving force – Pressure – State – Impact – Response; see Figure 1) is meant to capture the key 'factors' involved in the relationships between agriculture and the environment and to reflect the complex chain of causes and effects linking these factors. However, as with other models, the DPSIR model is a simplification of reality. Many of the interactions between agriculture and the environment are not (yet) sufficiently understood or are difficult to capture in a single framework. In addition, there are other, socio-economic, factors independent of the policy framework which can determine changes in farming systems and rural areas and can also significantly affect the environment.

Table 1 provides an explanation of the concepts behind the different domains/sub-domains of the DPSIR model and lists the indicators developed through the IRENA operation.

Figure 1: DPSIR framework for agriculture (from the IRENA Indicator Report)

[5] All the IRENA outputs (with the exception of the Evaluation Report) can be found on the IRENA website: http://webpubs.eea.europa.eu/content/irena/index.htm.

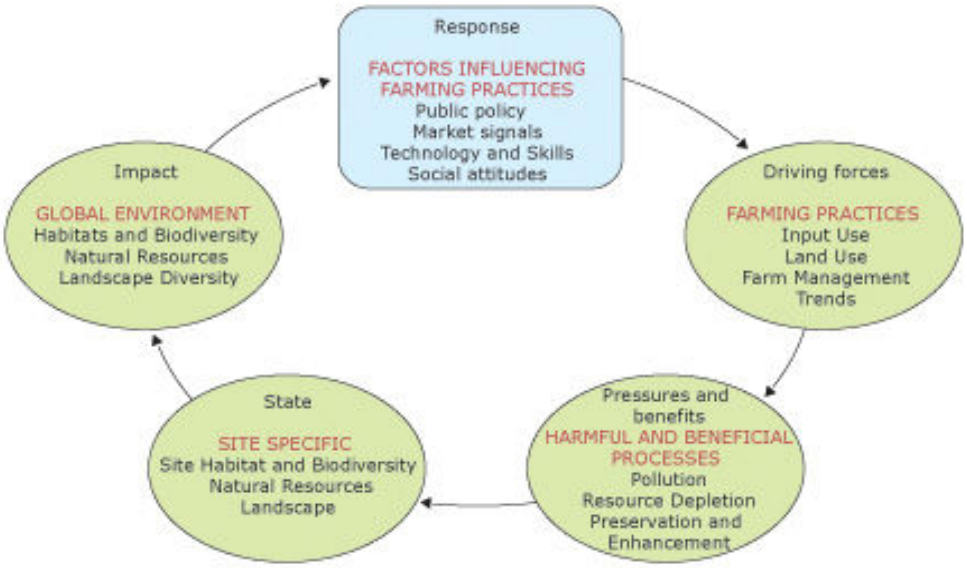

Table 1: The DPSIR framework and the IRENA indicators

Domain	Sub-domain	Explanation	N°	Indicator
Responses	*Public policy*	Farming activities are strongly influenced by agricultural and environmental policies and sensitive to input and product price signals. Moreover, changes in technology, farmers' skills, and consumers' and producers' attitudes affect production methods and agricultural practices.	1	Area under agri-environment support
			2	Regional levels of good farming practice
			3	Regional levels of environmental targets
			4	Area under nature protection
	Market signals		5.1	Organic producer prices and market share
			5.2	Organic farm incomes
	Technology and skills		6	Farmers' training levels
	Attitudes		7	Area under organic farming
Driving forces	*Input use*	A key characteristic of different farming systems and determinant of farming intensity is the use of inputs (fertilisers, pesticides, energy and water).	8	Mineral fertiliser consumption
			9	Consumption of pesticides
			10	Water use (intensity)
			11	Energy use
	Land use	Land use changes as well as cropping and livestock patterns indicate land use intensity and trends in the agricultural sector.	12	Land use change
			13	Cropping/livestock patterns
		Farm management practices include, inter alia, rotation patterns, soil cover, tillage methods and the handling of farm manure.	14	Farm management practices
	Trends	Key trends in farming activities at an aggregate (e.g. regional, national) level can be expressed in terms of intensification/extensification, specialisation/diversification, and marginalisation.	15	Intensification/extensification
			16	Specialisation/diversification
			17	Marginalisation
	Pollution	Agriculture can lead to nutrient and pesticide residues in soil and water as well as to ammonia and methane emissions. The use of sewage sludge can improve soil fertility, but needs to be carefully monitored from a pollution perspective.	18	Gross nitrogen balance
			18sub	Atmospheric emissions of ammonia
			19	Emissions of methane and nitrous oxide
			20	Pesticide soil contamination
			21	Use of sewage sludge
	Resource depletion	Inappropriate use of water and soil leads to environmental pressures. Changes in land cover and genetic diversity can have similar consequences.	22	Water abstraction
			23	Soil erosion
			24	Land cover change
			25	Genetic diversity

	Preservation and enhancement of the environment	Agriculture provides environmental benefits via the management of high nature value farmland and the production of renewable energy sources.	26	High nature value (farmland) areas
			27	Production of renewable energy (by source)
State	*Biodiversity*	The state of farmland birds provides a measure of the state of the overall species diversity in farmed areas.	28	Population trends of farmland birds
	Natural resources	The state of key natural resources (soil quality, water quantity and quality) needs to be monitored.	29	Soil quality
			30	Nitrates/pesticides in water
			31	Ground water levels
	Landscape	Agriculture has a strong influence on the state of Europe's landscapes through cropping patterns, grazing of upland areas, landscape elements such as hedgerows, etc.	32	Landscape state
Impact	*Habitats and biodiversity*	The share of agriculture in wider environmental issues can be significant. Here the focus is on the global impact of agriculture at a national or EU level. Its impact on natural and landscape diversity is also important, but often spatially concentrated and scale-dependent.	33	Impact on habitats and biodiversity
	Natural resources		34.1	Agricultural share of GHG emissions
			34.2	Agricultural share of nitrate contamination
			34.3	Agricultural share of water use
	Landscape diversity		35	Impact on landscape diversity

2.3. Main IRENA results regarding indicator development

The IRENA operation has largely achieved its objectives in terms of indicator development, collection of data, and production of reports. A valuable effort has been made regarding the conceptual development[6] of the indicators, the identification of appropriate data sources, and the compilation of relevant data.

The indicators are based on data from a wide range of sources (e.g. agricultural and environmental databases, models, and administrative data) and collected at different geographical and time scales.

The table in Annex 1 provides the list of indicators and sub-indicators, their definition, the data sources used, the geographical reporting level, and the time series provided.

2.3.1. Geographical level

A key requirement for IRENA was the development of indicators at the appropriate geographical level, so as to reflect the regional diversity of environmental conditions (e.g. soils, climate) and types of agricultural production systems and structures (e.g. specialisations, production patterns, farming methods). The targeted geographical scale for reporting across the EU-15 was the administrative regions NUTS[7] 2 or 3. In order to achieve similarly sized regional units, the NUTS levels used for the different Member States were:

– NUTS 2: Austria, Belgium, Germany, Greece, Luxembourg, Netherlands, Italy, Portugal and United Kingdom,

– NUTS 3: Denmark, Finland, France, Ireland, Spain and Sweden.

About **one third of the indicators are based on data at the targeted regional level (NUTS 2 or 3).** Nearly two-thirds of the indicators use national or sub-national level data (i.e. NUTS 0 and

[6] To support this task, and in particular to improve the policy relevance and analytical soundness of certain indicators, several IRENA expert meetings (with participation of researchers, Member State representatives, etc.) were organised.

[7] Nomenclature of Territorial Units for Statistics.

1), although data at a lower geographical level are provided for three of these indicators for some Member States. Several indicators of the state/impact domains were developed on the basis of modelled data or case studies.

Table 2: Spatial scale of IRENA indicators

NUTS level	IRENA N°	Number of indicators
NUTS 0	1, 2, 3, 5.1, 5.2, 8, 9, 11, 14.2, 18, 18sub, 19, 21, 25, 26, 27, 28, 30.1, 30.2, 33, 34.1, 34.2, 34.3	23
NUTS 0/1	15, 16, 17 (except for ES, FR and IT for which the reporting level is NUTS 2)	3
NUTS 2/3	4, 6, 7, 10, 12, 13, 14.1, 14.3, 22, 24, 32, 35 (32 and 35 on a case study basis only)	12
NUTS 2/3 based on modelling	20, 23, 29	3
Case study	31, 32, 35	3

2.3.2. Time series

With regard to the temporal scale, the target of the IRENA operation was to cover the years between 1990 and 2000. This time period includes the MacSharry reform of the CAP in 1992 and precedes the implementation of the Agenda 2000 CAP reform.

Time series are provided for about half of the (sub-)indicators. Eighteen indicators cover the period between 1990 and 2000. The indicators with trends between 1990 and 2000 are often based on data from the 12 Member States that made up the EU in 1990 (EU-12). The indicators for which trends are not provided are those for which only single-year data are available (e.g. indicators No 25, *genetic diversity*, and 34.2, *agricultural share of nitrate contamination*), those based on case studies (e.g. No 31, *ground water levels*, No 33, *impact on habitats and biodiversity*) and indicators for which time series data are particularly difficult to obtain due to their complexity (e.g. No 23, *soil erosion* and No 29, *soil quality*).

Table 3: Temporal scale of IRENA indicators

Temporal scale	IRENA N°	Number of indicators
1990–2002	18sub, 19, 22, 28, 34.1	7
1990–2000	8, 10, 11, 12, 13, 15, 16, 17, 18, 24, 35 (also 1990–98, and 1996–2001)	11
Shorter time series	1, 7, 9, 20, 21, 34.3, 30.1, 30.2, (the two last cover 1992–2002)	6
No time series	2, 3, 4, 5.1, 5.2, 6, 14.1, 14.2, 14.3, 23, 25, 26, 27, 29, 31, 32, 33, 34.2	18

3. IRENA INDICATOR REPORT

3.1. Outline of the report

The Indicator Report (*"Agriculture and environment in EU-15 – the IRENA indicator report"*)[8] reviews **agri-environmental interactions** on the basis of the indicator results and provides an

[8] The report was jointly published by the Commission and the EEA in December 2005. It is available on the web site http://reports.eea.europa.eu/eea_report_2005_6/en.

assessment of the **progress made** in the development and compilation of agri-environmental indicators during the IRENA operation.

Agri-environmental ***storylines***, based on the DPSIR framework, are used to present the indicator results and the conclusions that can be drawn as regards the effect of farming on specific environmental areas: (a) agricultural water use and water resources; (b) input use and the state of water quality; (c) land use, farm management and soils; (d) climate change and air quality; and (e) biodiversity and landscape.

