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AEMBAC

How to Develop Effective Local Agri-Environmental Measures

Introductory Guidelines for Rural Development Planners and Administrators

Edited by Riccardo Simoncini, Simon Milward
and Andrew Terry

Based on the work of the AEMBAC Partners
IUCN – The World Conservation Union, 2004

How to Develop Effective Local Agri-Environmental Measures (AEMs)

This booklet introduces to rural development planners and local agricultural administrators throughout Pan-Europe a practical methodology on how to develop effective, scientifically and economically verifiable local Agri-Environmental Measures (AEMs). The methodology has been developed by the AEMBAC project of the EU 5th Framework Programme 1998-2002 (Contract Ref. QLRT-1999-31666). Further information about the methodology is available on the web site **www.aembac.org** (e.g. Riccardo Simoncini, *The AEMBAC project final report,* IUCN, 2004).

The methodology developed can be used for both areas of high nature value and other agricultural land (i.e. for developing both zonal and horizontal schemes).

The guidelines presented here consist of nine practical steps that lead to the development and implementation of AEMs at the local level. Each step is illustrated with examples extracted from fifteen case studies carried out in seven Central and Western European countries:

Section 1. Identifying agriculture's environmental impacts and related pressures

STEPS

Section 2. Creating agri-environmental measures

The booklet also covers the use of GIS to analyse and assess AEMs (see page 21).

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Edited by Riccardo Simoncini, Simon Milward and Andrew Terry

Introduction

Agri-Environmental Measures for Biodiversity Assessment and Conservation (AEMBAC) was a three-year EU 5th Framework project, co-financed by the Nando Peretti Foundation and coordinated by IUCN, that concluded in February 2004.

A consortium of experts from seventeen institutions in seven Western and Central European countries (see inside cover for details) formed a partnership with the core goal of developing a single methodology to aid the development of local agri-environmental measures (AEMs) that ensure the effective conservation of biodiversity and the environment by improving the sustainability of agricultural practices. In achieving this goal the project's results are expected to bring benefits to the development of agri-environmental policy both at local and European levels.

The AEMBAC methodology

The heart of the AEMBAC methodology lies in the identification and analysis of two sets of indicators and their relationships. These *indicators* describe:

i. the state of each agro-ecosystem and its ability to perform environmental functions;

ii. the pressures local agricultural systems exert on the environment; and

iii. the causal relationships between environmental states and the pressures that impact upon these environmental states.

Indicators are derived from the collection and collation of environmental, agricultural, social, economic, cultural and scientific data. They are used to provide recommendations on how to enhance the economic, cultural, agricultural and ecological sustainability of AEMs for biodiversity and landscape conservation at the local level.

AEMBAC has developed a process of nine sequential steps that start with the identification of environmental functions for a local area and the selection of indicators with which to analyse these functions[1] (see table 1.1 on page 8 for examples of environmental functions). These indicators are then used to identify the Environmental Minimum Requirements (EMRs) for the successful delivery of these functions and then to identify the consequences of changes to different agricultural pressures in terms of environmental sustainability. This process enables objective discussion of the effects of agricultural practices on the environment and, ultimately, the identification of scientifically and economically justified policy targets.

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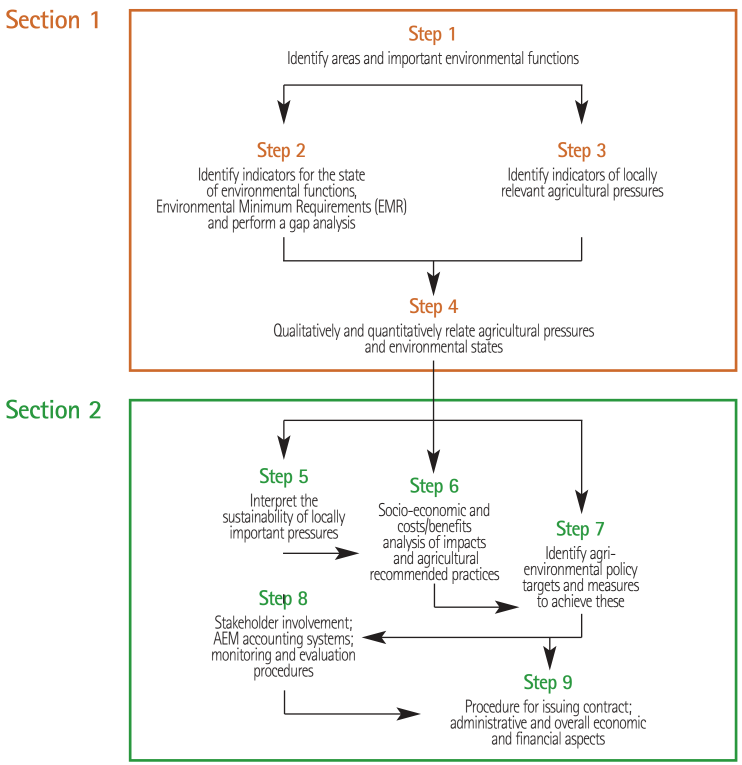
[1] Environmental functions are defined as *"the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly"* (De Groot, *Functions of Nature,* 1992)

This booklet

This booklet outlines for local administrators throughout Europe how to design and implement, workable, scientifically and economically justified AEMs at the local level that “internalise” environmental externalities and maximise the supply of environmental goods and services (environmental functions). Throughout the booklet there are illustrations of how the AEMBAC procedure has been used to develop effective AEMs such as to control soil erosion in Chianti Classico vineyards in Italy and to modify meadow mowing dates to conserve bird life in the Netherlands.

This booklet separates the AEMBAC methodology into two sections. The first section identifies the agricultural pressures that affect the environment and their environmental effects. The second section uses this information to produce a set of precisely defined Agri-Environmental Measures (AEMs) and a quantifiable prediction of the environmental consequences of implementing these measures (see below).



The relationships between the different steps of the AEMBAC methodology

Section 1

Identifying agriculture's environmental impacts and related pressures

Semi-natural meadow and water-mill in the Upper Lusathian Heath and Pond Landscape Biosphere Reserve; Saxony, Germany; photograph by Olaf Bastian, 2001

Step 1 Identify agricultural areas and important environmental functions

This first step identifies areas in which the implementation of the AEMBAC methodology can have the greatest benefits.

Areas should be selected at the local level (i.e. the level of the agro-ecosystem) using the following criteria. They should:

- contain *valuable natural diversity and valuable environmental functions* (e.g. aesthetic views or rare species);
- have an environment which is significantly affected by agriculture (negatively or positively);
- be *homogeneous* in terms of agricultural ecological and socio-economic features;
- have existing data available on recent agricultural activities and the state of the environment; and
- be *representative* of areas within the country in terms of agricultural and environmental aspects in order to allow for the possible cautious extrapolations of some results to similar agro-ecosystems.

Example 1.1.

Identifying areas in the Palamuse Community (Jõgeva County) in Estonia

Total area:	21 607 ha
Total agricultural land:	10 286 ha
Agricultural land in current use:	9 349 ha
Contrasting natural factors:	Situated in higher Estonia[2] on Devonian sandstone, Continental eastern climate
Contrasting agricultural activity and biodiversity/landscape:	A unique (drumlin area) heritage landscape value with intensive agricultural production on relatively fertile soils
Administration:	Palamuse Community (Jõgeva County)
Co-operative local actors:	The local government and the county government
Availability of secondary data sources:	The local government, the county government and also The Estonian Agricultural University and The Centre for Ecological Engineering
Local political support/approval:	The local government is very interested in having their community as a pilot area and appreciates a need for agri-environmental measure

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[2] Estonia is divided into higher and lower Estonia. Lower Estonia has been more influenced by glacial lakes and by the sea, is more marshy, more densely wooded and flatter than higher Estonia, which has been untouched by flooding from glacial lakes and the sea.

Site description

The site description should contain an outline of the chosen site's ecological, economic and socio-cultural characteristics. This outline must contain sufficient information to identify the relevant environmental characteristics such as:

- physical geography (e.g. topography, geology, soil, water resources and climate);
- biogeography (ecosystems, biodiversity, land cover);
- economic activities, infrastructure, land use, demography, history, tourism, other major economic activities and social aspects; and
- the main environmental problems/opportunities.

In order to follow up the analysis and produce environmental state indicators in Step 2, the site description must contain enough environmental and socio-economic information to identify the most relevant environmental functions that must be maintained or improved. Potential sources of this information include: interviews with farmers[3] and consulting analogue and digital data sources from local governments, cadastral offices, agricultural registers, information boards, land boards, nature funds, statistics offices, environmental and agricultural ministries, research centres, and conservation and agriculture organisations.

Identifying local environmental functions

Example 1.2.

Selection of environmental functions: A summary of the preliminary assessment of Oberes Fricktal, Switzerland

When assessing the delivery of ecosystem goods and functions it is important to identify the key underlying processes that are critical to their performance. These processes must then be condensed into a few key environmental functions. For example in the Oberes Fricktal area in Switzerland, the most important functions were identified as:

Landscape related function: 'Aesthetic information'
The Oberes Fricktal study area contains a diverse landscape that still retains much of its traditional natural and cultural character – as identified by a patchwork of forests on mountains and hill tops, grasslands with high stem fruit trees on the slopes, vineyards on the southern slopes and fields and settlements in the valleys. Thus, in the assessment, the region scores highly for the "aesthetic information" environmental function.

Biodiversity related function: 'Refugium'
The study area supports considerable biodiversity, with over 40% covered by forest and 7% protected within nature reserves. Although a large proportion of the meadows and high-stem fruit trees have recently been destroyed, the agricultural landscape is still relatively well structured with high stem fruit trees, hedgerows, and extensively used grassland. Thus the "habitat function" for wild animals and plants is rated as "relatively well performed".

