INCORPORATING BIODIVERSITY INTO INTEGRATED ASSESSMENTS OF TRADE POLICY IN THE AGRICULTURAL SECTOR

Volume II: Reference Manual

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Foreword

Agriculture is the most important economic activity in many of the world’s poorest countries and most vulnerable regions. It is an important employer providing a cash income to millions of farmers and workers, supporting large rural populations, and making a vital contribution to food security. In some regions, commercial agricultural plantations are expanding and are major contributors to both GDP and export earnings. And trade in agricultural products is increasing. This trade can provide both challenges and opportunities. For subsistence agriculture, open markets and increasing levels of imports can pose a challenge to competing agricultural production. On the other hand, for industrial and export-oriented agriculture, open markets and increasing export opportunities can encourage development.

However, many of the countries whose economies are dominated by the agricultural sector are also custodians of much of the world’s biological diversity, boasting a wide variety of species and habitat diversity and very high levels of endemism. Biodiversity is an integral part of a healthy ecosystem including agricultural ecosystems, which comprise cultivated biodiversity (such as crops and livestock) and use biodiversity to provide a range of ecosystem services. The most important threat to biodiversity is loss of natural habitat, which comes about through changes in land use and in particular the conversion of land for agriculture – both the cultivation of cash crops and for subsistence. Agricultural practices themselves can lead to the deterioration in soil, water and air quality and loss of biodiversity, through overuse of agrochemicals, intensification and monoculture; agricultural practices that encourage the use of fewer and fewer species threaten crop genetic diversity if they replace native plant species.

Trade policies have typically been developed without consideration of the costs associated with the damage to, and irreversible loss of, biodiversity. In order to avoid these outcomes, policy-makers should take the impacts on biodiversity into account when developing trade policy and negotiating trade agreements. Advice is required to help policy-makers reduce the risks of damage to biodiversity and the livelihoods of the populations who depend on biodiversity. Attention is also required to develop policies and sectors that rely on the protection of biodiversity and a healthy ecosystem as a basis for development, whether in agriculture or in other sectors, such as tourism.

This Manual, which presents an approach to integrated assessment with a focus on biodiversity, is a vital tool for achieving that goal, by encouraging the comprehensive analysis of the complex issues linking trade liberalisation, agricultural production, and all levels of biodiversity. In the hands of governments and other practitioners, it should lead to the design of trade policies and trade-related policies that promote development and contribute to achieving the United Nations Millennium Development Goals, through the conservation and sustainable use of biodiversity.
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Executive Summary

International trade in goods and services provides many social and economic opportunities. However, it can also pose significant threats to biodiversity including wild biodiversity, agricultural biodiversity and ultimately ecosystem services. Trade policies in the agriculture sector in particular can negatively impact biodiversity. They can also encourage countries to protect their wild and agricultural biodiversity and develop farmed biodiversity in order to meet food security needs and poverty reduction objectives. Agriculture and trade policies have a particularly complex relationship, not only between themselves, but also with biodiversity, ecosystem services and human well-being. Many trade situations have failed to deliver an optimal balance between biodiversity conservation and socio-economic goals. The potential exists for trade policies to be developed to encourage the sustainable use and conservation of biodiversity for future generations.

Integrated assessment can assist countries in recognising and assessing the environmental, social and economic impacts of trade policy, which are not always taken into account. Biodiversity impacts are embedded within environmental, social and economic change. Understanding the potential impacts of trade policy on biodiversity (and ultimately human well-being and the poverty reduction) will assist in more informed policy and decision-making processes and an understanding of the potential trade-offs. Currently, biodiversity is rarely prioritised in integrated assessment of agricultural trade policies. Integrated assessments that focus on biodiversity can encourage sustainable trade, stimulate inter-ministerial and inter-sectoral policy dialogue, strengthen good governance in trade policy and increase transparency in decision-making.

Volume I of UNEP’s Manual on Incorporating Biodiversity into Integrated Assessments of Trade Policy in the Agricultural Sector divides the assessment process into six generic stages as and explains what actions should be taken at each stage to address biodiversity and ecosystem services. This reference document is Volume II of UNEP’s Manual, which elaborates on the stages and more specific actions, identifying key components of an integrated assessment, highlighting key points and identifying further resources. A summary of the key points of the major components of an integrated assessment covered in this volume is presented in the table below.

Summary of Key Points in the Components of an Integrated Assessment

<table>
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<th>Component</th>
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</table>
| **The Relationship between Agriculture and Biodiversity** | • Agricultural ecosystems form the basis of global food security, which relies on and provides ecosystem services. Ecosystem services are essential for human well-being. Biodiversity and agricultural biodiversity are integral for maintaining healthy ecosystems and services.  
• The extensification and intensification of agriculture activities have had serious impacts on biodiversity and ecosystem services.  
• There are opportunities for the conservation and sustainable use of biodiversity and agricultural biodiversity within agricultural ecosystem, through the use of practices such as agro-forestry. |
| **Trade Measures and the Trade Policy-Making Process** | • Agricultural trade policies are a major influence on land use patterns and are a driving force behind agricultural practices and, ultimately, on biodiversity.  
• Integrated assessment can assist countries in recognising not only the social, economic and broader environmental impacts a trade policy may have, but also to consider its impacts on biodiversity and ecosystem services. Using such a tool can assist countries (including developing countries) to use trade to maximise development opportunities while minimising impacts on biodiversity. |
| **Stakeholder** | • Stakeholders should be identified at the outset of an integrated assessment. |
## Component Key Points

### Participation and Consultation
- Stakeholders can fall into different categories, depending on whether they will be affected by the plan or policy, whether they are intermediaries, or whether they have an influence on the planning process.
- It is important to identify the most relevant stakeholders to involve, ensuring a representative group for the purpose of the assessment.
- It is vital to understand the positions, perceptions, and interests of the identified stakeholders to be aware which stakeholders may be hostile to the process, which are vital for the success of the project, and how to generate and maintain interest in the assessment with respect to a core group of stakeholders.
- The assessment should consider the most effective and efficient methods for consultation, taking into account the characteristics of the main stakeholders, the availability of technology, the budget of the project, and other factors that will help determine whether face-to-face meetings, written comments, or internet consultations would be most effective and/or most feasible, and when those consultations should be held.

