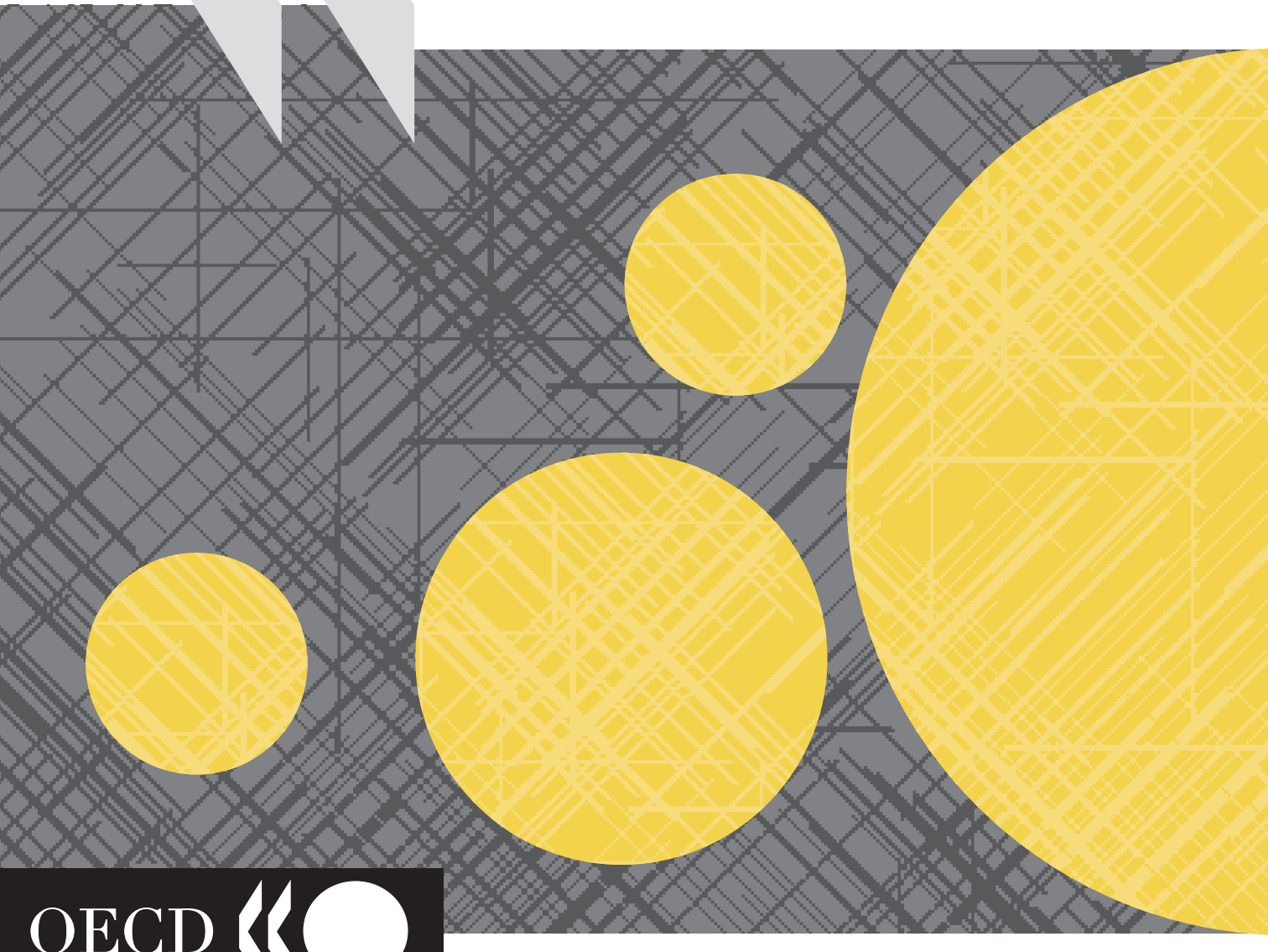
Agriculture and Biodiversity

DEVELOPING INDICATORS FOR POLICY ANALYSIS



OECD

Agriculture and Biodiversity: Developing Indicators for Policy Analysis

Proceedings From an OECD Expert Meeting

Zurich, Switzerland, November 2001

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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FOREWORD

Many countries have made commitments under the international Convention on Biological Diversity, agreed in 1992, which aims at conservation of biodiversity, including genetic resources, wild species and habitats. Part of this task is to quantify the linkages between human activities and biodiversity, including agriculture. This is not an easy task and few countries have systematic monitoring systems in place that track the trends in biodiversity. Also there are formidable scientific difficulties in linking changes in biodiversity associated with agriculture to specific policy measures.

To overcome some of these deficiencies the OECD is developing a set of agri-biodiversity indicators, which is part of a wider OECD activity to develop agri-environmental indicators. As part of the process to establish indicators OECD Member countries have hosted a series of Expert Meetings on specific agri-environmental issues (see www.oecd.org/agr/env/indicators.htm). This Proceedings reports on one of these Expert Meetings on agri-biodiversity indicators, hosted by the Swiss Federal Research Station for Agroecology and Agriculture, Zurich-Reckenholz, and held in Zurich-Reckenholz, November, 2001.