The storylines are developed in thematic chapters. They are introduced by a presentation of the general trends in EU-15 agriculture, which describes the main trends in farming and land use based on the indicators from the "driving force" and "response" domains.

Alongside the agri-environmental analysis, the Indicator Report carries out an **evaluation** of all IRENA indicators on the basis of the following criteria: policy-relevance, responsiveness, analytical soundness, data availability and measurability, ease of interpretation and cost effectiveness[9]. The final chapter assesses the suitability of all data sources used and proposes ways for improving the data sets. Additional recommendations for future agri-environmental indicator development are provided in the *Evaluation Report*.

The report builds on the 40 Indicator Fact Sheets (IFS). For each (sub-)indicator, the IFS presents the data and the assessment of the indicator (summarised at the beginning of the fact sheet in the form of key messages), the agri-environmental context and policy relevance, and a metadata section.

3.2. Evaluation of the indicators

Based on the pre-defined criteria, an **evaluation framework** was built to classify the indicators into three categories: 'useful', 'potentially useful' and 'low potential'.

Out of the 42 (sub-)indicators, **11 were evaluated as being useful**, **30 as being potentially useful,** and only one was considered as having low potential. Data-related criteria (geographical coverage, availability of time series) and conceptual criteria (analytical soundness, data quality) had a significant influence on the evaluation results, which are summarised in the table in Annex 2.

The following main conclusions emerge from the evaluation of the indicators related to the different agri-environmental *storylines*.

3.2.1. General trends in agriculture

Five out of 13 of the indicators that show agricultural trends are in the 'useful' category, while the rest are classified as 'potentially useful'. In general, the indicators based on FSS[10], FADN[11] and CORINE land cover[12] have a higher score, because these data sources provide harmonised regional information. However, an outstanding issue is the difficulty of linking indicators that are reported at different scales. This concerns, for example, national data on mineral fertiliser consumption (No 8), which are difficult to link with regional data on cropping and livestock patterns (No 13) and regional data on yields (No 15).

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9 Criteria identified in COM(2001) 144.

10 Farm Structure Survey.

11 Farm Accountancy Data Network.

12 **CO**oRdinate **IN**formation on the **E**nvironment. It provides spatially referenced information on land cover and land cover changes across Europe.

3.2.2. Agricultural water use

Six indicators are regarded as 'potentially useful' and one indicator has 'low potential' (No 31, *groundwater levels*). Data on trends in groundwater levels would be very useful, but EU-level data are not available and national level data sets are very expensive to acquire. Pressure, state/impact and response indicators are underpinned by low or medium quality data, and the links between the indicators are rather weak. Greater efforts are required to improve the indicators for monitoring the impact of agriculture on water resources. Modelling may have a role to play, whereby climatic information is combined with crop and land use data to determine water requirements from agriculture.

3.2.3. Agricultural input use and state of water quality

The three indicators classified as 'useful' are: *mineral fertiliser consumption* (No 8), *cropping/livestock patterns* (No 13) and *area under organic farming* (No 7). The other eight indicators are classified as 'potentially useful', including *gross nitrogen balance* (No 18) which is not available at regional level. In most cases, these indicators have not reached a level of development to be considered as 'useful', because of inadequate data availability, data measurability and analytical soundness. Information on the use and impact of pesticides is particularly difficult to obtain.

3.2.4. Agricultural land use, farm management practices and soils

Four indicators are classified as 'useful': the driving force indicators *land use change* (No 12), and *cropping/livestock patterns* (No 13), the pressure indicators *land cover change* (No 24) and the response indicator *area under organic farming* (No 7). The remaining indicators are evaluated as being 'potentially useful'. These indicators have weaknesses regarding data availability, measurability and analytical soundness. Several indicators are based on modelling, and further efforts are needed to improve these models in order to achieve a greater degree of robustness and acceptability (e.g. No 23, *soil erosion* and No 29, *soil quality*). The indicators related to 'farm management practices' have the lowest score. Information about farm practices is highly relevant for several important indicators (e.g. *gross nutrient balance*, *GHG emissions*, *soil erosion*), but there is little harmonised information available at European level.

3.2.5. Climate change and air quality

Most of the indicators (six of the nine) used in this storyline fall into the 'useful' category. The indicators with the highest score are those related to emissions, such as *atmospheric emissions of ammonia* (No 18sub), *emissions of methane and nitrous oxide* (No 19), as well as the *share of agriculture in GHG emissions* (No 34.1). The response indicators (*regional levels of environmental targets* (No 3) and *production of renewable energy* (No 27)) are considered as 'potentially useful'. To become useful, their measurability would need to be improved. The generally high evaluation of the indicators in this storyline is due to the fact that the pressure and state indicators are reported at national rather than regional level. Moreover, these indicators are developed on the basis of internationally harmonised procedures.

3.2.6. Biodiversity and landscape

Half of the indicators (eight out of 16) are classified as 'useful'. These are the driving force indicators: *land use* (No 12), *intensification/extensification* (No 15), *specialisation* (No 16), *cropping/livestock patterns* (No 13) and *land cover change* (No 24), the state indicator on *populations of farmland birds* (No 28), and the response indicators *area under nature protection* (No 4), and *area under organic farming* (No 7).

The indicators that are considered as 'potentially useful' are marginalisation (No 17), genetic diversity (No 25), high nature value farmland areas (No 26), landscape state (No 32), impact on landscape diversity (No 35), area under agri-environment support and regional levels of good farming practice (No 2). These indicators, from the state, impact and response domains, suffer from a lack of regional data and inadequate time series. Some would also need further methodological development (e.g. No 26, No 32).

3.3. Conclusions and challenges for improving the indicators

A substantial amount of **expertise** concerning the technical feasibility of the indicators and their interpretation has been gained through the IRENA operation. A significant amount of information has been gathered on the state of and trends in the environmental conditions relating to agriculture and on the agricultural measures available to deliver environmental integration.

However, several **limitations** have become apparent during the agri-environmental analysis based on indicators, and through the evaluation of the usefulness of the indicators for assessing environmental integration. These are:

- limits of the **indicator-based approach** itself for environmental reporting. The indicators give an insight into 'real-life' processes and their causal relationships, but they cannot fully represent them. More comprehensive information based on research and knowledge about the interactions between agriculture and the environment is required to interpret the indicator results;
- the **DPSIR** framework has revealed certain limits due to the insufficient development of key indicators in several domains (e.g. water resources) and the difficulty in reflecting the complex chain of causes and effects between the factors intervening at the interface of agriculture and the environment;
- deficiencies in the **data sets** in terms of harmonisation, data quality and/or geographical coverage have been identified as the most critical constraints. These deficiencies concern certain indicators related to agricultural driving forces and, even more so, the indicators in the water, soil and biodiversity domains, which are the most limited in terms of coverage, time series and reliability;
- the differences between indicators in terms of data reliability and **spatial resolution** limit the scope for performing the cross-referencing that is needed for a regional analysis. For instance, it is difficult to link the indicator on mineral fertiliser use, which is reported at national level, with the regional data on cropping and livestock patterns and yields;
- however, the regional breakdown of information for many IRENA indicators does allow some differentiation of environmental pressures/state across the EU-15. Thus, "association analysis" of the indicators can be carried out to assess aspects of integration (e.g. targeting of agri-environmental measures at agricultural areas under Natura 2000 as a proxy for integration);
- a number of the current indicators still require further **methodological** (conceptual and technical) development and/or more appropriate data (in terms of quality and/or geographical scale).

Following an in-depth analysis of the strengths and weaknesses of all the data sources used for producing the 42 (sub)-indicators, some of the **challenges** ahead for improving these indicators are:

- **Availability of the relevant information at the required geographical level**. The reporting scale is a critical issue for indicator development. The data sets for reporting at EU-level can be coarser than those for national or regional analysis. They make it possible to perform comparisons at EU level, because of the greater degree of harmonisation of data collection. However, the EU indicator data sets are, in the ideal case, aggregated from more local, spatial information. This allows a detailed analysis of agri-environmental issues which is not possible using EU-level data. The appropriate level of reporting will ultimately depend on the type of indicator.
- **Precise spatial referencing** of relevant data sets in a geographical information system (GIS) is a key element for improving regional environmental analysis. It also enables integration with other data sets.
- **Further development and validation of models**. Several IRENA indicators are underpinned by models (e.g. *soil erosion risk*). Modelling is an important approach for overcoming the lack of direct measurements, although it requires good input data. It also requires the gathering of field data to calibrate and validate the estimates. In addition, spatialisation methods (e.g. redistribution of agricultural data, reported at administrative level, to different geographical units) offer further opportunities to obtain the relevant information, although these techniques need further development and validation.
- **Better use of administrative data.** Administrative data can fill important gaps, but efforts should continue to improve such data sets so as to obtain greater added value, for example by adding geo-referencing information. The agri-environmental indicators may also benefit from the existing (e.g. Nitrates Directive) or future (e.g. Water Framework Directive) monitoring systems in the context of environmental policy.
- **Integration of databases.** There is a need to integrate the data sets used to develop indicators in order to achieve synergies, thus enabling common analytical objectives to be achieved more effectively. For example, the integration of LUCAS (ground observations) and CORINE Land Cover (satellite image interpretation) may lead to improvements in the validation of land cover information.
- **Typology approach.** The farm typology approach used for some driving force indicators (e.g. *cropping/livestock patterns*) could be further explored as a means of relating indicators to different types of farms, and to facilitate the interpretation of the indicator results.

4. IRENA INDICATOR-BASED ASSESSMENT REPORT

4.1. Outline of the report

The Indicator-based Assessment Report *("Integration of environment into EU agriculture policy – the IRENA indicator-based assessment report")*[13] builds on the indicator-based agri-environmental analysis developed in the Indicator Report.

The report provides an overview of the main **agri-environmental policy issues** in the EU, and of the national/regional implementation of the CAP measures that have the potential to meet the environmental integration objectives. It analyses the spatial (regional) targeting of several CAP measures (on the basis of "policy response" indicators) at two key environmental issues: the conservation of biodiversity, and nutrient management. The **degree of targeting** is used as a proxy measure for environmental integration. The analysis is complemented by policy examples

[13] Available at: http://reports.eea.europa.eu/eea_report_2006_2/en.

from Member States to show positive experiences with the implementation of agri-environmental instruments.