### A Conceptual Framework
- A conceptual framework can be used to ensure that there is a common understanding between different stakeholders of the issues involved and the links between the issues.
- A generic conceptual framework is included to illustrate the links between trade policies, agriculture, biodiversity and ecosystems, and human well-being. The framework is adapted from the conceptual framework of the Millennium Ecosystem Assessment (MA).
- Countries are encouraged to adapt the conceptual framework presented in this Manual to their own domestic situations.

### Indicators for Assessment
- The selection and calculation of indicators is central to an integrated assessment as indicators provide measurements and aid understanding of the criteria against which an impact can be determined to be important and acceptable.
- Indicators also need to be developed to assist in the process of exploring and analysing the issues and likely impacts of the proposed policy, guided by the conceptual framework.

### Approaches to Valuation
- Assigning values to biodiversity resources, functions and associated ecosystem services has the potential to improve decision-making as most resource management and investment decisions are strongly influenced by considerations of the monetary costs and benefits of different policy choices.
- Valuation should address the relevant components of the Total Economic Value (TEV) of non-marketed ecosystem services to provide information on changes in the value of ecosystem services that result (or could result) from policy decisions or other human activities.
- The choice of the valuation tool or tools will be informed by the characteristics of the case, including the scale of the problem, the types of value deemed to be most relevant, and data availability and the availability of human and financial resources.
- In general, tools based on observed behaviour (revealed-preference techniques) are preferred to tools based on hypothetical behaviour (stated-preference techniques) and cost-based approaches are particularly useful when a specific decision-making problem calls for a comparison of the costs of different replacement or restoration options. Benefits transfer can provide reliable estimates under certain conditions with the potential to alleviate challenges posed by poor data and limited funds, which are often encountered in valuation.

### Other Tools Used in Integrated Assessments
- Integrated assessment uses a range of tools and techniques to provide information to decision-makers on actual impacts of trade policy.
- Tools include Computable General Equilibrium (CGE) models, Cross Impact Matrix (CIM), Root Cause Analysis (RCA), Stakeholder Analysis and Mapping (SAM),
<table>
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<td>poverty measure and analysis, and scenario building.</td>
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| Policy Responses | • Policy responses at the national level can help countries mitigate negative impacts or capture the positive impacts trade policies may have on biodiversity and ecosystem services.  
• Policy response may be classified as either trade or non-trade related. It is recommended that policy response be based on five key approaches: valuation of ecosystem services, ownership over biodiversity and genetic resources, protection of traditional knowledge, ecosystem approach, and the integration of biodiversity into economic sectors.  
• Capacity building is an essential component of developing policy responses and contributes to economic growth and poverty reduction. |
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<th>Description</th>
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<tr>
<td>AC</td>
<td>Avoided cost</td>
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<td>ACP</td>
<td>African, Caribbean and Pacific</td>
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<td>BT</td>
<td>Benefit-Transfer</td>
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<td>BTFP</td>
<td>BioTrade Facilitation Programme</td>
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<td>CAC</td>
<td>Citizen Advisory Committee</td>
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<td>CAP</td>
<td>Common Agricultural Policy</td>
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<td>CBA</td>
<td>Cost-Benefit Analysis</td>
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<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<td>CCA</td>
<td>Casual Chain Analysis</td>
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<td>CE</td>
<td>Choice experiments</td>
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<td>CGE</td>
<td>Computable General Equilibrium</td>
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<td>CIM</td>
<td>Cross Impact Matrix</td>
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<td>CV</td>
<td>Contingent valuation</td>
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<td>DIP</td>
<td>Deliberative and inclusionary approach</td>
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<td>EP</td>
<td>Expert Panel</td>
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<td>EU</td>
<td>European Union</td>
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<td>FAO</td>
<td>Food and Agriculture Organisation for the United Nations</td>
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<td>GDP</td>
<td>Gross domestic product</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<td>GEO</td>
<td>Global Environment Outlook</td>
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<td>GM</td>
<td>Genetically modified</td>
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<td>GMO</td>
<td>Genetically Modified Organism</td>
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<td>GMZ</td>
<td>Gene Management Zones</td>
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<td>H</td>
<td>Hedonic pricing</td>
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<td>HA</td>
<td>Health Analysis</td>
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<td>IEA</td>
<td>Integrated environmental assessment</td>
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<td>MA</td>
<td>Millennium Ecosystem Assessment</td>
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<td>MCA</td>
<td>Multi-Criteria Analysis</td>
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<td>MDG</td>
<td>Millennium Development Goal</td>
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<td>MERCOSUR</td>
<td>Southern Common Market</td>
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<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<td>NTFP</td>
<td>Non-timber forestry product</td>
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<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>P</td>
<td>Production approach</td>
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<td>PE</td>
<td>Partial equilibrium</td>
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<td>PMCA</td>
<td>Participatory Multi-Criteria Analysis</td>
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<td>PSR</td>
<td>Pressure-State-Response</td>
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<td>TRIPS</td>
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<td>UNCTAD</td>
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<td>WTO</td>
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<td>WTP</td>
<td>Willingness to Pay</td>
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1. Introduction

Integrated assessment is a tool that can assist countries to recognise the potential economic, social, and environmental impacts of trade policy. It is flexible and comprehensive enough to take into account specific impacts on biodiversity and ecosystem services. By employing this tool, in conjunction with trade policy making, countries (including developing countries) can help ensure that trade maximises development opportunities, while minimising impacts on biodiversity.

This Reference Manual (hereafter the “Manual”) on Incorporating Biodiversity into Integrated Assessments of Trade Policy in the Agricultural Sector aims to support the implementation of the Convention on Biological Diversity (CBD) and was developed as a direct response to the CBD Conference of the Parties Decision VI/5, which requested the Executive Secretary to further study the impacts of trade liberalization on agricultural biodiversity. It provides a framework for integrated assessment and a process that national institutions and governments can employ to assess, design and implement trade-related policies in the agriculture sector that aim to maximise development goals (such as poverty alleviation) in a manner compatible with the conservation and sustainable use of biodiversity.