The Proceedings of the OECD Expert Meeting on Agri-biodiversity Indicators provides a selection of 18 of the 34 papers presented by authors from some 24 OECD Member countries, the European Commission and international organizations. The full set of meeting papers are listed in the Annex to this publication and available on the OECD website at the address above.

The Proceedings follows the order of the presentations at the meeting, covering an OECD overview of agri-biodiversity indicators, followed by papers on agricultural genetic resources, wild species, ecosytems and finally, papers linking habitats to species. The summary of the discussions that followed these presentations resulted in a set of recommendations to OECD with respect to agri-biodiversity indicators, which are included at the beginning of this publication. The summary of this publication is also available in French, German and Spanish, see the website above.

In compiling the Proceedings, no attempt was made to change the original content or message of individual papers. With the exception of formatting, the papers are reproduced here as they were submitted to the meeting. Many of the figures in these papers were prepared in colour, which can be viewed on the website above.

Acknowledgements

The OECD Secretariat wishes to thank the Swiss government authorities for hosting this OECD Expert Meeting, especially all the staff at the Swiss Federal research Station for Agroecology and Agriculture, in particular Andreas Gruening and Thomas Walter. OECD would also like to thank all the participants for their contribution to the success of the meeting, with a special thanks to those that helped as Chairs, Rapporteurs and Discussants. The following OECD Secretariat staff, under the overall guidance of Wilfrid Legg, also contributed to the meeting: planning and organisation, Kevin Parris; preparing the Proceedings for publication: Françoise Bénicourt and Laetitia Reille; and the staff of the OECD publications service.

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PREAMBLE

This report provides a selection of papers and the conclusions and recommendations reached by the experts who participated in the OECD Expert Meeting on Agri-biodiversity Indicators, held in Zurich, Switzerland, 5-8 November, 2001, under the auspices of the OECD Joint Working Party on Agriculture and Environment (JWP). At the JWP's meeting in April 2002 they agreed that the conclusions and recommendations of the experts should be made available to the wider public as a contribution to the development of agri-environmental indicators, and national and international efforts to establish agri-biodiversity indicators.

The conclusions and recommendations are those of the participants and do not necessarily reflect the views of the OECD, the JWP or its Member Countries.

The OECD undertakes analysis of agri-environmental policy issues within the JWP. As part of that work, the JWP is developing a set of agri-environmental indicators to measure the environmental performance of agriculture by:

1. providing information to policy makers and the wider public on the current state and changes in the conditions of the environment in agriculture;

2. assisting policy makers to better understand the linkages between the causes and impacts of agriculture, agricultural policy reform, trade liberalisation and environmental measures on the environment, and help to guide their responses to changes in environmental conditions; and,

3. contributing to monitoring and evaluating the effectiveness of policies addressing agri-environmental concerns and promoting sustainable agriculture and natural resource management.

The JWP has identified a number of criteria which agri-environmental indicators need to meet, including:

- *policy relevance* in addressing the key environmental issues faced by governments and other stakeholders in the agricultural sector;

- *analytical soundness* being based on sound science but recognising that their development is an evolving process;

- *measurability* in terms of data availability and cost effectiveness of data collection; and,

- *interpretation* in that the indicators should communicate essential information to policy makers and the wider public in a way that is clear and easy to understand.

In order to help establish policy relevant indicators, a number of OECD Member countries have hosted Expert Meetings on specific agri-environmental issues, in particular, to further develop two of the criteria: analytical soundness and the measurability of indicators. The Expert Meeting on Agri-biodiversity indicators, hosted by Switzerland, was one of the series of these Expert Meetings, and the full set of meeting papers and other related information (*i.e.* web links and country reports) are available on the OECD website at http://www.oecd.org/agr/env/indicators.htm

SUMMARY AND RECOMMENDATIONS

This chapter of the report provides the recommendations and summary of the discussion of the OECD Expert Meeting on Agri-biodiversity indicators, held in Zurich, Switzerland, November 2001. The main recommendations of the experts are provided in Section 1, which are further elaborated in Section 4. Background to the meeting is described in Section 2, and Section 3 provides a summary of the discussion at the meeting, supported by five Annexes.

