OVERVIEW OF BIODIVERSITY INDICATORS RELATED TO AGRICULTURE IN BELGIUM

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Abstract

The sustainability of farming systems is currently under debate. Nowadays, agriculture has become not only a food provider but also a provider of goods and services for tourism, leisure, landscape management, nature conservation, etc. Agricultural management practices have a key impact on biodiversity conservation, a serious decline of many plant and animal species which are traditionally linked to agricultural areas has been demonstrated. Although not all impacts are negative, a need to identify and monitor pressures on biodiversity coming from agriculture has been identified. Agrobiodiversity indicators are the proposed mean to achieve that objective. This paper summarises the state-of-the-art in Belgium (at Federal and Regional levels) of the use of indicators to monitor and analyse agricultural impacts on biodiversity.

Keywords: Agrobiodiversity indicators, Belgium, Flanders, Wallonia

INTRODUCTION

There is a strong concern that industrialisation and other changes in agriculture have long term consequences, which may compromise future levels of desired outputs from agricultural and other resources. Remarkable increases in agricultural productivity have occurred in many parts of the world during the last four decades thanks to intensification. Main characteristics of intensive agriculture are: specialisation, concentration, high fertilisation levels, regular biocide application (insecticides, fungicides, herbicides), irrigation/water abstraction, drainage and mechanisation (EEA, 1998). These characteristics however imply the loss or export of certain substances in large amounts (organic matters, nutrients, pesticide residues) and also the deposition in large amounts of other substances (nitrogen, phosphorus), leaving nutrient excess in the environment (García Cidad, 1999). Agricultural practices often affect not only the production areas but also the surrounding habitats, through, for example, water abstraction, and run-off and leaching of excess fertilisers and pesticides. Intensification in agriculture involves the development of capital-intensive and geographically specialised farming, leading to problems for landscape, biodiversity, but also for soil, water and air (ECNC, 1999). A serious decline of many plant and animal species which are traditionally linked to agricultural areas has been demonstrated (Green, 1990; Barr *et al.*, 1993; Fuller *et al.*, 1995; Andreasen *et al.*, 1996; Krebs *et al.*, 1999). Concerns are therefore increasing as to whether productivity gains can be maintained in the long term. As a result of those concerns, the notion of sustainability has arisen. In recent years, criteria have been developed (Van Mansvelt, 1997; Bühler-Natour & Herzog, 1999) and specific measures have been taken to benefit biodiversity and reverse the declines (Ovenden *et al.*, 1998). Society demands on the agricultural landscape have also changed with the increase in urbanisation. People urge a broad spectrum of functions from agricultural landscapes: food production, industrial use, recreation, housing, nature conservation, global environmental control (Vos and Meekes, 1999).

Agricultural management practices and trends have a key impact on biodiversity conservation (ECNC, 2001). Participants of the CBD/COP 5 Conference (CBD, 2000), have recognised that “understanding of the underlying causes of the loss of agricultural biodiversity is limited, as is understanding of the consequences of such loss for the functioning of agricultural ecosystems (Decision V/5)”.

An approach adopted to better understand those complex relationships is the use of indicators. An indicator can be defined as a representative survey (a qualitative or quantitative variable) of a phenomenon occurring within a complex system (Quintin, 2001). The advantage of using indicators is that they condense information and facilitate the understanding of the complex phenomenon they survey by simplifying it. They help to transmit information to decision-makers and to the general public at the same time that they facilitate monitoring and evaluation of the state of biodiversity.

In general indicators can be classified as *means* and *result* indicators. *Means* biodiversity indicators concern agricultural practices and can be considered as indirect measures of the status of biodiversity. Most of them are included into the different OECD thematic groups (pesticide use, water quality, etc.). It is assumed that the recorded features have an impact (positive or negative) on biodiversity, i.e. organic agriculture or pesticide use. R*esult* biodiversity indicators are a direct measurement of biodiversity, i.e. species abundance or species richness. *Result* indicators, although more reliable, are usually more expensive to monitor than *means* indicators. Moreover, it is generally difficult to compare *result* indicators between countries or regions, because species and natural habitats concerned are different.

The *means / results* classification is complementary to the OECD methodological frame (Driving Force-State-Response – DSR - model - OECD, 1997), being *result* indicators approximately equivalent to State indicators and *means* indicators to Driving Force indicators. However, as already explained, *means* indicators can also be seen as *indirect* State indicators (i.e. length of hedges, surface of extensive grasslands) through a causal relationship. The three sections composing the OECD model take into account agricultural characteristics, its relation with the environment and the role of agriculture in sustainable development. The framework identifies: driving force indicators, focusing on the agricultural elements causing modifications in the environmental conditions, such as changes in farm management practices and the use of farm inputs; state indicators, highlighting the effects of agriculture on the environment, for example, impacts on soil, water, and biodiversity; and response indicators covering the actions taken to respond to the changes in the state of the environment, such as variations in agri-environmental research expenditure (OECD, 2001).