4.2. Main findings on the usefulness of the indicators for assessing environmental integration

– The IRENA indicators provide **a useful basis of information** for environmental analysis. The regional breakdown of information for many indicators allows some differentiation of relevant environmental driving forces/pressures/state across the EU-15. Thus, association analysis can be carried out between indicators for the purpose of assessing policy targeting. This produces some interesting results, for instance, in the area of biodiversity.

– However, indicators of pressure, state and policy response are not sufficiently underpinned by regional data to carry out a **spatial targeting analysis**. Moreover, the complexity of agri-environmental processes and the lack of data or knowledge to substantiate (hypothetical) causal links limit the possibilities of drawing firm conclusions on environmental integration.

– The current set of indicators does not cover all **relevant CAP policy instruments**. The progress that has been made in integration would need to be reflected in the composition of any future indicator list.

4.3. Conclusions and recommendations

– The agri-environmental indicators appear to be more useful for agri-environmental analysis than for integration assessment.

– Some key state/pressure/policy response indicators would need to be developed at regional level to allow an assessment of the extent to which key CAP instruments are targeted at environmental problems.

– An **indicator-based analysis alone is not sufficient** to assess the environmental effect of policy integration efforts. The indicators allow an overview of agri-environmental issues at EU-15 level and of the extent to which these have been addressed by the available CAP measures. They also provide national/regional **environmental contextual information**, against which the specific local trends can be evaluated, which is the level at which the measures are implemented.

– The use of indicators has to be complemented by targeted monitoring and evaluations of the effectiveness of different agri-environmental policy measures at local and regional level (e.g. agri-environment schemes).

5. IRENA EVALUATION REPORT

5.1. Outline of the report

This report **reviews the progress made in developing indicators** and analyses the **resources** employed for this task, as well as the adequacy of resources employed in relation to the objectives. Some findings are drawn from structured interviews carried out with members of the IRENA steering group and representatives of Member States that have closely followed the operation. The report also includes a comparison of the IRENA indicator results with other indicator-reporting exercises at EU level (e.g. sustainable development) and at international level (OECD). An evaluation is conducted of the current weaknesses of the indicators and databases that would need to be addressed in the future, including a brief analysis of the main steps

required for the different indicators to become operational. This builds on the individual evaluation sheets prepared for each indicator.

5.2. Practical recommendations

- **Limited resources** for data collection and analysis, both at national level and at EU level, as well as the need to extend the indicator-based reporting to the new and future Member States, make it necessary to select very carefully the **set of indicators that can be maintained over the longer term**. The experience gained under the IRENA operation as regards what is **technically possible**, and a careful evaluation of the **policy relevance** of the indicators, should be the guiding criteria in this regard.
- On the basis of the preparation of the Indicator Report and the Assessment Report, the EEA considers that some of the indicators developed are not absolutely necessary for environmental reporting, whereas other indicators could be added to respond to new policy information needs.
- The establishment of procedures that would allow the **collection** of the necessary data and the development of supporting methodological tools should be a priority task for future agri-environmental indicator development at EU level. However, this will require a strong commitment by the Member States.

6. ACTIONS FOR FUTURE WORK ON AGRI-ENVIRONMENTAL INDICATORS

Three major challenges can be identified for future agri-environmental indicator work:

1. Streamlining the IRENA indicator set and strengthening its policy relevance.
2. Consolidating the selected indicators, extending the coverage to the new Member States and correcting existing weaknesses.
3. Setting up a permanent and stable arrangement needed for the long-term functioning of the indicator system.

This chapter elaborates on the actions needed in response to each challenge.

6.1. Streamlining the IRENA indicator set and strengthening its policy relevance

The technical experience gained under the IRENA operation (e.g. methodological issues, relevant trends), and the evaluation of the policy relevance and feasibility of the indicators are used as guiding criteria for the **setting of priorities for future work on agri-environmental indicator development**. In the light of the conceptual and technical limitations of certain indicators, a critical choice needs to be made regarding the list of indicators to be maintained and further developed.

The IRENA indicators can be grouped in three categories according to their level of development (see table in Annex 2):

A. **Operational indicators**, for which the concept and measurement are well-defined and for which data are available at national and, where appropriate, at regional level (e.g. *area under organic farming*).

B. **Indicators that are well defined**, but cannot realise their full information potential due to a lack of regional data (e.g. *area under agri-environment support*) or weaknesses in the modelling approaches on which they are based (e.g. *soil erosion*).

C. **Indicators that need substantial improvements in order to become fully operational**. These include indicators that have conceptual limitations or are not well defined (e.g. *high nature value farmland area*) and indicators where the quality of existing data needs to be improved, new data collection systems need to be set up (e.g. consumption of pesticides), or where modelling tools need to be further developed (e.g., soil quality).

Of the current 42 IRENA indicators and sub-indicators, 26 are proposed to be maintained, further developed and extended to the EU-25 (EU-27).

Some of these indicators are included in the C category and will need major conceptual and/or methodological development, and improved or new data collection systems or modelling tools. In addition, as a result of the work under IRENA and new needs emerging, **it is proposed that two new indicators should be added**. Annex 2 lists the set of indicators that are proposed to be developed and maintained in the future, and highlights the main requirements for their further development and improvement.

Nine IRENA indicators are considered not to have enough potential to be among those to be further developed in the next stage of the work (see Annex 3). With one exception, they were all evaluated as 'potentially useful' or 'low potential', and classified among the less developed (C category) indicators. All these indicators are among those that would need major investment in conceptual and/or methodological development and data collection.

Moreover, Indicator No 24 (*land cover change*) was evaluated as 'useful', but it is proposed to exclude it as an individual indicator, and include it instead as a measure of landscape change under the indicator *landscape – state and diversity.* The inclusion of three sub-indicators of indicator No 34, concerning the *share of agriculture in GHG emissions, nitrate contamination, and water use,* under the respective indicators (GHG emissions, nitrate concentrations in water, and water use) is also proposed.

However, while these are the indicators to be considered for the next stage of the work, in the long run the indicator list needs to have some flexibility so that it can be adapted to the evolving environmental and agricultural policy context, and emerging environmental issues.

6.2. Consolidating the selected indicators, extending the coverage to the new Member States and correcting existing weaknesses

Although the initial objective of the IRENA operation was to maximise the use of existing data sources, it was clear from the beginning that additional information would be needed, and that this need would have to be met mainly by extending the scope of the existing statistical or administrative data sets. New data collection systems should be set up only where the requirements cannot otherwise be met.

A prerequisite for the maintenance of the selected indicators is the consolidation of the required data sources. This section looks at the main actions that the Commission, in co-operation with the Member States, needs to undertake in order to support the improvement of existing data and to start the collection of new information. These actions are presented by data source and indicator.

The work carried out during the IRENA operation should be transformed into a continuous process of updating and maintaining the indicators and, at the same time, developing them at the proper geographical level and extending them to the new Member States. The necessary data should be made available as soon as possible by the new Member States.

At the same time, the indicators that are not yet fully operational and the new indicators should be further developed in collaboration between the Commission services, the EEA and national authorities. The table in Annex 2 names the lead-service(s) for each indicator.

It is important that co-ordination with other EU and international indicator initiatives is ensured. There is scope for improving the synergies between other EU activities (e.g. sustainable development indicators, Streamlining European 2010 Biodiversity Indicators – SEBI 2010, EEA Indicators Core set) and international indicator activities (e.g. OECD agri-environmental indicators, indicators under the Convention on Biological Diversity). Stronger ties could also be developed with other initiatives on developing EU-wide data sets, such as the Global Monitoring for Environment and Security (GMES) and the Infrastructure for Spatial Information in Europe (INSPIRE), as well as with international initiatives such as the Global Earth Observation System of Systems (GEOSS).

6.2.1. Review of agricultural data sources

6.2.1.1. Agricultural statistics

The present system of agricultural statistics focuses on information to support policy making mainly in relation to economic and production issues. The IRENA operation has identified the information related to the interactions between agriculture and the environment, and how the statistical system needs to be adapted to produce these data. This can partly be done by adapting the present statistical tools. However, in some cases the information required might be better collected by setting up new surveys. Considering that Member States have developed different data collection strategies, they should be given the choice as to how they want to set up the new statistical tools, except when there are clear constraints to this option.

When reviewing the usefulness of agricultural statistics (and other data sources) some key requirements of environmental analysis need to be taken into account. The first is the importance of linking spatially the environmental impacts from agriculture. This means that the geo-referencing of agricultural statistics is very important for their use in environmental analysis. The second principle arises from the need to be able to link different agricultural data sources with each other, e.g. farm structure surveys with farm management data and the geo-physical context of a given farm. Data on individual farms should, therefore, be collected using specific identification numbers (while adhering to data protection principles).

The Farm Structure Survey (FSS) is the backbone of European agricultural statistics. The survey is fully harmonised between the Member States and, since the individual data are sent to Eurostat for processing, it is very flexible in terms of the possibility of extracting data. The FSS is constantly being reviewed with a view to adapting the survey to new policy needs. In the context of agri-environment indicator development, this calls for an evaluation of the usefulness of individual variables from an environmental perspective.

The main purpose of FSS is to follow structural trends in agriculture and this might lead to limitations on the use of certain variables for agri-environmental analysis. An example is the Utilised Agricultural Area (UAA), as FSS censuses only include holdings above certain thresholds and do not include common grazing land that is not allotted to individual holdings. Consequently, when the aim is to compare overall crop or livestock production in the EU,

additional data sources will be useful. Moreover, even if the FSS is quite an efficient tool for collecting and analysing data on the individual farm level, it also has some limitations in terms of the type and the amount of information that can be included. In this respect, only variables that are easy to define and that the farmers can easily respond to should be included. In addition, there is also a limit to the number of variables that the survey can support without a reduction in quality.

The extent of the need for potential new surveys will depend on the new list of characteristics for the FSS from 2010 onwards, which is currently under discussion, and the development of other surveys. The Commission is suggesting setting up a separate survey on production methods that would be linked to the FSS. In the following, the indicators for which the agricultural statistics can provide data are listed.