1. Main recommendations

i) Establish agri-biodiversity indicators within a common, flexible and transparent framework that provides a hierarchy with multiple spatial and temporal scales in which to identify, structure, combine and aggregate indicators (Figure 1). The framework enables countries to identify the strengths and weaknesses in their existing compliment of indicators and takes into account an agro-ecosystem's: *diversity of elements* (*e.g.* flora and fauna); *complexity of interactions* (*i.e.* social, economic and environmental) and the *interaction with other ecosystems* (*e.g.* forests). It also recognises the *hierarchical structure* within the agro-ecosystem, including: the agro-ecosystem base (*i.e.* agricultural land; production species-crops and livestock; and production support species, *e.g.* soil biodiversity); habitat types, their structure and management; and wild species use of agro-ecosystems for different requirements (*e.g.* breeding, feeding).

ii) Member countries should provide the OECD on a regular basis, when available and where relevant, a set of agri-biodiversity indicators that monitor the effects and performance of agriculture on biodiversity (*i.e.* at the genetic, species and ecosystems levels) and which are linked to actions by farmers, the agro-food chain and governments.

iii) Integrate the agri-biodiversity indicators into policy monitoring, evaluation and in predictive scenarios to improve policy effectiveness in promoting sustainable agriculture.

iv) Invest in the scientific understanding and research of the linkages between the genetic, species and ecosystems levels related to agri-biodiversity, and the interactions between farming and biodiversity. This research should help to further develop the associated information and basic data, including in those areas not yet covered by the OECD work, notably indicators of environmental services, such as soil biodiversity, pollinators and natural pest control.

v) Continue to engage a wide range of stakeholders in developing agri-biodiversity indicators, including farmers and food industry representatives, environmental groups, government scientists and policy advisors, by drawing on and sharing their perspectives, expertise and information sources related to monitoring agri-biodiversity for policy purposes.

vi) Contribute and cooperate with other international initiatives related to developing agri-biodiversity indicators, especially those under the Convention on Biological Diversity and in FAO, by conveying the OECD work to these organisations and convening joint meetings with them for the purposes of indicator development and co-ordination, and in order to promote global consistency, similar to indicators in the socio-economic field, and also to share the OECD work with non-Member countries.

2. Background

The OECD Expert Meeting on Agri-Biodiversity Indicators (ABIs) was convened to contribute and build on the work in the OECD to develop a set of Agri-Environmental Indicators (AEIs). The meeting, hosted by the Swiss Federal Research Station for Agroecology and Agriculture, Zurich-Reckenholz, Switzerland, was attended by nearly 90 participants, drawn from 24 of the 30 OECD Member countries and involved many international organisations.

This summary and recommendations from the meeting, also includes additional information drawn from the reports of the Rapporteurs and Discussants (Annexes 1-5). All 34 papers presented at the meeting, including the list of participants, web links and country reports, are available on the OECD website at http://www.oecd.org/agr/env/indicators.htm

An oral report of the meeting was presented by the OECD Secretariat to the 7th meeting of the Subsidiary Body on Science, Technical and Technological Advice (SBSTTA, held in Montreal, Canada, November 2001) and the Conference of the Parties 6th Meeting (COP-6, held in The Hague, The Netherlands, April 2002) of the ***Convention on Biological Diversity*** (CBD) (see the CBD website at: http://www.biodiv.org/doc/meeting.asp?lg=0&wg=sbstta-07). The results from the Expert Meeting were also provided for information to the ***Pan-European Conference on Agriculture and Biodiversity***, hosted by France, in Paris, 5-7 June, 2002, and organised by the Council of Europe (COE) in cooperation with the UNEP (see the COE website at: http://nature.coe.int/conf_agri_2002/)

3. Summary

There was recognition that the overall objective of the ABIs is to monitor the effects and performance of agriculture related to biodiversity, linked to actions by farmers, the agro-food industry, and governments (Annex 1), in:

i) providing crop and livestock genetic resources, as the basis for food production, and the development of agricultural raw materials, such as renewable energy through biomass;

ii) enriching society through maintaining and enhancing the variety of wildlife habitats and wild species related to agriculture, of value for economic, scientific, recreational, aesthetic, intrinsic, landscape and other amenity purposes; and in,

iii) supporting the functioning of ecosystems and production support systems critical to agriculture, such as soil fertility protection through soil microbial activity, pollination, nutrient cycling, water filtration, and climate influence.

ABIs that can help countries and the international community to monitor progress towards achieving a sustainable agriculture need to reflect both the genetic, species and ecosystem levels in agri-biodiversity relationships and also the socio-economic interactions between farming and biodiversity, as recognised under the Convention on Biological Diversity (CBD). Annex 1 provides the classification and coverage of OECD ABIs, and their compatibility with the CBD.

Experts emphasised ABIs need to be developed within the context of the OECD's objectives for work on agri-environmental indicators, including as a:

i) source of information on the status and trends in biodiversity related to agriculture; and a,

ii) tool in policy monitoring, evaluation and in predictive scenarios, to improve policy effectiveness in promoting sustainable agriculture and management of natural resources.

The further development of ABIs should build on the solid basis already achieved by OECD (see OECD, 2001, Environmental Indicators for Agriculture — Volume 3: Methods and Results, notably the chapters on Biodiversity and Wildlife Habitats), and be selected on the basis of the OECD criteria of policy relevance, analytical soundness, measurability and ease of interpretation, and the specific guidelines for selecting agri-biodiversity indicators recommended by experts (Annexes 4 and 5). Moreover, to enhance the effectiveness of policy decision making, the indicators should be made available as soon as feasible.

