

**INDICATOR AND MONITORING FRAMEWORKS FOR THE
ASSESSMENT OF THE EFFECTIVENESS OF AGRI-
ENVIRONMENTAL MEASURES: KEY ISSUES FOR A PRACTICAL
APPLICATION IN LITHUANIA**

Žymantas Morkvėnas* and Gerald Schwarz**

***Baltic Environmental Forum Lithuania**

****Thünen Institute**

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1. Introduction

Agri-environmental measures (AEMs) were introduced in the 1980s in a few EU Member States on their own initiative, and were taken up by the European Community in 1985 in Article 19 of the Agricultural Structures Regulation. The McSharry reform in 1992 led to the widespread implementation of AEMs in the Common Agricultural Policy (CAP) through the Council Regulation (EEC) 2078/92 (EU-Commission, 1992). Since then, voluntary AEMs have become a key policy instrument for the conservation and enhancement of the environment and in the last Council regulation on rural development (EC) 1698/2005, these measures remained compulsory for the Member States (EU-Commission, 2005), which underlines their continuing importance in agricultural policy. As of 2009, 22% of the Utilized Agricultural Area of the EU-27 was under an agri-environment agreement, while community expenditure on AEMs was €13.1bn in the period 2007 - 2011. In Lithuania, 6.8% of the Utilized Agricultural Area was under an agri-environment agreement in 2009, while €135.7 Mill. of the EARFD budget was spent on AEMs between 2007 and 2011 (European Network for Rural Development, 2011).

The available evidence on the effectiveness and success of AEMs provides a mixed picture. On the one hand, a number of studies have confirmed that as a whole, the environmental status of agricultural habitats subject to AEMs is better than it would have been if these measures had not been in place (e.g. Primdahl et al., 2003, and Perkins et al., 2011). On the other hand, there is also evidence that current AEMs do not fully utilize the potential environmental benefits they could deliver (e.g. Kleijn et al., 2006, Beredendse et al., 2004 and Wrbka et al., 2008) suggesting the need for further improvements of the design, targeting and implementation as well as for greater provision of advice to farmers and investment in improving institutional capacity. In this context, a recent report of the European Court of Auditors criticizes the lack of environmental targeting of current AEMs. In 39% of the examined individual contracts no evidence of specific environmental pressures was found. Key issues in the discussion of future improvements of the effectiveness of AEMs are improved targeting of environmental outcomes, long-term attitudinal and cultural change of land managers and improved spatial targeting (Burton & Paragahawewa, 2011, Whittingham, 2011).

Whittingham (2011) emphasizes that AEMs are more likely to deliver substantial ecosystem service benefits, if they are located in landscapes with high levels of biodiversity. Greater biodiversity on farmland is likely to increase the provision of a range of ecosystem services, which, in turn, should buffer agricultural land against likely future environmental changes. This indicates that spatial targeting can further increase the benefits of AEMs and suggests a

focus of AEMs on areas with large areas of high nature value farmland and thus rather extensive farming systems. The importance of spatial targeting is also highlighted by Boatman et al. (2008) who conclude that the effectiveness of AEMs has been improved in cases where the management prescriptions were tailored to specific issues and needs of individual sites. At the same time, they also highlight the challenge for future AEMs to achieve the same level of benefits on a broader scale.

There is little consensus as to the optimum scale for managing different ecosystem services (Wood, 2010). However, AEMs operate through contracts with individual farm managers and face the challenge of delivering ecosystem service benefits at landscape, catchment or even wider scale. For example: arable weeds require sensitive management of vegetation at a field scale; farmland birds require a mix of habitats and the creation of habitat networks at a landscape scale; water quality may best be considered at a catchment scale; a regional scale is appropriate in considering how to improve the resilience of habitats to climate change; and strategies for protecting carbon sinks may best be developed at a national scale (Woods, 2010, Gimona et al, 2011). Kleijn (2010) concludes that despite the large amount of money spent on agri-environmental schemes each year, the number of studies assessing the ecological effectiveness in a robust way is still small.

The key challenge for an indicator and monitoring framework assessing the effectiveness of AEMs is to achieve a balance between considering the complexity of managing ecosystem services across multiple scales and the feasibility and political acceptance of its practical implementation with respect to data requirements and the levels of administration and transaction cost.

Against this background, the main objective of this report is to review existing indicator and monitoring frameworks measuring changes in ecosystem functions and services and to highlight key issues for the assessment of the effectiveness of agri-environmental measures in Lithuania. The report is divided into two main parts. The first part starts with a brief outline of the formal indicator and monitoring requirements for AEMs (and other rural development measures) defined in the Common Monitoring and Evaluation Framework (CMEF) as the policy background to the literature review following in the second part. The review compares indicator and monitoring frameworks for biodiversity and eutrophication reduction described in the literature and synthesizes key issues for the assessment of the effectiveness of agri-environmental measures in Lithuania using the Landscape Stewardship Scheme as an example, and incorporating feedback from stakeholder discussions.

It is important to emphasise that the aim of the report is not to develop guidelines for the development of methods to evaluate environmental impacts of AEMs. The evaluation of environmental net-effects of AEMs across different scales is a substantial research task and would go beyond the scope of this report.¹ The report rather focuses on indicator and monitoring framework measuring changes in ecosystem services provided by agro-ecosystems, which can then be used as basis (and database) to implement and assess the effectiveness of AEMs targeted at specific ecosystem services in specific areas.

2. Policy background - the Common Monitoring and Evaluation Framework (CMEF)

This section briefly outlines the structure of the indicator framework in the CMEF, which forms the basis for the formal evaluations of AEMs and rural development programmes in EU Member States, and synthesizes the criticism on its practical application.

2.1. The CMEF and agri-environmental measures

Indicator and monitoring requirements for the mandatory ex-ante, mid-term and ex-post evaluations of the AEMs in the rural development programmes of the EU Member States are defined in the Common Monitoring and Evaluation Framework (CMEF), drawn up by the Commission in collaboration with the Member States. Article 81 of Regulation (EC) No 1698/2005 (European Commission, 2005) defines that the progress, efficiency and effectiveness of rural development programmes 2007-2013 (including AEMs) in relation to their objectives shall be measured by means of indicators relating to the baseline situation as well as to the financial execution, outputs, results and impact of the programmes. The CMEF provides a single framework for monitoring and evaluation of all rural development measures and defines a common set of input, output, result, impact and baseline indicators for the rural development programmes.

¹ The ENVIEVAL project, a new project financed by the European Commission and involving BEF Lithuania, the Thünen Institute and a number of other European research organisations, will deal with these methodological issues and produce a methodological handbook for the evaluation of environmental impacts of rural development programmes and measures.

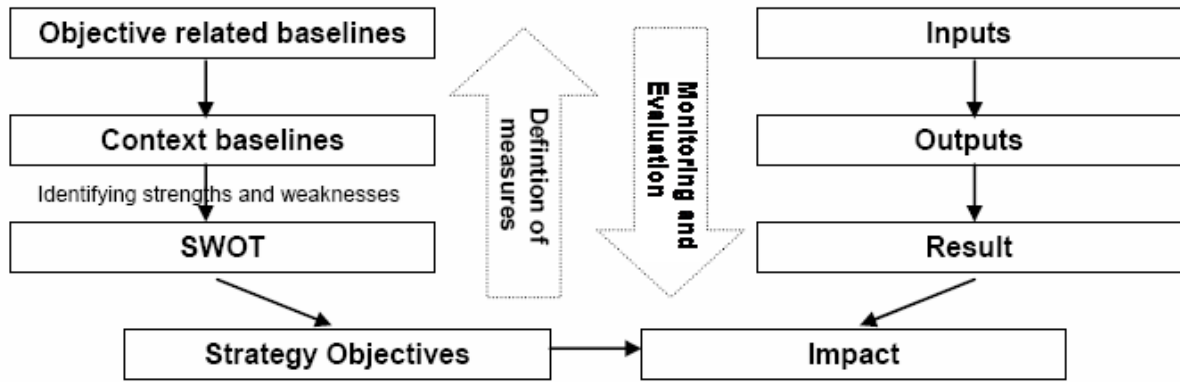


Figure 1 Steps of the programming approach and CMEF indicators

Source: EU-Commission (2006a)

Baseline indicators are used to develop a SWOT analysis as the basis to define strategy objectives. Baseline indicators can be differentiated between objective and context-related baseline indicators. The former are directly linked to the wider objectives of the programme and form the reference against which a programme impact will be assessed. Examples are employment in the food industry, index of population of farm birds, self-employed persons and share of population covered by Local Action Groups (LAGs). Context-related baseline indicators provide information on relevant aspects of the general contextual trends (economic, social and environmental) that are likely to have an influence on the performance of the programme. Examples are percentage of land that is defined as Utilised Agricultural Area (UAA), percentage of UAA under Natura 2000, and percentage of long-term unemployment.

Impact indicators are defined in order to evaluate the benefits of the programme beyond its immediate effects on direct beneficiaries. Environmental impact indicators include reversing biodiversity decline, maintenance of high nature value (HNV) farmland and forestry, improvement in water quality and combating climate change measuring the changes against the corresponding baseline indicators.