Indicator	**Action**
Farmers' training levels and use of environmental advisory services. (IRENA 6)	The present data, showing the percentage of farmers having only practical experience, basic or full agricultural training, are not sufficiently targeted to draw conclusions regarding their environmental knowledge and attitudes. If possible, the indicator should focus on environmental training. This information could therefore be collected either through the FSS or by means of specific surveys. The indicator can also cover the use of environmental advisory services. The relevant information could be better obtained though administrative monitoring data for rural development programmes.
Area under organic farming (IRENA 7)	Regional data have been obtained from FSS. In future, it will be important for agricultural statistics and administrative data to be harmonised (see also 6.2.4).
Water use (IRENA 10)	Variables on irrigable area, irrigable crops and irrigation techniques used, are currently included in the FSS. Future FSS questionnaires or other, specific, surveys on irrigation should continue to cover these variables. It is proposed to call the indicator "Irrigation" so as to reflect its content more accurately.
Cropping/Livestock patterns (IRENA 13)	Data are available from different sources, of which the FSS seems to be the most useful. A new specific survey on production methods would be able to provide valuable data to further develop the information potential of this indicator, which consists of 2 sub-indicators.
Farm management practices (IRENA 14)	Farm practices can include several indicators that are relevant from an agri-environmental perspective. These various indicators could be covered by the FSS, but together they form a complex that is interdependent and too broad to be covered with only a few new questions. A complementary FSS survey linked to the FSS on production methods would make it possible to improve the indicator.
Farm management	Data on spring and winter cereals are collected in crop

practices: soil cover (IRENA 14.1)	production statistics, but not data on cover crops in winter. In addition, regional data/coefficients on seeding and harvesting dates, as well as information about the correlation of rainy weather conditions and plant stand, are needed.
Farm management practices: tillage practices (IRENA 14.2)	The tillage practices designed to manage the soil in a way that alters its natural composition, structure and biodiversity as little as possible, known as "conservation agriculture", include direct sowing, non-tillage or minimum tillage. The information about the use of different tillage methods should be developed to a significant extent.
Farm management practices: manure storage (IRENA 14.3)	The source of the data is the FSS. Additional information about certain topics, i.e. whether the storage containers are covered or not, would be needed and it could be gathered via a complementary survey on production methods.
Intensification (IRENA 15)	The possibility of extending animal and crop statistics to the regional level could be investigated, in order to provide improved data on yields.
Specialisation (IRENA 16)	The FSS and the Community typology of farms can be used for distinguishing between specialised and non-specialised farms. No changes or additional data are necessary.
Marginalisation (IRENA 17)	The indicator needs to be further developed. A possible solution would be to use data from the FSS to try to identify regions where there is a danger of land abandonment.
Gross nitrogen balance (IRENA 18.1)	Data on cropping area, livestock type and numbers, and nitrogen-fixing crops (legumes and pulses) are used in combination with coefficients to calculate gross nutrient balances. The FSS provides numerous parameters for the calculation of GNB, but further information is needed in the form of different coefficients and other base data. There might be a need for specific actions to create the base data. The development of the indicator needs to be continued, in order also to be able to estimate regional GNB.
Risk of pollution by phosphorus (New)	The FSS can provide several parameters for the calculation of gross phosphorus balances, but further information is needed in the form of different coefficients and other base data. There might be a need for specific actions to create the base data. Development of the indicator in collaboration with the OECD has already begun.
Production of renewable energy (IRENA 27)	The inclusion of information on areas devoted to renewable energy in either the FSS or the crop production statistics should be examined. Data on other types of renewable energy (like wind energy) will be difficult to collect in agricultural statistics. Data on supported areas for renewable energy production can be obtained from administrative data in the context of the implementation of the CAP. These data could be supplemented with information

	concerning: (a) the CO_2 benefits (b) the contribution of energy crops to improved rotation systems and to the viability of farms in high nature value areas.

6.2.1.2. Farm Accountancy Data Network

The Farm Accountancy Data Network (FADN), which is an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy, was one of the data sources used in the IRENA operation. Derived from national surveys, the FADN is a harmonised micro-economic database which combines data on farm structure, input use, and economic variables. As regards input use, it does not record the volumes of inputs used but the total value of expenditure on certain inputs (fertilisers, pesticides, feedingstuffs, energy, water, etc.) purchased by the holding (considered as a whole).

In the context of the ongoing upgrading of the FADN, it is planned to analyse the possibility of improving and extending the coverage of the FADN in order to respond to the growing demand for agri-environmental analyses. The improvements may concern the following indicators and data in particular:

Indicator	**Action**
Mineral fertiliser consumption (IRENA 8)	At present, the consumption of mineral fertilisers is mainly estimated on the basis of sales figures. The proposal for a complementary FSS survey on production methods should also cover the use of mineral fertilisers. Alternatively, the inclusion of variables on farm level fertiliser consumption (N, P) in the EU FADN farm return could be considered. Several Member States already collect this information in their national farm returns.
Gross nitrogen balance (IRENA 18.1) and risk of pollution by phosphorus (New)	Regional fertiliser application rates per crop are necessary in order to estimate regional gross nutrient and phosphorus balances.
Water abstraction (IRENA 22)	The possibility of collecting farm level data on volumes of water for irrigation is being considered. However, a survey carried out by DG AGRI on the availability of (quantitative) data on use of inputs has shown that there are currently few possibilities of collecting such data, as volumes of irrigation water are not consistently recorded at farm level.
Energy use (IRENA 11	At present, information on energy use is available on a national level only. FADN provides data on energy expenditure. Volume data should be obtained; this could be done by including the relevant variables in the FADN.

Intensification (IRENA 15)	The farm typology approach has been used to illustrate trends in the share of agricultural area managed by low-input, medium-input or high-input farm types (based on the average expenditure on inputs per hectare). A framework for enabling comparison of FADN input cost data between Member States could be developed.

6.2.1.3. Land Use/Cover Area Frame Statistical Survey (LUCAS)

The LUCAS survey has been used only in a limited way in IRENA due to its pilot character and the low sampling density. Its main contribution is information on landscape features, which is used as a parameter for the *landscape state* indicator (IRENA No 32). Farm practice data were explored for inclusion in the *farm management practices* indicator (No 14), but the data were not of sufficient quality to be included. LUCAS would be a useful complementary tool, as it provides geo-referenced land use and land cover data which can help in validating CORINE Land Cover. The usefulness of LUCAS will be further improved with the new methodology recently introduced, leading to a higher sampling density and accuracy.

The possibilities of using the LUCAS survey should be explored, in particular for the following two indicators:

Indicator	**Action**
Land use change (IRENA 12)	Validation and improvement of the existing CORINE Land Cover inventory.
Landscape change (IRENA 32)	Transect data provide the number of agriculturally-linked linear elements per square kilometre for case study areas selected to illustrate the diversity of landscapes across Europe. The possibilities for further use should be explored.

6.2.1.4. OECD/Eurostat Joint Questionnaire

Information from the OECD/Eurostat Joint Questionnaire has been used to underpin the three IRENA indicators mentioned below. Although it is an annual survey, some Member States do not provide the information.

Indicator	**Action**
Water abstraction (IRENA 22)	Continuation of co-operation with OECD on the joint ESTAT/OECD questionnaire is necessary. These data could partly be replaced if FADN gave reliable farm level data on volumes of water use for irrigation at regional level.
Share of agriculture in nitrate contamination (IRENA 34.2) and Share of agriculture in water use (IRENA 34.3).	Co-operation with OECD on the joint ESTAT/OECD questionnaire must continue.

6.2.2. Review of environmental data sources

6.2.2.1. CORINE Land Cover

The CORINE Land Cover (CLC) programme provides spatially referenced information on land cover and land cover changes across Europe during the past decade. CLC works on the principle of identifying land cover classes for polygons of a minimum size of 25 ha. This means that it cannot provide land cover information for each individual land parcel, but only information that is representative for a wider area. Due to the spatial referencing of polygons it increases the possibilities for environmental analysis, especially when combined with other data sets.

Indicator	**Action**
Land use change (IRENA 12)	Validation and improvement of the existing CLC inventory on the basis of national data and ground surveys is needed.
Landscape change (IRENA 32)	CLC has been used for analysing patch density on a case study basis. Land cover change aspects could be integrated in this indicator.

6.2.2.2. EIONET Water

EIONET[14] Water is a monitoring network designed for collecting data on the status and trends of water resources in terms of quality and quantity, and for analysing how this reflects pressures on the environment. Currently, EIONET Water does not include enough monitoring stations to provide reliable regional analyses. Also, the monitoring stations included are not designed to monitor non-point sources of pollution from agriculture. Instead, stations are positioned to monitor major industrial and sewage recycling plants. Therefore, considerable work is needed in order to meet the monitoring requirements of pollution from agriculture. Efforts are currently being made to geo-reference monitoring stations to the new catchments database developed by the JRC. In future, the network will be adapted to meet the reporting needs of the Water Framework Directive.

Indicator	**Action**
Nitrates in water (IRENA 30.1) and Pesticides in water (IRENA 30.2)	Encourage Member States to increase and harmonise transmission of national monitoring data to EIONET Water. Data reported by Member States under the Nitrates Directive could be used as part of a monitoring system to measure pollution from agriculture.

6.2.2.3. Pan-European Common Bird Monitoring Database

The Pan-European Common Bird Monitoring Database is maintained by the Royal Society for the Protection of Birds (RSPB), the European Bird Census Council (EBCC), and BirdLife International. Survey methods and data compilation follow tested and widely recognised approaches in the biological monitoring field. Data gathering is largely carried out by volunteer ornithologists, who are trained to achieve maximum standardisation and data quality.

[14] European environment and observation network.

Indicator	**Action**
Population trends of farmland birds (IRENA 28)	Continuation of cooperation with data providers is needed in order to secure, consolidate and harmonise the existing data set. The existing data should be extended and transparency increased. Trends should be established for different groups of birds (steppe, meadow, etc).

6.2.3. Review of modelling approaches

Modelling approaches are adopted for indicators where surveyed environmental data are not available. Models can be very useful tools for environmental analysis as long as the required input data are available and of sufficient quality. The following indicators are developed on the basis of modelling approaches:

Indicator	**Action**
Gross nitrogen balance (IRENA 18.1)	The methodology for calculating GNB is well developed for national data. However, to create regional balances, there is a need to develop regional data/coefficients.
Risk of pollution by phosphorus (New)	The indicator has to be developed, although work on phosphorus balances has already been initiated in collaboration with the OECD.
Soil erosion (IRENA 24)	A new pan-European risk assessment of soil erosion by water will be carried out (JRC). A new pan-European risk assessment of soil erosion by wind will also be developed.
Soil quality (IRENA 29)	A new definition and assessment of soil quality will be carried out a as part of the Thematic Strategy on Soil Protection.
Pesticide risk (New)	A research project on Harmonised Pesticide Risk Indicators (HAIR), which is financed by the Commission and involves the JRC, aims to provide a harmonised European approach for indicators of pesticide risk. This project is expected to make a useful contribution to the development of the pesticide risk indicator.
Atmospheric ammonia emissions (IRENA 18.2)	The data are based on official national data submissions reported by Member States under the UNECE/EMEP Convention on Long-Range Transboundary Atmospheric Pollution. Estimates of emissions could be improved with more accurate data on the size of different emission sources (including the contribution of agriculture to air pollution), as well as with improved emission coefficients.
Emissions of methane and nitrous oxide (IRENA 19)	The data come from the official annual national submissions of total and sectoral greenhouse gas (GHG) emission data to United Nations Framework Convention on Climate Change (UNFCCC), the EU Monitoring Mechanism and EIONET. The data are compiled for the EU by the EEA. Emission estimates could be improved with better emission coefficients.