This Manual builds on earlier work on integrated assessment by UNEP and others and can be situated in the wider context of the mandate of the UNEP to undertake environmental assessments and promote capacity building. Given its specific focus on biodiversity and agricultural trade policies, it aims to contribute to the general body of work on assessment promoting an integrated approach, as developed under UNEP’s Global Environmental Assessment initiative and the Millennium Ecosystem Assessment (MA). It also intends to contribute to capacity building in environmental assessment within the framework of the Bali Strategic Plan on Technology Transfer and Capacity Building.

The Manual is divided into two volumes. This volume, Volume II, is a Reference Manual that accompanies Volume I, which is a Practical Step-by-Step Approach to undertaking integrated assessments of trade policy in the agricultural sector, and prioritising biodiversity. While Volume I presents the practical aspects of incorporating biodiversity into an integrated assessment, this Volume explains in detail the importance of biodiversity and ecosystem services and the complex linkages that exist between trade in the agriculture sector and biodiversity. It also contains additional relevant supporting information on both procedures and substance to support efforts to undertake integrated assessment focused on biodiversity.

Chapter 2 of this Volume addresses the relationship between agriculture and biodiversity. Biodiversity merits particular attention in this context because of the global significance of agricultural impacts on biodiversity, the relationship between biodiversity and agricultural ecosystems, the strong inter-dependence of biodiversity with food security and poverty alleviation, and the significant impact that trade can have by driving changes in land use and agricultural practices.

Chapter 3 discusses trade measures and the trade policy-making process. Agricultural trade policies are a major influence on land use patterns and a driving force behind agricultural practices and ultimately on biodiversity. It is likely that there will be important changes to global agricultural trade

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1 The Global Environment Outlook (GEO) is UNEP’s flagship assessment, which includes sub-national, national, sub-regional, regional, thematic, ecosystem, and global assessments. The GEO assessment is multi-sectoral, multi-thematic, and multidisciplinary, bringing together diverse stakeholders to address a specific mandate for such an assessment at different spatial levels. In the context of the GEO, integrated environmental assessment (IEA) provides a participatory, structured approach to linking knowledge and action.

2 The Bali Strategic Plan for Technology Support and Capacity Building seeks to “enhance delivery by UNEP of technology support and capacity building to developing countries and countries with economies in transition, including through mainstreaming technology support and capacity building throughout UNEP activities.” See: UNEP Governing Council Decision 23/1/1.
following successful negotiation and implementation of the World Trade Organisation’s (WTO) Doha Development Agenda, and these changes will have an impact on biodiversity.

Chapter 4 examines issues related to stakeholder participation and consultation. Effective participation is a vital component of integrated assessments. It is desirable to establish a process that is as inclusive as possible and ensures that all views are heard at key stages in the assessment process.

Chapter 5 presents a conceptual framework for analysis, adapted from the Millennium Ecosystem Assessment (MA) approach. The MA was carried out between 2001 and 2005 to assess the consequences of ecosystem change for human well-being and to analyze options available to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being. Responding to requests for information (including through the CBD), it was carried out by 1,395 experts from 95 countries, and has been extensively peer reviewed by governments and experts. Chapter 6 includes examples of indicators that can be used to help measure the impacts of key issues that are included in the conceptual framework.

Chapter 7 provides approaches to valuation. Biodiversity (including biodiversity resources and functions) is intuitively valuable. Few would contest the fact that the decline of biodiversity would be costly to humankind, in particular with regard to those functions that cannot be replicated. But this does not shed light on how to identify, describe and measure the specific values that are held in respect of biodiversity and biological resources and functions. Chapter 7 explores approaches that take into account economic and non-economic values of biodiversity in order to contribute to sound decision making and policy making.

There is no single methodology to employ in undertaking an integrated assessment. Therefore, Chapter 8 presents a wide range of tools and techniques that might be employed to assess the impacts of agricultural trade on biodiversity. The methods presented include a range of qualitative and quantitative techniques that can be used alone or together in an assessment. Chapter 9 includes guidance on developing and selecting appropriate policy responses in response to the findings of the integrated assessment. These are classified as both trade-related and non-trade related with an emphasis on policies that promote capacity building.

Finally, to assist the users of this Manual, Chapter 10 contains a glossary of terms related to integrated assessment, agriculture, trade, and biodiversity. Chapter 11 includes references and resources where users of the Manual might turn for further information on substance and the process associated with undertaking integrated assessments in the agricultural sector, and in particular those with an emphasis on biodiversity.

Note: This Manual builds on earlier work produced by UNEP on integrated assessment, in particular:

The Manual is also intended to complement the general integrated assessment frameworks developed by the CBD, the Food and Agricultural Organization of the United Nations (FAO), GEO, the European Union (EU), the International Association for Impact Assessment, International Union for the Conservation of Nature, World Wide Fund for Nature, and others. Specifically, this Manual builds on from the framework and results of the MA.

The reader is encouraged to consult documents developed by other UNEP when there is a need for further information, detail and analysis. The innovative part of the Manual consists of the integration of the biodiversity perspective. It is envisaged that work undertaken in the context of individual country projects will help refine the biodiversity dimension of integrated assessment.

The integrated assessment process (Volume I) and conceptual framework (Chapter 5, Volume II) are intended to be adapted to the unique and varied situations found in different countries. National institutions are encouraged to refine the framework and process to meet their specific needs.
2. The Relationship between Agriculture and Biodiversity

Key points

- Agricultural ecosystems form the basis of global food security, which relies on, and provides, numerous ecosystem services. Ecosystem services are essential for human well-being. Biodiversity and agricultural biodiversity are an integral component for maintaining healthy ecosystems and services.

- The extensification and intensification of agriculture activities have had serious impacts on biodiversity and ecosystem services.

- There are opportunities for the conservation and sustainable use of biodiversity and agricultural biodiversity within agricultural ecosystems, through the use of practices such as agro-forestry.

2.1 Biodiversity

Biodiversity is complex. It includes the diversity of landscapes, ecosystems, communities, populations and genes and it plays an essential role in both natural and cultivated ecosystems. For the purpose of this Manual, biodiversity includes agro-biodiversity (Box 2.1) as well as biodiversity with no recognisable role in food production (which may nevertheless be affected by changes in agricultural land use and production).