The "sustainability" framework — which encompasses economic, social and environmental dimensions — can be useful to situate ABIs in their broader context. It can also help to avoid that ABIs have too narrow a focus on existing systems by recognising the possibility of change brought about by other sustainability considerations, especially economic and social factors.

The driving force-state-response model can help structure analysis of agri-biodiversity relationships. For example, *driving forces*, such as government agricultural support policies and market conditions (*e.g.* agricultural commodity and input prices) influence on pesticide use and pest management practices. This is causing the *state* of biodiversity in agriculture to change as a result of the impact of pesticide use and pesticide management on wild species, and this may in turn lead to farmer, agro-food industry and government *responses* to promote biodiversity conservation, such as through the adoption of integrated pest management and changes in government crop and pesticide input support policies and pesticide risk reduction regulations.

The importance of developing ABIs for policy monitoring, evaluation and in projection studies was emphasised, not only by experts from OECD Member countries and the EU Commission, but also by representatives of international governmental organisations (European Environment Agency, FAO, Ramsar, UNEP, and the World Bank), and non-governmental organisations representing farmers (International Federation of Agricultural Producers, IFAP), the food industry (Business and Industry Advisory Committee to the OECD, represented by Unilever), and environmental interests (Birdlife International, European Centre for Nature Conservation, World Conservation Union (IUCN), Wetlands International and the World Seed Organisation).

It was recognised that a major challenge for OECD Member and non-Member countries is to reconcile the need to expand agricultural production while meeting national and international objectives and commitments for the conservation and enhancement of biodiversity, given the projected need to increase global food production by over 20% by 2020.

Experts called on OECD Member countries to consider several issues in developing and providing indicators to:

i) reflect a comprehensive view of agriculture and its effects on biodiversity, and not just focus on protected areas and endangered species;

ii) recognise the complexity of agri-biodiversity and hence use a combination of indicators;

iii) develop existing data sets to meet the immediate needs of policy makers and, over the longer term, in recognition of the limitations in the current scientific understanding and data to measure agri-biodiversity, make further effort (in terms of scientific research and data collection) to address these limitations;

iv) establish metadata (*i.e.* descriptive notes) for ABIs that defines and describes genetic, species and ecosystems information;

v) undertake further research to improve understanding of ecosystem services related to agriculture (*e.g.* soil biodiversity, pollinators, natural pest control) and develop relevant indicators;

vi) recognise the consequences of uncertainty on changes in agri-biodiversity linkages, for example, the impact of climate change, genetic mutations and alien invasive species;

vii) provide ABIs and related data and metadata sets to the Secretariat on a regular basis as soon as feasible; and,

viii) integrate the indicators into policy monitoring, evaluation, and projection studies.

To improve interpretation of ABIs experts recommended it is necessary to take into account the:

i) spatial and temporal coverage of indicators, in particular, to take into account not only species presence, but also changes in species abundance and their distribution;

ii) overall trends rather than absolute levels across countries;

iii) baselines if established at the national level (not the OECD level) could help to improve the assessment of the performance of agriculture in achieving identified future goals and targets;

iv) causes of change on biodiversity in agriculture, both negative (*e.g.* excessive farm chemical use) and positive (*e.g.* creating field margins as wildlife corridors), in particular the effects of different farming practices and management systems; and the,

v) linkages with other agri-environmental indicators, such as farm management indicators.

It was observed that the OECD agri-biodiversity indicators are applicable to many non-Member OECD countries. The OECD work could thus provide useful synergies and input into other international efforts to develop ABIs, especially under the CBD and the FAO's work on monitoring trends in global agricultural biodiversity. Experts also noted the need for cooperation in work on ABIs, not only between OECD Member and non-Member countries, but also drawing on the expertise and databases of other international organisations, such as Birdlife International, ECNC, the EEA and its European Topic Centres, FAO, IUCN, Wetlands International and the World Bank. Even so, data drawn from other international organisations would need to be verified in terms of their validity and quality.

4. Recommendations

4.1. The Agri-Biodiversity Framework (ABF)

Experts recommended drawing together different agri-biodiversity indicators of genetic resources, habitats, and wild species within a coherent and comprehensive framework (Figure 1). The agri-biodiversity framework (ABF) provides a hierarchical framework with multiple spatial and temporal scales in which to structure and organise national (and sub-national) indicators of agri-biodiversity. The framework takes into account the socio-economic and environmental interactions in an agro-ecosystem which provide both commodities (*i.e.* food and non-food outputs) and environmental services (*e.g.* scientific, recreational, ecological).

The ABF recognises (Figure 1) the:

i) ***Diversity of elements in an agro-ecosystem***, which consists of plant and animal communities (domesticated crops and livestock, and wild species) and their environmental functioning as an ecological unit, strongly influenced, created and/or maintained by agricultural management activities within which are a diversity of different habitats. Each habitat type is defined as including both living and non-living aspects, limited to an area where a certain number of ecological factors and farm management practices are broadly homogenous and stable.