Measures are defined in the light of this strategy and the rural regulation framework. For each measure, including AEMs, financial input, output and result indicators are established. Input indicators which refer to the budget or other resources are allocated at each level of assistance. Output indicators are measure specific and quantify activities in the programme, for example the total area under agri-environmental support. Result indicators measure the direct and immediate effect of the activities and provide information on changes such as the performance of beneficiaries measured in physical or monetary terms (e.g. area under successful land management contributing to water quality). The evaluation of the extent to

which a programme has achieved its strategy objectives, is built up from the outputs and results of individual measures through the hierarchy of objectives and assessed against the impact indicators at programme level. In other words, input, output and result indicators are applied at measure level, i.e. at AEM level, while the impact indicators aim at measuring the environmental (as well as socio-economic) effects of the whole programme.

Since common indicators may not fully capture all effects of programme activity, for example in relation to national priorities and site-specific measures, it is necessary that Member States and programme partnerships define additional indicators for each type of indicators in a flexible manner, but in accordance with the general principles of the CMEF. Moreover and where the nature of the assistance permits, the data relating to the indicators shall be broken down by sex and age of the beneficiaries. **The establishment of additional indicators is a key element for ensuring a correct and comprehensive assessment of environmental impacts. Farmland Bird Index data are not intended to measure the effectiveness of specific, fine-scale AEMs at site level. In most cases additional site specific monitoring studies including control sites are required** (Lukesch and Schuh, 2010, European Commission, 2006a).

Table 1 Overview of CMEF baseline indicators for agri-environmental measures

Indicator type	Indicator	Measurement
Baseline (objective-related)	Biodiversity: Population of farmland birds	Trends of index of population of farmland birds (Index, 2000 = 100)
	Biodiversity: High Nature Value farmland and forestry	UAA of High Nature Value farmland in ha of UAA
	Water quality: Gross Nutrient Balances	Surplus of nutrient per ha in kg/ha
	Water quality: Pollution by nitrates and pesticides	Annual trends in the concentrations (Index, 1992-1994 = 100)
	Soil: Areas at risk of soil erosion	Areas at risk of soil erosion in Tons/ha/year
	Soil: Organic farming	Utilised Agricultural Area under organic farming in ha
	Climate change: Production of renewable energy from agriculture and forestry	Production of renewable energy from agriculture and forestry in KToe (1000 tons of oil equivalent)
	Climate change: UAA devoted to renewable energy	Utilised Agriculture Area devoted to energy and biomass crops in ha of UAA
Baseline (context-related)	Agricultural land use	Emissions of greenhouse gases and of ammonia from agriculture in 1000 t of CO ₂ equivalent for greenhouse gases and 1000 t of ammonia
		Utilised Agricultural Area in arable area / permanent grass / permanent crops in %

	Land cover	Area in agricultural / forest / natural / artificial classes in %
	Areas of extensive agriculture	% Utilised Agricultural Area for extensive arable crops % Utilised Agricultural Area for extensive grazing
	Natura 2000 area	% of territory under Natura 2000 % UAA under Natura 2000 % forest area under Natura 2000
	Biodiversity: Protected forest	% FOWL protected to conserve biodiversity, landscapes and specific natural elements
	Forest ecosystem health	% trees / conifers / broadleaved in defoliation classes 2-4
	Water quality	% territory designated as Nitrate Vulnerable Zone
	Water use	% irrigated UAA
	Protective forests concerning primarily soil, water and other ecosystem functions	FOWL area managed primarily for soil & water protection in %

Source: European Commission (2006a)

The agri-environmental baseline and impact indicators largely build on the IRENA and Eurostat agri-environmental indicator frameworks (Eurostat, 2011, European Environment Agency, 2006). Table 1 and 2 provide an overview of the baseline and output, result and impact CMEF indicators for agri-environmental measures and themes differentiating between type of indicators and their proposed measurement.

Table 2 Overview of CMEF output, result and impact indicators for agri-environmental measures

Indicator type	Indicator	Measurement
Output	Number of farm holdings and holdings of other land managers receiving support	Number of holdings
	Total area under agri-environmental support	Supported ha of UAA (conservation of local breeds: number of livestock units)
	Physical area under agri-environmental support under this measure	Ha
	Total Number of contracts	Number of commitments
	Number of actions related to genetic resources	Number of actions
Result	Area under successful land management contributing to: (a) biodiversity and high nature value farming/forestry (b) water quality (c) mitigating climate change (d) soil quality	Total amount of hectares.

	(e) avoidance of marginalisation and land abandonment	
Impact	Reversing Biodiversity decline	Change in trend in biodiversity decline as measured by farmland bird species population (in % change complemented by qualitative judgment)
	Maintenance of high nature value farming and forestry areas	Changes in high nature value areas (Quantitative change and qualitative judgment)
	Improvement in water quality	Changes in gross nutrient balance (Value and trend)
	Contribution to combating climate change	Increase in production of renewable energy (Ktons)

Source: European Commission (2006a)

2.2. Criticism of the CMEF

The CMEF aims at making results of the evaluations more comparable across the Member States and easier to synthesise at EU level (Grajewski and Schrader, 2005). However, the heterogeneity of rural environments poses an important challenge for the analysis of AEMs using a standardized EU indicator and monitoring framework. The state and extent of the provision of different public goods from agriculture such as biodiversity, water quality and landscapes vary greatly across the different rural environments across the EU. Mortimer et al. (2010) argues that such heterogeneity of rural environments requires a flexible evaluation framework using a mix of different methods and a broad suite of indicators. In this context, stakeholders and evaluators report the need for less common indicators across the different indicator levels of the CMEF, but more flexibility in the selection of appropriate impact indicators to address spatially explicit environmental problems and objectives in the CMEF post 2013 (MEN-D, 2011, Eggers et al., 2007). More research is required to define further suitable impact indicators and monitoring requirements which need to be tested through elaborated case studies (Gijsegham et al., 2011, Oréade-Brèche, 2005).

Terluin and Berkhout (2011) question the cost-effectiveness of the strict application of the common impact indicator approach in the CMEF and suggest a mixed case study approach combining integrating qualitative methods to achieve a better understanding of the causal-relationships and to reduce the data requirements and associated costs and efforts.

Water as a public good is strongly linked to agriculture both in terms of quantity and of quality. Irrigation use leads to a depletion of exhaustible resources such as groundwater reservoirs and it increases conflicts with competitive use of water resources. Intensive agriculture, which relies on the use of fertilizer and pesticide application, plays an important role in increasing agricultural production, although contributing to water pollution. The

CMEF includes the impact indicator ‘improvement of water quality’, which is measured by changes in gross nutrient balance. Experts argue that while the gross nutrient balance provides information on the cause-side it is not sufficient for assessing the actual impacts (Huelemeyer and Schiller, 2010). Substantial resources have been invested in rural development programmes over many years to cope with diffuse pollution of agricultural origin, but causal links between agri-environmental schemes and other rural development measures and benefits for the environment and the society are affected by significant sources of uncertainty, deriving from very complex interactions in space and time involving human behaviours and the environment. The main physical and chemical phenomena are well known, and quantification is possible at local scales, but the assessment of impacts and benefits from alternative agricultural management practices and agri-environmental policies remain challenging issues. Focused efforts are required on integrated assessment methods to be adapted to local conditions.

The CMEF attempts to capture the impacts of rural development programmes on biodiversity through the impact indicators ‘reversing biodiversity decline’, measured by the farmland bird indicator, and maintenance of high nature value farming and forestry areas. A guidance document has been published by the European Evaluation Network for Rural Development (Beaufoy and Cooper, 2009) concerning the High Nature Value indicator, which recommends the use of sample surveys to capture changes in HNV farming practices and in associated nature values. However, Bormann et al. (2009) still report uncertainties about what should be measured as high nature value areas which led to delays in the fieldwork for data collection.

The farmland bird indicator is designed as an impact indicator for the whole programme at regional or national scale and is not intended to measure the effectiveness of specific agri-environment measure implemented at site level (Lukesch and Schuh, 2010). In addition, the decline of biodiversity is not only to be reversed in farmland which implies that additional indicators for other habitats need to be integrated. Although the bird index provides some indications of the presence of other living organisms such as worms, insects, seeds, since birds are quite high in the food chain, the extent and quality of the decline of wildlife and endangered species can not only be measured by farmland bird populations and need to be expanded by indicators which take into account wider species composition and abundance as well as the state of the biotopes (Barankova et al., 2010; Huelemeyer and Schiller, 2010). A wider indicator approach was used by Gomiero et al. (2011) comparing the environmental performance of organic and conventional farming on the basis of a wide range of different indicators including crop, fauna and habitat diversity as well as effects on pest control and pollinators. In addition, the EU project BioBio tested and validated habitat, species level, genetic and farm management indicators of organic and low-intensity farming systems in

different case study regions across the EU (Dennis et al., 2010). Similarly, also Simoncini (2010) proposes a monitoring approach with several sets of indicators capturing the state of the agro-ecosystems, the local agricultural land use and practices and the impacts of agri-environmental measures upon the ability of agro-ecosystems to deliver environmental goods and services.

The CMEF needs to be understood as unified minimum requirements at EU level and flexibility applied in the selection of appropriate indicators to address spatially explicit environmental problems. Additional environmental outcome indicators at measure level will help to assess the required impact indicators at programme level.

The following section will review existing indicator and monitoring approaches in more detail to identify key issues for the application of additional indicators and monitoring efforts in the assessment of AEMs in Lithuania.