Box 2.1 Agricultural biodiversity or ‘Agro-biodiversity’

Agricultural biodiversity is the basis of global food security and millions of lives and livelihoods depend directly on it. The CBD defines agricultural biodiversity as:

“a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agro-ecosystem: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes” (CBD Decision V/5, appendix).

Agricultural biodiversity is a continuum, often with only the extremes of the spectrum easily identified: planned biodiversity and wild biodiversity. It is the two extremes of the spectrum that are more broadly discussed, however, agriculture biodiversity can of discussed in terms of:

- **Cultivated or ‘planned’ biodiversity**: is largely domesticated biodiversity such as crops, livestock, and freshwater aquaculture fisheries and is supplemented by wild food sources including woodland, forest, rangeland and aquatic plants and animals (used for food, milk, fur, power and other natural resources based products). This diversity, including crop wild relatives comprises the genetic resources directly needed for food production.

- **Associated biodiversity**: is the biodiversity that supports agricultural production through nutrient cycling, pest control, and pollination. Associated biodiversity includes soil microbes, natural enemies of pests, and pollinators. Biodiversity that provides broader ecological services, such as watershed protection, and alternative forage plants for pollinators, as well as, biodiversity in the agricultural landscape are included in this dimension.

- **Additional biodiversity**: is other biodiversity that occurs within the agricultural ecosystem but does not directly provide support, such as fish and amphibian populations in rice paddies. This is known as wild biodiversity that depends on niches provided by the agricultural landscape. There are examples where the wild species have co-evolved with agricultural practices (e.g., fire-managed ecosystems in semi-arid areas have promoted large herbivore populations and their predators).

- **Wild biodiversity outside agricultural ecosystems**: is biodiversity that occurs beyond that which is used or is directly supporting the production system. However, this group of biodiversity does contribute to other indirectly relevant ecosystem services such as watershed protection, and cultural and amenity services.

Biodiversity is an essential and integral part of healthy environments. If too much biodiversity is lost, many essential ecosystem services will be undermined or lost as well. Many of these ecosystem services are fundamental to productive farming (which in turn provides other services to the ecosystem) and their loss poses a particular risk to poor communities, which depend directly on local natural resources for their livelihoods. For example, if specific species are harvested, the decreasing stock of these species may affect the provision of food and other influences on human well-being. The quality of a particular regulating ecosystem service is influenced by the species richness of an ecosystem, but more particularly, to the types of species present (species composition). Biodiversity loss, even small short-term losses, may have a negative impact on the capacity of an ecosystem to adapt to internal and external shocks (stability and resilience).

Biodiversity is therefore increasingly measured (in terms of the services it provides to people) so that its benefits are recognized and accounted for in policy development. For example, several studies on the commercialization of non-timber forest products (NTFP) have highlighted the importance of biodiversity’s contribution to the reduction of rural poverty. Policy intervention to help commercialise NTFP must be well-targeted and reduce the risks of any negative impacts on biodiversity, such as overexploitation of the natural resource (Marshall et al. 2006). Table 2.1 presents several examples of impacts on biodiversity and ecosystem services resulting from agricultural production, and examples of trade-offs.

Table 2.1 Impacts on biodiversity and ecosystem services of agricultural production

<table>
<thead>
<tr>
<th>Activity</th>
<th>Examples of negative biodiversity impacts</th>
<th>Examples of negative impacts on ecosystem services</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct (directly attributable to agriculture)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest clearance, cultivation of grassland</td>
<td>Loss of important habitat and associated species.</td>
<td>Loss of products provided by habitat, such as timber and non-timber forest products (e.g., food, medicines); forest loss reduces water storage / flood attenuation capacity, soil erosion in grasslands.</td>
<td>Increased area of land for cultivation. Rural landless poor migrate to marginal areas and poverty pressures alter the environment. Loss of ecotourism potential.</td>
</tr>
<tr>
<td>Cultivation and mechanical farming operations in grasslands and wetlands</td>
<td>Destruction of ground nesting birds.</td>
<td>Soil erosion, CO₂ emission from oxidized carbon in soil organic matter.</td>
<td>Short-term gain in increased agricultural production yields leading to increase food security and human health.</td>
</tr>
<tr>
<td>Irrigation of drylands</td>
<td>Loss of dryland species.</td>
<td>Long-term salinisation and soil damage.</td>
<td>Increased agricultural production yields but also an increased occurrence of waterborne disease such as malaria.</td>
</tr>
<tr>
<td>Drainage of wetlands</td>
<td>Loss of wetland species.</td>
<td>Loss of non-crop species of food, medicinal or other value. CO₂ emission from oxidized carbon.</td>
<td>Increased area of fertile land for cultivation. Rural landless poor migrate to marginal areas and poverty pressures alter the environment. Loss of ecotourism potential.</td>
</tr>
<tr>
<td>Use of artificial fertilisers</td>
<td>Decline in plant (and associated species) diversity due to dominance of weed species favoured by high nutrient conditions.</td>
<td>Loss of non-crop species of food, medicinal or other value.</td>
<td>Increased agricultural production yields, but continual use of fertilisers required to maintain crop yields. Increased food security and human health due to reduced risk of crop failure.</td>
</tr>
<tr>
<td>Activity</td>
<td>Examples of negative biodiversity impacts</td>
<td>Examples of negative impacts on ecosystem services</td>
<td>Trade-offs</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Use of pesticides / insecticides</td>
<td>Declines in directly impacted species and reductions in food chain supplies for others Increases in pests and disease, when resistance to chemicals evolves</td>
<td>Contamination of non-crop foods; loss or population declines in natural predators. Loss of natural pest management systems.</td>
<td>Increased agricultural production yields, but continual use of pesticides and insecticides required to maintain crop yields. Increased food security and human health due to reduced risk of crop failure.</td>
</tr>
<tr>
<td>Use of modern commercial crop varieties</td>
<td>Fast growing dense crops out-compete native species.</td>
<td>Loss of genetic diversity and potential future crop varieties.</td>
<td>Reduced use of fertilisers, pesticides and insecticides, increased nutritional value of crops. Increased food security and human health due to reduced risk of crop failure. Increased income as less capital input required (e.g., pesticides) however, seed cannot be sourced from the crop and must be bought regularly.</td>
</tr>
<tr>
<td>High stocking density</td>
<td>Losses of grazing sensitive species.</td>
<td>Competition with wild herbivores used for food and loss of ecotourism.</td>
<td>Increased agricultural production yield leading to increased food security and human health in the short-term. Increased income in the short term as surplus food can be sold in markets.</td>
</tr>
<tr>
<td>Use of veterinary drugs</td>
<td>Secondary poisoning risk (e.g., vultures in India).</td>
<td>Loss of scavenging species that assist with carcass disposal.</td>
<td>Healthy livestock, leading to increased income and human health. Increased capital input in the purchasing of veterinary drugs.</td>
</tr>
<tr>
<td>Hunting of wildlife that damage crops and livestock</td>
<td>Loss or declines in species (e.g., tigers).</td>
<td>Loss of potential food species and species of ecotourism importance.</td>
<td>Livestock and crop protected, leading to increased agricultural production yields. Food security is increased, as is human health.</td>
</tr>
</tbody>
</table>