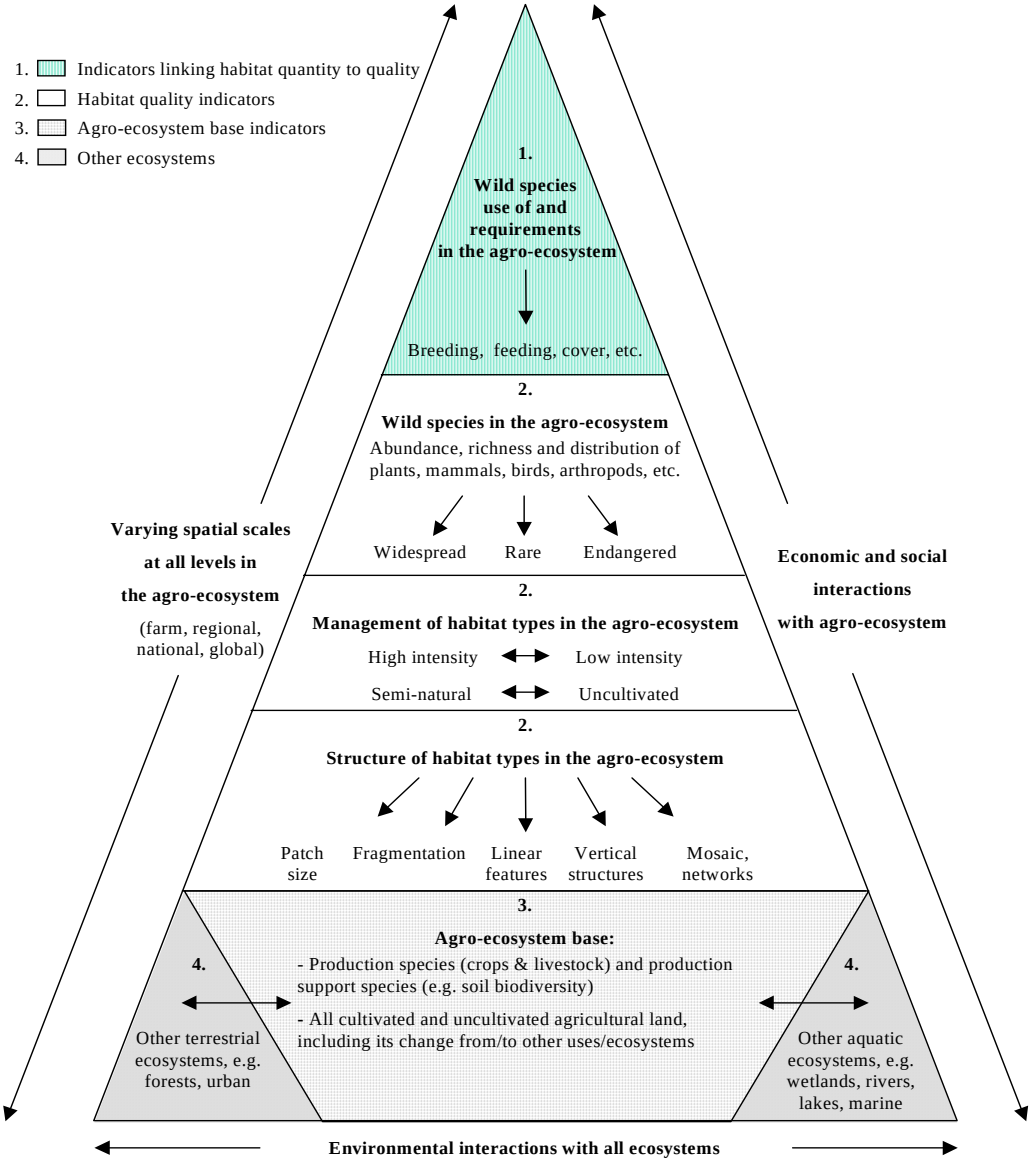
ii) ***Complexity of the interactions among the different elements in the agro-ecosystem***, in particular, between the economic (*e.g.* agricultural commodity prices and support measures), social (*e.g.* farmer education, skills, cultural values), and environmental elements (*e.g.* physical environment, biological elements) interacting on the diversity of habitat types, production species (crops and livestock) and wild species (including production supporting species) within the agro-ecosystem.

iii) ***Interaction between agro-ecosystems and other ecosystems***, both terrestrial (*e.g.* forests) and aquatic (*e.g.* wetlands), especially in terms of the effects of farming practices on other ecosystems (*e.g.* off-farm impacts from nutrient/pesticide run-off into aquatic ecosystems) and land use changes from agricultural land to other land uses (and vice versa). This can have both beneficial and harmful effects on biodiversity depending on the nature of the change in land use, such as a change from semi-natural grassland to commercial forest or a change from a tropical forest to cultivated cropland.

iv) ***Hierarchical structure of different layers within the agro-ecosystem***, including the current state and changes in the: agro-ecosystem base, including production species and production supporting species and the land use stock and changes between agriculture and other ecosystems; structure of habitats within the agro-ecosystem; management of the habitats in agro-ecosystems; wild species in the agro-ecosystem; and the use and requirements by wild species of the habitats within the agro-ecosystem (*e.g.* breeding, feeding).

v) ***Tangible and quantifiable specification of biodiversity*** (*i.e.* genetic resources, habitats and wild species) across the whole agro-ecosystem and the spatial distribution of habitats and wild species related to agriculture.