High Nature Value Farmland (IRENA 26)	Continuation of co-operation between the EEA, the JRC and the Member States is needed. DG AGRI has launched a study on HNVF, which could also contribute to the development of this indicator.

6.2.4. Review of administrative data sets

6.2.4.1. Common monitoring and evaluation framework for rural development programmes

The databases on the monitoring of rural development programmes are managed by DG AGRI.

Indicator	**Action**
Area under agri-environment support (IRENA 1)	The reporting by Member States within the rural development monitoring framework should be further standardised, and more appropriate and clearly identifiable categories of agri-environmental commitments should be developed. The geo-referenced data on the uptake of agri-environment schemes that the Member States have to provide (from 2005) through the Integrated Administration and Control System (IACS) will allow better spatial reporting.
Use of environmental farm advisory services (New sub-indicator of IRENA 6)	The number of farms that use environmental advisory services has been proposed as an output indicator for the monitoring and evaluation of future rural development programmes.

6.2.4.2. Organic farming

Indicator	**Action**
Area under organic farming (IRENA 7)	Data are supplied by Member States to DG Agriculture and Rural Development, using the administrative data from the organic farming questionnaire (database OFIS). Reporting should be made compulsory and the collection time delays minimised to follow the dynamic development of the sector more closely. The proposal for a new regulation on organic farming includes an article on the statistical information to be collected. These data are to be collected under the responsibility of Eurostat, as it is essential that the data be harmonised with other agricultural statistics.

6.2.4.3. NATURA 2000

The Habitats Directive component of the Natura 2000 database is managed by the European Topic Centre on Nature Protection and Biodiversity of the EEA. There is no common protocol for collecting the data, and different approaches have therefore been adopted by Member States in filling out the standard data form.

Indicator	**Action**
Area under nature protection (IRENA 4)	Consolidation and more standardised reporting procedures within Natura 2000 monitoring would be needed.

6.2.5. Other data sets

Indicator	**Action**
Genetic diversity (IRENA 25)	The information on the risk status of livestock breeds is obtained from the FAO's Domestic Animal Diversity Information System (DAD-IS). A common definition of the risk status for all countries is available. However, data are limited and difficult to assess. There is a need to assess trends in the genetic diversity of crops and livestock.

6.2.6. New data sets

Indicator	**Action**
Pesticides consumption (IRENA 9)	A proposal for a Regulation concerning statistics on plant protection products, under which would require statistics on the sale and use of plant protection products to be collected on a mandatory basis, is being prepared by the Commission.

6.3. Setting up a permanent and stable arrangement needed for the long-term functioning of the indicator system

Defining the relevant indicators is only a part of the work required to build the information system for monitoring environmental integration. The results of the IRENA operation suggest that, in order to arrive at an indicator system that is durable in the long-run, it is necessary to develop a stable and continuous process of systematic data collection and management, indicator compilation, and improvement of models, methods and concepts underpinning the indicators.

This requires the setting up of an organisational structure (in terms of partners involved) with well-defined management arrangements (in relation to the division of tasks) and procedures.

The establishment of this permanent and stable arrangement should be a priority task for future indicator development at EU level, in particular for the systematic collection of necessary data on an appropriate geographical scale and the development of supporting methodological tools.

It is clear that improving data quality and availability, and maintaining and updating the indicator data base, will require the full involvement and commitment of the Member States. This concerns in particular the collection of geo-referenced data or data at appropriate territorial level, which has been identified as the main weakness of the current indicators. This entails that Eurostat will be called upon to play a pivotal role in the management of the future information system, based on close co-operation with the Statistical Offices of the Member States and the Ministries of Agriculture and Environment, and in collaboration with other European bodies, such as the EEA. The future development of certain agri-environmental indicators will benefit from the involvement of other Commission services, such as the Joint Research Centre, and particularly from the contribution that they can give to the improvement of models, methods and concepts related to certain indicators.

ANNEX 1

Development of agri-environmental indicators under the IRENA operation[15]

Domain/ Sub-domain	No	IRENA Indicator	Headline indicator and *sub-indicators*	Data sources	Spatial scale	Temporal scale
Responses – Public Policy	**1**	**Area under agri-environment support**	Trends in the agricultural area enrolled in agri-environmental measures and share of the total agricultural area.	Common indicators for monitoring of implementation of RDP, DG AGRI.	NUTS 0 (some RDP programming regions)	1998, 2002
			1) Trends in agri-environment expenditure per hectare of utilised agricultural area (UAA) *2) the endangered breeds under agri-environment measures.*	1) European Agriculture Guarantee and Guidance Fund (EAGGF), DG AGRI. 2) Common indicators for monitoring of implementation of RDP, DG AGRI.	NUTS 0	1) 2000–2003. 2) 2001
	2	**Regional levels of good farming practice**	Range and type of relevant categories of farming practices covered by the codes of good farming practices defined by regions in their Rural Development Programmes.	National/regional codes of Good Farming Practices included in Rural Development Programmes (RDPs) (period 2000–2006)	NUTS 0 level, except Belgium (2 = NUTS 1) and Italy (1 = NUTS 2 region)	Current status in 2004
			1) The 'regulatory' (requirements based on legislation) or 'advisory' approach (based on recommendations) taken by Member States in preparing their code of GFP.			
			2) The range of GFP requirements being verifiable standards (subject to control).			
	3	**Regional levels of environmental targets**	Environmental targets set at Member State level relevant to agriculture.	Commission and national policy documents	NUTS 0	Current status in 2004
	4	**Area under nature protection**	Proportion of Natura 2000 sites covered by targeted habitats that depend on a continuation of extensive farming practices.	Database of sites proposed under the Habitat Directive as NATURA 2000 areas	NUTS 0	Data received between 1997 and March 2005
					NUTS 2 and 3	Data received between 1997 and July 2004
Responses – Market signals	**5.1**	**Organic producer prices and market share**	Organic producer prices and market share (to indicate levels of consumer demand for organic products and market signals to organic producers).	Research project OMIaRD (Organic Marketing Initiatives and Rural development)	NUTS 0	2000, 2001
	5.2	**Organic farm incomes**	Organic farm incomes compared to similar conventional farms (to indicate combined impacts of prices, agri-environmental support payments and other factors on financial viability of organic holdings).	FADN	NUTS 0	Partial coverage 2000, Complete coverage 2001

[15] The acronyms used are: **CLC** (CORINE Land Cover), **ECPA** (European Crop Protection Association), **EFMA** (European Fertiliser Manufacturers Association), **FSS** (Farm Structure Survey), **FADN** (Farm Accountancy Data Network), **RDP** (Rural Development Programme), **SIRENE** (section of the Eurostat-New Cronos database with information on energy use in agriculture).

Responses – Technology skills	**6**	**Farmers' training levels**	The level of agricultural training of managers of agricultural holdings.	FSS	NUTS 2 and 3	1990–2000
			Training in agri-environmental issues.	Common indicators for monitoring of implementation of RDP, DG AGRI.	NUTS 0	2001
Responses – Attitudes	**7**	**Area under organic farming**	Trends in organic farming area and in the share of organic farming area in the total utilised agricultural area (UAA).	Organic farming questionnaire on Regulation (EEC) No 2092/91 1998–2002, DG AGRI	NUTS 0	1998 to 2002.
				FSS (for regional share)	NUTS 2 and 3	2000
Driving forces – Input use	**8**	**Mineral fertiliser consumption**	Mineral fertiliser consumption is indicated by the evolution of the consumption of nitrogenous (N) and phosphate (P_2O_3) mineral fertilisers over time.	FAOSTAT	NUTS 0	Most recent 2002 Trend 1990– 2001
			Fertiliser application rates for selected crops.	EFMA	NUTS 0	Most recent 1999/2000
	9	**Consumption of pesticides**	The consumption of pesticides (here plant protection products, excluding biocides and disinfectant products) is indicated by: (a) Used/sold quantities of different pesticide categories; (b) Application rates of different pesticide categories (insecticides/herbicides/others).	ECPA (use data), Member States (sales data)	NUTS 0	Use: 1992–99; Sales: 1992–2002
	10	**Water use (intensity)**	a) Trends in irrigable area (area covered with irrigation infrastructure) and b) trends in total areas (and by crops) irrigated at least once a year (actual area irrigated).	FSS	NUTS 2 and 3 (Only Greece, France, Spain reported b) in 1990–2000	Most recent 2000 Trend 1990–2000
			Trends in the share of irrigable area in total UAA.	FSS	NUTS 2 and 3	Most recent 2000 Trend 1990–2000
	11	**Energy use**	Energy use is indicated by the annual use of energy at farm level by fuel type (GJ/ha).	FADN, SIRENE , FSS	NUTS 0 (and 1)	Trend 1990–2000
			Estimate of energy used to produce mineral fertilisers for agricultural use (GJ/ha).	FAOSTAT for fertiliser use, 'energy content' based on industry data (the Netherlands)	NUTS 0	Trend 1990–2000