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[3] When interviewing farmers it may be useful to use the AEMBAC Survey Questionnaire available on the AEMBAC website (www.aembac.org)

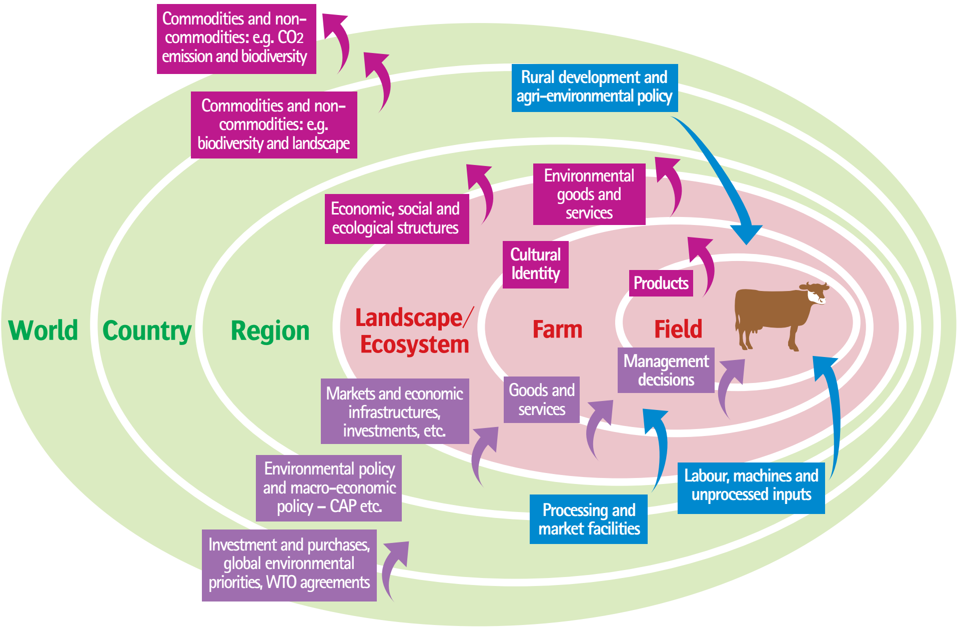
Table 1.1.

Examples of environmental functions, critical aspects and performances[4]

Examples of environmental functions	Critical attributes and characteristics necessary for their performance (e.g. ecosystem processes and components)	Examples of performance (i.e. goods and services)
1. BIODIVERSITY-RELATED FUNCTIONS **(Habitat functions: Providing suitable living space for wild plants and animals; Regulation functions: Maintenance of essential ecological processes and life support systems)**		
Refugium	■ Suitability to provide food, shelter and reproduction habitat	■ Maintenance of biological and genetic diversity ■ Nursery functions for wild species
Life support	■ Role of biota in movement of floral gametes ■ Population control through trophic-dynamic relations	■ Pollination of crops ■ Control of pests and diseases ■ Reduction of herbivory (crop damage)
Genetic resources	■ Maintenance of wild relatives for plant species and animal breeds	■ Improvement and adaptation of cultivated plants and domestic animals
2. LANDSCAPE-RELATED FUNCTIONS **(Information functions: Providing opportunities for cognitive development)**		
Aesthetic information	■ Attractive landscape features	■ Enjoyment of scenery (scenic roads, housing etc)
Recreation	■ Variety of landscapes with (potential) recreational uses	■ Travel to natural ecosystems for eco-tourism, outdoor sports etc
Cultural and artistic information	■ Variety of natural features with cultural and artistic value	■ Use of nature as motive in books, folklore, national symbols, film, painting, architecture, advertising etc.
Spiritual and historic information	■ Variety of natural features with spiritual and historic value	■ Use of nature for religious or historic purposes (i.e. heritage value of natural ecosystems and features)
Science and education	■ Variety of nature with scientific and educational value	■ School excursions etc. ■ Scientific field laboratories etc
3. SOIL COMPLEX RELATED FUNCTIONS **(Regulation Functions: Maintenance of essential ecological processes and life support systems)**		
Soil erosion control	■ Role of vegetation root matrix and soil biota in soil retention	■ Prevention of damage from erosion/siltation
Maintenance of soil fertility	■ Production of biomass	■ Maintenance of arable land
4. WATER COMPLEX RELATED FUNCTIONS **(Regulation Functions: Maintenance of essential ecological processes and life support systems)**		
Groundwater supply	■ Filtering, retention and storage of fresh water (e.g. in aquifers)	■ Provision of water for consumption (e.g. drinking, irrigation and industrial use)
Surface water supply	■ There are many, and diverse, functions of running and standing water, in particular to provide fresh water	■ Provision of water for consumption (e.g. drinking, irrigation and industrial use)
5. OTHERS		

Fig. 1.1.

The levels of analysis of the agro-ecosystem analysed by (red) or taken into account by (green) the AEMBAC methodology



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[4] Adapted from de Groot *et al* "A typology for the classification of environmental functions, description and valuation of environmental functions, description and valuation of ecosystem functions, goods and services", *Ecological Economics*, 41, Elsevier, 2002.

Step 2

Identify environmental state indicators and identify their Environmental Minimal Requirements (EMRs)

State Indicators of Environmental Functions

- Step 1 identified the local environmental functions important in a broad context (e.g. providing a habitat function for key species, or soil erosion control and maintenance of aesthetic landscape qualities etc.).
- **State indicators** are now identified to describe in detail the most relevant components, structures and processes of agro-ecosystems that allow the performance of an environmental function (see table 2.1). For example the state indicator of a habitat function could include indicators of ecosystem extent, diversity and quality and indicators of the abundance and richness of key species.
- Typically the AEMBAC methodology uses between 10 and 20 indicators to describe each environmental function. Many of these indicators are already used by local administrations and national and international agencies such as the OECD, EEA and EU (see table 2.2 on page 12).
- State indicators must be selected in a hierarchical approach to link them to their respective level of analysis e.g. field/farm and ecosystem/landscape (see fig. 2.1).
- Both historic data and envisaged future trends have to be taken into account together with the current ecological conditions to accurately assess the state of an area.

Fig. 2.1

Possible hierarchical process for selecting indicators at varying spatial scales

Identify the different ecosystems (natural/semi-natural, agricultural/man-made) in the study area and assess historic trends in land cover and land use.

Define the most appropriate mix of ecosystem diversity and their extent *(quantity indicators)* which, are believed to provide the best circumstances for the performance of the environmental function studied.

Define indicators to assess the *quality* of each ecosystem. In agro-ecosystems the presence of (semi-)natural habitats such as meadows, shrub land, marshland, hedgerows, ponds, lakes or animal species such as birds in the fields, insects, earthworms, etc.

Identify the indicators that will be used in the development of agri-environmental targets and measures.

Table 2.1.

Definitions of key information required for each state indicator
For examples, see Table 2.2 overleaf

Indicator n°	Description
Scale	What is the level of analysis for the indicator and *unit of measurement used* (e.g. field/farm, ecosystem/landscape, whole study area)
Purpose	For what is the indicator used?
Relevance to the environmental function	How relevant is the indicator for the analysis of the selected environmental function (e.g. does it measure crucial aspects of performance?)
Limitations of the indicator	What are the limitations in terms of the indicator's ability to reflect accurately the characteristic environmental, agricultural, socio-economic) being measured?
Alternatives	Are there any other possible indicators to measure the same aspects?
DPSIR category	E.g. is it a state indicator or a pressure indicator?
Linkages (relationships) to other state or pressures indicators	Are there correlations with other state or pressure indicators?
Measurement methodologies	What methodologies are used to calculate the value of the indicator?
Data required	What data are needed to measure the indicator?
Data availability and sources (including time series)	What is the availability and what are the sources of data (including time required to obtain data)?
International Conventions and agreements in which it is addressed	Is the indicator already in use in the international arena?
Was the indicator thought suitable for monitoring?	Should also include reasons why the indicator was or why the indicator was not through suitable for monitoring
Additional comments	E.g. in which study areas it was used or, whether it is easy to use

Threatened arable plant "Weasel's Snout" *(Misopates orontium)*; Moritzburg study area, near Dresden, Germany; photograph by Olaf Bastian, 2001

Table 2.2

A selection of landscape-related state indicators used in the Chianti region of Italy

Indicators	Diversity of the scenery	Harmonisation of the landscape	Land cover diversity	Openness versus closedness
Definitions	Number of CORINE classes in a 3x3 km^2 window	Coherence of land use with the features of classed landscape systems	Shannon Index applied to CORINE classes	Proportion of woodland and open spaces + matrix fragmentation
Scale and type of output	Scale: Whole study area Output: Number	Scale: Whole study area Output: % of land use	Scale: Whole study area Output: Absolute number	Scale: Whole study area Output: % of land use
Purpose	Creates a chronological series suitable for monitoring landscape dynamics. Also identifies sub-systems	Measures the balance between particular landscape elements in multiple categories	Creates a chronological series suitable for monitoring landscape dynamics	Measures the balance between woodland and open spaces including % of wooded areas in plots < 100 ha
Relevance to analysis of environmental function	Gives an objective measure of a perceptive aspect of the landscape	Gives an objective measure of stylistic coherence	Gives an objective measure of a perceptive aspect of the landscape	Gives an objective measure of a perceptive aspect of the landscape
Limitation of the indicator	Parameter is only meaningful when it can be referenced to other cases	Difficult to fix standard values for patches which are not the landscape matrix or for the incoherent ones	Parameter is only meaningful when it can be referenced to other cases.	Must be referenced to other cases. Matrix fragmentation helps understanding
DPSIR category	State indicator	State indicator	State indicator	State indicator
Linkages to other indicator	Land cover diversity	Openness versus closeness	Diversity of the scenery	Harmonisation of the landscape
Measurement methodologies	Extension of Arc-View; moving window method	Theme mapping	Extension of Arc-View	Arc-View (surface measure)
Data needed to compile the indicator	CORINE and similar inventories; landscape unit classifications	CORINE and similar inventories CORINE and similar inventories	CORINE and similar inventories	CORINE and similar inventories
Data availability and sources	CORINE available; landscape unit classification available	Double database: CORINE and Regional Forest Inventory	Double database: CORINE and Regional Forest Inventory	Double database: CORINE and Regional Forest Inventory
Conventions and agreements (addressed in)	NUTS – a methodology developed by the EU allowing large-scale comparisons	Accurate classification of landscape units and sub-units needed	Shannon index is commonly accepted in EU and elsewhere	Definition of natural ecosystems in RIVM report 402001014

Box 2.1.