3. Literature review of indicator and monitoring approaches

Following a short outline of general criteria for selecting and structuring indicators, this section provides an overview of the existing main international agri-environmental indicator frameworks (e.g. IRENA and OECD frameworks) identifying relevant indicators for biodiversity and eutrophication reduction. This is followed by a literature review of new developments and applications indicator and monitoring frameworks specifically for the purpose of assessing the effectiveness of AEMs including some relevant examples for the application of alternative or additional indicator and monitoring studies in other EU countries. The section also considers data requirements and applications of qualitative methods to overcome existing data gaps.

3.1. General criteria for selecting and structuring indicators

A number of different studies have summarized key criteria for selecting agri-environmental indicators. Niemeijer and Groot (2008) summarized common environmental indicator selection criteria under seven different dimensions including scientific, historic, systemic, intrinsic, financial and practical, and policy and management dimensions. Dennis et al. (2009) and Le Roux et al. (2008) provide an overview of the criteria for selecting (biodiversity) indicators differentiating between criteria for single indicators and sets of indicators:

- ❖ **Single indicators**
- Policy relevant and meaningful
- Biodiversity relevant
- Scientifically sound

- Broad acceptance
- Affordable monitoring
- Affordable modelling
- Sensitive
- ❖ **Sets of indicators**
 - Representative
 - Small number
 - Aggregation and flexibility

In order to clarify the inter-relationships between human beings and the environment, the European Environment Agency (EEA), OECD, Eurostat and other institutions have adopted conceptual frameworks for the derivation of indicators (EFTEC and IEEP, 2004). Commonly used terms for this type of framework are Pressure-State-Response (PSR), Driving force-State-Response (DSR) or Driving force-Pressures-State-Impact-Response (DPSIR) (EEA, 2000; FAO, 1999; Coffey and Baldock, 2000). EEA, Eurostat and European institutions tend to use the DPSIR framework, which is used to assess and manage environmental problems. Driving forces are the socio-economic and socio-cultural forces driving human activities, which increase or mitigate pressures on the environment. Pressures are the stresses that human activities place on the environment. State, or state of the environment, is the condition of the environment. Impacts are the effects of environmental degradation. Responses refer to the responses by society to the environmental situation (UNEP, 2012).

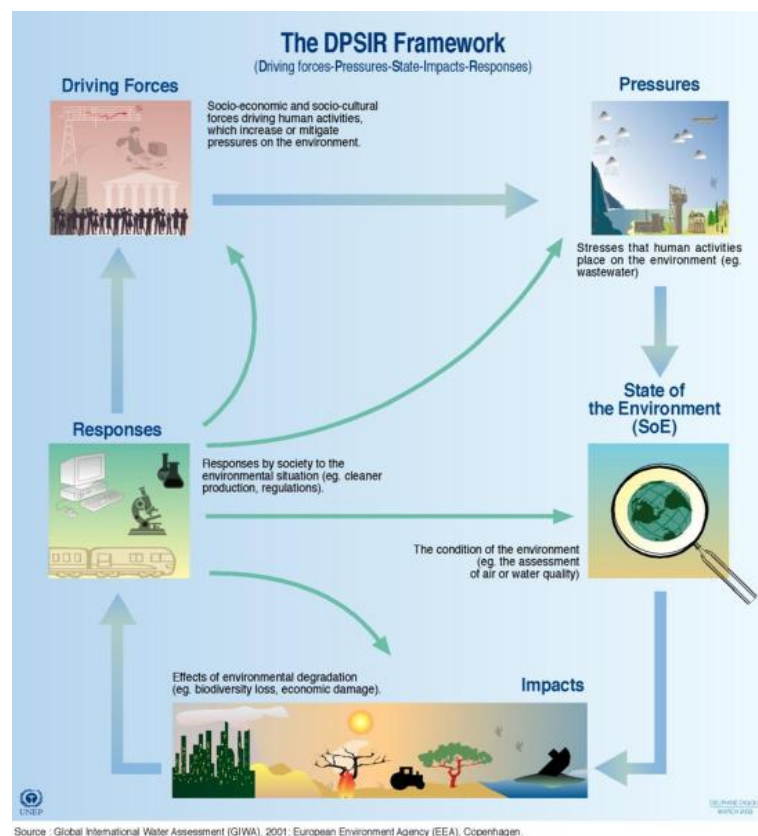


Figure 2 The DIPSIR framework

Source: Global International Waters Assessment (GIWA) (2001) taken from UNEP (2012) http://www.grida.no/graphicslib/detail/dpsir-framework-for-state-of-environment-reporting_379f#

A variation of the DPSIR framework is the DSR framework, launched by the OECD in 1997 (OECD, 1999). The DSR framework takes into account the specific characteristics of agriculture and its relation to the environment. The DSR framework addresses a set of questions related to the complexity of agri-environmental linkages and feedbacks (OECD, 1999), including:

- What is causing environmental conditions in agriculture to change (driving force)?
- What effect is this having on the state or condition of the environment in agriculture (state)?
- What actions are being taken to respond to changes in the state of the environment in agriculture (response)?

3.2. Agri-environmental indicator frameworks

Undoubtedly indicators are of growing relevance for the international environmental policy analysis. Latest since the Rio Conference in 1992 methods are in great request which enable a quantitative and qualitative environmental observation (Piorr, 2003). Major international efforts to develop agri-environmental indicators include the IRENA and OECD indicator frameworks. The purpose of the IRENA operation was to develop and compile, for the EU-15, the set of 35 agri-environmental indicators at the appropriate geographical levels and, as far as possible, on the basis of existing data sources (EU-Commission, 2006b). The indicators were developed in line with the DSR framework (OECD, 1999), and are listed in annex 3 of the IRENA report (EEA, 2005). The following indicators are directly link to biodiversity, water use and water quality:

❖ **Biodiversity**

- Genetic diversity (1. Crops: Share in production of main crop varieties registered and certified for marketing. 2. Livestock: Diversity of breeds in total livestock population for different types of livestock)
- Population trends of farmland birds (Population trends of up to 23 selected bird species that are common and characteristic of European farmland landscapes.)
- Impact on habitats and biodiversity (1) Share of Important Bird Areas (IBA) in the EU-15 affected by agricultural intensification and/or abandonment; 2) Population trends of agriculture-related butterfly species in Prime Butterfly Areas)

❖ **Water use**

- Irrigation (water intensity) (Share of irrigable areas/UAA)
- Water abstraction (Indicated by the annual water allocation rates for irrigation)
- ❖ **Water quality**
- Gross Nutrient balance (Potential surplus of nitrogen on agricultural land (kg N/ha/year))
- Water quality – Nitrate pollution (Nitrates in water are indicated by annual trends in the concentrations of nitrate or total oxidised nitrogen (expressed in mg/l NO₃) in ground and surface water bodies.)
- Water quality – Pesticide pollution (Pesticides in water are indicated by annual trends in the concentrations (µg/l) of selected pesticide compounds in ground and surface waters.)
- Ground water levels – Trend in ground water levels

In the follow up of the IRENA operation (COM(2006)508, European Commission, 2006b) the European Commission identified key challenges for future work on EU agricultural agri-environmental indicators including streamlining and consolidating the indicator sets and currently a set of 28 indicators is under development in collaboration with the Member States. However, in terms of the biodiversity indicators only the indicators genetic diversity and population trends of farmland birds are included.

The OECD has developed a comprehensive environmental indicator system differentiating between core, key, sectoral, environmental accounting and decoupling environmental indicators (OECD, 2003). Sectoral environmental indicators provide sets of indicators for agriculture and forestry. Specifically for agriculture, the OECD has developed an agri-environmental framework which covers a wide range of themes including land, energy, air, nutrients, soil, biodiversity, pesticides, and water farm management, as well as some socio-economic aspects and provides 18 indicators developed based on the DSR model (OECD, 2008, OECD, 1999). Several of the OECD agri-environmental indicators have been selected in the evaluations of the Member States and their regions as additional impact indicators (Lukesch and Schuh, 2010, Grajewski et al., 2010).

OECD biodiversity indicators are differentiated between genetic diversity, wild species diversity and ecosystem diversity. Wild species and ecosystem diversity includes the following 5 indicators:

- ❖ **Wild species diversity**
- Wild species that use agricultural land as primary habitat.

- Populations of a selected group of breeding bird species that are dependent on agricultural land for nesting or breeding.
- ❖ **Ecosystem diversity**
- Conversion of agricultural land area to (land exits) and from (land entries) other land uses.
- Area of agricultural semi-natural habitats (i.e. fallow land, farm woodlands) in the total agricultural land area.
- National important bird habitat areas where intensive agricultural practices are identified as either posing a serious threat or a high impact on the area's ecological function.

On water issues, the OECD framework includes 3 indicators on water use and the following 4 indicators on water quality:

- ❖ **Water quality**
- Nitrate and phosphate contamination derived from agriculture in surface water and coastal waters.
- Monitoring sites in agricultural areas that exceed recommended drinking water limits for nitrates and phosphorus in surface water and groundwater.
- Monitoring sites in agricultural areas that exceed recommended drinking water limits for pesticides in surface water and groundwater.
- Monitoring sites in agricultural areas where one or more pesticides are present in surface water and groundwater.