**Indirect (indirectly attributable to agriculture)**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Examples of negative biodiversity impacts</th>
<th>Examples of negative impacts on ecosystem services</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eutrophication of water bodies (from nutrient rich runoff and soil erosion)</td>
<td>Degradation of wetland habitats, river systems and marine and coastal areas.</td>
<td>Reduced drinkable water supplies and fish stocks.</td>
<td>Increased malnutrition and incidents of disease in poor communities. Other communities benefit from increased agricultural production brought about through the use of nitrogen.</td>
</tr>
<tr>
<td>Poultry and livestock rearing and rice production</td>
<td>Terrestrial eutrophication and loss of nutrient sensitive species.</td>
<td>Atmospheric nitrogen pollution (green house gas emissions) contributing to climate change.</td>
<td>Benefits from increased agricultural production but loss of other ecosystem services.</td>
</tr>
</tbody>
</table>

**Secondary impacts (resulting from actions that are not an intrinsic part of the agriculture)**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Examples of negative biodiversity impacts</th>
<th>Examples of negative impacts on ecosystem services</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased road and infrastructure development</td>
<td>Further habitat loss from footprint and sourcing of building materials, disturbance, habitat</td>
<td>Hydrological disruption and pollution of water bodies, loss of arable land.</td>
<td>Increased human well-being in some communities. Income increases and costs are reduced due to easier</td>
</tr>
<tr>
<td>Activity</td>
<td>Examples of negative biodiversity impacts</td>
<td>Examples of negative impacts on ecosystem services</td>
<td>Trade-offs</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>to supply agricultural areas</td>
<td>fragmentation.</td>
<td></td>
<td>transportation of commodities and access to of infrastructure.</td>
</tr>
<tr>
<td>Migration and displacement of people</td>
<td>Loss or declines in wild food species (e.g., bush meat) in marginal areas.</td>
<td>Loss in food resources if accessed unsustainably. Pressures on urban environments, if migration is to urban centres.</td>
<td>Rural landless poor migrate to marginal areas and poverty pressures alter the environment. Potential work force migrates to urban centres searching for work.</td>
</tr>
<tr>
<td>Increased incomes from farming</td>
<td>Loss of biodiversity and degradation of habitat.</td>
<td>Hydrological disruption and pollution of water bodies, loss of arable land, loss of food species and drinkable water.</td>
<td>Reduction of poverty in some communities and capital input available to contribute to increasing production rates. Rural landless poor migrate to marginal areas and poverty pressures alter the environment.</td>
</tr>
</tbody>
</table>

### 2.2 Ecosystem services, biodiversity and agricultural ecosystems

Agricultural systems are the basis of global food security, with approximately 24 per cent of the Earth’s terrestrial surface occupied by cultivated systems including, *inter alia*, croplands, shifting cultivation, confined livestock production, and freshwater aquaculture (Figure 2.1). Most ecosystems have been modified or cultivated to some extent by human activity for the production of food, income and for livelihood security. Over the past 25 years, agricultural land has expanded by around 130,000 km², predominantly through the conversion of natural forests and grasslands.

Despite this, an increase in the demand for food over the past 50 years has resulted in a major shift away from agricultural expansion globally to intensification (producing greater yields per unit of time and area). Regional variations occur, with land still being converted for agricultural use in developing countries (particularly in sub-Saharan Africa). Recent studies by FAO suggest that in the future there will be very little land available for additional extensification of agriculture, and that increases in yield will result largely from intensification and increased efficiency of production on existing land. The management and policy challenge is to achieve a balance that optimises both biodiversity and production in the long term, as millions of lives and livelihoods depend directly on agricultural biodiversity.
Agricultural systems rely on the use of biodiversity and ecosystems services including, *inter alia*, pollination, nutrient cycling, soil formation and freshwater for irrigation. There are also a range of benefits that people obtain from agricultural ecosystems (ecosystem services are either supplied or influenced by agricultural systems) (Table 2.2).

**Table 2.2  Ecosystem Services Provided by Agricultural Ecosystems**

<table>
<thead>
<tr>
<th>Provisioning services:</th>
<th>Cultural services:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Food (including wild plants)</td>
<td>• Cultural diversity</td>
</tr>
<tr>
<td>• Genetic resources</td>
<td>• Spiritual and religious values</td>
</tr>
<tr>
<td>• Biochemical, natural medicines and pharmaceuticals</td>
<td>• Knowledge systems</td>
</tr>
<tr>
<td>• Fresh water</td>
<td>• Educational values</td>
</tr>
<tr>
<td>• Fuel</td>
<td>• Inspiration</td>
</tr>
<tr>
<td>• Fibre</td>
<td>• Aesthetic values (scenic qualities)</td>
</tr>
<tr>
<td>• Shelter (such as forests)</td>
<td>• Social relations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulating services:</th>
<th>Supporting services:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pollination</td>
<td>• Cultural heritage values</td>
</tr>
<tr>
<td>• Air quality regulation</td>
<td>• Recreation and tourism</td>
</tr>
<tr>
<td>• Climate regulation</td>
<td>• Soil formation</td>
</tr>
<tr>
<td>• Water regulation</td>
<td>• Primary production</td>
</tr>
<tr>
<td>• Water purification</td>
<td>• Nutrient cycling</td>
</tr>
<tr>
<td>• Erosion regulation</td>
<td>• Seed dispersal</td>
</tr>
<tr>
<td>• Disease regulation</td>
<td>• Natural hazard regulation (such as flood control)</td>
</tr>
<tr>
<td>• Pest regulation</td>
<td>• Herbivory and predation</td>
</tr>
</tbody>
</table>

These ecosystem services are important for human well-being and generally have the following features:

- Ecosystem services are built up over a period of time and this rate differs between services. For example, food (such as crop production) can be quickly provided by an ecosystem compared to soil formation services or natural hazard regulation services.