Figure 1. **OECD Agri-Biodiversity Indicators Framework**



Source: OECD Secretariat.

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

The ABF is recognised by experts as potentially having a number of advantages, in particular because it:

i) establishes a structure and hierarchy in which indicators can be clearly identified, organised, combined and aggregated, providing a classification that can be used to identify the strengthens and weaknesses in the existing compliment of indicators of individual OECD countries;

ii) encompasses all agricultural land, including uncultivated habitats on agricultural land, and all species (production species, production supporting species and wild species) that use farm land or are affected by agricultural activities;

iii) provides flexibility by taking into account the varying policy priorities, agro-ecosystems and farming systems, across OECD countries, for example, from alpine pastures, rangelands, tropical plantations, to rice paddies and arable crops, and different spatial scales necessary to monitor trends in agri-biodiversity at the local, regional, national to international levels;

iv) draws on existing data sets, some of which are already well defined, such as agricultural land census data, and can help identify where data gaps exist;

v) facilitates the use of terminology that avoids value judgements or relies on imprecise definitions of different agricultural habitats by measuring habitat quality through the species use, structure and management of agricultural habitats, supported by quantitative data and clear descriptions of habitat categories and related data;

vi) recognises countries are at different stages in their development of ABIs and provides a coherent structure within which countries can begin to calculate indicators and assemble data sets that are transparent and comparable across countries;

vii) allows for the possibility that the framework could be extended and used to cover not only agro-ecosystems but other ecosystems, such as forests and mountains; and,

viii) offers the potential to integrate some of the indicators into national economic or ecological accounts, for example, changes in the stock of habitats, the habitat-species matrix and the natural capital index.

Further developing the ABF requires more attention to the following points:

i) identify baselines, targets and/or trends which countries are using or developing to assess the performance of policy measures aimed at biodiversity conservation;

ii) analyse the impact of driving forces on biodiversity in agro-ecosystems, in addition to farm management practices, such as the effects of alien invasive species, genetic mutations, changes in water table levels, and climate change on biodiversity in agro-ecosystems;

iii) explore methods that can better express spatial and temporal variations in biodiversity across a country, based on various technical methods, such as remote sensing and stratified sampling;

iv) improve both scientific understanding of the relationships between changes in agricultural genetic resources, habitat quantity, and habitat quality, and the data gaps and data quality that draw a representative picture of biodiversity, in space and time; and,

v) exchange information across OECD countries and with non-Member countries, to start a process of harmonising agro-ecosystem habitat classifications, definitions and related information and indicators (see also Annex 4 in this context).

4.2. Agri-Biodiversity Indicators (ABIs)

There are four groups of indicators within the ABF that form an integrated framework which countries are recommended to develop: ***first,*** agricultural genetic resources (4.2.1); ***second***, habitat quantity (4.2.2); ***third***, habitat quality (4.2.3); and a ***fourth*** group which combines the last two groups, habitat quantity and quality, and expresses the overall loss (gain) of biodiversity (4.2.4). Most of the indicators, highlighted in boxes below, with some small modifications are already included in the current set of OECD agri-environmental indicators, but some indicators are recommended as new additions in order to make the OECD indicator framework more comprehensive.

4.2.1. Indicators of Agricultural Crop and Livestock Genetic Resources

Experts recommended the OECD build on its current set of indicators related to agricultural crop and livestock genetic resources by providing the following indicators:

i) Total number of crop varieties/livestock breeds for the main crop/livestock categories (*e.g.* wheat, rice, cattle, pigs) that have been registered and certified for marketing, including native and non-native species and landraces.

ii) Share of crop varieties in total production for individual crops (*e.g.* wheat, rice).

iii) Share of livestock breeds in total livestock numbers for respective categories of livestock (*e.g.* cattle, pigs, poultry, sheep).

iv) Number and share of national crop varieties/livestock breeds used in agricultural production that are endangered.

v) Number of available species and accessions (samples) conserved *in situ* and *ex situ* in national programmes.

Indicators i) to iv) are already included in the current set of OECD agri-environmental indicators, although for indicator i) it is recommended 'native and non-native species and landraces' be added to the indicator definition. It is recommended that indicator v), concerning genetic resource conservation is added to the current OECD indicator set, while indicators ii) and iii) could be expressed with use of the biodiversity/evenness index (*e.g.* Shannon index) rather than as a share of major crop varieties/livestock breeds in total crop/livestock production.