A summary of the state-of-the-art in Belgium (at Federal and Regional levels: Wallonia and Flanders) of the use of indicators to monitor and analyse agricultural impacts on biodiversity, is presented below.

BELGIUM

Over the past years the Belgian agricultural sector has generated a 1.5% of the Belgian Gross National Product, placing agriculture in eighth position in the rankings of value added generated by the primary and secondary sectors (CLE, 2001). About 2% of the workforce is employed in the agriculture sector. Agriculture is becoming increasingly less important in economic terms, but remains the main activity in the countryside, where more than 45% of land is under cultivation (CLE, 2001). Nowadays, agriculture has become not only a food provider but also a provider of goods and services for tourism, leisure, landscape management, nature conservation, etc. The number of holdings has fallen by 25% in the past decade (CLE, 2001).

Environmental responsibilities in Belgium are shared by the Federal Government and the Regions. Belgium is a Federal State which consists of Communities and Regions. There are three Communities based on language (the Flemish Community, the French Community and the German-speaking Community), and three Regions (the Flemish Region, the Brussels Capital Region and the Walloon Region). Each Region has been developing its own biological diversity monitoring programme and there is little coordinated information or inventory available at national level (Belgian National focal Point to the Convention on Biological Diversity, 2001). In the case of agriculture, some indicators are compiled at national level by the Federal Ministry of Agriculture and by the National Institute of Statistics (Belgian National focal Point to the Convention on Biological Diversity, 2001).

At Federal level, the report on indicators for Biological Diversity in Belgium has just been produced (Belgian National focal Point to the Convention on Biological Diversity, 2001). The objective was to compile the currently used biodiversity monitoring indicators in Belgium. The report is based on the reference list of biological diversity indicators provided by the CBD Secretariat (CBD, 2001). The report includes the following list of indicators specific to agriculture (indicators marked in bold were added to the original list and are specific to the Belgian context (table 1).

Table 1. CBD indicators for agricultural biological diversity in Belgium.

	INDICATORS	Federal level	Wallonia	Flanders
ECOSYSTEM	**Land use for agriculture: agricultural area, n°. of farms; average agricultural area per farm**[1]	x	x	x
	Agricultural area per crops (cereal, oil crops, forage, woodlands) [1]	x	x	x
	Agricultural area (intensively farmed, semi-intensively farmed and uncultivated) [2]	x (partly developed)		
	Change in area of agricultural land (conversion to or from agriculture) [3]	x	x	
	Organic farming [4]	x	x	x
	Use of agricultural pesticides[5]	x	x	x
	Use of agricultural fertilizers[5]	x	x	x
	Afforestation of agricultural land (ha); incl. Christmas tree plantations not including hedges[6]	x	x	
SPECIES	Number of species threatened by agriculture by group e.g. birds, mammals, vascular plants, vertebrates, invertebrates) [7]		x (partly developed)	x (partly developed)
	Number of vertebrate **or invertebrate** species using habitat on agricultural land by species[7]			x (partly developed)
	Differences in species diversity and abundance of arthropods and earthworms in organically and conventionally cultivated arable land	Under development		
	Rate of change from dominance of non-domesticated species to domesticated species	Not applicable		
	Species diversity used for food	Under development		
GENES	Erosion/Loss of genetic diversity patrimony	Under development		
	Crops/livestock grown as a percentage of number of 30 years before	Under development		
	Accession of crops and livestock in ex-situ storage (number or percentage)	Under development		
	Replacement of landraces with few imported ones	Under development		
	Replacement of indigenous crops	Under development		
	Accessions of crops generated in the past decade (per cent)	Under development		
	Coefficient of kinship or parentage of crops	Under development		
OTHER	Inbreeding/outbreeding rate	Under development		
	Rate of genetic interchange between populations (measured by rate of dispersal and subsequent reproduction of migrants) [8]			x (partly developed)
	Use of agri-environmental measures (amount of money granted) [9]		x	x

[1] These indicators are compiled annually by the National Institute of Statistics (NIS), both at federal and regional level. See agriculture indicators of the NIS at http://www.statbel.fgov.be/figures/agriculture_fr.htm

[2] The NIS provides some data at national level on extensively farmed land: total area of extensive vegetable cultivation and high-stem orchards.

[3] The NIS compiles annually the total area of land taken away from agricultural production, both at national and regional level.