Identifying state and pressure indicators for AEMBAC

The identification of accurate indicators is central to the AEMBAC methodology. The most important are:

- **Environmental state indicators**
  Measurable physical characteristics that reflect the performance of one or more environmental function that results in important environmental goods and services e.g.:
  i. Biodiversity *state* indicator: Abundance and species composition of plants infields and field edges
  ii. Landscape *state* indicator: Length of linear features e.g. water/land boundaries, hedgerows, etc.
- **Agricultural pressure indicators**
  Measurable agricultural practices that accurately reflect agricultural pressures on the environment e.g.:
  i. *Pressure* indicator: Crop rotation (years per cycle)
  ii. *Pressure* indicator: Land use conversion
- Quantifiable indicators, when available, allow AEMBAC objectively to analyse the impact of each locally important *pressure on the performance of the environmental function studied.*
- This correlation-analysis of agricultural pressures and environmental states, combined with further economic and socio-economic analyses, can be used to analyse, develop and implement AEMs.
- For AEMBAC's methodology to produce comprehensive and effective AEMs, the state indicators must describe the most relevant aspects of the agro-ecosystem and the pressure indicators must fully describe the most important local agricultural practices.

(For further information on agri-environmental indicators see: the IUCN manual on assessment of biodiversity[5]; the OECD website[6]; and work by ECNC[7] .)

Traditional wooden fences and solitary trees may serve as indicators for reflecting biodiversity, cultural heritage or aesthetic functions; Alseda study area, Sweden; photograph by Knut Per Hasund, 2002

Actual values and Environmental Minimum Requirement (EMR) values of state indicators

- Once state indicators have been identified and their actual values measured, AEMBAC defines Environmental Minimum Requirements (EMRs) for each state indicator.
- The measurement of actual values of state indicators is carried out either by field research or by utilising recent bibliographic data.
- An EMR is a single value (a threshold) or a set of values (a range) for a state indicator that provides a baseline against which to measure whether ecological processes are expected to be contributing positively, negatively or neutrally to the provision of environmental functions. (See box 2.2. for details on assessing EMR values.)
- If the actual value of a state indicator is the same as the EMR, then no impact (either positive or negative) on the performance of the environmental function relating to the state indicator is detected. If the state indicator value does not reach the EMR or exceeds it, then a gap analysis must be carried out (see below).

Gap analysis – explanation of environmental changes and consequences

- The "gap" between an environmental state indicator's actual value and the EMR identifies the positive or negative impact of agricultural or other practices on environmental functions.
- The "gap" is a clear target for land planners to assess how a state indicator contributes to the performance of the related environmental function.
- A positive gap indicates the actual value of the state indicator is already satisfying its EMR whereas a negative 'gap' indicates the environmental changes that need to occur for the state indicator to achieve its EMR and adequately supply environmental goods and services. (See later sections, especially Step 4 for more details.)

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[5] IUCN International Assessment Team, 1998: Manual on Assessment of Biodiversity

[6] Particularly at http://www.oecd.org/topic/0,2686,en_2649_33795_1_1_1_1_37401,00.html [7] http://www.ecnc.org

Box 2.2.

Calculating environmental minimum requirements

In order to assess agricultural impacts, the following methods for identifying reference values of state indicators were suggested for (semi)-natural and agricultural areas respectively (please note that the reference level adopted in AEMBAC corresponds to option three for agricultural area):

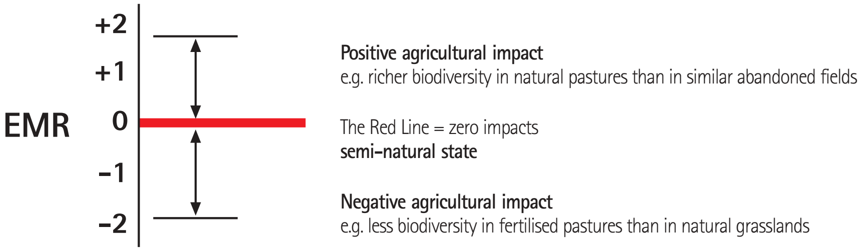
- (Semi)-Natural areas

  First best: the actual or closest possible value to the (semi-)natural situation at the study area level. If this information is available (e.g potential natural land cover), it could be used to indicate the positive/negative off-farm impacts of agricultural activities (amongst others pressures) on the performance of environmental functions.

  Second best: The actual value of state indicators in similar (semi-)natural habitats in Protected Areas.

- Agricultural areas

  First best: the value of the same state indicators in similar agro-ecosystems that have been abandoned for 10, 20, 25, etc. years (depending on the agri-ecosystem type and potential natural vegetation, in very particular cases it may happen that biodiversity is richer in agri-ecosystems than in abandoned ecosystems e.g. richer plant species in semi-natural pastures than in abandoned fields).



Second best: the value of the state indicator in similar agri-ecosystems that perform the environmental function resulting in measurable (and sufficient) supply of environmental goods and services.

Third best: the value of state indicators determined by Best Professional Judgement, which would be expected to ensure the environmental function would be performed adequately.

Best Professional Judgement (BPJ), based on scientific evidence available, is the factor determining the value of EMR (standard for the study area). This means that the researcher, on the basis of her/his knowledge and experience, for each state indicator has to identify an EMR value that ensures the ecological aspect being studied contributes positively to the performance of the environmental function. Needless to say, the EMR value can be revised and refined according to the verified correctness of the BPJ assessment (for instance by field research).

Agriculture is essential for many semi-natural meadows such as this; Daubener Heide, Germany, photograph by Olaf Bastian, 2001

Step 3

Identify agricultural pressure indicators

Identifying agricultural pressure indicators and underlying driving forces

- Step 1 provided the information used to identify environmental functions and Step 2 showed how to identify state indicators and relative EMR values. Step 3 now requires identification of **agricultural pressure indicators.**
- Agricultural pressure indicators describe qualitatively and quantitatively the locally most relevant pressures that a local agricultural system exerts on environmental functions.
- This step also requires identification of the driving forces influencing these pressures, which should ensure that the most relevant causes of detected impacts are considered for proposing effective agricultural changes.
- AEMBAC suggests four classes of agricultural pressure indicator (although others can be used in specific cases):
  - i. **nutrient management indicators;**
  - ii. **soil and land management indicators;**
  - iii. **irrigation and water management indicators; and**
  - iv. **pesticide use indicators.**
- Wherever possible, agricultural pressures should be analysed using internationally accepted indicators adapted to the local level (e.g. from OECD[8] or the Farm Accountancy Data Network – FADN[9] , see also table 3.1 overleaf).
- Background research should be undertaken to produce qualitative and quantitative descriptions of local agricultural systems, concentrating on the current state and trends of:
  - i. **environmental characteristics:** e.g. land-use, chemical inputs, land management, water, soil, energy and biodiversity resources;
  - ii. **economic characteristics:** e.g. description of farm structure, production, labour, study of incomes, production costs, details of assets and liabilities, subsidies, government payments and taxes; and
  - iii. **social characteristics:** e.g. population, age, birth-rate, cultural heritage, infrastructures, services and farmers' environmental awareness.

  This information will be useful for conducting Steps 7-9.
- In most cases some data can be collected through interviews with land users. We recommend a minimum of at least 20 interviews of local farmers. Information from other sources (such as of fertiliser consumption or from historic maps that indicate land-use and local agricultural experts) will also be required.

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[8] See OECD Workshop on Agri-Environmental Indicators, York, UK, 1998 [9] See http://europe.eu.int/comm/agriculture/rica/index_en.cfm

Table 3.1.