Driving forces – Land use	**12**	**Land use change**	Area of land use change from agriculture to artificial surfaces between 1990 and 2000.	CLC 1990 and 2000	NUTS 2 and 3	1990–2000
			Sector share of land converted from agriculture to artificial surfaces.	CLC 1990 and 2000	NUTS 2 and 3	1990–2000
	13	**Cropping/livestock patterns**	Cropping patterns: trends in the share of the utilised agricultural area occupied by the major agricultural land uses (arable, permanent grassland and permanent crops). Livestock patterns: trends in the share of major livestock types (cattle, sheep and pigs).	FSS, FADN	FSS: NUTS 2 and 3 FADN: NUTS 0 and 1	1990–2000
			Trends types of farms particularly relevant for environment (typology).			
Driving forces – Farm management	**14**	**Farm management practices**	1) Cropping method: soil cover.	FSS	NUTS 2 and 3	2000
			2) Cropping methods: tillage methods.	PAIS II project (2005)	NUTS 0	only 2003–2004
			3) Type and capacity of storage for farm manure and slurry.	FSS	NUTS 2 and 3	2000
Driving forces – Trends	**15**	**Intensification/ extensification**	a) Trends in the share of agricultural area managed by low-input, medium-input or high-input farm types (based on the average expenditure on inputs per hectare).	FADN	FADN: NUTS 0 and 1	1990 and 2000
			b) Livestock stocking densities per selected types of farm.	FSS, FADN.	FSS: NUTS 2 and 3 FADN: NUTS 0 and 1	1990 and 2000
			c) Trends in yields of milk and cereals.	FADN	NUTS 0 and 1	1990, 1997, 2000
	16	**Specialisation/ diversification**	Specialisation: trends in the share of the agricultural area managed by specialised types of farm.	FADN	NUTS 0 and 1	1990 and 2000
			Diversification: share of agri-environment payments in gross farm income.	FADN	NUTS 0 and 1	1990 and 2000
	17	**Marginalisation**	Share of holdings with low Farm Net Value Added per Annual Work Unit in combination with a high share of holdings with farmers close to retiring age.	FADN	NUTS 0 and 1	1990 and 2000

Pressures – Pollution	**18**	**Gross nitrogen balance**	Gross soil surface balance for nitrogen.	OECD website and EEA calculations on the basis of Eurostat's ZPA1 data set or FSS	NUTS 0	1990 and 2000
	18b	**Atmospheric emissions of ammonia (NH_3)**	This indicator shows the annual atmospheric emissions of ammonia (NH_3) in the EU-15 for 1990–2002, and the contribution that agriculture made to total atmospheric emissions of ammonia in 2002.	Officially reported 2004 national total and sectoral emissions to UNECE/EMEP (Convention on Long-Range Transboundary Atmospheric Pollution)	NUTS 0	1990 to 2002.
	19	**Emissions of methane (CH_4) and nitrous oxide (N_2O).**	Aggregated annual emissions from agriculture of methane (CH_4) and nitrous oxide (N_2O). Emissions are shown relative to 1990 baseline levels expressed as CO_2 equivalents.	Official national total, sectoral emissions, livestock and mineral fertiliser consumption data reported to UNFCCC and under the EU Monitoring Mechanism and EIONET	NUTS 0	1990 to 2002
	20	**Pesticide soil contamination**	The indicator uses a model to calculate the potential average annual content of herbicides in soils.	Calculation of the total PPP quantity present in a specific NUTS 2 region is based on EUROSTAT pesticide statistical data (2002) and FSS (1997, 2000)	NUTS 2 and 3	1993 to 1999
	21	**Use of sewage sludge**	Use of sewage sludge in agriculture	Data submitted by Member States to the European Commission in the context of the requirements under the standardised reporting directive (91/692/EEC)	NUTS 0	1995 to 2000
Pressures – Resource depletion	**22**	**Water abstraction**	Water abstraction by agriculture is indicated by the annual water allocation rates for irrigation.	Joint OECD/Eurostat questionnaire	NUTS 0	1990 to 2000
			Regional water abstraction rates for agriculture	Joint OECD/Eurostat questionnaire, FSS	NUTS 2 and 3	2000
	23	**Soil erosion**	Annual risk of soil erosion by water.	PESERA model using CLC (Land use), GTOPO30 (Relief), MARS database (Meteorology), European Soil Database	NUTS 2 and 3	2003
	24	**Land cover change**	Net land cover changes for arable land and permanent crop and pasture between 1990 and 2000.	CORINE Land Cover	NUTS 2 and 3	1990 and 2000
			Changes in net arable and permanent crop and pastureland cover between 1990 and 2001.	CORINE Land Cover	NUTS 2 and 3	1990 and 2000
	25	**Genetic diversity**	Distribution of risk status of national livestock breeds in agriculture.	FAO's Domestic Animal Diversity Information System (DAD-IS)	NUTS 0	July 2003.

Pressures – Benefits	**26**	**High nature value (farmland) areas**	This indicator shows the share of the Utilised Agricultural Area that is estimated to be High Nature Value farmland.	CORINE Land Cover and FADN	NUTS 0	1990
	27	**Production of renewable energy (by source)**	Land use devoted to energy/biomass crops, and primary energy produced from crops and by-products.	FSS; European Biodiesel Board; EurObserv'ER; Fachverband Biogas; SKstat: International Energy Agency; FAOSTAT	NUTS 0	2003
State – Biodiversity	**28**	**Population trends of farmland birds**	Population trends of up to 24 selected bird species that are common and characteristic of European farmland landscapes.	Pan-European Common Bird Monitoring project (RSPB/EBCC/BIRDLIFE International)	NUTS 0	1990–2001
			Share of farmland birds with declining populations.	BIRDLIFE, EBCC (2000): European Bird Populations – Estimates and trends. BIRDLIFE Conservation series No 10.	NUTS 0	1990–2002
State – Natural resources	**29**	**Soil quality**	Topsoil (0–30cm) organic carbon content.	Soil: European Soil Database, CORINE Land Cover, Global Historical Climatology Network – GHCN, Pedo-transfer model to calculate organic carbon content	NUTS 2 and 3	(2000)
	30.1	**Nitrates in water**	Annual trends in the concentrations of nitrates (mg/l N) in ground and surface water bodies.	EUROWATERNET	NUTS 0	1992–2001
	30.2	**Pesticides in water**	Annual trends in the concentrations (µg/l) of selected pesticide compounds in ground and surface waters.	EUROWATERNET DK: NERI (2004); GEUS (2004); Ministry of Environment (2003) UK: Environment Agency (2004) AU: UBA Vienna (2005) FI: FEI (2001	NUTS 0	1992–2001
	31	**Ground water levels**	Trends of groundwater levels.	Ministry of Environment of Spain	Case study (Spain)	1978–1998
State – Landscape	**32**	**Landscape state**	The diversity of agricultural landscapes across Europe is shown by analysing selected landscape parameters with strong links to agricultural land use. These parameters have been calculated for selected regional case study areas representative of different European landscapes	CLC (patch density) FSS (crop distribution) LUCAS (linear elements)	NUTS 2 and 3 (for case studies)	CLC 1990 and 2000 FSS 1990 and 2000

Impact – Biodiversity	**33**	**Impact on habitats and biodiversity**	1) Share of Important Bird Areas (IBA) in the EU-15 affected by agricultural intensification and/or abandonment	IBA programme of Birdlife International	NUTS 0	2004
			2) Population trends of agriculture-related butterfly species in Prime Butterfly Areas	Survey of Prime butterfly areas by Butterfly Conservation International.	NUTS 0	2003
Impact – Natural resources	**34.1**	**Share of agriculture in GHG emissions**	Contribution of the agricultural sector to total EU-15 emissions of the greenhouse gases CO_2, CH_4, and N_2O.	Official national total, sectoral emissions, livestock and mineral fertiliser consumption data reported to UNFCCC and under the EU Monitoring Mechanism and EIONET	NUTS 0	1990 to 2002
	34.2	**Share of agriculture in nitrate contamination**	Nitrogen emissions to water by economic sector.	*OECD website and UBA, 2001*	NUTS 0	1990 and 1998
	34.3	**Share of agriculture in water use**	Share of agriculture in water use from surface and ground waters.	Joint OECD/Eurostat questionnaire FSS (variable Irrigable area – area covered with irrigation infrastructure)	NUTS 0	1990 and 1998
Impact – Landscape	**35**	**Impact on landscape diversity**	Trends of indices of overall agricultural diversity. This indicator presents the evolution of some of the parameters calculated in IRENA 32. The changes of the crop type distribution (e.g., arable, grasslands) and patch density are shown for the selected landscape types.	CLC (change number of agricultural classes and patch density) FSS (change in crop areas)	NUTS 2 and 3 for case studies	1990 and 2000
			Changes in total linear landscape features (km).	UK Countryside survey Swedish Countryside Survey – Monitoring landscape features, biodiversity, and cultural heritage (LiM project)	NUTS 0 (UK, Sweden)	1990 to 1998

ANNEX 2

Agri-environmental indicators to be maintained/updated and, where appropriate, further developed/added

DOMAIN/ *Sub-domain*	IRENA OPERATION					PROPOSED SET OF AGRI-ENVIRONMENTAL INDICATORS			
	No	Indicator	Usefulness	Level of development		No	Title and measurement	Main limitations / Improvements needed	Main lead for the indicator
RESPONSES *Public policy*	1	**Area under agri-environment support**	Potentially useful [13-15]	**B**	▶	1	**Agri-environmental commitments** ▪ Area under AE commitments (per category) ▪ Share of area under AE commitments / total UAA ▪ Area under AE commitments within Natura 2000 sites ▪ Share of agricultural holdings with agri-environmental commitments/total number of agricultural holdings ▪ Share of total expenditure for AE payments/ total rural development expenditure ▪ AE payments/ UAA	Improve and further standardise the reporting concerning AE commitments by Member States in the context of the annual reports on the implementation of rural development programmes. The Common monitoring and evaluation framework is meant to include more detailed categories of AE commitments	AGRI/ ESTAT
	2	**Regional level of good farming practice**	Potentially useful [9-10]	**C**					
	3	**Regional levels of environmental targets**	Potentially useful [11]	**C**					
	4	**Area under nature protection**	Useful [17]	**A**	▶	2	**Agricultural areas under Natura 2000** ▪ UAA (ha) under Natura 2000 ▪ Area of habitat types dependent on extensive agriculture under Natura 2000 ▪ UAA under Natura 2000 / total UAA ▪ Share of Natura 2000 payments/total rural development expenditure		EEA/ AGRI