[4] The NIS also provides data on organic farming, through the number of organic farms and the total area for organic pastures and cultivated land.

[5] Data is compiled at federal level by NIS, but additional data is available at regional level. The main indicators used are the product quantity/ha/year (amount of fertilizers used or amount of active matter used for pesticides). Flanders: A monitoring programme specifically evaluates agricultural pressures (MAP - Manure Action Plan). In this regard, the region assesses the pressure from manure spreading on the soil and ground- and surface-water quality (amount of manure produced and spread on fields, in terms of phosphate and nitrogen production).

[6] The NIS estimates annually the total area of agricultural land afforested (including the total area of Christmas tree plantations), both at federal and regional level. Wallonia also uses as an indicator the total area concerned by financial support for afforestation (area/tree species planted).

[7] Flanders: exhaustive species inventories and red lists have been established for a wide range of habitats, including grasslands. Information is also available for agricultural lands. Species include vascular plants, butterflies, spiders (see indicators 145 and 155-170). Trends analysis has been carried out for some bird species in agricultural areas. Wallonia: data are available for birds in agricultural areas.

[8] Flanders: a research project is carried out at regional level on 3 vulnerable vascular plant species (*Primula vulgaris*, *P. veris* en *P. elatior*) typical of agricultural areas.

[9] Wallonia, Flanders: the financial assistance (amount of money) given for the implementation of the EU's agri-environmental measures is used as an indicator by both Wallonia and Flanders. These measures include the plantation of hedges, late mowing practices, rare cattle breeds and extensive grazing, establishment of wetlands and ponds, etc.

Source: Belgian National focal Point to the Convention on Biological Diversity (2001). Report on "Indicators for Biological Diversity in Belgium". Royal Belgian Institute of Natural Sciences.

FLANDERS

At regional level

Since 1994, the Flemish Environmental Agency produces regular reports on the state of the environment and nature in the Flemish region. After the first two publications of 1994 and 1996 which gave a broad and in-depth insight into the environmental issues in Flanders (Verbruggen, 1994; 1997), the structure of the reporting changed in order to be more useful for policy making and policy evaluation. Indeed, on the one hand, there was the need to have appropriate up-to-date information available for the definition of the yearly environmental action plans, on the other hand, exploring case studies and an extensive evaluation study of past and current policy practice was considered to be of great help to elaborate the five years environmental and nature policy plans. Three different products are published since then:

- The yearly thematic reports (MIRA-T), containing the state of nature and environment in relation to the different environmental themes or disturbance processes (e.g. light pollution, fragmentation, eutrofication, acidification, depletion of the ozone layer, etc)
- The five-yearly scenario report (MIRA-S), describing potential developments in the state of environment and nature, given a set of societal, economic, technical hypothesis
- The five-yearly policy evaluation reports (MIRA-BE) with an in-depth evaluation of environmental policy.

In 1998 and 1999 thematic reports were published (Verbruggen, 1998; Vandeweerd, 1999) and in 2000 the first scenario report was finished (Van Steertegem, 2000).

Except for the first report, the state of nature and environment has been described with the help of indicators, following the OECD approach (pressure, state and response indicators. This has yield an exhaustive list of which some can also be used as agri-biodiversity indicators. Agriculture is recognised to have a huge impact on environment and nature. The extent of this impact is assessed by analysing the use of natural resources and the emissions caused by agriculture. Specific pressure variables are then linked with the relevant environmental themes (see table 2).

Table 2. Relations between pressure indicators of agriculture and environmental themes as used in the Flemish 'Reports on the environment and nature'

Pressure indicator	Theme
Water use	Desiccation
Energy use	Greenhouse effect
Production of animal manure, chemical fertilisers use	Eutrofication, acidification, odour, greenhouse effect, water quality
Pesticide use	Pollution
Emission of NH3	Eutrofication, acidification
Emission of SO2	Acidification
Emission of CH4, N2O, CO2	Greenhouse effect

Source: Helming et al, 2000

For the different themes the contribution of agriculture to the total pressure is then calculated. However, an unequivocal relation between the pressures exerted by agriculture and effects on nature or biodiversity that result from them, is seldom given; at least for Flanders as a whole. On the local scale however, a lot of case studies are convincing in this respect.

Assessing the impact of agriculture on biodiversity is done the other way around: more general data sets on biodiversity are compiled and analysed in the light of potential agricultural impacts. This state of biodiversity and the associated role of agriculture are well documented in the reports mentioned earlier and especially in the "Nature Report" (Kuijken, 1999). The Nature Report is published bi-annually by the Institute of Nature Conservation. It gives a very detailed description of the state of the different major taxonomic groups, the characteristic communities and the ecosystems of Flanders. In the 2001 edition (Kuijken, in press), an analysis, starting from the relevant disturbance themes, is also included.