Examples of agricultural pressure indicators

(N.B. each local situation will require a locally tailored set of indicators)

Indicators	Description
NUTRIENT MANAGEMENT INDICATORS	
Farm gate nutrient balance	The sum of: N and P purchased in fertiliser and feed + N fixed by legumes – N and P in products sold. Possible information: N surplus Kg/ha; P surplus kg/ha; Ammonia evaporation kg/ha; N leaching kg/ha
Adjusting application rates to crop needs	Indicates nutrient use efficiency by whether application rates are adjusted to expected crop yield increases
Adjusting timing of nutrient applications	Indicates nutrient use efficiency by whether application rates are adapted to times of maximum plant uptake
Crop rotations	Measures the system of crop rotations such as average length of cycle
Placement of fertilisers	The position of fertiliser application e.g. on fields, on vegetation rows or next to seeds
Fertilisers used per hectare	The amount of fertilisers used per hectare
Livestock density (LU/ha)	The number of livestock per hectare
SOIL AND LAND MANAGEMENT INDICATORS	
Land use	Utilisation of the territory for different purposes
Soil cover, mowing, hay cutting, grazing	N° days that soil is covered by vegetation and crop residues multiplied by % soil cover provided (OECD, 1998)
Land management	% of crop land cultivated using minimum and zero tillage practices, crop rotations, grassed waterways, contour strip cropping, etc. (OECD, 1998)
Landscape management	Valuation of the status of fencerows, walls, hedges, wetlands and woodlands, including fencing riparian areas to protect them from damage by livestock. Areas of buffer strips and fenced land along ditches and watercourses can also be included (OECD, 1998)
IRRIGATION AND WATER MANAGEMENT INDICATORS	
Water use efficiency	Volume of agricultural produce /unit area of irrigation and /water volume consumed; Volume of agricultural produce /unit area of rain fed agriculture and /water volume consumed (OECD, 1998)
Irrigation delivery systems	% of irrigation irrigated by: flooding; high pressure rain guns; low pressure sprinklers; and drip-emitters. Indicate probable water use efficiency, and risk of over-irrigation (OECD, 1998)
Drainage/diversion/extraction processes	Area drained, length of drains installed, length of outlet drains excavated; proportion of total surface and groundwater resource diverted/extracted for all purposes and specifically for agricultural production; proportion of total renewable water resource used by agriculture. These indicate the disturbance to wildlife and the pressure on the water table (OECD, 1998)
PESTICIDE USE INDICATORS	
Pesticide use /ha	Valuation of the amount of active ingredients (kg/ha) and the total amount used (kg/ha) (OECD, 1998)
Use of integrated pest management (per area and timing)	Area of crops where integrated pest management is used (OECD, 1998)
Use of alternative (non-chemical) pest control methods	Area of crops where pest control is achieved without use of chemicals (OECD, 1998)
Timing of herbicide use	% of use due to weed pressure, rather than pre-plant and pre-emergence which are used as insurance (OECD, 1998)
Timing of insecticide use	% of insecticide use linked to level of infestation (use only as required by insect infestation) (OECD, 1998)
Toxicity of pesticide used	e.g. total amount of LD50 doses applied /ha

Main sources: OECD Workshop on Agri-Environmental Indicators, York, UK, 1998 and ECNC, Agri-environmental indicators, 2000. Also see the AEMBAC website for further information.

Step 4

Relate pressure indicators to state indicators

Presenting the causal relationships between pressures and impacts

- Produce matrices to correlate qualitatively, or if possible quantitatively, the main locally relevant agricultural pressures with their detected impacts on the state indicators – i.e. the gap between actual and EMR values – (see tables 4.2 & 4.3)[10] . This should be conducted separately for each environmental function studied.

- This description of **the direct influence** of locally relevant agricultural pressures on the detected "gap" between the EMR and the measured state indicator (see Step 2) has two main benefits:
  - i. It shows if the gap between the EMR and actual value of the state indicator is caused only by agricultural impacts, or if pressures from other activities are acting simultaneously.
  - ii. It identifies the relative importance of different agricultural pressures simultaneously impacting on the same state indicator (e.g. removal of hedgerows and pesticide use on abundance of key animal species). This becomes useful when prioritising targets for AEMs.

- Each matrix assigns a positive/negative qualitative rank (high-red, significant-yellow, low-green, see table 4.2 on page 19) or a quantitative percentage (see table 4.3 on page 20) to the positive/negative effect each pressure has on the identified "gap".

- The matrix should be accompanied by detailed descriptions of how the qualitative ranking or the percentages and +/- signs were evaluated and of what agricultural changes could be made to improve sustainability. This information will be useful later on when choosing which AEMs will be most effective.

Ranking tiers of sustainability

- The matrices produced (see tables 4.2 & 4.3) explain how much each agricultural pressure affects the performance of a particular environmental function, i.e. they measure the **"environmental sustainability"** of the agricultural pressures in contributing to the supply of environmental goods and services.

- To simplify the identification of the most important pressures, a qualitative ranking is now made of each pressure to generate *tiers of sustainability*. Table 4.1 shows the ranking system.

- This ranking system of sustainability, depending on the dose-effects information available may or may not need further scientific research to be validated. In any case, it provides a framework to discuss sustainability and creates a more analytical picture of the sustainability of individual local agricultural pressures. It is based on the best scientific knowledge available and can be used as an effective policy tool to identify where AEMs are most required.

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[10] based on the OECD's and EEA's Driving Force Pressure State Impact Response (DSPIR) models

Table 4.1.

The qualitative ranking system for expressing the sustainability of agricultural pressures

Tier		Impact
+	2	Presence of high and only positive impacts
+	1	Presence of only medium and positive impacts i.e. environmental goods and services are supplied at this tier and above
+/-	0	No influence or low positive/negative impacts i.e. ecological sustainability
-	1	Presence of medium and negative impacts i.e. impeding the production of environmental goods and services
-	2	Presence of high negative impacts

Example 4.1.

Visual examples of grass-cover in vineyards in Chianti, Italy

The pictures below are a visual representation of the most probable surface conditions that are necessary to achieve different tiers of sustainability with regard to soil erosion.

Tier −2
No cover, soil tilled and exposed to rain splash and runoff

Tier −1 (at top of hill)
Tier 0 (at middle of hill)
Natural sparse cover (Tier 0) with many exposed areas (Tier-1)

Tier +1
Cover crops on alternate rows

Tier +2
Grass cover on almost 100% of vineyard

Visual examples of the *pressure* indicator *grass cover in vineyards* which affects the performance of *soil erosion* control; photograph by Paolo Bazzoffi, 2003

Example 4.2.

Habitat Function in the Gelderse Valley, The Netherlands

In terms of habitat functions, the most significant current agricultural pressures in the area are related to nutrient-use and mowing[11] . Nutrient-use directly affects the surrounding fauna and flora. However, the relationship between nutrient use and the surrounding biodiversity is complex. For example, eutrophication is one of the keys reasons for the decrease of many pasture species but increased soil fertility leads to an increase in worm numbers and food availability for birds. Atmospheric decomposition is also an important source of nutrients, independent from agriculture, and the high concentration of bio-industry in the Gelderse Valley is estimated to deposit 4500 mol/ha/year of Nitrogen.

Mowing regimes and dates have impacts on insect numbers (including butterflies which have decreased dramatically in the Netherlands) as densities are correlated to vegetation height and complexity. This has important knock-on effects for bird populations.

Table 4.2.

A qualitative rank of the effect of agricultural pressures on state indicators in the Gelderse Valley, The Netherlands

⬜	None
🟩	Low
🟨	High
🟥	Significantly High

Pressure indicators

State indicators	LAND USE	Area agricultural land (as percentage of total area)	Average field size (ha)	NUTRIENT MANAGEMENT	Net organic and inorganic input of N (kg per hectare)	Net organic and inorganic input of P (kg per hectare)	Net organic and inorganic input of K (kg per hectare)	Wet atmospheric deposition of NH4 (kg per hectare)	Dry atmospheric deposition of NH4 (kg per hectare)	LAND MANAGEMENT	Mowing period grassland: first date of mowing to last date of mowing	Mowing intensity grassland: number of cuts during mowing period	Grassland grazing intensity: number of grazing cows per hectare	Field management	PESTICIDE USE	EPA-categorie-1 active ingredients applied (kg per hectare of cultivated land)	EPA-categorie-2 active ingredients applied (kg per hectare of cultivated land)	EPA-categorie-2 active ingredients applied (kg per hectare of cultivated land)	WATER MANAGEMENT	Direct shallow groundwater extraction by agriculture (m3 per hectare)	Drainage (percentage of total cultivated land drained)	Groundwater level decrease (cultivation improvement related decrease (in meters) since 1900
Forest cover (ha)		🟨 -	🟩																			
O2 concentration Woudenb. Grift		🟩			🟥 -	🟥 -	🟥 -	🟥 -	🟥 -							🟥 -	🟨 -	🟩 -		🟨 -	🟨 -	🟩 -
Length of non-canalised streams			🟥																			
\No. of pools with crested newts			🟨 -		🟨 -	🟨 -	🟨 -	🟨 -	🟨 -				🟨 -			🟨 -	🟩 -			🟨 -	🟨 -	🟨 -
Depth of groundwater level		🟩 -																		🟥 -	🟥 -	🟥 -
No. of bird species		🟩 -	🟨 -		🟨 -	🟨 -	🟨 -	🟨 -	🟨 -		🟥 -	🟥 -	🟥 -	🟥 -		🟥 -	🟨 -	🟩 -		🟨 -	🟨 -	🟨 -
Breeding couples of the b-t godwit			🟩 -		🟨 -	🟨 -	🟨 -	🟨 -	🟨 -		🟥 -	🟥 -	🟥 -	🟥 -		🟥 -	🟨 -	🟩 -		🟨 -	🟨 -	🟨 -
Length of field edges		🟨 -	🟥 -											🟥 +/-								
No. of grassland species					🟥 -	🟥 -	🟥 -	🟥 -	🟥 -		🟩 -	🟩 -	🟩 -	🟩 -		🟥 -	🟨 -	🟩 -		🟥 -	🟥 -	🟥 -
Tier of Sustainability		−1	−2		−2	−2	−2	−2	−2		−2	−2	−2	−2		−2	−1	NR		−2	−2	−2

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[11] In contrast, the most important processes have previously been land conversion to agricultural use (until around 1950), and land consolidation (1950-1970)

Table 4.3.