Eurostat, together with the European Commission's Environment and Agriculture and Rural Development DGs, the Joint Research Centre and the European Environment Agency, started to collect data on the 28 agri-environment indicators defined in COM (2006) 508 final. The aim is to monitor the development of regional farming pattern as the basis for assessing the risks policy or production changes pose to the conservation of the environment, or, if these changes are contributing positively to the preservation and enhancement of environmental resources. 6 out of the 28 indicators (agricultural areas under nature protection (Natura 2000), area under organic farming, irrigation, intensification/extensification, specialization, share of agriculture in greenhouse gas emissions) are ready to use, with well-defined concepts and measurement and with data available at the appropriate regional level (Eurostat, 2011). While indicators directly targeted at biodiversity are not included amongst those 6 indicators, the indicator agricultural areas under nature protection (Natura 2000) could be used as a proxy indicator biodiversity highlighting areas with higher biodiversity potential.

For many of the other indicators, for example nitrogen balance and water quality, Eurostat has identified the availability of regional data as the main issue which needs to be tackled. The main source for Eurostat's agricultural statistics is the farm structure survey, which is carried out every three years. Additional data sources are crop and animal production data, agricultural monitoring statistics, and the land use/cover area frame survey (LUCAS). However, there are still many gaps to be filled (Eurostat, 2011).

3.3. Recent developments in indicator and monitoring frameworks for the assessment of AEMs

A number of European studies have developed and tested agri-environmental indicator and their monitoring requirements with the aim to improve the effectiveness of AEMs targeted at biodiversity and landscape effects (e.g. AEMBAC project (Simoncini et al., 2004) and the Biobio project (Dennis et al., 2009)). Other studies have tested indicator and monitoring requirements for measuring biodiversity in different agro-ecosystems (e.g. Matzdorf et al., 2008, Billeter et al., 2008, Kaiser et al., 2010, Nascimbene et al., 2012 and Hawes et al., 2010). Indicator and monitoring requirements for water quality and nutrient enrichment control (eutrophication reduction) in marine and coastal environments have been tested by Baan and Buuren (2003). Different approaches for measuring the nutrient balance for nitrogen are reported by Gybels et al. (2009). Other relevant studies include, for example, Niemeijer and Groot (2008), Kersebaum et al. (2006), Carpani et al. (2008), Zalidis et al. (2004) and Osterburg and Techen (2011). The considers the overall concept, selected or developed indicators, monitoring approach and identified key issues in terms of strength and weaknesses for the application of assessing AEMs.

The AEMBAC approach

The overall objective of the AEMBAC methodology was to set up the design and development of agri-environmental measures (AEMs) that ensure the effective conservation of biodiversity and the environment by improving the sustainability of local agricultural practices (Simoncini et al., 2004 and Simoncini, 2010). However, the methodology can be used for a wide range of different ecosystem services. The methodology builds on the analysis of two sets of indicators and their relationships covering the state of each agro-ecosystem and its ability to perform selected environmental functions, the local agricultural land use and practices and the impacts of agri-environmental measures on the ability of agro-ecosystems to provide environmental ecosystem services. Simoncini (2010) argues that the environmental functions approach synthesises many ecological information but at the same time maintains the complexity of biophysical relationships between biodiversity, air, water, soil, landscape

and agriculture systems. The usefulness of an ecosystem function approach is also supported by a large number of other studies (e.g. Costanza et al. 1997, Millennium Ecosystem Assessment 2005, Fisher, Turner and Morling, 2008, EASAC 2009).

The analysis is carried out through a process of three sequential steps starting with the identification and analysis of agro-ecosystems, followed by the analysis of agro-ecosystem functioning for the provision of environmental goods and services. In a third step, the expected impacts of agri-environmental measures on the defined state indicators is incorporated in the analysis providing the basis for monitoring and assessing the effectiveness of agri-environmental measures at the end of their implementation period (Simoncini et al, 2004 and Simoncini, 2010). These steps represent logical steps in the assessment of the effectiveness of AEMs defining the scale of the analysis, selecting indicators to measure the baseline, and assessing the impacts of AEMs.

At the beginning of the first step, criteria (land cover, soil data, topographical data, etc. depending on the characteristics of the rural environment) for the definition of different types of agro-ecosystems are selected. The different identified agro-ecosystems are then further classified according to the degree of intensity of the local agricultural systems applying agri-environmental indicators developed by OECD and EEA (see above). To do the classification, Simoncini et al. (2004) propose the use of four broad indicator groups in relation to nutrients management, pest control management, land use and soil management and water and irrigation management. The classification and analysis of agro-ecosystem services largely builds on existing data. Existing data, for example obtained through a range of monitoring stations and/or farm structure surveys can be rearranged from analyzing and presenting the data at administrative boundaries to agro-ecosystem boundaries classified according to the defined agro-ecosystem criteria (for example soil qualities, altitude and type of agricultural management).

Ecosystem health is defined by the functions that an ecosystem performs (Constanza, 1992). The second step identifies the relevant environmental functions of the different agro-ecosystems and analyses their environmental minimum requirements to supply environmental goods and services. The identification of ecosystem function can build on those functions which are already identified in the rural development programmes. Each environmental function is analysed by a set of locally relevant state indicators describing ecological structures, processes and components at agro-ecosystem (landscape) level. The state indicators are the main tools to define the environmental minimum requirements of the selected functions of the agro-ecosystems to provide the environmental goods and services

which are then used as a baseline to measure the state of health of an ecosystem, the sustainability of the impacts of local agricultural practices, and the effectiveness of AEMs.

In the context of the environmental function “conservation of biodiversity” Simoncini (2010) suggests the following state indicators:

- Genetic diversity of cultivated crops and reared animals
- Abundance and richness of key wild species
- Presence and extension of biotopes
- Landscape diversity
- Spatial matrix of cultivated parcels

The range of state indicators addresses the need for defining supplementary biodiversity indicators for the assessment of the effectiveness of AEMs which take into account wider species composition and abundance as well as the state of the biotopes in addition to the CMEF impact indicator ‘reversing biodiversity decline’. Taking into account the state of the biotopes directly incorporates the main pressures on biodiversity in agricultural landscapes (such as intensification of agriculture, abandonment of agricultural landscape and climate change) in the indicator and monitoring framework (Schindler, 2009, Barankova et al., 2010).

The third step in the AEMBAC methodology assesses the effectiveness of AEMs based on the environmental minimum requirements of the environmental functions of the agro-ecosystems measured in step 2. However, the third step consists of two separate parts – assessment of status quo in relation to the environmental minimum requirements and the actual assessment of the effectiveness of AEMs – and a differentiation of these two steps into a third and fourth step is suggested in this review (compare with step 3 and step 4 in Figure 3). The environmental minimum requirements provide the baseline for the assessment of the impacts of local agricultural practices in terms of delivering environmental goods and services in selected agro-ecosystems. By looking at the gaps between the actual values of the set of state indicators and the corresponding values of environmental minimum requirements, the analysis can identify which ecological factors need to be improved to achieve the provision of desired environmental goods and services in a specific agro-ecosystem. By incorporating the expected impacts of AEMs in reducing (or ideally eliminating) the gap between actual values and minimum requirements of the analysed state indicators, the AEMBAC approach allows to monitor and assess the effectiveness of agri-environmental measures in contributing to providing environmental goods and services (Simoncini, 2010).