Biodiversity and agriculture in Flanders, some figures and trends

From all these reports and from earlier or parallel studies, some general and major trends concerning the impact of agriculture on biodiversity are clear. Some clear examples are given below:

From the 21 bird species typical for agricultural landscape, 15 show a sharp decline and 6 almost got extinct. Habitat area, habitat quality and available non-toxic food seem to be the critical factors. Thus, the presence and abundance of these species reflect land use, landscape structure and scale, agricultural management and crop rotation, presence of semi-natural habitat patches, all aspects that are to a very high degree influenced by the transformations of agriculture. It can be concluded that abundance measurements of the guild of characteristic breeding birds of the agricultural landscape yield a suitable indicator to assess general agricultural impact on biodiversity. As an alternative also the abundance of individual species can be used as an indicator. Once common birds such as the Sky Lark (*Alauda arvensis*), Tree Sparrow (*Passer montanus*), Yellowhammer (*Emberiza citrinella*), have proven to be very suitable in this respect in Flanders. Species that are nowadays very rare in Flanders, such as the Red-backed Shrike (*Lanius collurio*), are only useful in specific regions.

Butterflies are suitable to be used as integrative but also very specific indicators, owing to their (sometimes exclusive) dependence as a caterpillar on a certain host plant and as an adult on nectar plants and biotope structure. Besides that, their often limited dispersion capacity makes them very sensitive to decrease of habitat area and fragmentation (Maes & Van Dyck, 1999). In Flanders, a comparison with data from 1991 showed that rare species are becoming rarer and general species more general (Maes & Van Dyck, 1996). Species of vegetation in early and late succession stages are declining sharply, while species of the intermediate succession stages do not follow this trend. In particular butterflies of dry and wet heath, dry and humid species-rich grasslands, natural forests and marches are threatened. The destruction of the small habitat patches, scattered in the agricultural landscape, the disappearance of host plants through acidification, eutrofication or desiccation, mean the end of the populations.

Finally, vascular plants are widely used as indicators to assess the impact on biodiversity of landscape transformation and changes in environmental qualities. For Flanders it turned out that of the 12 habitat types that have more than 50% of their characteristic plant species in the Red List categories vulnerable, endangered, critically endangered or extinct, 5 biotopes are characteristic for the agricultural land, while 3 are found in what is left of the semi-natural biotopes in that agricultural area (De Blust *et al.*, 1997). It is striking that these plant species all depend on moderately or nutrient poor often calcareous soils.
When analysing the plant species that have recently (after 1972) declined in Flanders (Cosyns *et al.*, 1994) (irrespective their initial abundance), the portion of (potentially) endangered or extinct species is the greatest for the flora that is characteristic for arable land on loamy soils: 80-90 % of those species have declined, the same amount as for the socio-ecological group of the nutrient poor calcareous fens (not an agricultural habitat).

The causes for the current state vary widely. Direct destruction of the habitat is undoubtedly very important. In addition desiccation, acidification and eutrofication of the countryside environment have a very negative impact on the flora as has been shown in very many detailed studies of species and areas. But when ones tries to examine whether clear relations can be established between changes in these specificic factors and changes in the total flora of Flanders, results are far less clear. Plant species can be grouped according their ecological amplitude regarding a certain environmental factor. Based on this, species can be assigned indicator values e.g. for the humidity and the acidity of the site, the nutrient content relative to the availability of ammonium or nitrate in the topsoil (see e.g. Ellenberg *et al.*, 1992). When for the indicator values of different environmental factors, the frequency distribution curves of the sub-sample of the Red List species in Flanders (categories endangered and extinct) and that of the total flora of Flanders are compared and tested for significance, the environmental variables 'nutrient content' and 'light' appeared to be highly significant (De Blust *et al.*, 1997). Thus plant species indicative of open areas and of habitats that are poor in nutrient, appear to be strongly represented among the endangered species. Shading, what means a lack of management, and eutrofication are probably among the most important causes of decline, whatever region or habitat in Flanders.

Deposition rates of N are very high everywhere in Flanders, with an average of 39 kg N/ha and year (Van Gijseghem *et al.*, 2000). When compared with the critical loads for nitrogen deposition for forest ecosystems -the best studied objects in Flanders until now (n = 652)- in more than halve of them, the critical load is exceeded. The critical load for N varies between 7.5 and 13.6 kg N/ha and year. For the other semi-natural ecosystems, most of high importance for nature conservation and hence found in the nature reserves scattered in the countryside, the figures are even more alarming. In a study that compared actual deposition according a deposition model with the critical loads for different types of highly vulnerable mesophilic fen, extensively managed semi-natural grassland and heathland, it was concluded that everywhere in Flanders those critical loads were exceeded.