In terms of ***genetic erosion*** while it may be useful to know that 90% of the national dairy herd belong to only three breeds, for example, this information does not help to address the questions of what is happening to the other 10% of dairy breeds and are their populations large enough to avoid genetic erosion? Moreover, using the dairy example, in one country the populations of the 10% of "minor" dairy breeds may be large enough to ensure their stability, but in another country a 10% share may involve a much smaller number of individuals and be too few to protect minor dairy breeds from genetic erosion. Hence, the biodiversity/eveness index (*e.g.* Shannon index) can help in solving this problem of minor livestock breeds or crop varieties, although the difficulties of individual population sizes and changes in the status of endangerment are areas for further development (Annex 2).

Experts recognised that in the ***future development of agricultural genetic diversity indicators*** OECD Member countries need to:

i) clarify definitions, in particular, through strengthening cooperation with FAO's work on agricultural genetic diversity, and to harmonise with the definitions already established by the CBD and FAO for: native and non-native species/breeds and, endangered species/breeds;

ii) quantify within species diversity and genetic difference, by using molecular markers, etc., which improves upon monitoring only numbers of varieties and breeds; and,

iii) establish a national registration process for landraces, *i.e.* identify species/types in production.

Annex 2 provides further detail on the agricultural genetic diversity indicator characteristics and areas proposed by experts for further development. Annex 3, identifies the conclusions of experts on the driving forces, state and responses to the conservation and management of agricultural genetic diversity.

4.2.2. Indicators of Habitat Quantity

These indicators provide information on the stock and flows of habitat types across all agricultural land including intensively and extensively farmed land, semi-natural areas, and uncultivated land, and changes in land use between agro-ecosystems and other ecosystems (*i.e.* terrestrial and aquatic ecosystems).

i) The current area and share (stock) of different habitat types across all agricultural land, including intensively or extensively farmed land (*e.g.* arable crops, rangeland, rice paddies), semi-natural areas (*e.g.* certain grasslands, heather moorland) and uncultivated land (*e.g.* fallow, areas of remnant native vegetation, ponds).

ii) Changes in the area and shares of habitats (flows) both within agriculture (*e.g.* less arable land, more pasture) and between different land uses (*e.g.* from agricultural use to forestry or change from wetlands to agricultural use).

All agricultural land and the full range of habitat types should be covered by these indicators, including those areas of uncultivated habitat (*e.g.* ponds, woodlands) within farming areas, while flexibility needs to be exercised in categorising habitat types in agro-ecosystems by recognising the:

i) historical time series data already developed in OECD countries; and the,

ii) diversity of agro-ecosystems and farm management systems across OECD countries.

At present two main systems of agricultural land categorisation and data time series are evident in OECD countries, including habitats defined in terms of:

i) agricultural land use and cover types, mainly drawing on data collected through regularly updated agricultural census, for example, arable land, permanent crops and managed pasture;

ii) biological and ecological characteristics, for example, mires and heathland, semi-natural grasslands, wild prairies, rangelands, and broader ecozones.

In some cases these two types of habitat data are supplemented with additional information/data to describe variations in their quality, characteristics and systems of management, increasingly complemented with sample-based surveys and remote sensing observation techniques of land cover mapping. ***To move toward consistency across OECD countries, experts recommended a set of guidelines to select habitat indicators related to agriculture***, elaborated in Annex 4, which recognise the need for countries to:

i) include all agricultural land that comprises the agro-ecosystem;

ii) provide the criteria used to select each habitat type within the agro-ecosystem;

iii) define the characteristics of each habitat type through metadata (*i.e.* descriptive notes);

iv) develop a comprehensive list of the different habitat types selected for an agro-ecosystem; and

v) identify the regularity with which data on the current area (stock) and changes (flows) in habitats across agro-ecosystems are collected and describe the methods used to collect the data.

As more information becomes available from OECD countries as to how habitats on agricultural land are classified and defined, it will be necessary for the OECD to ***establish a harmonised and comparable system of habitat classification and definitions across OECD countries***. This will require more structured and regular expert exchange between countries, and include drawing on existing cross national systems for habitat and land cover classification, such as in Europe under the EUNIS and CORINE systems (for further details of EUNIS and CORINE see the European Environment Agency website at: http://reports.eea.eu.int/topic_report_2001_06/en/Topic_6_2001.pdf .

4.2.3. Indicators of Habitat Quality

These indicators provide information on the ***quality of different habitats types*** across agro-ecosystems in terms of their:

i) structure (indirect measure of habitat quality);

ii) management (indirect measure of habitat quality); and their,

iii) use and requirement by wild species (direct measure of habitat quality).

In general, the quality of agricultural land from a biodiversity perspective is higher the greater the number of wild species and their corresponding abundance and diversity, and the greater the diversity of habitat structures and the less intensive the management of the land (this may vary according to local conditions, *e.g.* soil types, climate). While the availability of these three indicators will depend on the resources, databases and monitoring systems of a country. If no data is available on wild species, then indirect measures of habitat quality (*i.e.* structure and management) could be used instead.

Habitat Structure Indicator: Trends in the quality and quantity of habitat features and their spatial composition across agricultural land.

Indicators of habitat structure in terms of the quality and quantity of habitat features (*e.g.* extent of alpine meadows, area of field margins, area and fragmentation of remnant native vegetation patches on agricultural land) and their spatial composition across agro-ecosystems (*e.g.* patch size and patch mosaic, fragmentation of habitats, linear features and networks), are an indirect measure of habitat quality.