A quantitative rank of the effect of agricultural pressures on state indicators in the Egyek-Pusztakócs Area, Hungary

State indicators	Pressure indicators Crop rotations	Fertilizer application rates	Timing of nutrient applications	Livestock density (LU/ha)	Land use intensity	Pesticide use per ha	Toxicity of pesticide used	Gene preservation	Water management	Total % of importance of impacts correlated to agricultural pressures	Total % of importance of impacts correlated to other socio-economics pressures
Length of habitat boundaries											
Number of agricultural habitat blocks											
Presence of organic farming	-20	-20				-10	-30			80	20
Grazing in endemic grasslands				-70				-30		100	0
Adequate land use for characteristic species											
Number of nesting bird species					-30	-30			60	40	
Number of migrating bird species						-50			100		
Number of protected bird species						-50			100		
Number of cultivated plant species or varieties.	-40							-30		70	30
Number farm animal breeds							-60		60	40	
Number of local plant species or varieties	-50							-50		100	0
Number of local farm animal breeds							-60		60	40	
Integrated pest management	-35					-30	-35			100	0

An example of complex pressures acting on the environment, including land abandonment a road and afforestation as compensation for the widening of the road; Moritzburg study area, Saxony, Germany; photograph by Michael Lütz, 2001

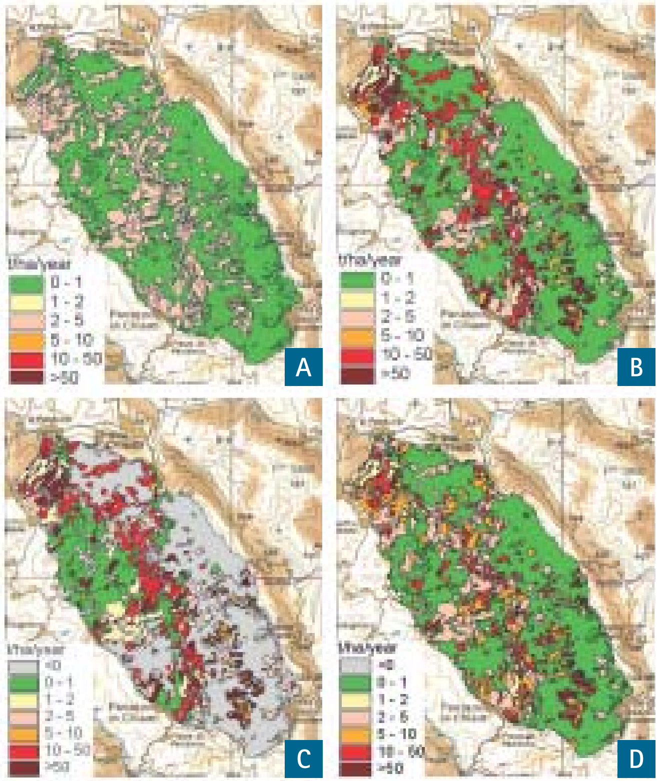
Example of the use of GIS to analyse and assess AEMs

Geographical Information Systems (GIS) and digital image interpretation techniques are powerful tools that can aid production and implementation of effective AEMs. Within AEMBAC, these techniques are particularly helpful for:

- gathering, analysing and visualising spatial data to help identify and describe areas for implementing AEMs (Step 1) e.g. data on land cover/land use, species diversity, soils, water;
- identifying and analysing environmental functions (Step 1) and state indicators (Step 2); assessing EMRs of state indicators and performing gap analyses (see Step 2); and assessing pressure indicators (Step 3);
- applying and evaluating tiers of sustainability (Step 5); and
- implementing, monitoring and evaluating agri-environmental measures (Step 8).

As well as helping technical analysis of parameters and indicators, GIS can also help communicate this information to administrators and the public. It is particularly useful that this information can be made easily available in electronic form and via the internet. The data, analysis and results can easily be integrated into land information systems.

Fig. 4.1.



Using GIS to show the "gap" for the function *soil erosion* control in the Chianti Area; by Paolo Bazzoffi and Rosario Napoli

A The EMR calculated for soil erosion

B Actual soil erosion risk (using the RUSLE model)

C The gap between the EMR and the actual state (B minus A)

D A scenario analysis of soil erosion risk that would occur if the agri-environmental measure "grass soil cover" were applied in vineyards to tier +1 (75% soil covered by grass)

Section 2

Creating agri-environmental measures

Bundles of reeds on a coastal meadow. Grazing maintains the high biodiversity and aesthetic value of the coastal meadows by preventing succession of reeds; Kihnu Island; photograph by Arne Ader, 2001

Introduction

- Section 1 explained how to identify impacts exerted by local agricultural pressures on environmental function performance and thus developed the first stage necessary for producing and implementing Agri-Environmental Measures (AEMs).
- Section 2 predicts how modifications to agricultural practices may impact on state indicators. It then uses economic, socio-cultural, agricultural and political analyses to identify the modifications that will be most effective. Finally it shows how the modifications can be developed and implemented as AEMs (see Example 7.1. on page 31).

Step 5

Identify ways to change agricultural pressures and their environmental consequences

- Building on Step 4's analysis of sustainability for each agricultural pressure, Step 5 identifies recommendations for ways to alter each pressure (either by adjusting or eliminating existing agricultural practices) in order to lessen agriculture's negative environmental impacts and enhance its positive impacts.
- Possible actions are analysed to explain what activities would be necessary in order to move the pressure to a new tier of sustainability. These recommendations are then tested for their feasibility, e.g. for their effects on productivity or the ability of farmers to undertake them.
- This joint process of identifying both actions that could move a pressure to a different tier of sustainability and the feasibility of these actions provides a secure basis for the economic analyses carried out in Step 6 and the identification of agro-environmental policy targets undertaken in Step 7.

Example 5.1.

Hypothetical example for the pressure maintenance of hedgerows and/or semi-natural habitats

The pressure of inadequate maintenance of hedgerows and/or semi-natural habitats exerts four significant and two high negative impacts on the state indicators: plant and animal species richness and abundance; and ecosystem extent and quality. This pressure is currently ecologically very unsustainable and ranks Tier -2. Possible actions to alter this pressure and the tier of sustainability that these actions would achieve are presented in table 5.1.

Table 5.1.

Possible actions to alter the pressure maintenance of hedgerows and/or semi-natural habitats

Tier	Impacts	Possible agricultural practices
2	Very positive	20% of existing used agricultural area reconverted to (semi-) natural habitat.
1	Positive	5% of existing Utilised Agricultural Area (UAA) reconverted to (semi-) natural habitat
0	Sustainable i.e. meets EMR	Hedgerows 3m wide for at least 30 % of existing field margins
-1	Negative	Hedgerows 3m wide for at least 10 % of existing field margins – this is expected to lessen the negative impacts on plants, animals and ecosystems
-2	Very negative	Very sporadic field margins with hedgerows – this is the actual situation

Box 5.1.

Adjusting or changing agricultural pressures

Adjusting or changing existing agricultural practices requires an understanding of the underlying pressures causing the impact (identified in Step 3). Listed here are some basic examples of changes that could be made to lessen/eliminating negative impacts caused by agricultural pressures or enhance positive ones.

a. Nutrient management

i. Select the most appropriate fertilisers according to soil and crop requirements.

ii. Adjust application rates to crop requirements.

iii. Respect the timing of nutrient applications in order to avoid leaching.

iv. Make use of crop rotations to fertilise the soil.

v. Identify the most appropriate techniques for placing fertilisers.

vi. Reduce fertilisers used per ha: e.g. to a total of *X* kg/ha/yr of N.

b. Land use and land management

i. Change land use to protect and maintain the diversity of landscape features.

ii. Reduce livestock density (LU/ha) to ensure a sustainable grazing pressure.

iii. Adopt land management practices (e.g. mowing, tillage) compatible with performance of environmental functions.

iv. Protect and maintain landscape features that support biodiversity, e.g. stone walls, field boundaries, hedges, ditches and banks.

c. Irrigation and water management

i. Improve efficiency by minimising water loss.

ii. Promote and maintain sustainable irrigation delivery systems.

iii. Avoid drainage/diversion/extraction processes that damage habitats in order to maintain surface and ground water levels.

d. Pesticide use

i. Reduce or eliminate pesticide use per hectare.

ii. Promote the use of integrated pest management.

iii. Promote the use of alternative pest control methods.

iv. Adopt appropriate timing for herbicide and insecticide use to avoid collateral damage to biodiversity.

v. Reduce the toxicity of the pesticides used.

White Storks *(Ciconia ciconia)* in farm wetlands; Estonia; photograph by Kalev Sepp, 2003

Conduct socio-economic analyses and economic evaluations in order to identify possible agri-environmental measures

Step 6

- Step 5 identified agricultural practices that could be adopted to reduce negative and enhance positive impacts of agricultural pressures. It also estimated the intensity required for these changes to move the pressure between tiers of sustainability.
- Step 6 uses this to assess:

i. the local socio-economic characteristics, including those not directly related to agriculture, that must be considered while developing AEMs (e.g. socio-economic driving forces); and

ii. the economic costs and benefits of the recommendations proposed.

Analysis of local social, cultural, economic and institutional features

- A thorough understanding of the local socio-economic environment within which farmers and their families live and work must be gained through studying the local social, cultural, economic and institutional features. This is necessary because:

i. Socio-economic factors may be **driving forces** for agricultural pressures including:

- **local driving forces** originating at the local socio-economic level such as specific traditional knowledge or specific local economic forces (e.g. economies of scale or scope); and
- **foreign driving forces** originating at the regional, national, international or global level such as national policy, the CAP or WTO agreements.

ii. It is important to consider the possible socio-economic effects of AEMs aside from agricultural ones e.g. effects on income distribution, per capita income and employment.

iii. Socio-economic aspects such as social values and existing institutions may play a role in implementing AEMs. For example, the environmental awareness of the local community will influence the content and type of proposed AEMs.