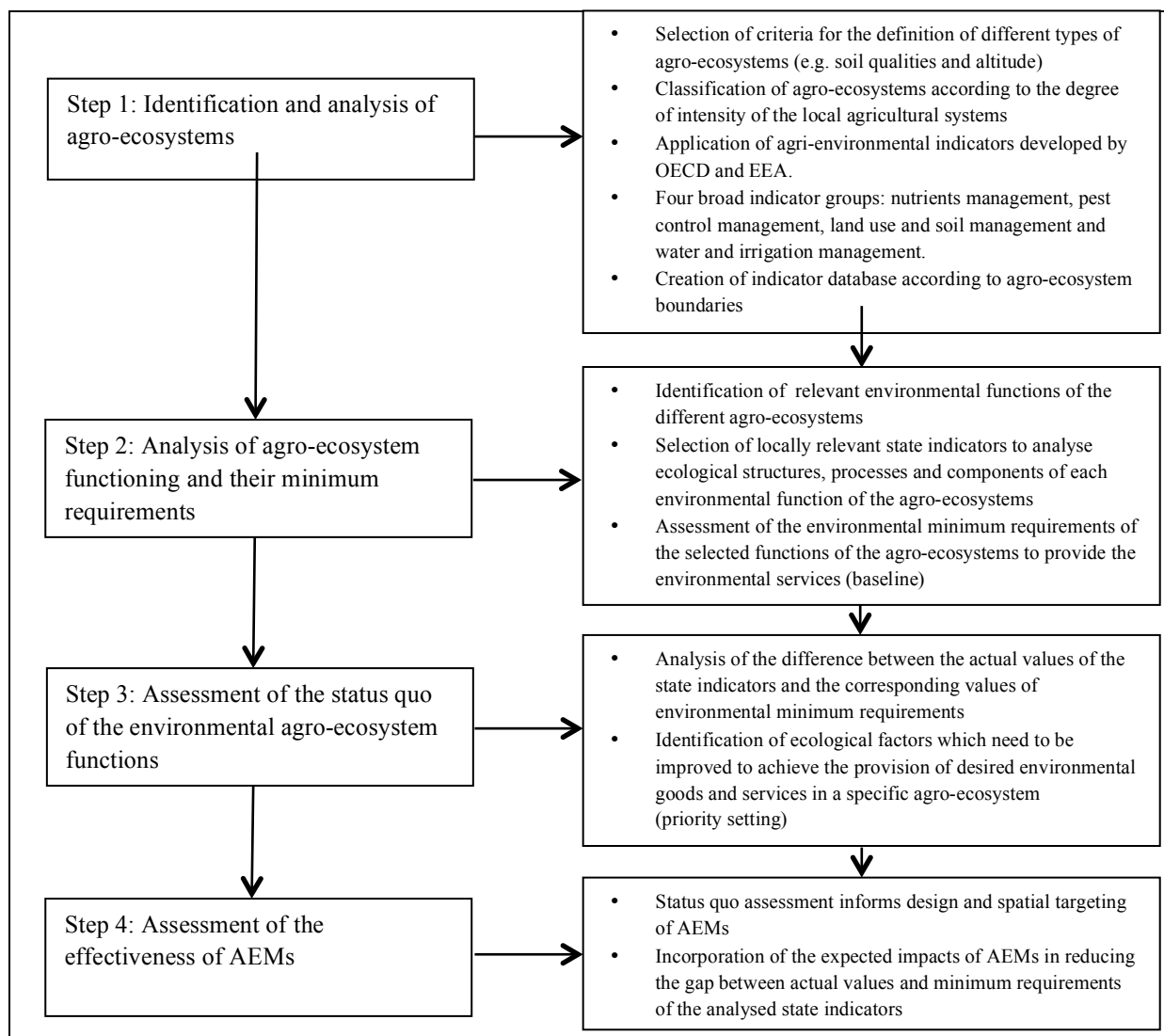


Figure 3 Step-by-step approach of the AEMBAC methodology

Source: Adapted from Simoncini (2010)

However, the impacts of agri-environmental schemes can only reliably be determined if environmental changes on scheme sites are compared with those on suitable control sites and if results are properly statistically analysed. The studied scheme sites should be a random sample of all scheme sites to ensure representativeness for the scheme in general. This furthermore ensures that not only the effectiveness of agri-environmental measures is tested, but also the way in which a scheme is being implemented (Kleijn, 2010, Kleijn and Sutherland 2003).

The agro-ecosystem function approach applied in the AEMBAC methodology integrates information and data on local agricultural systems with those on most relevant ecological

aspects. A selection of state indicators is used to define indicator baselines quantifying the environmental minimum requirements of the different ecosystems functions to achieve the delivering of site specific environmental goods and services which then can be integrated to a landscape scale assessment. Depending on the policy objectives, the analysis can focus on state indicators of the most policy or ecologically relevant ecosystem functions and can thus also be used for ecosystem functions other than biodiversity conservations. The AEMBAC methodology has been developed with the aim of providing an integrated indicator and monitoring framework for the implementation and impact assessment of AEMs. The assessment of the state of the agro-ecosystems in comparison to the environmental minimum requirements can inform the implementation of spatially targeted AEMs according to the status quo situation of different agro-ecosystems in different region. Through analytical sound monitoring of the state indicators before, during and after the implementation of the AEMs, the effectiveness of these measures (in terms of improving the provision of environmental goods and services) can be assessed against their expected results in reducing the gap between actual values and environmental minimum requirement values of state indicators.

The AEMBAC approach provides a comprehensive agro-ecosystem framework considering different phases of AEM assessment. While its implementation for the assessment of AEMs in Lithuania in the current programming period does not seem to be feasible, the approach highlights important aspects for the assessment of AEMs in the next programme period such as targeting agro-ecosystem functions and implementing environmental status quo assessments.

The BioBio approach

Specifically targeted at biodiversity conservation, the BioBio project aims at developing a generic indicator system covering genetic, species and habitat diversity, to assess the benefits of organic and low-input farming systems for farmland biodiversity. The BioBio project follows the proposition of Le Roux et al. (2008) in dividing biodiversity indicators into indirect and direct indicators (Dennis et al. 2009). Both types of indicators may report on biodiversity itself but may also provide information on associated functions (Clergue et al., 2005).

Dennis et al. (2009) define indirect indicators as factors acting on biodiversity and representing risk or opportunity for biodiversity, or consequences of biodiversity state. These indicators are primarily oriented toward decision making and the evaluation of measures that favour biodiversity (e.g. change of agricultural practices, success of agri-environmental measures). The general selection criteria listed above can be applied to the selection of

indirect indicators. However, indirect indicators are not part of biodiversity and the relationship between the potential indirect indicator and any direct indicator needs to be examined and confirmed.

Table 3 Biodiversity indicators in the BioBio project

A) Genetic diversity	B) Species diversity	C) Habitat diversity	D) Indirect
Animal husbandry	1) Flowering plants of semi-natural habitats	1) Habitat patch density	1) Diversity of enterprises at the farm
1) Number and amount of different breeds per species (Breeds)	2) Earthworms	2) Habitat richness	2) Average stocking rates (grazing livestock units ha-1) on farm
2) Information on breeding practices ("on-farm" bull, artificial insemination,...)	3) Bird species richness	3) Habitat diversity	3) Area of land without use of mineral based fertilisers
3) Where available, pedigree of the herd	4) Araneae-spiders	4) Number of crops in rotation	4) N input
Arable crops, legumes and trees	5) Hymenoptera, bees and wasps	5) Percentage area of arable land	5) Input or direct and indirect energy for crop production
4 + 5) Number, amount and origin of different cultivars / landraces / accessions per species		6) Percentage area of permanent grassland	6) Certified as Organic
6) Information on seed propagation practices (on farm multiplication, sharing with neighbors, etc.)		7) Percent of tree cover	7) IRENA Indicator 1: area under agri-environment support
7) Where possible, description of the cultivars based on IPGRI descriptors (through the farmer)		8) Cover of shrub layer	8) IRENA Indicator 15: intensification/extensification
8) Where available, pedigree information on the cultivars grown		9) Availability of nitrogen, pH, moisture as Ellenberg values	9) Pesticide use – treatment frequency indicator
Grassland		10) Weeds in crops	10) Area of land without or with reduced use of chemical pesticides
9) Where available, number and amount of different cultivars		11) Cover of flowering plants: flowers of different colours	11) Frequency and timing of field operations
10) Information on seed propagation practices and amount of re-seeding		12) Vegetation composition: share of valuable habitats	12) Frequency and intensity of livestock grazing
		13) Linear elements: hedgerows, grassy strips between fields, streams, rivers and lakes, stone walls and terrace walls	13) Productivity (cereal, milk or meat)
		14) Multispecies grassland swards	14) Irrigation
		15) Grassland quality	

Source: Based on Dennis et al. (2009)

The BioBio project divides indirect indicators into different categories including regulatory and certification, farm type and structure, enterprises (e.g. diversity of enterprises and proportion of breeds), specific management practices, overall diversity indicators (e.g. habitat density and habitat richness). Indirect indicators are largely based on data from farm structure surveys, FADN, farmer interviews and assessment of management intensity during farm visits (Dennis et al. 2009).

Direct indicators are broad in scope and are available to assess the genetic diversity of cultivated plants and livestock breeds, the genetic characterisation of soil micro-organisms and the species diversity of plant and animal life, both domesticated and representing wildlife. The final group of indicators is measurements of habitats and landscape of farms, including linear features that are often refugia for much of the species diversity.

The four distinct lists of indicators (indirect, genetic, species and habitats/ landscape) were evaluated by an expert group applying scientific selection criteria. This produced a priority list for each group for evaluation based on the application of criteria proposed by a stakeholder group and an assessment of cost of effort in the field, laboratory, for analysis and communication elements of the implementation of each candidate indicator. In total, the list included 10 indicators for the genetic diversity, 5 for the species diversity, 13 for the habitat diversity and 12 indirect or farm management indicators (table 3).

The BioBio project differentiates between indirect indicators measuring changes in farm and land management and direct indicators directly measuring changes in genetic, species and habitat diversity. Interactions between these indicator sets were next assessed and the most complementary combinations were selected to cover the necessary range of biological organisation and spatial scales. The selected indicators were chosen as sensitive to year to year changes in farming systems. However, data for some indicators will have a time lag before analysis and reporting.

The OECD Agri-Biodiversity Indicators Framework (ABF) pyramid

Both, the AEMBAC methodology and the BioBio biodiversity indicator frameworks broadly reflect the structure of the OECD Agri-Biodiversity Indicators Framework (ABF) pyramid (OECD, 2001).

The pyramid draws together different agri-biodiversity indicators of genetic resources, habitats, and wild species within a coherent framework which recognizes the diversity of elements in an agro-ecosystem, the complexity of the interactions among the different elements in the agro-ecosystem, hierarchical structure of different layers within the

agro-ecosystem, and tangible and quantifiable specification of biodiversity. The ABF offers the possibility to identify and structure a range of indicators for different policy purposes and at varying spatial scales.