The problem is that a quick change in this situation may not be expected. A case study revealed that except for the sustainable development scenario, there is little hope that nitrogen deposition will decrease sufficiently to meet the requirements of the vulnerable ecosystems. In 2010 still 38% of the forest ecosystems will suffer from exceeding depositions and hence with the scenario's business as usual (BAU= complete execution of all measures foreseen in current policy) and improved BAU+ (=complete execution of all measures foreseen in current policy + some extra technological measures), the intermediate policy targets will not be reached. The same holds, and even more dramatically, for the most vulnerable ecosystems of interest for nature conservation. Even with BAU+, only for 5% of the area occupied by these ecosystems, the conditions will have improved so far that critical loads are no longer exceeded.

But even when the nitrogen deposition decreases, this amelioration must coincide with an equal improvement of the landscape characteristics and with ecologically sound management. The scale of application will be critical in this respect. For instance, there are chances for birds of agricultural areas to recover in so far that e.g. management agreements and restoration of small landscape elements, together with a decrease in the spread of toxic products, are applied on a broad scale. But still, as calculations revealed, even with the BAU scenario for about halve of the species the future will remain uncertain, resulting in unstable populations that may face extinction on the long run (De Bruyn *et al.*, 2000).

Finally, when environmental conditions will improve in the future, there still has to be space for the habitats. That is another bottleneck. Old species-rich semi-natural grassland e.g., the community that is most endangered by agriculture because of it being turned into temporary sown grassland or corn fields over huge areas, only occupies 0.3 to 0.6 % of the total area of Flanders (4640 – 8870 ha in total), scattered over hundreds of parcels (Kuijken, 1999). It is unnecessary to underline that the chances to maintain and preserve these ecosystems are becoming very small.

Monitoring land use and biodiversity in agriculture

A comprehensive and integrated monitoring scheme has to be elaborated in order to document regularly the state of a complex landscape and at the same time to shed light on the processes involved in its change. Because of this, variables are selected according their role in the DPSIR-conceptual model (OECD, 1997). Besides the functional interrelations between these variables, the spatially nested surveillance of the variables is another fundamental character of such an integrated monitoring. Variables to be sampled and the calculated indicators must represent the different components of the agroecosystem, the landscape and the associated biodiversity.

A detailed methodology to monitor all these changes has been elaborated in Flanders by Antrop *et al.* (2000). They developed an integrated and nested monitoring scheme that will be executed for the first time in 2002. The selection of variables and indicators was not only based on the DPSIR-conceptual model, but also tried to coincide with the successive sectors of environmental policy and management. Hence, the integrated monitoring programme for landscape and biodiversity of the Flemish countryside will work with a series of linked indicators (table 3) (De Blust & Van Olmen, in press). The monitoring project developed for Flanders' countryside include 165 objects (the mapping units) with all together 175 attributes and biodiversity measures such as total flora, vegetation descriptions of the major land use types, breeding bird sensus, butterfly inventories and counts of amphibians (Antrop *et al.*, 2000). Monitoring is done within 1 square kilometre plots. 30 sample quadrates distributed in the rural areas of Flanders are proposed. A stratified random sampling was used based upon the division of the traditional landscapes of Flanders.

Table 3. Examples of series of pressure, state and impact indicators as used in the integrated monitoring programme for landscape and biodiversity of the Flemish countryside

	Pressure indicators to be derived from local data collection	State indicator	Impact indicator
Desiccation	Area of parcels with subterranean drains Total volume of permitted groundwater extraction	Water level in gauges and ditches Groundwater quality expressed as conductivity and ion ratio	Number of obligate phreatophyte plant species Share of the different moisture plant indicator classes (sensu Ellenberg[1]) in the total flora
Eutrofication	N and P emission from local sources (e.g. total number of cattle and pigs)	N deposition (wet and dry) measured in (semi-) natural vegetation to allow comparison with critical loads[2] Soil P saturation in representative parcels	The proportion of clearly dominant plant species in the herb layer Share of plant species characteristic for oligo- to mesotrophic conditions (sensu Ellenberg[1]) in the total flora
Acidification	Potential acidifying emission expressed as total acid equivalents	Real deposition (wet and dry) as total acid equivalents in (semi-) natural vegetation to allow comparison with critical loads[3] pH of phreatic water	Forest vitality, degree of leaf damage Share of the different acidity plant indicator classes (sensu Ellenberg[1]) in the total flora
Fragmentation	Increase/decrease of hard barriers (length/area) Presence of mitigating infrastructure (ecoduct etc.)	Landscape metrics	Difficult to define in general Presence/absence of species functional groups according their dispersion strategies and capacities
Erosion	Total area of land without vegetation cover in winter related to terrain slope Presence of permanent vegetated talus and verges in raised areas	Presence of eroded ground and gullies Length of roads covered with mud Organic matter content of the topsoil of arable land	Area of un-vegetated patches in small landscape elements Number of pioneer plant species in the total flora of small landscape elements