- There are a number of topics that could be specifically addressed within the latter broad category of "socio-economic aspects". These include:
    - i. The potential for social development (e.g. demographic characteristics and trends, sanitation levels, education and unemployment).
    - ii. Social identity/ethics/values (e.g. historic, religious, cultural and artistic information and value systems).
    - iii. Human material needs (e.g. food sufficiency, housing, health services).
    - iv. Opportunities for satisfying human recreational and non-material needs (e.g. landscape attractiveness, leisure activities).
    - v. Institutional systems and functioning.
    - vi. Potential for economic development (e.g. markets, infrastructure for agriculture, tourism, fisheries, access to credit).
    - vii. Existing socio-economic sectors, local production, income and investment (e.g. per capita income, employment).
    - viii. Equitable sharing of economic benefits (e.g. income distribution).

Translating analysis of environmental functions into economic information

- By translating the impacts identified in Section 1 into economic terms, it is possible to develop an indicative economic value to be used alongside environmental and socio-economic information. This helps to identify the costs and benefits of agriculture's impacts on the provision of ecosystem goods and services, and therefore aids development of the most appropriate agri-environmental policy targets for the local situation.
- Importantly, this economic valuation facilitates the further integration of natural and social sciences and increases the understanding of the importance of conserving ecosystems by non-scientists.

Methods of conducting an economic evaluation

- Economic evaluation is used in AEMBAC to evaluate the costs and, possibly also, the benefits of achieving different tiers of sustainability. The two main evaluation methods used by the AEMBAC methodology are:

i. **Total Economic Value**

This provides a comprehensive analysis of the costs/benefits required to compare the economic advantage of one type of natural resource use over another. In AEMBAC this identifies the costs/benefits involved in achieving different tiers of sustainability. The economic value of the benefits of environmental goods and services may be evaluated using the most appropriate monetary evaluation technique (be this of the type *stated preferences* or of the type *revealed preferences*). These are then compared to the costs (i.e. undertaking and opportunity costs) of achieving higher tiers of sustainability

ii **Cost Assessment Method**

This evaluates only the costs (undertaking and opportunity costs) of achieving higher tiers of sustainability through the implementation of AEMs. It does not evaluate the benefits of improving the supply of ecosystem goods and services and is therefore not comprehensive. However, in many cases this may be sufficient. For instance, ratification of the Convention on Biological Diversity by the European Commission or EU commitments to halting the loss of biodiversity by 2010 can be seen as a proxy of the demand of biodiversity conservation by European Citizens. It is therefore only necessary to calculate the associated undertaking and opportunity costs in order to work out the most cost-efficient way of achieving these goals. Indeed, this is the approach used in Reg (EC) 1257/99[12].

Table 6.1.

Evaluating different tiers of sustainability

Tiers	Associated impacts	Recommended necessary agricultural practices	Option 1: Total Economic Value	Option 2: Costs Assessment
Tier +2	Presence of only high positive (red) impacts	20% of existing UAA reconverted to (semi-) natural habitat – expected to have very positive effects on plants, animals and ecosystems	Assessment of the environmental benefits and opportunity and undertakings costs resulting from achieving upwards tiers starting from the actual situation *(This cost-benefit analysis has to be done separately for each tier)*	Assessment of opportunity and undertaking costs resulting from achieving upwards tiers starting from the actual situation *(This cost-benefit analysis has to be done separately for each tier)*
Tier +1	Presence of only significant positive (yellow) impacts	5% of existing UAA reconverted to (semi-) natural habitat – expected to have positive effects on plants, animals and ecosystems		
Tier 0	Achieving EMR = no, or only low, positive/ negative impacts exerted by agriculture	Hedgerows 3m wide for at least 30 % of existing field margins in the area – expected to have sustainable impacts on plants, animals and ecosystems		
Tier –1	Presence of significant negative (yellow) impacts	Hedgerows 3m wide for at least 10 % of existing field margins in the area – expected to lessen the negative impacts on plants, animals and ecosystems		
Tier –2	Presence of high negative (red) impacts	Very sporadic field margins with hedgerows – ACTUAL SITUATION		

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[12] Reg (EC) 1257/99 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations http://europa.eu.int/eur-lex/pri/en/oj/dat/1999/l_160/l_16019990626en00800102.pdf

Example 6.1.

Economic valuation of establishing buffer strips along running waters and valuable biotopes, Saxony, Germany

Establishing buffer strips could effectively protect running waters and valuable biotopes in each of the three German study areas: Jahna, Röder and the Upper Lusatian Heath and Pond Landscape Biosphere Reserve in Saxony. An estimation of the costs of establishing these strips requires knowledge of the:

i. **opportunity costs** of using the required land; and

ii. **undertaking costs** of establishing and maintaining strips (mowing and mulching). (Establishment costs are not shown below but can be found from standard planning data, with adjustments for particular regional conditions.)

Table 6.1 shows these estimated costs. The opportunity costs of land depend on physical production conditions (costs are higher for more fertile and more productive land) and farm structural and market conditions (opportunity costs are higher where there is high demand for land). Another determinant is the policy environment, as opportunity costs are likely to be higher where production is subsidised.

The Kleine Spree river in the Upper Lusatian Heath and Pond Landscape Biosphere Reserve; Saxony, Germany; photograph by Olaf Bastian, 2001

Table 6.2.

Annual costs of establishing buffer strips along running waters and valuable biotopes

Costs		Units	Jahna Area	Röder Area	ULHPL
Opportunity costs of using land – "gross margin/ha"	Arable land	€/ha	511	315	274
	Grassland	€/ha	409	236	137
Establishment costs (distributed over 10 years)		€/ha	–	–	–
Maintenance costs		€/ha	50	50	50
Total annual cost/ha of buffer strip		€/ha	459	286	187
Total cost/100m of buffer strip (assuming each buffer strip is 5m wide)		€/100m	23	14	9

Figures are based on survey data and standard farm planning data

Identify locally appropriate agri-environmental policy targets and instruments

Step 7

- The tiers of sustainability defined in Step 5, along with the economic analysis of costs and benefits undertaken in Step 6, now serve as a starting point for defining realistic and effective policy targets (environmental goals) to be achieved through AEMs.
- Step 7 builds on this information and incorporates data from the local ecological, social and economic situation to find the most appropriate policy targets.

Identification of the most appropriate policy target for the study area

- The choice of policy targets will be always a political decision. However the approach proposed by AEMBAC will aid decision makers to define the policy targets by providing them with relevant, accessible, scientifically-supported information. The assessment of undertaking and opportunity costs calculated in Step 6 will be particularly helpful in defining policy targets.
- The many socio-economic issues to be taken into account in the selection of the policy targets include: farm economic and financial data (e.g. gross margin, fixed and current costs, farm income, debts, etc.), the environmental awareness of farmers, the local institutional functioning, the financial resources available for agri-environmental policy and the commitment of local and national government to achieving agricultural sustainability (e.g. ratification of the CBD, PEBLDS).
- The results of the agronomic feasibility analysis, which identify the most important opportunities and barriers to implementing recommended actions, are also important.

Studying locally suitable agri-environmental measures to reach policy targets

- Once agri-environmental policy targets have been defined, it is possible to develop AEMs to achieve them.
- Three types of policy instruments could be used to achieve the desired agri-environmental targets.

i. **Command and control**
Changes occur through laws and standards, as opposed to contracts (e.g. EU Nitrate Directive). The adoption of this approach may be necessary if the ecological impact is so widespread and negative that rectification requires a law that guarantees respect of environmental minimum requirements. This can also be used to put into practice the "polluter pays" principle for damaging practices (associated with negative tiers of sustainability).

ii. **Quasi-market**
Direct payments are provided through contracts between farmers and Administrators (e.g. support for rural development from the European Agricultural Guidance and Guarantee Fund – Reg (EC) 1257/1999[13]). This method aims to reward environmentally friendly agricultural practices (positive tiers within the AEMBAC methodology).

iii. **Market**
Changes are directly driven by markets such as through consumers paying higher prices for products produced using healthier and more environmentally friendly methods (e.g. less chemical inputs in organic production) or agro-tourists paying for conservation of aesthetic landscapes through accommodation prices.

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[13] Council Regulation (EC) No. 1257/1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain regulations

- It is important to note that the European Agricultural Guidance and Guarantee Fund (Reg. (EC) 1257/1999[14]) supports AEMs implemented using quasi-market methods.
- Other important supporting measures for implementing AEMs include training, extension services and research.
- The extent to which each of these different methods is required will depend, amongst other factors, on whether the goods are public (non-excludable and non-rival) or private. Generally the first two methods are used to deal with public goods.
- When using quasi-market methods to implement AEMs, the following decisions need to be made:

i. **Zonal or horizontal schemes**
Generally zonal schemes will be more effective for reaching a well-defined target in a defined area (e.g. Environmentally Sensitive Areas in the UK) whereas horizontal schemes can be applied over wider areas and to broad schemes (e.g. conversion to organic farming).

ii. **Time period of the AEMs**
This determines whether the AEM has to be permanent or implemented only for a specific time span. This includes developing time plans to reach different tiers of sustainability (e.g. from 0 to 1 and then later from 1 to 2).

iii. **Minimum number of farmers that must participate**
The number of farmers that must participate in any AEM will be important to its success and thus a minimum number of farmers required to participate must be calculated. For example to achieve a target of 30% of existing hedgerows being maintained at a width of three metres requires enough farmers to participate to encompass at least 30% of existing hedges.

iv. **Eligibility criteria for farmers**
Not all farmers will be eligible for enrollment in a particular AEM (e.g. in the example above, an eligibility criterion could be that only farmers with more than Xm of hedgerows on their farm are able to join, or that those possessing more environmentally important hedgerows have priority).

v. **Payments to farmers**
Calculating payments to farmers requires consideration of the expected loss of income, the costs of compliance with the necessary agri-environmental undertakings (above those costs consistent with "Good Farming Practice"), the savings on expenditure (e.g. reduced production operations) and regulations governing the size of incentive payments[15].