Taking into account the implications of different habitat structures and patterns for wild species in agro-ecosystems, further work is required to define indicators that measure:

i) ***patch size***: the size of habitat patches is important for some species;

ii) ***fragmentation***: the extent to which a given habitat type is divided into separate patches;

iii) ***linear features and networks***: for example, the length, age, quality and connectivity of hedges;

iv) ***vertical structures***: habitat structures in terms of vertical layers (*e.g.* bushes and tress), which are especially important to bird and invertebrate communities; and,

v) ***mosaic*** of different habitats in an agro-ecosystem: for example, habitat diversity, location, juxtaposition and heterogeneity of land cover, and linkages to indicators of agricultural landscape in countries where this is important.

Habitat Management Indicator: Trends in farm management practices and systems which affect biodiversity.

Changes in farming practices and management systems are a key driving force affecting habitat quality. ***Habitat management indicators***, which provide an indirect measure of habitat quality, are included under the OECD overall core set of agri-environmental indicators concerning farm management covering the effects on biodiversity from farming practices (*e.g.* timing of grass cutting, nutrient and pesticide management, stocking densities), and different farm management systems (*e.g.* integrated land management systems, organic farming).

It is important to ***clearly define different farming practices and management systems***. To avoid the difficulties and ambiguities in defining terms such as ‘intensive’, ‘extensive’, ‘traditional’ and ‘industrial’ agricultural production systems, it is necessary to know in terms of wild species impacts information on farming practices, such as the use of farm inputs (*e.g.* fertilisers, pesticides, water); livestock husbandry practices, (*e.g.* livestock stocking densities); and farming systems, such as the number of farms under environmental whole farm management plans and the area of organic farming.

Wild Species Indicator: Trends in the abundance (*i.e.* the number), richness (*i.e*. diversity) and ecologically indicative value (*i.e.* species associated with specific habitats such as prairie grazing land) of wild species using agricultural habitats or affected by farming activities.

While ***indicators of wild species*** provide a direct measure of habitat quality, they are also useful indicators in their own right to reveal the current stock and trends in wild species, including wild relatives of domesticated crop and livestock species, and widespread, rare and endangered species. Many species, particularly fauna, use a variety of farmed habitats and cannot be easily associated with a single habitat type. Because many species use a variety of farmland habitats and cannot be associated with a single habitat type, they may consequently be better indicators of agro-ecosystems. The Chough (*Phyrrocorax phyrrocorax)* is an example of this as it is a bird that moves between using different farmland habitats throughout the year. Trends in alien invasive species are also of importance to a number of OECD countries, but are currently not part of the OECD work on agri-biodiversity indicators (Annex 1).

To move toward consistency across OECD countries**, *experts recognised the need for guidelines to select indicators of wild species related to agriculture***, elaborated in Annex 5, including selecting:

i) a minimum set of wild species collectively representing a wide range of habitat types across agricultural land;

ii) a range of wild species that require different types of agricultural land and from various species groups (*e.g.* birds, mammals, arthropods, plants, etc.);

iii) rare, endangered and widespread species; and, selecting;

iv) wild species relevant to policy issues at different scales from the local to global level.

In developing these guidelines it will be important to ***recognise the scientific uncertainty about the current and future links between biodiversity and agriculture***, and to also reveal the criteria used and rationale for wild species chosen within a country. To improve consistency of wild species indicators across countries, will also require in the future improved data availability and comparability, and the exchange between countries of their practice in cost effective data collection. Also the need for further examination of the function of baselines is recognised as an important issue in the future.

4.2.4. Indicators Linking Habitat Quantity to Quality

These indicators integrate habitat quantity and quality indicators to provide information on how land use and land cover changes are affecting wild species (flora and fauna) in their use and requirements of habitats in agro-ecosystems.

Habitat-Species Matrix: Changes in the area and management of all agricultural habitat types and the identification, explicitly (*i.e.* direct observations) or implicitly (*i.e.* indirect information such as expert knowledge), of the impact of these changes on wild species (flora and fauna).

Natural Capital Index: The product of the *quantity* of agricultural habitat types and their *quality* in terms of wild species abundance, richness, habitat structure and management, measured between the current state of the agro-ecosystem and a baseline state.

By ***combining indicators of habitat quantity and quality*** these two indicators allow the effects and changes in agriculture on biodiversity to be summarised more succinctly. The indicators also provide the possibility to project the implications for wild species related to future changes in agricultural land use and cover. However, both these indicators have a number of areas where methodological improvements could be made to further improve them, including the science and methods used in projection studies of agri-biodiversity which requires more work.

The *natural capital index*, has been previously discussed in OECD expert meetings/workshops related to agri-environmental indicators, including within the OECD Working Party on the Economic Aspects of Biodiversity. The index has also been developed as a contribution to the implementation of the Convention on Biological Diversity, together with other indicators described in this paper.