[1] Ellenberg *et al.* 1992.
[2] Bobbink *et al.* 1998.
[3] De Vries, 1988.
Source: Antrop et al., 2000

WALLONIA

At Regional level

Since 1993, the Ministry of the Walloon Region (Direction générales des Ressources Naturelles et de l'Environnement) produces regular reports containing the Environmental Status of the Walloon Region (Etat de l'Environnement Wallon). In 1995, the report (Ministère de la Région Wallonne, 1995) was specially dedicated to agriculture, but at that moment no specific mentions to biodiversity was included. The 2000 report (Ministère de la Région Wallonne, 2000) had a chapter dedicated to agriculture and was more focused on indicators but again no specific agrobiodiversity indicators where mentioned.

A study is now being elaborated with the objective of producing a summary of the agri-environmental indicators used in the agricultural sector in the Walloon region (Quintin, 2001). The study adopts the general DSR (Driving Force-State-Response) framework propose by the OECD (OECD, 1997). The objective of this study is the selection of 50 indicators enabling a monitoring of the interrelations between agriculture and environment. In the study, environment is understood as the sum of the different physical environmental compartments (air, water, soil), landscapes and biodiversity parameters (genes, species and habitats). This time agro-biodiversity indicators have been integrated. The ones indicated in the document (Quintin, 2001) are:

- Importance of the ecological network in agricultural land (hectares, km);
- Farmers managing nature reserves (management contracts, hectares);
- Agricultural surface located in an environmentally sensitive area (hectares);
- Afforestation of agricultural land (hectares).

Other important indicators for biodiversity have been classified according to Quintin (2001) into Regional agricultural policy:

- Measures for conserving threaten local animal races and vegetal varieties (number of farms, number of animals, Euro);
- Number of farms applying agri-environmental measures; Another study elaborated recently in Belgium (Bogaert *et al.*, 2000) highlights the importance of a very similar indicator (hectares of farmland per region for which a management agreement is signed in the frame of agri-environmental measures) to reflect landscape aspects.

Biodiversity and Agriculture in Wallonia, some figures and trends

The Observatory of Fauna, Flora and Habitat (OFFH, 2001) of Wallonia aims to coordinate the collection and analysis of biological diversity data. Wallonia is one of the Regions in Europe where the biological patrimony is best known. A big number of naturalist have contributed for more than one century to improve the existing knowledge of species distribution and outstanding habitats. The actual situation of biodiversity in Wallonia is rather negative: several of the monitored species have already disappeared (5 to 15 %) and several others are declining (30 to 50 %), being the main cause the disappearance and fragmentation of habitats (OFFH, 2001).

Four programmes conform the fields of activity of the Observatory of Fauna, Flora and Habitat:

- Inventory and monitoring of biological diversity (ISB) – Monitoring the state of the environment through bio-indicators (SURWAL), to describe and monitor the distribution of species belonging to major biological groups;
- Inventory and monitoring of habitats (ISH), to make a standardised inventory of habitats and to monitor their regional dynamics;
- Inventory of sites of great biological interest (SGIB), to gather information on areas that harbour species and habitats of great biological interest;

- System of information on biological diversity in Wallonia (SIBW), to disseminate information collected within the scope of the first three programmes.

The biological groups being monitored at present in the first programme (Inventory and monitoring of biological diversity – Monitoring the state of the environment through bio-indicators), are (ISB-SURWAL, 2001): birds, reptiles, butterflies, dragonflies, orchids and ladybirds. Although this programme is not specifically focused on agriculture, it is clear that agricultural ecosystems are fundamental for the monitoring of the mentioned biological groups.

Within the thematic group of birds, a monitoring programme was launched in 1990 based on listening points (points d'écoute). The surveys consist of different transects (repeated annually) of 15 listening points all over Wallonia (an average of 2300 points per year). From a total of 160 observed species, only 77 were analysed (OFFH, 2001). From those 77, the population of 12 was identified as increasing significantly, 27 decreasing and the rest were considered to be stable. The general tendency in Wallonia appears then to be negative.