RESPONSES *Technology skills*	6	**Farmers' training levels**	Potentially useful [13]	**A/B**	▶	3	**Farmers' training levels and use of environmental advisory services** ▪ Share of farmers having practical experience, basic training, and full agricultural training ▪ Number (share) of farmers having made use of environmental farm advisory services per year	The IRENA indicator refers to the level of agricultural training of managers of agricultural holdings, based on FFS data. This indicator is deemed to be not sufficiently targeted to draw conclusions regarding the environmental knowledge of farmers. If possible, the indicator should focus on environmental training. This information could be collected either through the FFS or specific surveys. Moreover, it would be relevant to develop a sub-indicator on the use of environmental farm advisory services. Existing and future farm advice and training will be essential for providing the necessary information to farmers to better comply with cross-compliance rules and improve their environmental farm management. As regards the use of environmental advisory services, the relevant information can be provided by the annual reports on the implementation of rural development programmes	AGRI/ ESTAT
RESPONSES *Market signals and attitudes*	5.1	**Organic producer prices and market share**	Potentially useful [13]	**C**					
	5.2	**Organic farm incomes**	Potentially useful [13]	**C**					
	7	**Area under organic farming**	Useful [18]	**A**	▶	4	**Area under organic farming** ▪ Area under organic farming ▪ Share of areas under organic farming/total UAA	There are two possible sources for data on organic farming: the FSS and the data sent to DG AGRI within the administrative framework set up under Regulation 2092/91. The proposal for a new regulation on organic farming includes an article on the statistical information to be collected. It is important that the data are harmonised with other agricultural statistics.	ESTAT

DRIVING FORCES *Input use*	8	**Mineral fertiliser consumption**	Potentially useful/ Useful [14-15]	**B**	▶	5	**Mineral fertiliser consumption** Absolute volumes and application rate by crop of: ▪ N (nitrogen), ▪ P (Phosphorus)	Regional fertiliser application rates should be obtained. They are also necessary for estimating regional gross nutrient balances, via existing or new surveys. The Commission is currently preparing a proposal for a complementary FSS survey on production methods, which is meant to cover, inter alia, the use of mineral fertilisers. Alternatively, the incorporation of variables on farm level fertiliser consumption (by crop type) into the FADN surveys should be considered.	ESTAT/ AGRI
	9	**Consumption of pesticides**	Potentially useful [12-14]	**C**	▶	6	**Consumption of pesticides** ▪ Used/sold quantities of different pesticide categories; ▪ Application rates of different pesticide categories	The indicator needs better data, particularly at regional level, in order to be fully operational. Currently, there is a lack of comparability between use and sales data. The Commission is currently preparing a legal framework to collect statistics on the sale and use of plant protection products on a mandatory basis, to overcome the existing data deficiencies at national level. In order to overcome the existing data deficiencies at regional level, ideally, specific periodical surveys on the use of plant protection products should be organised.	ESTAT
	10	**Water use (intensity)**	Potentially useful [16]	**A**	▶	7	**Irrigation** ▪ Irrigated areas; ▪ Irrigated crops; ▪ Irrigated area/total UAA ▪ Share of irrigated area according to irrigation systems.	The FSS variables related to irrigation areas were complemented in the 2003 survey by data on the type of irrigation equipment or techniques being used (surface, sprinkler, rain gun, drip). Either the information on type of irrigation equipment should be kept in future FSS questionnaires or other, specific surveys on irrigation should be set up. The Commission is currently preparing a proposal for a complementary FSS survey on production methods. This is meant to cover, inter alia, the irrigation methods employed and the source of irrigation water used.	ESTAT
	11	**Energy use**	Potentially useful [13]	**B**	▶	8	**Energy use** ▪ Annual use of energy at farm level by fuel type (GJ/ha)	Existing surveys need to be consolidated and harmonised.	ESTAT/ EEA

DRIVING FORCES *Land use*	12	**Land use change**	Useful [15-17]	**B**	▶	9	**Land use change** ▪ Land use change from agricultural land to artificial surfaces (ha) ▪ Percentage of the total agricultural area that has changed compared to a reference period	There are some important differences between the estimates with CORINE Land Cover (CLC) and national surveys. Validation and improvement of the existing CLC inventory on the basis of national data and ground surveys (e.g. LUCAS).	EEA/ JRC/ ESTAT
	13	**Cropping/livestock patterns**	Useful [17-19]	**B**	▶	10	**Cropping/livestock patterns** **Two sub-indicators:** **1. Title "Cropping patterns"** ▪ Area occupied by the major agricultural land types (e.g. arable crops, permanent grassland and permanent crops) ▪ Share of agricultural land types/total UAA **2. Title "Livestock patterns"** ▪ Number of major livestock types (e. g. cattle, sheep, pigs, and poultry) ▪ Share of major livestock types ▪ Stocking rate (LU/UAA) ▪ Grazing stocking rate (grazing LU/grasslands and forage crops)	The policy relevance of this indicator could be improved by targeting the "farming systems" associated to certain "crop types" or "livestock types". In this respect, one aspect to be further explored could be the farm typology approach for further differentiation of the analysis, focusing on the share of agricultural area managed by different farm types. As regards "cropping patterns", it would also be useful to know more about the "rotation systems" that are associated with the "base" arable crops (i.e. the arable crops occupying the highest percentage of the UAA in a region). Moreover, concerning "livestock patterns", it would be useful to know more about the main characteristics of the grazing livestock production systems, and particularly concerning the grazing systems (housing vs. grazing) and the feeding systems (pasture/meadow vs. maize silage vs. concentrates) used.	ESTAT/ AGRI

DRIVING FORCES *Farm management*	14	**Farm management practices**	Potentially useful/useful [8/16]	**B/C**	▶	11	**Farm management practices** **Three sub-indicators:** **1. Title "Soil cover"** ▪ Share of the year where the arable area is covered by plants or plant residues **2. Title ""Tillage practices"** ▪ Arable areas under conservation tillage **3. Title "Manure storage"** ▪ Type of storage for farm manure and slurry.	The soil cover estimates need to be improved. The following issues could be considered: seeding date and date of harvest, as well as information about the coincidence of rainy weather conditions and plant stand. Regional coefficients may be created per type of crop. The data on the use of different tillage methods should be built up significantly. The indicator can be extended to different farming methods following accepted guidelines, where the aim is to use sustainable farming practices. Data on manure storage are collected through the FSS. They also provide input to the indicator related to ammonia emissions. The policy relevance of the indicator could be improved by targeting further topics related to the way farmers manage their holdings, such as "agricultural practices with limited input" (e.g. integrated pest management), adoption of "anti-erosion measures" (e.g. terraces, contour farming), use of "fertiliser plans", etc.	ESTAT/ AGRI
DRIVING FORCES *Trends*	15	**Intensification/ extensification**	Useful [15]	**A**	▶	12	**Intensification/extensification** ▪ Intensification (e.g. share of low, medium, high-input farms (based on average input expenditure/UAA). ▪ Milk yield ▪ Cereal yield	The farm typology approach could be further explored. A framework for enabling comparison of FADN input cost data between Member States should be developed. The possibility of extending the animal and crop statistics to a regional level could be investigated to give improved data on yields. FADN input data would benefit from better harmonisation.	ESTAT/ AGRI
	16	**Specialisation/ diversification**	Useful [15]	**A** (spec.) **C** (diver.)	▶	13	**Specialisation** ▪ Share of the agricultural area (ha) managed by specialised farm types	The indicator should focus exclusively on specialisation, which has the strongest link with the environment.	ESTAT
	17	**Marginalisation**	Potentially useful [13]	**C**	▶	14	**Risk of land abandonment**	The indicator needs conceptual and technical development to be relevant to agri-environmental analysis. A modelling approach combining socio-economic data with an assessment of the risk of farm abandonment resulting from geographic conditions could de developed. An assessment could be undertaken of the relevance and possibility of including data on land in receipt of direct payments, and so covered by obligatory standards of good agricultural and environmental condition (GAEC), but which is not actually being used for farming purposes.	JRC/ AGRI

PRESSURES *Pollution*	18	**Gross nitrogen balance**	Potentially useful [14]	**B**	▶	15	**Gross nitrogen balance** ▪ Potential surplus of nitrogen on agricultural land (kg N/ha/year).	The model underpinning the gross nitrogen balance is well-developed. However, this indicator needs to be developed at the regional level. To this end, the availability of data on the use of nitrogen fertilisers at regional level needs to be improved. A further necessary improvement concerns the "Livestock excretion rates", i.e. the coefficients (kg N/animal/year) to be applied to different livestock categories to estimate the nitrogen input from livestock manure. The Commission is currently preparing a proposal for a complementary FSS survey on production methods, which is meant to cover, inter alia, the use of mineral fertilisers. Alternatively, the inclusion of variables on farm level fertiliser consumption into the FADN surveys should be considered.	ESTAT/ EEA
					NEW	16	**Risk of pollution by phosphorus** **Two associated sub-indicators**: **a. Phosphorus balance**. ▪ Potential surplus of phosphorus on agricultural land (kg P/ha/year). **b. Vulnerability to phosphorus leaching/run-off**	For the development of this indicator, two associated aspects need to be analysed: a. Potential surpluses of phosphorus. In this respect, ground work on phosphorus balance is already in place through collaboration with OECD. However, the availability of data on the use of phosphorus fertilisers at regional level needs to be improved. The Commission is currently preparing a proposal for a complementary FSS survey on production methods, which is meant to cover, inter alia, the use of mineral fertilisers. Alternatively, the insertion of variables on farm level fertiliser consumption into the FADN surveys should be considered. b. Vulnerability of the area concerned to phosphorus leaching/run-off. In this respect, a recent study by DG ENV “Addressing phosphorus related problems in farm practice” could be helpful. The study proposes vulnerability classes, based on propensity for soil erosion and P sorption capacity. The methodology proposed in that study needs to be validated and, if appropriate, improved.	ESTAT/ EEA

PRESSURES *Pollution*					NEW	17	**Pesticide risk** ▪ Index of risk of damage from pesticide toxicity and exposure	The indicator on "Consumption of pesticides" does not allow an assessment of the potential increase in environmental risk associated with higher pesticide sales or use volumes. The new indicator is meant to address this issue. The conceptual and, where appropriate, modelling framework underpinning this indicator needs to be developed. A specific research project financed by the Commission and with the involvement of the JRC on Harmonised Pesticide Risk Indicators (HAIR) aims to provide a harmonised European approach for indicators of the overall risk of pesticides. This project is expected to make a useful contribution. The Commission is currently preparing a legal framework to collect statistics on sales and usage of plant protection products on a mandatory basis, to overcome the existing data deficiencies at national level. In order to overcome the existing data deficiencies at regional level, ideally, specific periodical surveys on the use of plant protection products should be organised.	ESTAT/ JRC/ ENV/ AGRI
	18b	**Atmospheric emissions of ammonia (NH_3)**	Useful [18]	**B**	▶	18	**Ammonia emissions** ▪ Emissions of NH_3 in tonnes (T) ▪ Share of agriculture in total ammonia emissions ▪ Distance to NEC targets	Estimates of emissions are based on a model, which could be improved with more accurate data on the size of different emission sources (including the contribution of agriculture to air pollution) as well as with improved emission coefficients.	EEA/ JRC
	19	**Emissions of methane (CH_4) and nitrous oxide (N_2O)**	Useful [18]	**A**	▶	19	**Greenhouse gas emissions** ▪ ktonnes CO_2 equivalents ▪ Share of agriculture in GHG emissions	Estimates of emissions are based on a model, which could be improved thanks to the availability of better emission coefficients for methane and nitrous oxide. Cooperation with Member States is needed to develop country-specific emission factors instead of the IPCC standard values. An assessment could be undertaken of the possibility of including data on stocks of soil and plant carbon.	EEA/ JRC
	20	**Pesticide soil contamination**	Potentially useful [10]	**C**					
	21	**Use of sewage sludge**	Potentially useful [12]	**C**					