Indicators can be used, for example, to highlight the risk of genetic erosion of domesticated crop varieties and livestock breeds (indicators of genetic resources); to track the performance of a particular policy measure aimed at reducing wetland loss to agriculture (indicators of habitat quantity); and monitor the progress of a policy measure seeking to increase the population size of rare and endangered wild species associated with agriculture (indicators of habitat quality). Also combining indicators to measure current or future trends concerning the impact on wild species of changes in agricultural land use and cover patterns, habitat structure and farm management practices and systems (indicators linking habitat quantity to quality) (OECD, 2001).

Other studies on biodiversity indicators – some examples

In addition a large number of studies have developed and tested selected indicator types and monitoring requirements for measuring specific biodiversity effects of AEMs in different agro-ecosystems. The following paragraphs briefly review some examples including studies on HNV farmland, bird species index and bird indicator species, arable plant communities and plant indicator species in grassland. In recent years the application of biodiversity indicators for outcome-based AEMs has received increasing attention, in particular with respect to bird and plant indicator species.

Pointereau et al. (2010) developed a farming system approach to identify High Nature Value (HNV) farmland. The farming system approach was developed in a French context in 2006 (Pointereau and Thomas, 2006) and is based on an aggregated indicator describing three main characteristics of farming systems and practices in relation to biodiversity: the diversity of crops, the extensivity of farming practices and the presence of landscape elements. A scoring system offers the possibility to have a variable HNV threshold (Pointereau et al., 2010). In contrast, the approach developed at European level by JRC/EEA (Paracchini et al., 2008) was based on land cover and biodiversity data.

Butler et al. (2010) quantified the impact of land-use change to European farmland bird populations (measured through the European Farmland Bird Index (EFBI)) and analysed the key drivers of population change in agricultural landscapes across 20 countries. The authors concluded that changes in resource availability within the cropped area of agricultural landscapes have been the key driver of current declines in farmland bird populations.

The EFBI is based on data collected under the Pan-European Common Bird Monitoring Scheme (PECBMS). The PECBMS generates national population indices for 135 bird species (Gregory et al., 2005). Supra-national indices for four European regions, North (Finland, Norway & Sweden), West (Austria, Belgium, Denmark, Germany, Holland, Ireland, Switzerland & United Kingdom), East (Czech Republic, Estonia, Latvia, Hungary & Poland) and South (France, Italy, Portugal & Spain), are calculated as the weighted average of a species' trend in the constituent countries. The trends are weighted by relative breeding population size of each bird species in each country (taken from BirdLife International, 2004 cited in Butler et al., 2010). Pan-European trends are calculated based on the weighted average of regional trends, again based on the relative proportion of the European breeding population found in each region. Multi-species indices, such as the EFBI, are calculated at a regional or pan-European scale by calculating the geometric mean of contributing species' trends.

However, as outlined in section 1, the common farmland bird indicator (FBI) is designed to measure broad programme effects and is generally not intended to measure the effectiveness of specific agri-environment measures implemented at site level (Lukesch and Schuh, 2010). Only in cases where the AEM in question is being implemented at a very broad scale, and there are enough sample plots in areas where the measure is applied it might be possible to use also the results of common farmland bird monitoring to assess the effectiveness of the measure. In this context, Lukesch and Schuh (2010) suggest that countries whose FBI data have a very good coverage may use these data also for the assessment of impacts of measures.

In most cases the FBI does not have such a good coverage or the data do not coincide with areas under specific measures. In these cases the existence and use of other previous or ongoing bird monitoring have to be investigated. The assessment of individual measures or schemes requires ad hoc and highly replicated field studies, including pair-wise comparisons with control sites. It is also necessary to partition environmental variability that is not directly linked to the AEM, making it possible to separate effects actually caused by the measure on the population of bird species from other effects. The choice of wildlife species or communities to monitor should be governed primarily by the specific objectives of the individual measure. The scale of the monitoring is largely determined by the mobility of the species relevant for the specific AEM. For species that disperse widely monitoring should take place at field and landscape scale. Species that are less dispersive and slow to reproduce should be monitored at the field-scale or patch-scale, as populations will respond directly to localised land management (Lukesch and Schuh, 2010).

Lukesch and Schuh (2010) report an example for AEM-related bird monitoring from Estonia. Together with other biodiversity data (bumblebees, vascular plants and earthworms) farmland birds are monitored also for the RDP 2007–2013 period in 66 farms in total covering different regions (reflecting different soil conditions and agricultural intensities), farm sizes and farm practices (e.g. organic farms and conventional farms). Monitoring sample also consists of reference farms not participating in the agri-environmental scheme. Depending on the region and landscape structure the composition of bird species may vary quite significantly in Estonia. Birds are counted annually using the line transect method (0.5 - 2 km per field). Farmland bird data are analysed together with data for other taxa (especially bumblebees) and landscape (Agricultural Research Centre, 2010 cited by Lukesch and Schuh, 2010).

The assessment of the impacts of AEMs on birds in England is carried out through a combined approach integrating three parameters (DEFRA, 2010 cited by Lukesch and Schuh, 2010):

- The farmland bird index and the national population data for each of the 19 species that make up the index,
- measurement of the area of suitable habitat that is known to be of value to the index species, and
- additional site specific monitoring of the populations of rare and localised farmland bird species known to benefit from agri-environmental management.

Detailed guidelines on bird monitoring as well as of trend calculations for the EFBI can be found in Gregory et al. (2004 and 2005) or on the European Bird Census Council website (www.ebcc.info).

The potential of outcome-based PES is also generating increased interest in Europe and a number of outcome-based AEMs mainly targeted at grassland biodiversity and specific bird species were implemented and tested in a number of EU countries. Musters et al. (2001) conducted a trial on using per-clutch payments to preserve nesting Lapwings and Black-tailed godwits in the Netherlands, and Verhulst et al. (2007) similarly studied the use of per-clutch payments to enhance wader breeding success within Dutch agricultural cooperatives. A scheme in Schleswig-Holstein paid farmers for the conservation of four endangered bird species differentiating between single breeding pairs and entire colonies (Stapelholmer Naturschutzvereine, 2007). The Dutch examples provide payments for the presence of clutches from the targeted bird species in the agricultural land under the AEM contract. Farmers and volunteers monitor the outcome indicators (numbers of clutches on farmland) which presumably lower monitoring costs. Verhulst et al. (2007) conclude that the

implementation of per-clutch payments by agri-environment collectives is more effective than establishing fixed mowing dates, although the combination of these two scheme elements did not result in a significantly higher wader abundance (Schwarz et al., 2008).

Hawes et al. (2010) examined the application of arable plant communities as indicators of conventional, integrated and organic farming practices. Arable plant communities were used to assess the species richness at field scale as well as regional and landscape scale. The diversity and abundance of the within-field seedbank and emerged weed flora was measured in over 100 fields from conventional, integrated and organic farms across the arable east of Scotland. The authors conclude that increasing the diversity of crop types and cropping practices between fields may offer a complementary approach to reducing agrochemical inputs for enhancing arable biodiversity across landscapes. The approach of using arable plant community indicators can be relevant for AEMs targeted at promoting integrated and organic farming practices.

Matzdorf et al. (2008) developed biodiversity indicators to design efficient agri-environmental schemes for extensively used grassland, covering different site conditions and types of grassland. A particular innovative aspect of this study was the design of biodiversity indicators for an outcome-based AEM approach, paying land managers for the delivery of specified (in terms type and quantity or quality) environmental outcomes or services on grassland agro-ecosystems. Similar approaches have been analysed by Klimek et al. (2008) and in the MEKA-Programme in Baden Württemberg in Germany (Oppermann and Gujer, 2003). Matzdorf et al. (2008) demonstrated how a checklist of indicator plant species can be derived by using expert knowledge and statistical crosschecks with a database of pre-existing vegetation samples. The quality or conservational value of the species-rich agriculturally usable grassland was defined according to the three criteria number of species, species indicating extensive use and Red List species, which guided the selection of indicator species. The suite of indicator species was used to identify potentially valuable sites to enter into AEMs and the progress of the management on the site. Grassland sites were eligible for support, if at least a threshold of four selected indicator species was identified.

One of the challenges in deriving an indicator checklist was to represent quality through species that not only satisfy scientific criteria like validity, but are also easily identifiable and thus operational within AEMs. The number of listed indicator species is apparently sufficient to overcome seasonal variation in presence, but may still require more than one monitoring per year, which increases the monitoring efforts of AEMs. **This is, however, is not problem if farmers make own continuous assessment of the presence or absence of indicator species.** The monitoring of simple presence/ or absence of indicator species avoids difficulties

of assessing plant cover (Schwarz et al., 2008). Klimek et al. (2008), for example, observe that on-the-spot inspections revealed that farmers were able to conduct floristic inventories by themselves and to rank their grassland sites according to the quality-levels of ecological goods”.

Other studies on water quality and nutrient enrichment control – some examples

Indicator and monitoring requirements for water quality and nutrient enrichment control (eutrophication reduction) in marine and coastal environments have been tested by Baan and Buuren (2003). The authors developed a DPSIR assessment framework for eutrophication in coastal waters and identified the run-off of nutrients to surface water from the use of fertiliser and manure on agriculture land as one of the key pressures. Different approaches for measuring the nutrient balance for nitrogen are reported by Gybels et al. (2009). The study calculated a gross nitrogen balance at Nuts 3 level in Belgium that takes into account organic and mineral fertilizer use, atmospheric nitrogen deposition, biological nitrogen fixation, the use of seeds and planting material, crop removal and ammonia emission to calculate the soil surplus. Vinther and Borgensen (2010) used agri-environmental indicators N and P surplus to evaluate the impacts of Environmental Action Plans. They estimated the nutrient surplus from a farm gate balance using data from Statistics Denmark combined with measured values of N and P contents of individual products.