One of the surveys on butterflies concentrates on 21 species considered prioritaire. All the selected species were surveyed by direct observation or by counting imagos on the ground, either in transects or observation points. Six of the 21 species have sown a significant decline between 1990 and 1999 (i.e. *Eurodryas aurinia*) , and other five species presented also a declining trend. Two *species (Coenonympha hero* and *Strymonidia spini*) may have even disappeared in Wallonia between 1990 and 1999. The rest of the species seem to have a stable population. The most threatened species are to be found in semi-natural habitats and therefore always involving a certain degree of human activity, i.e. extensive grasslands. The major threats to those species are agricultural, intensification, afforestation of open landscapes and eutrofication. Urbanisation and desiccation of humid areas have also been identified as secondary threats (OFFH, 2001).

At field/farm level

Several studies exist up to date characterising, through the use of indicators, the environmental status or performance of different areas in Wallonia. One of the first studies on biodiversity indicators at farm level started in 1993 in the framework of a European project (Van Bol & Peeters, 1996). The project aimed at the improvement of farm sustainability by developing an ecological network in pilot-farms. Two indicators were finally selected for biodiversity: area of ecological infrastructure (percentage of farm area managed for biodiversity; e.g. field margins, hedgerows, extensive grasslands) and the Plant Species Diversity Index (i.e. the Shannon Weaver Index calculated on dicot species). Two other indicators, based on birds and butterflies populations, were investigated but finally rejected because both indicators appeared expensive to record at farm level and moreover, both biological groups were not only influenced by farming practices but also by the neighbouring landscapes. During this project, Plant Species Diversity Index and area of ecological infrastructure were thus considered the best indicators of the global state of biodiversity at farm level.

A more recent example is the study about the environmental performance of agriculture inside a Natural Park (Walot *et al.*, 2000), elaborated by the GIREA (Applied ecology interuniversitaire research group). The description of environmental performance of agriculture includes a point dedicated to the impact on biodiversity and ecological network. The indicators selected to characterise this point were:

- Stocking rate (LU/ha);
- Riverside exposed to cultivated fields (m; %);
- Riverside exposed to pastures (m; %);
- Marginal pastures within the farm (%);
- Use of good fertilisation practices (according to the existing legislation in the Walloon region) (ha);

- Average fertilisation applied in grasslands (kg/ha);
- Application of agri-environmental measures (ha; %);
- Average parcel size (ha);
- Hedges density (m/ha);
- Existing natural elements (% surface);
- Threatened livestock breeds and crop varieties.

In order to evaluate environmental performance of agriculture at farm level, there exists in the Walloon region a computer tool under development: PAEXA, Portrait Agri-environmental de l'EXPlotation Agricole (Grosjean, 2000). A first version of the prototype was tested in 2000. This programme aims to produce agri-environmental evaluations at farm level through the use of 21 agri-environmental indicators (Cossement, 2000). PAEXA was conceived as a tool for (a) evaluation (in order to identify and estimate the pressures exerted at farm level by different practices); (b) management (fix objectives to achieve in the near future, through the modification of agricultural practices); (c) prediction (modelling, simulating different evolutionary scenarios) and (d) monitoring (evaluation of the achievement of prefixed objectives). PAEXA describes the interrelations between agriculture and the environment at three levels (Josselin, 2001): Agri-environmental indicators (analysed individually); Environmental evaluation (aggregation of indicators), Agri-environmental management plan (interpretation of results and proposals for improvement). Amongst the twenty-one agri-environmental indicators, the following are considered to give information about the state of biodiversity at farm level:

- Stocking rate (LU/ha);
- Use of good fertilisation practices (according to the existing legislation in the Walloon region) (ha);
- Use of alternative techniques to herbicides (ha);
- Area occupied by landscape elements within the farm (% surface);
- Area of extensive practices within the farm (ha; % surface);
- Cutting dates in grasslands for the first cut (date);
- Application of organic nitrogen in grasslands (kg/ha);
- Threatened local breeds and crop varieties.

PAEXA is a programme still under development and some proposals for improvement after the first prototype was tested in 2000, are being considered at present (Walot & Josselin, 2001).

SUMMARY AND CONCLUSIONS

At Federal level, there is little coordinated information or inventory of biodiversity. Each Region has been developing its own biological diversity monitoring system. In the case of agriculture, some indicators are compiled at national level by the Federal Ministry of Agriculture (that has now been regionalised) and by the National Institute of Statistics.

In Flanders, there is big concern of the future trends of biodiversity related to agriculture. Several case studies and scenario analysis have been carried out up-to-date, demonstrating the importance of agriculture. An agrobiodiversity monitoring methodology has been developed and will be tested in 2001. Meanwhile many data are already available about the state of biodiversity in Flanders. The state of biodiversity and the associated role of agriculture are well documented, although not always an unequivocal relation between the pressures exerted by agriculture and effects on nature or biodiversity is provided.