- A diversity of species contributes to the development of the ecosystem services. For example, a range of species contributes pollination services, which is in jeopardy in terrestrial environments, including agricultural landscapes (Box 2.2).

- Natural systems are credited with the highest levels of biodiversity, which correlates to a high potential for providing ecosystem services. However, unmanaged ecosystems are generally lower in agricultural biodiversity and have a reduced capacity to provide provisioning services unique to agricultural ecosystems.

- Using ecosystem services may cause changes in the ecosystems. However, in agricultural ecosystems, the use of certain ecosystem services (such as pollination, pest regulation and cultural services) does not necessarily deplete the ecosystem services and can contribute to maintaining a healthy system.

- Generally ecosystem services can recover after use. However, overexploitation can lead to the ecosystem passing a threshold from which the system cannot recover. For example, over hunting of bushmeat may drive a species to extinction and result in the loss of a source of protein for the local community, which is dependent on this ecosystem service.

- An investment is needed to extract some goods and services. The cost of this investment may not be very high for the rural poor, and it may be more feasible for them to extract natural resources (such as picking fruit and utilising other NTFP) than make costly investments in farming.

- After use, ecosystems regenerate through natural processes. However, humans can also intervene with restorative investments (such as replanting forests and implementing measures to conserve soil). A minimal level of biodiversity is needed to absorb such investments.

**Box 2.2 Examples of biodiversity supporting ecosystem services for agriculture**

**Pollination service.** Three-quarters of the world’s major crops rely on animal pollination. Of these, 73% (including cashews, mangos, and cocoa) are pollinated by species of bees. However, domestic bees pollinate only 15% of the hundred crops, which contribute to most of the world’s food supply. Wild bees and other wildlife, including flies, bats, wasps, beetle, birds, butterflies and moths, pollinate 80% of crops. Estimates of the value of pollination services supplied by wild pollinators are thought to be US $4.1 billion a year to US agriculture alone. In Costa Rica, forest-based pollinators have been shown to increase the value of coffee production at a single farm by US $60,000 per year through increase in yields and improved crop quality. Farms around the world are now paying for pollinator services, with farmers importing and raising pollinators. There is a growing concern that many pollinator species are at risk of extinction and ultimately placing important ecosystem services in jeopardy. Pollinator numbers are declining due to habitat fragmentation, agricultural and industrial chemicals and associated pollution, parasites and disease and the introduction of exotic species.

**Pest Management.** Natural enemies to crop pests include insects, spiders and other arthropods. These are promoted by high temporal and spatial heterogeneity in the landscape. For example, the patchwork of rice fields in Central Java, has retained natural vegetation and a greater abundance of natural predators. The natural vegetation supplies alternative food sources when populations of crop pests drop in number, thus keeping natural predator populations high or constant.

2.3 The dynamic relationship between agricultural ecosystems and biodiversity

Agricultural ecosystems and biodiversity have a complex and dynamic relationship which tends to be characterised by the following two common, yet overly simple, perceptions:

- the more diverse agricultural ecosystems tend to be more stable; and
- modern agricultural practices always reduce biodiversity whereas traditional farming practices are compatible with high levels of biodiversity and may even promote biodiversity.

These perceptions do not hold true in all cases. It is difficult to categorise agricultural ecosystems into high or low biodiverse systems (Figure 2.2 “Diversity attributes of selected systems”). For example, tropical irrigated rice systems are planted as monoculture but can be one of the most stable agricultural ecosystems. The key to their stability is not vegetative, but stems from the diversity in landscape temporal planting patterns, the use of soil organic matter, and the elimination of the use of pesticides. Dykes between paddies are also able to support vegetable patches. These systems supply habitat for fish, insects, amphibians and water birds (Figure 2.2 “Diversity attributes of management options in intensive tropical rice production”).

Figure 2.2 Dimensions of diversity in selected production systems

![Figure 2.2 Dimensions of diversity in selected production systems](image)


Entirely artificial habitats (such as croplands) also support much biodiversity, particularly where they form a small part of the landscape and are not managed intensively. Indeed, many semi-natural habitats that are now highly valued (such as open grasslands) are the result of human activities (such as clearing trees and burning vegetation). For people living in the savannah grasslands of tropical Africa nomadic pastoralism is a major activity, which depends on semi-natural habitats. Data on the biodiversity value of cultivated habitats in the developing world are not always readily available. However, there is evidence that roughly half of Costa Rica’s native forest species of birds, mammals, butterflies, and moths also occur in agricultural areas.

Nevertheless, biodiversity is declining globally and there are clear links between agricultural change and this decline, across a wide range of agricultural systems. Agricultural expansion has historically
been a major contributor to loss of global biodiversity. There is also increasing evidence that intensification of agricultural production (using agrochemicals and fossil fuels) is altering ecosystems to the point where they may not be viable in the long term and there are increasing risks to productive agriculture from environmental damage. Historically, the expansion and intensification of agricultural systems has been seen to have had a small overall impact on biodiversity compared to other activities such as urban development, hunting, mining, construction, invasive alien species, industrial pollution, land degradation and energy development. However, the current scale and technology of agricultural land use have made agricultural production a leading threat.