The Federal Office for Agriculture (FOAG) monitors agri-environmental indicators (including water and nutrient related indicators) in Switzerland with the intention of determining the influence of agriculture on environmental quality, as well as the development of the environment as a function of agricultural practices. The AEI FADN project provides a network of data-recording farms (AEI FADN) as a basis for the calculation of AEIs for regions and farm types that take into account the heterogeneity of Swiss agriculture (Stutz and Blaser, 2010). Participating farms are classified according to regional criteria and farm type differentiating between 11 farm types and 3 regions (valleys, hills, and mountains). The farm type classification follows the standard FADN farm types.

The environmental indicators collected and analysed for the participating farms are classified according to indicator types and subject area. To address the problem of time gaps between changes in indicators of the state of the environment and causes or actions responsible for these changes, two indicator types ‘Driving Forces’ and ‘Potential Environmental Impacts’ have been added. The indicator type ‘Driving Forces’ summarises the practices which are effectively taking place on the farms, whilst the indicator type ‘Potential Environmental Impacts’ gauges potential consequences of these actions through the application of model

calculations (Stutz and Blaser, 2010). The indicators relevant for water quality and nutrient enrichment control are summarized in Table 4.

Table 4 Classification of water and nutrient indicators in the AEI FADN project

Subject areas	Indicator types		
	Driving forces: agricultural practices	Environmental Impacts: Agricultural Processes	State of the Environment
Nitrogen	Nitrogen balance in agriculture	Potential nitrogen emissions (nitrate, ammonia and nitrous oxide emissions)	Nitrate pollution of groundwater from agriculture
		Ammonia emissions	
Phosphorus	Phosphorus balance in agriculture	P contents of soils	Phosphorus pollution of lakes from agriculture
Water	Use of plant-protection products	Risk of aquatic ecotoxicity	Pollution of groundwater owing to plant-protection products
	Use of veterinary pharmaceuticals		Veterinary pharmaceuticals

Source: Adapted from Stutz and Blaser (2010)

Model applications, based on a model developed by Kersebaum et al. (2006), were also used by Matzdorf et al. (2007 and 2010) to simulate environmental indicators for the outcome-based remuneration of farmers for the reduction of nitrate leaching from the root zone. The model simulations were carried out for four agricultural practices (conventional arable land, conventional grassland, organic arable land, and organic grassland/ extensive grassland management). Spatially explicit calculations (at the level of the smallest administrative unit with an average size of 190 ha) of nitrate leaching reduction are made for different land conversion scenarios including conversion of conventional arable land into extensive grassland, changing conventional arable land into organic arable land, and changing conventional grassland into organic grassland or extensively used grassland (Matzdorf et al., 2010).

The ecological benefits of the N reduction will depend on initial starting level and on passing a threshold after which some positive impact may be likely. In addition, the scale of the achieved ecological impacts of result-oriented schemes targeted at enhancing water quality depends on a whole catchment approach as freshwater ecological conditions are always subject to adjacent and upstream processes and time-lags in the cause-and-effect chain are typical. Matzdorf et al. (2007 and 2010) offer a model-based simulation of nitrate-leaching figures as a solution to non-point pollution and time-lag problems in the design of outcome-based AEMs.

The calculated effects of the AEMs depend on accuracy of model in determining appropriate N reduction. However, Schwarz et al. (2008) conclude that even if the model is not strictly

accurate in all situations, it is still likely to produce a sensible weighting for N reduction. In this example, the scenario simulations suggest average N-leaching reduction for the whole of Brandenburg between 44.0 kg and 5.8 kg N ha⁻¹ (Matzdorf et al., 2007). The lowest level of reduction (5.8 kg ha⁻¹) is unlikely to have any detectable ecological effect even with expensive monitoring (Schwarz et al., 2008).

Techen and Osterburg (2011) analysed the monitoring and verification requirements of outcome-based approaches to reduce farm N surplus implemented in new AEMs implemented in three Federal States in Germany (Thuringia, Saxony-Anhalt and Brandenburg). Farms participating in the result oriented AEM have to be situated in priority regions of WFD and must comply with the following requirements (Freistaat Thüringen, 2007; Land Sachsen-Anhalt, 2007; Land Brandenburg; 2010):

1. Keeping N surplus below 30-40 kg N/ha on a 3-year-average on all arable land of the farm, and thus below the legal reference of 60 kg N/ha.
2. Participating in training courses on fertilisation.
3. Taking measures of improved fertilisation management.

Strictly speaking, the outcome-based component is a supplement to an action-based AEM, as only the first element is result oriented. The other two components are action-based prescriptions. While the prescriptions are comparatively easy to verify through administrative and on-the-spot controls, the monitoring of the effectiveness of the AEMs in achieving the reduction of the N balances is more complex. Techen and Osterburg (2011) highlight that a verification of N balances is not possible at 100% certainty, but a combination of adequate plausibility checks, off-site and on-site, can provide adequate control. The declaration of detailed N accounting data to the competent authority (parcel and aggregated balances), using given forms or software, allows for computer-based administrative control. On-the-spot checks of selected farms are by far the most expensive part of the control procedure. Bookkeeping data are inspected, and visual checks of crops can provide signs for high fertiliser inputs, e.g. the presence of certain wild herbs used as indicator plants (Techen and Osterburg, 2011). The authors conclude that because of the high administration costs only large farms of several hundred hectares are participating in these measures and options to implement such outcome-based measures on smaller farms should be further explored.

AEMs targeted at enhancing water quality require catchment approach. At the catchment scale, particular problems arise with respect to measurement and monitoring of multiple and multiplicative outcomes and to the need for differentiated yet coordinated contributions across individual land managers: “who does what and where” matters (Schwarz et al., 2008). Diffuse water pollution may technically be measurable at source, but it is usually monitored at

selected points in-stream. This means that the observed outcome represents the combination of several individual land managers' efforts. This can make it difficult to calculate appropriate rewards (or penalties) for individuals. Indeed, if it is not possible to observe individual contributions, the problem of moral hazard with potential for "free-riding" within a group emerges (Goldman et al., 2007).

Rather than entering into individual agreements with each land manager the Government could agree a collective contract with a group of land managers. This shifts the burden of individual monitoring and allocation of individual rewards from the Government onto the group itself. That is, provided that the aggregate outcome is achieved, a single payment is made to the group which then has to decide amongst itself as to how much each has contributed and how the aggregate payment should be divided (Schwarz et al., 2008).

This approach has the attraction of internalising problems of individual monitoring and moral hazard, relying on peer-pressure and self-governance to achieve an effective and equitable outcome. However, its success depends partly upon the ability of a group of land managers to self-organise and self-regulate, and the capacity to do this may be weak in many cases (Schwarz et al., 2008). Recent research into community approaches to river catchment management may offer some insights into how incentives and governance might be designed to deliver collective outcomes (e.g. Bell et al., 2011 and Norton et al., 2011).

Data requirements and qualitative approaches

FERA (2009) compared three potential monitoring methodologies (a 'classical' approach with baseline assessments and paired scheme/non-scheme farms; an approach based on habitat monitoring, using expert judgement to link to dependent organisms, and a mixed approach incorporating habitat and species monitoring) coming to the conclusion that a combined approach, although more expensive per indicator, is preferable because it offers greater interpretive power compared to the standard approach. The final decisions on how many and which indicators are adopted should be based on (i) policy priorities; (ii) level of resources; (iii) availability of monitoring sites, linked to levels of uptake of relevant options.

Extensive data and monitoring requirements at different scales are a key challenge for the assessment of AEMs and rural development programmes. Some measures focus on individual farms, while other measures (should) operate at larger scales such as catchment scale. Consequently, existing data sets need to reflect different spatial levels, and spatial units are not consistent across different measures and different regional, national and European databases. Furthermore, findings from the ESPON project (Shucksmith et al., 2005) emphasise the need for new data infrastructures. Similarly, Elsholz (2008) points out data

gaps and emphasises that without detailed data it is difficult to observe treatment effects of rural development programmes and their measures which are allocating transfers to nearly all regions as well as overlaying effects between other intervening factors and environmental impacts of rural development measures. The identified data gaps and problems underline the importance of developing consistent and comprehensive data frameworks in order to fully capitalise on new developments in indicator and monitoring approaches.

The quality of the monitoring results largely depends on the delivery of data of sufficient quality by the participating farmers, volunteers or other organisations designing and conducting the monitoring. Adequate training and supervision of farmers is of particular importance to utilize the advantages of the involvement of farmers (and volunteers) in the monitoring of farm management and environmental outcome data (Techen and Osterburg, 2011, Schwarz et al., 2008). In the case of the Swiss AEI FADN project participating farmers receive training and support from a supervisor for the installation of the data software and for the initial recording of the structural data (general details on the farm, plot plan, farmyard-manure storage, etc.). In addition, a hotline for ecological issues and in case of problems with the use of the software is available to them for ongoing data monitoring (Stutz and Blaser, 2010).