In the Walloon region, the evaluation of agrobiodiversity is mainly based on *means* or Driving Force indicators. This implies that the analysis of agriculture is made with the underlying assumption that certain practices (extensive farming, organic agriculture, techniques that help reducing inputs,…) have positive impacts on biodiversity.

Concerning State indicators in Wallonia, the selected biological groups being monitored at present (birds, reptiles, butterflies, dragonflies, orchids and ladybirds) reveal general changes in the environment. On the other hand many of them can only show the evolution of very particular habitats that have small importance in the total Walloon agricultural sector, like for example: orchids in chalk grasslands; dragonflies in lakes and ponds; reptiles in dry slopes. Nevertheless, using specific species or plant communities as biodiversity indicators in agriculture (*result* or State indicators) must be encouraged. Actually, when such a specific species or habitat is correctly chosen, its monitoring can give precious qualitative information on the interactions between agricultural practices and biodiversity. So, at present, the lack of an indicator based in the evolution of plant communities is certainly a weak point of the programme for "Monitoring the state of the environment through bioindicators" (SURWAL).

In Europe, the advantages of integrated monitoring on a landscape scale are well understood. Consequently a lot of initiatives to implement these schemes on a national or regional scale are developed (table 4). The challenge is now to co-ordinate these projects on a European level in such a way that they can be used as an umbrella system to analyse the changes taking place in the wide variety of European landscapes. The central and directive role of the European Union and the Council of Europe regarding member states nature, environment and landscape policies, must be the catalyser. Table 4 situates the Belgian projects within the context of other European projects.

Table 4. National and regional projects for integrated monitoring on a landscape scale in Europe

Austria	Der Kulturlandschaftsforschung Österreich	Wrbka, 1998
Denmark	Small Biotope Monitoring System	Agger & Brandt, 1988
Estland	Agricultural Landscape Monitoring	Sepp, 1999
Flanders (B)	Integrated monitoring for the countryside	Antrop *et al.*, 2000
Germany	Ökologische Flächenstichprobe	Dröschmeister, 2001
Great Britain	Countryside Survey	Bunce *et al.*, 1992
	UK Environmental Change Network	Lane, 1997
Hungary	National Biodiversity Monitoring System	Ministry of Environment and Regional Policy, 1998
Sweden	Swedish countryside survey	Ihse *et al.*, 1999
Switzerland	Biodiversity Monitoring	Hintermann *et al.*, 1999
Wallonia (B)	Inventaire général de biodiversité	Defourny *et al.*, 1999

Final thoughts

The complete set of indicators selected for monitoring agrobiodiversity must be large enough for giving good information on the different elements of the studied system and at the same time as reduced as possible in order to allow quick an easy survey as well as understanding of the state of the system.

Most of the indicators measured in a system must evolve in a significant manner when a change in a management technique occurs, revealing short-term changes in the system. Other indicators reflecting long term trends, although less sensitive to short term changes and usually more expensive to survey, should also be included in the set as providers of complementary long-term information.

The evolution of indicator's values is informative by itself. But in the context of the implementation of sustainable systems, a norm should be associated to each indicator (Peeters & Van Vol, 2000; AWG, 1998). This norm represents a minimum or maximum value necessary in order to achieve a sustainability target. Norms are to be defined on a scientific basis, although the process may be influenced by economical, social and political considerations. Ideally, the choice of a norm must be the result of a negotiation process between different stakeholders (that will vary according to the monitoring scale): scientist, farmer representatives, farmer advisers, consumers, members of administration and politicians.

Finally it is essential to stress the importance of the monitoring scale. The choice of indicators will certainly vary depending on the monitoring purpose. They will differ at field or farm level from those selected at landscape, regional or country level. The most interesting scale for this OECD exercise is certainly the national (or regional) level. Nevertheless, country indicators are generally derived from values at farm level (i.e. aggregation, average, addition,…). However, some state biodiversity indicators are monitored at regional scale (i.e. abundance of a bird species in a rural area). Whereas contribution of agriculture is difficult to interpret, those indicators are better adapted to the concept of biodiversity (i.e. ecological network) than indicators derived from values at farm level. In Wallonia, for example, indicators such as these proposed by Quintin (2001) are derived from values at farm level, when indicators of the SURWAL program are not. As Wallonia is one of the Regions in Europe where the biological patrimony is best known, it should be rather easy to develop biodiversity indicators in agriculture monitored at regional scale. In addition, the European program NATURA 2000 and more generally, the growing importance given to the concept of ecological network, should also permit to develop such indicators in Europe.

Future developments of agrobiodiversity indicators in Belgium should comply with these general principles.

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