Agricultural development can lead to a variety of impacts (Table 2.1), which are often characterised by their incremental nature. While they can appear insignificant when examined on a case-by-case basis, major cumulative impacts can be observed when appraised at a landscape level. These effects are particularly well-documented in Europe. For example, there is a direct link between agricultural intensification and declining populations of once-common birds. In 2000, the Royal Society for the Protection of Birds reported that over one-third of Europe’s important bird areas were threatened by expansion of intensive farming and that there was some degree of threat from farming to 93 per cent of the 3,619 important bird areas across Europe. A report by Birdlife International reinforced this conclusion showing that European countries with the most intensive farming have experienced the most rapidly declining bird populations. Intensive farming was causing serious population declines in about one-third of Europe’s 515 bird species, including 12 of the 16 most threatened birds in Europe.

Land conversion (extensification) has played an important role in reducing biodiversity. Between 1961 and 1999 the area of global cropland increased by 12 per cent while permanent pasture increased by 10 per cent. A 2005 study (Pagiola et al.) compared agricultural systems with forest systems in Borneo and found substantially lower numbers of species in most groups in farmland than in forest. Farmland also supported relatively more common species, whereas forests supported a higher proportion of endemic and indigenous species. The study also found that traditional agro-forestry systems in Sumatra contained only half the diversity found in neighbouring primary forests.

Large areas of grassland savannah in Africa are threatened by continued conversion from natural grazing ecosystems to row-crop agriculture and cattle and wild-game ranching. Land use data from the FAO indicate that there has been a substantial increase in the area under arable and permanent agriculture over the last decade, with particularly significant increases in Africa (including, inter alia, Benin, Burkina Faso, Ghana, Guinea-Bissau and Malawi), parts of Asia (including, inter alia, South-east Asia, Bangladesh, Indus Valley, and Central Asia), the Middle East, and the Amazon Basin. In recent years there have been several cases where rapid and large-scale agricultural developments have led to major and ongoing impacts on biodiversity (Box 2.3).

One example of these impacts is in the expansion of soybean production in Brazil. Currently in Brazil soybean cultivation is expanding most quickly in the Cerrado region. Since the 1960s, two-thirds of the region has been converted to agriculture. It is known as the ‘development sacrifice zone’ and was created partly in response to international pressure to restrict clearing in the Amazon rainforest. Many natural and un-fragmented areas of the Cerrado contain biodiversity rivalling that of the Amazon. Soybean expansion in Brazil has been driven by market forces, advances in agricultural technology, and government support, which includes subsidies, credit schemes and infrastructure.

**Box 2.3  Cattle production and tropical deforestation**

Cattle production in tropical forest areas has caused extensive damage to biodiversity through deforestation. Growth in beef production encourages habitat destruction in two ways. First, expansion of grazing lands to accommodate larger herds often requires the conversion of natural habitat to pasture, and is a direct driver of deforestation and environmental degradation. Second, intensification of production requires an increasing supply of feed grains, which leads to conversion of natural habitat for maize, wheat, barley, and soybean monoculture.
Today there are over 1.3 billion head of cattle worldwide (32% more than in 1965) and this number is growing. Much of this growth has been in Asia, Latin America and Africa. About one-quarter of the world’s cattle are in Latin America. Most countries have historically produced most of the meat that they consume, with trade in beef accounting for less than 4% of all trade. Brazil, where beef exports are very important, is an exception. Growth in domestic demand led to pasture expansion and deforestation from the 1970s to the mid-1990s. However, the extensive deforestation in the Amazon in recent years has been linked with a five-fold increase in beef exports between 1997 and 2003.

The future impacts of cattle production on biodiversity will depend on the extent to which growing demand for beef is met by greater intensification or by expansion of grazing into areas currently occupied by important native habitat. Although intensive production systems reduce the pressure on natural ecosystems from deforestation, they pose an indirect threat in their increase demand for feed grain.

**Box 2.4 Intensification of agriculture in Europe**

Much of low-land western Europe is now characterized by intensive agriculture, driven by agricultural technology (machinery, agro-chemicals and plant breeding) combined with supportive agricultural policies and in particular, the EU’s Common Agricultural Policy (CAP). This policy environment led to not only an expansion in the area cultivated, but also to profound changes in farming practices on existing agricultural land. Intensification resulted in farm and field amalgamation with associated loss of wildlife habitats, which traditionally formed part of the farmed landscape (e.g., hedgerows, woodlands). Farms also tended to specialise and mixed farming declined. There were also marked switches in crop types and a substantial decrease in the area of biodiverse pastures and hay meadows. On the remaining semi-natural grasslands CAP support policies and socio-economic, technological, and structural changes to farming systems have led to increased livestock numbers in many areas of Europe.

Intensification leads to increased levels of use and variety of agrochemicals (particularly inorganic fertilisers, herbicides and pesticides). The biodiversity impacts of these agricultural changes are well documented, and include major population declines in many farmland birds across most of Europe. To overcome some of the environmental degradation from farming practices in Europe, a programme to ‘set aside’ land has been implemented, which involves compensation payments to farmers who do not undertake regular farming practices on set-aside land. However, the land is not left fallow, as farmers are still allowed to grow non-food products such as biofuel raw materials or ingredients for pharmaceutical on the set-aside land.

Subsides are also paid to farmers who:
1. Reduce the use of fertilisers or introduce organic farming;
2. Change to more extensive forms of crops, including forage production;
3. Reduce the number of sheep and cattle per forage area;

During the past decade an increase in global agricultural production has been due to increasing intensity of production (intensification). This trend has been most prevalent in developed countries. In much of the tropics, where most of the world’s biodiversity occurs, rates of intensification have lagged behind countries in the North, such as those in the European Union (EU) (Box 2.4).
4. Follow environmental friendly farming practices;
5. Ensure the upkeep of abandoned farmlands;
6. Set aside farmland for at least 20 years to establish biotope reserves and natural parks or to protect hydrological systems; and/or
7. Manage land for public access and leisure activities.

Such subsidies are currently under view with the aim to remove all subsides. For example, sugar beet is one of the crops subsidised by CAP. The EU is the largest sugar beet producer (16-18 million metric tons), and produces a similar amount of sugar to India and Brazil (who produce sugar from sugar cane). The EU is planning to cut the minimum sugar beet price by 39%, which will impact on nineteen Africa, Caribbean and Pacific (ACP) countries exporting sugar through changes to price on the EU market.