Example 7.1.

The AEM "extensively used meadows" developed following the AEMBAC methodology in Oberes Fricktal, Switzerland

Tool implemented	Quasi-market
Type of scheme	Zonal with emphasis on specific landscape types where more low input grassland is possible and important. In the rest of the region, conservation of the status quo.
Time period	At least 10 years.
Payments/ha	946€
Target value for area involved	Total of 342 ha extensively used meadows (in order to reach the Environmental Minimum Requirement).
Change required to reach the EMR	75 ha must be converted in order to reach the EMR (267 ha of extensively used meadows already exist).
Minimum number of farmers required to implement the AEM	At least 50% of farmers in the landscape types "Bergland" "Hügelland Ost", and "Hügelland West" ≈ 65 farmers. Each farm increases the area of extensively used meadows by an average of 1.15 ha.

Key features of the AEM:

- no fertilisation
- very restricted application of herbicides (only single plant treatment allowed)
- 1-3 cuts/yr depending on the botanical quality and the site, more cuts may be allowed (after consultation with an advisor)
- no mowing before 15th June (valleys), 1st July (hilly regions), 15th July (mountain regions)
- autumn grazing allowed, except on *Mesobrometum* meadows
- grass cut is collected and removed in order to remove the nutrients
- a minimum of 1 cut/yr left on the ground for hay production ("Bodenheu")
- grass piles and wood stacks left as refugia for animals
- minimum area of lot 0.05 ha
- if the botanical quality is low, then special seed mixtures must be sown

Requirements for a meadow to go beyond tier 0:

- graded cut (for areas > 0.5 ha) – meaning dividing the surface of individual plots into different areas which are mown at different times (time gap of 2-3 weeks)
- using mowing bars which set a minimum cutting height (recommended 8cm)
- no use of the "Aufbereiter" (a machine which cuts the grass into very small pieces and is detrimental to the meadow fauna)
- no silage allowed
- a minimum of one cut/yr left on the ground for hay production ("Bodenheu")
- meadows used contain high botanical biodiversity
- meadows used are within a biotope network or areas with high potential ecological value
- location is dry and sunny
- soil is poor in nutrients

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[14] Council Regulation (EC) No. 1257/1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain regulations

[15] Commission Regulation (EC) No. 1750/1999 laying down detailed rules for the application of Council Regulation (EC) No 1257/1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF)

The diversified landscape typical of the Oberes Friktal area; Oberes Fricktal study area, Switzerland; photograph by Gabriela Uehlinger, 2002

The skylark *(Alauda arvensis)*; once widespread in the open arable land of Switzerland, the skylark is now at risk of local extinction due to intensive cultivation and frequent cutting of the meadows

Step 8

Involve stakeholders and produce accounting and reporting systems

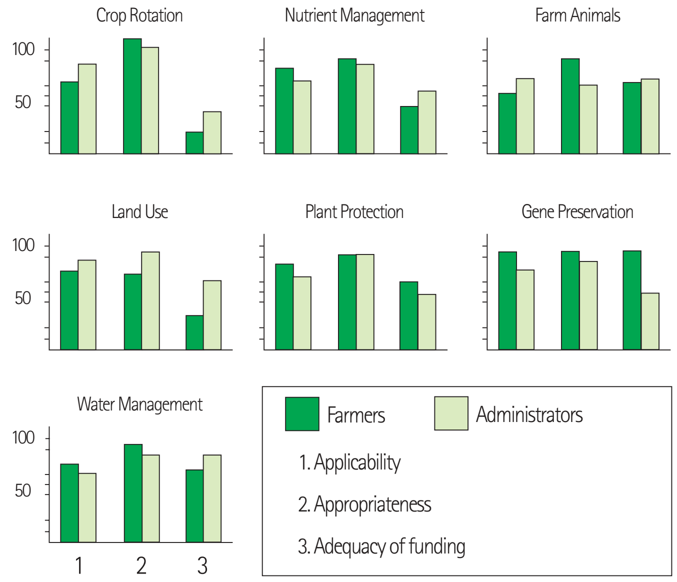
- The previous steps in the AEMBAC methodology prepared the necessary information and analyses to enable AEMs now to be discussed with stakeholders.
- The most relevant stakeholders are individual farmers who have to implement resulting AEMs. Other stakeholders include farmers' associations, local administrators, environmental groups and organisations, agro-industries (including retailers and agri-tourism agencies) and consumers' associations.
- Collaboration with stakeholders should consider: the experience they have with existing AEMs (Steps 1-5); their awareness of environmental impacts (Step 2) and pressures (Step 4); the required changes to agricultural practices (Step 5); their capacity to implement changes; their views concerning the costs (e.g. income foregone and undertaking costs); and monitoring systems required to implement AEMs (Steps 7-9).

Example 8.1.

Involving local stakeholders in producing AEMs In Hungary

- A number of possible AEMs were proposed to farmers and administrators for the study site in Hungary. Farmers and administrators were surveyed for their opinions on:
  - i. whether the proposed measures would be applicable in the study area;
  - ii. how appropriate the individual steps of the measure would be in the study area; and
  - iii. how adequate the payments would be for undertaking the measure.
- Farmers and administrators were shown to have similar opinions concerning these factors and generally the proposed measures were identified as appropriate and applicable, but more concern was expressed regarding payments, as shown by the greater range of values for that aspect (38-89%) in fig. 8.1. This has now led to a review of the financial aspects of these measures.
- A further questionnaire put the proposed measures into a broader regional context, as those surveyed manage approximately 23,000 hectares and had knowledge of a much larger region. Again there was broad support for the measures with only gene preservation and water management scoring lower than 70%. This is primarily due to limited experience with these issues in the region and has stimulated the development of pilot schemes to address the issues in the region.

Fig. 8.1.



A summary of graphs showing the results of surveys of farmers and administrators in Hungary. (The three columns in each graph indicate the farmers'/ administrators' assessments of a measure's
(1) applicability, (2) appropriateness and (3) adequacy of funding

Identifying AEM reporting systems

- First the necessary farm-level data must be identified that will demonstrate, particularly to local authorities, inputs for implementing AEMs and outcomes in terms of effectiveness.
- It is very important to minimise the paperwork involved in environmental accounting.
- AEMBAC recommends three categories of data to be collected:
  - i. Environmental data;
  - ii. Agricultural practice data; and
  - iii. Socio-economic data.
- Often data relevant to the inputs for implementing AEMs (e.g. time spent maintaining landscapes) is not recorded in farmers' accounting books but this is essential for assessing the costs of implementing AEMs.
- Pressure indicators from Step 3 should be used to develop accounting systems that require minimal paperwork and explain the farm-level environmental, agricultural and socio-economic inputs.
- The cost assessments made in Step 6 can help to identify economic data.
- Involving farmers in data collection for reporting outcomes of AEMs (e.g. species present or rates of soil erosion) will increase environmental awareness and appreciation of the value of AEMs and will be useful for monitoring and evaluation.
- The farm-level state indicators and their EMR values from Step 2 should be used to determine which outcome data is reported by farmers and which is supplied by specialised personnel.

Example 8.2.

Identification of farms' environmental accounting systems related to the agri-environmental measures in Chianti, Italy

To keep paper work as low as possible, only the most important and easily reported farm-level state indicators and their relative EMR values were used, along with other socio-economic indicators. Part of the aim was to increase farmers' appreciation of the AEMs by concentrating on socio-economic aspects.

AEM grass soil cover
This measure consists of growing grass on the soil between and around vines and olives and maintaining this grass for at least five years. For each AEM, indicators were suggested that farmers themselves could monitor once a year. For grass soil cover, the accounting scheme is based on the information in table 8.1 overleaf.

Biodiversity and landscape indicator presence of active swallows nests
This is an important indicator, being affected by agricultural intensification, pesticide use and building restoration; it is easy to learn how to monitor these; and monitoring by farmers will increase their awareness of the direct effects of agricultural practices on biodiversity. This indicator is indirectly related to the grass soil cover and it may also be utilised for other measures.

Landscape indicator change of grass colour
This is a useful indicator and is related to the risk of soil erosion.

Table 8.1.

The main indicators used in the farmers' environmental accounting schemes for the Chianti study area

Farm data and Indicators	Unit	Year 1	Year 2	...
Total farm area	ha			
Area carrying out the AEM	%			
BIODIVERSITY				
How many active* swallows nest are in the farm?	Number			
How many swallows hatched successfully in the farm?	Number			
LANDSCAPE				
Is the grass growing without problem?	Yes/No			
Are there areas where the grass is thin or yellow?	Yes/No			
What area is affected by the problem? < 30%, 30-50%, 50-70%, >70%	%			
SOIL				
What % of soil is covered by grass? 10%, 30-50%, 50-70%, >70%	%			
SOCIO-ECONOMIC DATA				
Time spent planting and maintaining grass soil cover	Hrs/ha			
Costs of operation (including labour)	Euro/ha			

* active nest = nest regularly occupied during breeding season, regardless of reproductive success

Monitoring and evaluation procedures

- Monitoring and evaluating AEMs is an essential for achieving policy targets. But it is also a complex process that requires further research.
- The concepts described in this booklet and developed during the three-year AEMBAC project provide a useful addition to the development of more solid monitoring and evaluation processes. For example, monitoring the achievement of agri-environmental objectives (e.g. biodiversity or landscape benefits) could use indicators identified in Steps 2, 4 and 6 and monitoring wider agricultural and socio-economic impacts could use indicators identified in Steps 3, 4 and 6.
- Monitoring socio-economic achievements could be helped by using the analyses of farm income, employment, farmers' environmental awareness and training conducted in Steps 3 and 7.