4. Synthesis – key issues for assessments of the effectiveness of agri-environmental measures in Lithuania

The main objective of the report is to review existing indicator and monitoring frameworks measuring changes in ecosystem functions and services and to derive key issues for future assessment of the effectiveness of agri-environmental measures in Lithuania.

In order to clarify the inter-relationships between human beings and the environment, the European Environment Agency (EEA), OECD, Eurostat and other institutions have adopted the Driving force-Pressures-State-Impact-Response (DPSIR) framework, or variations thereof such as Pressure-State-Response (PSR) and Driving force-State-Response (DSR) frameworks, for the derivation of a wide range of different indicators. Generally, environmental indicators should be policy relevant, relevant for the studied ecosystem services and goods, scientifically sound, broadly accepted, quantifiable and verifiable through affordable monitoring and / or modeling and sensitive to changes in (agro)ecosystems. In addition, sets of indicators should be representative, include a small number of indicators (i.e. manageable), and allow some form of flexibility and aggregation in the assessment.

Existing indicators for changes in biodiversity conservation can be classified into three diversity indicator groups including genetic diversity, (wild) species diversity, and habitat and

ecosystem diversity. Water-related indicators can be classified into two groups including water use and water quality. In addition, indirect environmental indicators are included in the frameworks to capture changes in agricultural practices or the success (in terms of uptake) of agri-environmental measures.

The CMEF provides a single framework for monitoring and evaluation of all rural development measures and defines a common set of input, output, result, impact and baseline indicators for the rural development programmes. While some of the environmental indicators described above are integrated into the CMEF as impact indicators at programme level, only indirect indicators measuring the financial input, output (for example in terms of number of farms with an AEM contract) and results (area under successful land management) are monitored at measure level. In other words, the indicators at AEM level measure the financial absorption and administrative effectiveness in terms of measure uptake rather than ecosystem benefits.

The CMEF needs to be understood as unified minimum requirements at EU level and flexibility applied in the selection of appropriate additional indicators to address spatially explicit environmental problems. While the CMEF approach is more strategic and consistent than earlier evaluation approaches, significant issues remain such as the linkages between the different levels of indicators (e.g. from result indicators at measure and axis level to impact indicators at programme level), and missing direct linkages between impact indicators and different AEMs and other measures. Specifically in the context of biodiversity and water quality, indicators need to be added which take into account wider species composition and abundance, state of the biotopes and linkages between different spatial scales.

The report reviewed existing indicator and monitoring frameworks for the assessment of the effectiveness of AEMs and highlighted a wide range of relevant outcome indicators and monitoring approaches that have been tested and are applied in different case studies. The successful examples of additional targeted indicator and monitoring studies (flora and fauna) in other EU Member States highlight their practical feasibility. However, the choice of indicators depends on the ecological and policy relevance, scheme objectives and design, monitoring requirements and data availability, and scale(s) of expected ecosystem benefits.

For example, the Landscape Stewardship Scheme is one of the four main agri-environmental schemes implemented in the Lithuanian rural development and has a broad array of objectives including maintaining natural and semi-natural meadows and wetlands. The scheme offers a menu of different activities farmers can sign up. Activity 1 is targeted at the protection and improvement of biodiversity on natural and semi-natural meadows and makes particular

reference to endangered communities of plants, ground-breeding wild bird populations, and insects. Participating farmers need to adhere to a range of different prescriptions such as that the mowing of the meadows has to be done between 15th of July and 30th of September and grazing cannot start before the 15th of June.

However, the uptake of the Landscape Stewardship Scheme, and in particular also of activity 1 'Management of natural and semi-natural meadows', is very low. According to data from the National Paying Agency the status of the implementation of activity 1 was only 0.08 % in 2010 (Navickas et al., 2011). Navickas et al. (2011) explain that the rigid scheme prescriptions and low payment levels create conflicts with profitable farm management. For example, after the 15th of July (the start date for grass cutting according to the scheme prescriptions) the grass is of poor quality both for cattle pasturage and for cattle feeding. In addition, the authors also emphasise that the efficiency and environmental targeting of activity 1 is very low. Only 1% of meadows with high biodiversity value are covered by activity 1.

Implementing an outcome-based grassland payment would address some of the existing key problems with the action-based grassland measure. As shown in the review of existing European outcome-based payments above, such payments have found a high acceptance among the farming community and have the potential to increase the uptake of AES. The environmental targeting of the activity would also be improved by linking the grassland payments to the desired biodiversity outcome and adding yearly monitoring of relevant biodiversity outcome indicators in relation to species diversity and abundance of plants, insects and birds (e.g. number of plant indicator species). The outcome monitoring should build as much as possible on already existing monitoring activities, e.g. commissioned by the Ministry of the Environment or nature protection agencies, to utilize synergies and to limit additional monitoring costs. The monitoring data (both existing and new) would also facilitate the spatial targeting of the agri-environmental support, increase the coverage of meadows with high biodiversity value, and thus increase its effectiveness.

The findings of the review have been discussed at a stakeholder workshop in Vilnius to discuss the practical feasibility of revised indicator and monitoring frameworks in the context of agri-environmental measures listed in the Lithuanian RDPs such as the Landscape Stewardship Scheme. The discussion focused on short / medium term aspects in relation to strengthening the forthcoming ex-post evaluation of AEMs at the end of this programming period and the improving the policy implementation process for next programming period.

Overall, the workshop participants agreed with the need to incorporate additional environmental outcome indicators and monitoring studies to strengthen the assessment of the

effectiveness of AEMs. However, it became evident that there is need to create an inventory of available data relevant for the assessment of the effectiveness of agri-environmental measures before data gaps and required additional data and monitoring studies can be identified. One key challenge in the development and application of a data inventory is the harmonization of the different datasets.

**❖ Key issues for the assessment of the effectiveness of AEMs in Lithuania:
Current programming period:**

- Incorporation of additional environmental outcome indicators and monitoring studies
- Creation of inventory of available data relevant for the assessment of the effectiveness of agri-environmental measures

**❖ Key issues for the assessment of the effectiveness of AEMs in Lithuania:
Next programming period:**

- Definition, and agreement amongst stakeholders, on the main objectives and priorities of agri-environmental support as well as on its role within a broader land use policy framework
- Collaboration between Ministries of Agriculture and Environment required defining policy objectives and priorities, solving data issues and designing effective measures
- Effective spatial targeting of agri-environmental support using existing data sources
- Development and tests of prototype outcome-based AEMs

In the context of the policy implementation process of the rural development programmes in the next programming period stakeholders highlighted the importance of defining and agreeing on the main objectives and priorities of agri-environmental support as well as on their role within a broader land use policy framework. It was emphasized that this step needs to happen at the beginning of the policy implementation process, before individual measures are designed and implemented in the rural development programme. While taking into account broader EU policy objectives and requirements, national (and regional) policy objectives and priorities need to guide the implementation and design of agri-environmental (and other rural development) measures. The process of defining policy objectives and priorities, solving data issues and designing effective measures requires collaborative efforts, in particular, of the Ministries of Agriculture and Environment.²

² Other issues raised in the discussion were constraints for outcome-based AEMs due to rigid requirements to calculate payments based on income foregone and additional costs, low uptake of agri-environment measures

In the longer term more fundamental changes are feasible to the indicator and monitoring framework in Lithuania. For example, the findings from the review suggest the consideration of ecosystem concepts in the design of agri-environmental policies, status quo assessment of ecosystems and their functions to enable spatial targeting of AEMs and the implementation of stronger linkages between the payments and the environmental outcomes or benefits. From the review and the stakeholder workshops the following long term key issues can be derived:

❖ **Key issues for the assessment of the effectiveness of AEMs in a longer term context:**

- Consideration of ecosystem concepts and required and available data from the beginning
- Combination of different types of indicators which captures linkages from land management changes to changes in ecosystem benefits and linkages across scales
- Status quo assessment of ecosystems and their functions to enable spatial targeting of AEMs
- Selection of relevant state (outcome based) indicators for specific AEMs
- Combination of different monitoring approaches to address data gaps and complexity of multi-scale impacts (e.g. verification of N measures)
- Outcome-based AEMs to improve environmental targeting and effectiveness

The European Court of Auditors has highlighted outcome-based payments as one future option for effective AEMs. Outcome-based payments receive increasing attention in the literature and an increasing number of examples emerges which directly link environmental outcome monitoring with the payment design and thus strengthening the environmental targeting of AEMs. The involvement of farmers and volunteers has shown to keep costs of additional monitoring efforts at acceptable level for administrations and the evidence emerging from existing outcome-based payment examples suggests good acceptability of this payment approach among farmers and stakeholders.

In the next step the project will compare the advantages and risks of outcome-based AEMs with standard action-based (or prescription-based) AEMs building on the substantial experience from successful examples in particular in the context of biodiversity conservation and N reduction objectives. Guidelines for the implementation of pilot scheme outcome-based

in intensive agricultural areas, and a lack of a general understanding why we have to pay for biodiversity conservation. Auctions have been highlighted as one possible mechanism (which is conform to the requirements of the current EU rural development regulation (EC) No. 1698/2005) to incorporate more flexibility in the payment calculations of outcome-based AEMs.

AEMs in Lithuania will be developed and presented at the stakeholder conference in October 2012.

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