PRESSURES *Resource depletion*	22	**Water abstraction**	Potentially useful [11]	**C**	▶	20	**Water abstraction** ▪ Water use for irrigation (m3/year) ▪ Share of agriculture in water use	Co-operation with OECD on the joint ESTAT/OECD questionnaire should continue. Data need to be improved either as part of FSS or through specific surveys. The reporting mechanism should be improved and Member States should be asked to provide an explanation of the data provided (droughts, increase in irrigation area, new reservoirs etc…). Availability of regional data should be improved.	ESTAT
	23	**Soil erosion**	Potentially useful [13]	**B**	▶	21	**Soil erosion** ▪ Estimated soil loss by water erosion (T/ha/year) ▪ Estimated soil loss by wind erosion (T/ha/year)	The existing models for water erosion can be further developed and calibrated through empirical data. A new approach combining empirical data and modelling can be developed making use of land use data from LUCAS in combination with land cover data from CORINE land cover. Wind erosion should be added. A new pan-European risk assessment of soil erosion by water will be carried out. A new pan-European risk assessment of soil erosion by wind will be developed.	JRC
	24	**Land cover change**	Useful [15-16]	**B**					
	25	**Genetic diversity**	Potentially useful [12]	**C**	▶	22	**Genetic diversity** ▪ Number and range of crop varieties and livestock breeds. ▪ Share in production of main crop varieties registered and certified for marketing. ▪ Number of breeds per total livestock population for different types of livestock ▪ Distribution of risk status of national livestock breeds in agriculture	Data on genetic diversity are limited and difficult to interpret. The data compiled by FAO should be improved in cooperation with Member States.	EEA/ AGRI

PRESSURES *Benefits*	26	**High nature value (farmland) areas**	Potentially useful [12]	**C**	▶	23	**High nature value farmland** ▪ Estimated area HNFV ▪ Estimated area HNFV/total UAA	Using the current data it is not possible to assess trends in HNV farmland for individual Member States, but the data do provide an overall estimate of the share of such areas. The methodology needs to be refined on the basis of CLC, FADN and biodiversity data, such as Natura 2000. Continuation of the co-operation between EEA, the JRC and involvement of Member States. DG AGRI has launched a study on HNVF, which could also contribute to developing this indicator.	EEA/ JRC/ AGRI
	27	**Production of renewable energy (by source)**	Potentially useful [14]	**B**	▶	24	**Production of renewable energy** ▪ Production of primary energy from crops and by-products (Ktoe) ▪ Area of energy crops (biodiesel crops, ethanol crops and short rotation forestry) ▪ supported areas for renewable energy production	Consolidate diverse sources of information concerning crops (oilseed crops, starch/sugar crops, grasses, etc.), short rotation forestry and by-products (livestock manure, cereal straws, etc.) used for the production of energy (biodiesel, ethanol, biogas, heat, electricity, etc.). Further aspects that could be added are: (a) The potential CO2 benefits. In this respect, consistency needs to be ensured with the values used in work on biofuels and other forms of renewable energy. (b) The potential contribution of energy crops to improved rotation systems and to the viability of farms in high nature value areas.	ESTAT/ AGRI
STATE/ IMPACT *Biodiversity and habitats*	28	**Population trends of farmland birds**	Potentially useful/ Useful [11-15]	**B**	▶	25	**Population trends of farmland birds** ▪ Farmland bird population index	Continue cooperation with data providers to consolidate and extend existing data set and increase transparency. Explore the relevance and possibility of calculating trends for different groups of birds (steppe, meadow, etc), which could allow a more detailed assessment of the effect of key agricultural land use trends on bird species by habitat and facilitate more targeted policy action where necessary. Explore the possibility of developing regionalised biodiversity indexes and of covering habitat state/impact aspects with the (sub-)indicators related to "Agricultural areas under Natura 2000" and "High Nature Value Farmland".	ESTAT/ EEA
	33	**Impact on habitats and biodiversity**	Potentially useful [13]	**C**					

STATE/ IMPACT *Natural resources*	29	**Soil quality**	Potentially useful [13]	**C**	▶	26	**Soil quality** ▪ Humus content (%) in the topsoil	The definition and assessment of soil quality needs to be in line with the Thematic Strategy on the Protection of Soil. Moreover, existing models need to be validated through ground calibration; use of LUCAS should be considered.	JRC
	30.1	**Nitrates in water**	Potentially useful [13]	**B**	▶	27.1	**Water quality – Nitrate pollution** ▪ Nitrate concentration in water bodies ▪ Share of agriculture in total nitrate pollution	Increase and harmonise transmission of national monitoring data to EIONET Water. Further explore the possibility of using data reported by Member States under the Nitrates Directive as part of a monitoring system to measure pollution from agriculture.	EEA/ JRC
	30.2	**Pesticides in water**	Potentially useful [13]	**B**	▶	27.2	**Water quality – Pesticide pollution**	Increase and harmonise transmission of national monitoring data to EIONET Water. In the future, data could be provided by the monitoring system under the Water Framework Directive.	EEA
	31	**Ground water levels**	Low potential [6]	**C**					
	34.1	**Share of agriculture in GHG emissions**	Useful [19]	**B**					
	34.2	**Share of agriculture in nitrate contamination**	Potentially useful [12]	**C**					
	34.3	**Share of agriculture in water use**	Potentially useful [9]	**C**					
STATE/ IMPACT *Landscape*	32	**Landscape state**	Potentially useful [12]	**C**	▶	28	**Landscape – State and diversity** ▪ Typology of farmed landscapes ▪ Changes/ landscape type ▪ Land-cover change	It is very difficult to capture all the different Europe-wide landscape features by means of landscape metrics and parameters; some of them are difficult to communicate. Work should continue on developing parameters of landscape change (likely to be based on a case study approach). DG AGRI has launched a study on traditional agricultural landscapes.	JRC/ EEA/ AGRI
	35	**Impact on landscape diversity**	Potentially useful [12]	**C**	▶				

ANNEX 3

IRENA indicators to be retained as sub-indicators or considered not to have the potential for further development

DOMAIN/ *Sub-domain*	IRENA operation		Usefulness	Level of development	Comments/ main steps required to improve indicators [16]
	No	Indicator			
RESPONSES *Public policy*	**2**	**Regional levels of good farming practice**	Potentially useful [9-10]	**C**	No longer policy relevant. In the new rural development regulation for the period 2007–2013, the Good Farming Practices as baseline for support of certain rural development measures have been replaced by the cross compliance requirements that, as from 2005, also apply to the beneficiaries of direct payments under the first pillar (market and income policy) of the CAP.
	3	**Regional levels of environmental targets**	Potentially useful [11]	**C**	This indicator has proven to be difficult to develop and is considered not to be relevant enough for environmental reporting. Therefore, it is recommended not to continue the indicator in the future. To be replaced by an indicator on "agri-environmental commitments". This would also incorporate the IRENA indicator "Area under agri-environment support".
RESPONSES *Market signals*	**5.1**	**Organic producer prices/ market share**	Potentially useful [13]	**C**	These indicators are difficult to develop due to the lack of harmonised data. The indicator on "Area under organic farming" is deemed to cover appropriately the matter "organic farming" in relation to both market signals and attitudes.
	5.2	**Agricultural income of organic farmers**	Potentially useful [13]	**C**	
DRIVING FORCES *Trends*	**16**	**Diversification**		**C**	The share of agri-environment payments in gross farm income was used as an indicator of diversification. However, this is deemed not to be a good indicator of "provision of environmental services", as a result of the farming activity. Moreover, "diversification" may also refer to other issues, such as combination of different agricultural activities (i.e. mixed farming) and pluri-activity (i.e. combination of agricultural and non-agricultural activities). The environmental implications of these issues are difficult to assess, however. In this context, it is proposed not to maintain "share of agri-environment payments in gross farm income" as a specific sub-indicator. In any case, the issue of diversification (in terms of combined production of different commodity outputs in the same holding) remains indirectly covered by the indicator "Intensification".

[16] This is based on the IRENA Evaluation report and the individual indicator evaluation sheets.

PRESSURES *Pollution*	**20**	**Pesticide soil contamination**	Potentially useful [10]	**C**	Due to its complexity, it is proposed not to maintain the indicator.
	21	**Use of sewage sludge**	Potentially useful [12]	**C**	On the basis of the current data sets the indicator is deemed not to be sufficiently useful for agri-environmental reporting.
PRESSURES *Resource depletion*	**24**	**Land cover change**	Useful [15-16]	**B**	It is proposed to be included as a measurement of landscape change under the indicator "landscape – state and diversity".
STATE *Natural resources*	**31**	**Ground water levels**	Low potential [6]	**C**	In principle, the only possibilities to get the data needed for computing the indicator would be purchasing commercial hydrological data or establishing specific regional surveys in cooperation with Member States. However, the possibilities to obtain harmonised data at EU level in the coming years appear remote. In this context, it is proposed not to maintain the indicator.
STATE *Biodiversity*	**33**	**Impact on habitats and biodiversity**	Potentially useful [13]	**C**	This aspect can be covered by indicators related to "Agricultural areas under Natura 2000", "High Nature Value (farmland) areas" and "Population trends of farmland birds".
IMPACT *Natural resources*	**34.1**	**Share of agriculture in GHG emissions**	Useful [19]	**B**	The share can be a sub-indicator of the indicator "Emission of greenhouse gasses".
	34.2	**Share of agriculture in nitrate contamination**	Potentially useful [12]	**C**	The share can be a sub-indicator of the indicator 'Water quality – Nitrate pollution".
	34.3	**Share of agriculture in water use**	Potentially useful [9]	**C**	The share can be a sub-indicator of the indicator "Water abstraction".