Evaluating the effectiveness of AEMs

- To evaluate the effectiveness of an AEM, evaluators (farmers, local administrators, independent evaluators and European Commission officers) must first be aware of its environmental objectives.
- AEMBAC aids this process by:
  - producing indicators for monitoring;
  - defining locally tailored baselines (EMRs) against which to evaluate effectiveness;
  - clearly defining objectives to be reached and evaluated; and
  - transparently explaining how objectives will be reached.
- The AEMBAC methodology also allows comparison and evaluation of the collateral effects, both direct and indirect, that the implementation of AEMs may have on other agricultural and socio-economic aspects. These include productivity, inputs, land use conversion and socio-economic factors such as employment, environmental awareness, income, competitiveness and markets. After a certain time for implementation, the results achieved could be checked and interpreted against the envisaged changes.
- When evaluating an AEM, it is also important to consider the possible synergies and/or conflicts that may occur with other agricultural, rural development and socio-economic sector policies.
- Also any evaluation procedure should consider the possible benefits that an AEM can have on other environmental functions, for example an AEM that maintains a habitat for its refugium function could also bring benefits to functions that improve the aesthetic quality of the landscape and control soil erosion. Not considering these collateral benefits risks underestimating the total benefits of the AEM.

Box 8.1.

Meeting European Commission monitoring requirements

The AEMBAC methodology, and particularly its use of indicators, can facilitate evaluations that are in line with the three main monitoring types proposed by the European Commission (EC Doc. VI/12004/00 Final):

- **Temporal:** comparing the starting situation with the results after 5, 10 or more years of implementation.
- **Counterfactual situation:** comparing the performance of the environmental function of interest in farms that are enrolled in AEMs and those that are not.
- **Benchmarking:** comparing state indicators actual values after implementation of AEMs with their Environmental Minimum Requirements.

Iron age grave in botanically rich semi-natural pasture; Selaö study area, Sweden; photograph by Knut Per Hasund 2002

Step 9 Produce contracts and implement AEMs

- On the basis of the agri-environmental measures which have been identified in Step 7 and further developed with stakeholders in Step 8, it is now time to draw up contracts for the delivery of agri-environmental goods and services for the local situation.
- It is important to note that out of the three approaches for implementing agri-environmental policy identified in Step 7, the quasi-market approach is the one recommended by EC Regulation 1257/99.
- Step 9 explains how to produce contracts for the quasi-market approach, where governments "purchase" specific agri-environmental goods or services to be delivered by farmers.

Draft contracts (see table 9.1 on page 39)

- Contracts in effect enable the public administration to purchase an increase in an environmental good or service and therefore must contain clear statements of:
  - **what is the object of the transaction** – what activities must occur (e.g. encouraging field margins next to hedgerows); and **what incentives will be given** (e.g. euros /increase of hedgerows of a certain width);
  - **where the AEM will take place;**
  - **when the measure will be implemented, for how long** and **when payments will occur;**
  - **who is the subject of the contract** (e.g. individual farmers or groups/ associations);
  - **how monitoring will be carried out**, including details of accounting methods, inspection activities and penalties for non-compliance;
  - **current legislation** to be respected; and
  - **other complementary activities** that must be undertaken.
- This information is generated by following the AEMBAC methodology, in particular Steps 7 and 8.

Calculate administrative and transaction costs

- Choosing the best implementation approach (i.e. command and control, quasi-market and market) requires each approach to be assessed for its fixed and variable administrative and transaction costs for both the farmer and the institution[16]. These include costs for:
  - designing agri-environmental policy;
  - applying to the EU for approval of AEMs proposed;
  - liaising with farmers, institutions and the general public;
  - dealing with applications;
  - producing contracts and managing payments;
  - controlling compliance/checking market functioning;
  - monitoring and evaluating policy effectiveness;
  - providing feedback on policy design and development; and
  - complementary activities.

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[16] Under Reg. 1257/99, reward for AEMs based on voluntary agreements is only envisaged for providing environmental goods and services that go beyond "Good Farming Practices" therefore only the "quasi-market" approach should need such analysis. However, in order to be comprehensive, AEMBAC covers other implementation approaches (such as command and control and markets) and so the cost assessment has also been proposed for these policy instruments.

Table 9.1.

Example of a contract drawn up to alter mowing practices in Northwest Overijssel, The Netherlands

The AEM: Alteration of Mowing Practices

Implementation requirements necessary to achieve the desired tier	Tier –1 (Only an objective if Tier -2 is currently accepted as "good farming" – NOT sustainable)	Tier 0 (Bare minimum of goods and services being provided)	Tier +1 (Positive amounts of ecological goods and services being supplied)	Tier +2 (Positive amounts of ecological goods and services being supplied)
Object of transaction	Mowing practices	Mowing practices	Mowing practices	Mowing practices
Agricultural activity proposed	25-50% of total agricultural land is managed using non-distributed mowing frequencies	50% of total agricultural land is divided into 7 plots that are subsequently mown in a period of 10 weeks, with intervals of 10 days, starting at the end of May	50-75% of total agricultural land is managed using reasonably well distributed mowing frequencies	>75% of total agricultural land is managed using well distributed mowing frequencies
Additional requirements	None	Participation is only possible if land is located in assigned regions	Participation is only possible if land is located in assigned regions	Participation is only possible if land is located in assigned regions
Compensation /unit for income foregone	314.48 Euros	328.15 Euros	341.82 Euros	355.50 Euros
Payments /unit for additional costs incurred	–	–	–	–
Incentive paid per unit	13.67 Euros	20.51 Euros	27.35 Euros	34.18 Euros
Where implemented (whole farm or specific sites)	None	Implementation on complete parcels only	Implementation on complete parcels only	Implementation on complete parcels only
The Contracting subject	Individual farmers and environmental co-operatives	Individual farmers and environmental co-operatives	Individual farmers and environmental co-operatives	Individual farmers and environmental co-operatives
Time plan of implementation	6 consecutive years of applying the measure, payments are made annually	6 consecutive years of applying the measure, payments are made annually	6 consecutive years of applying the measure, payments are made annually	6 consecutive years of applying the measure, payments are made annually
Monitoring	_	_	_	_
Accounting methods	_	_	_	_
Inspection activities	Random checks	Random checks	Random checks	Random checks
Penalties for non-compliance	–	–	–	–
Related environmental legislation	–	–	–	–

Evaluate the costs and benefits of implementing AEMs

- Before funds can be obtained to implement these contracts, the total costs and benefits must be evaluated qualitatively and quantitatively.
- Costs to be evaluated include:
  - **compensation costs** for reduced yields, other income foregone, undertaking costs, land use conversion, etc. (Step 6);
  - **costs of incentives** to encourage uptake of the AEM (Step 6);
  - **indirect and induced costs** specific to the local situation; and
  - **administrative and transaction costs**
- Benefits in terms of agri-environmental goods and services provided (i.e. above tier 0) to be evaluated include:
  - **benefits of environmental goods and services produced;**
  - **benefits of negative agri-environmental impacts avoided** by implementing the AEM (i.e. avoiding the negative impacts due to sustainability being below tier 0);
  - **benefits of reduced production costs** (e.g. reduced inputs);
  - **benefits in terms of diversification of the rural economies;**
  - **benefits of enhanced scientific research and ecological knowledge;** and
  - **other indirect or induced benefits** according to the local situation.

Produce a strategy to target possible funding resources

- This is necessary to enable financing resources to be accessed and to enable the measures to be implemented. A detailed strategy should be produced to assess all possible European, National and Regional funding sources from analysis of similar previous AEMs, and analysis of possible new financial sources such as:
  - using the funds coming from applying the *polluter pays principle*;
  - using fiscal incentives;
  - adopting green taxes; or
  - reducing incentives coupled to production.

Conclusion

The AEMBAC methodology is based on the premise that **agro-environmental policy and sustainable rural development** will be most effective if they are knowledge driven. The AEMBAC project therefore set about showing how to integrate scientific results into policy development both at local and at European levels. The AEMBAC methodology has been developed by adopting an approach based on the concept that agri-ecosystems are multifunctional – that they provide multiple environmental goods and services – and that these can be valued and compared. Further information, and in particular a scientific final report (Riccardo Simoncini, *The AEMBAC project: final report, 2004)* can be found on the website (www.aembac.org).

Making the most of the AEMBAC methodology now requires implementing it and members of the AEMBAC team are available for consultation on how to do so.

A stone wall; photograph by Kalev Sepp

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Acronyms

AEM	Agri-Environmental Measure
AEMBAC	Agri-Environmental Measures for Biodiversity Assessment and Conservation
BPJ	Best Professional Judgement
DPSIR	Drivers-Pressures-State-Impact-Responses
EMR	Environmental Minimum Requirements
FADN	Farm Accountancy Data Network
GIS	Geographical Information System
UAA	Utilised Agricultural Area

Semi-natural pastures and fields with stone cairns – crucial for the biodiversity, cultural heritage and social values of the landscape; Alseda study area, Sweden; photograph by Knut Per Hasund, 2002