However, there are many cases of agricultural degradation as a result of intensification and inappropriate agricultural management in most regions in the world. One of the most important causes of habitat degradation in arid zones is overgrazing of grasslands and deserts. For example, in Syria, overgrazing is widespread and causes extensive damage to the steppe and desert vegetation. Overstocking is partly a result of water supplies now being provided to livestock, where previously livestock numbers were limited by natural water sources. The required irrigation projects result in further habitat degradation through, *inter alia*, wetland drainage. In the Sahel area of Western and Central Africa, increased desertification has occurred in many areas as a result of extensive habitat degradation through intense logging (for firewood and timber), overgrazing and frequent burning, which is considered to have had major impacts on migratory birds.

In addition, practices such as the increasing use of genetically modified organisms (GMOs) are causing controversy in terms of their contribution to sound agricultural management (Box 2.5). Only a limited number of GMOs have been approved in some countries (such as cotton, maize, canola, papaya, potato, rice, soybean, squash, sugar beet, tomato, and wheat). Very few products (such as herbicide and insect-resistant maize, soybean and rape seed) are actually available on the international market as several countries have concerns about GMOs. Despite this, the area of genetically modified (GM) crops is expanding and some developing countries are opting for GM varieties for cultivation to contribute to food security. GMOs have met with consumer resistance that could disrupt trade and international negotiations.

The ongoing intensification of agricultural land is further in evidence by a global seven-fold increase in nitrogen fertilization, a four-fold increase in phosphorus fertilization, a two-fold increase in the amount of irrigated cropland, and the increase in land in cultivation (MA 2005). Agriculture is the major user of industrially fixed nitrogen and only a fraction of this fertilizer is used and retained in food products. Poor control of run-off of the excess nitrogen leads to biodiversity loss in inland water, coastal, and marine systems through eutrophication. Nitrogen loads in rivers eventually find their way to the coastal zone, where they also cause eutrophication.

### Box 2.5 Genetically Modified Organisms in Agriculture: Potential Benefits and Risks

<table>
<thead>
<tr>
<th>Potential benefits from the use of GMOs</th>
<th>Risks and concerns about the use of GMOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased productivity leading to increased incomes.</td>
<td>Products are tailored largely to the needs of large scale farmers and therefore resource poor farmers fail to benefit; market control of the seed industry reduces farmer choice.</td>
</tr>
<tr>
<td>New crop varieties for marginal areas increasing the sustainability of agriculture in poor farming communities.</td>
<td>Patenting of genes originating in the developing countries without compensation.</td>
</tr>
<tr>
<td>Decrease in dependence of chemical inputs.</td>
<td>Technologies that prevent farmers re-using seed.</td>
</tr>
<tr>
<td>Enhanced food security through reduced fluctuations in yields.</td>
<td>Food safety and the environmental risks of GMOs escaping and out-competing natural populations or recombinant DNA transferring to wild or weedy species.</td>
</tr>
</tbody>
</table>
2.4 Conservation of biodiversity and agricultural biodiversity within the agricultural ecosystem

The incidents of conflict between agricultural and biodiversity interests are expected to rise in the future, particularly in the most important protected areas, the ‘wider’ farmed landscape, and in areas not actively farmed where induced changes may occur. The scale of potential conflict is considerable. It is being driven by a global expansion in the area of land used for crops, pasture and plantations, and is associated with increasing levels of use of energy, water, and agrochemicals and by environmental damage, which places the capacity of ecosystems to sustain food production at risk. The constant growth in the world’s population drives much of this change.

Agricultural biodiversity itself is also under threat, with the diversity of animal breeds, plant and crop varieties, and the genetic resources they contain, generally declining. During the past century, over 90 per cent of crop varieties have been lost. Livestock breeds are disappearing at a rate of five per cent per year. Greater priority is now being placed on conserving wild relatives of crops and vegetables. Many countries also have their own national conservation programmes, such as the former Soviet Union’s national list of wild relatives of crops in 1981, Turkey’s 22 Genetic Management Zones, Mexico’s special biosphere reserve to protect the wild relatives of maize, India’s citrus reserve, and the United States’ policies to protect the wild relatives of grapes, onions, and potatoes.

In Armenia, for example, its plateau is recognised as an important centre of origin for cultivated plants. This is based upon both the number of wild relatives of crop plants and the number of varieties of different species occurring in the country. Archaeological and ethno-botanical studies also indicate long-term cultivation of grains (wheat, barley, rye, millet, oats), pulses (peas, lentils, chick peas, broad beans), fruit (water-melon, grapes, apricot, quince, plum, cherry, pomegranate, peach, apple), and nuts and wild grasses on the Armenian plateau. This extent of cultivation and variety of crops indicates that Armenia is an important site of origin for crop cultivars and the government has carried out extensive work to map and locate important wild relatives of crops to contribute to the development and implementation of a national strategy and related legislation to conserve wild crop relatives.

The management of agricultural land is particularly important because it covers so much of the world’s land surface. In western and central Europe, for example, farming occupies roughly 50 per cent of the land surface compared with protected areas, which cover only 10 per cent to 12 per cent. Agricultural policy in Europe has moved towards increased agri-environmental support as a means of sustaining agricultural biodiversity. Some of these programs have been successful in reversing declines in wildlife populations on farmland.

Agro-forestry is another way to manage agricultural biodiversity and wild biodiversity. It involves the integration of trees into farming systems to create a biodiverse system. Agro-forestry systems have brought many benefits to farmers in developing countries. For example, in the Philippines, the primary agro-forestry practice is contour hedgerows, where food crops are planted between hedges of woody perennials established along the contours of upland sloping farm plots. Pruned clippings from the hedgerows trees or shrubs are placed at the up-slope base of the hedges to trap eroding soil so that, over time, natural terraces are formed. Such hedgerows can improve soil conservation by 15 per cent to 20 per cent for a typical small farmer. In addition to erosion control, biophysical effects of contour hedgerows on soil include the maintenance or increase of organic matter and diversity, nitrogen fixation, enhancement of physical properties such as soil structure, porosity and moisture retention and enhance efficiency of nutrient use (MA 2005). Agro-forestry systems have also been shown to increase farmers’ incomes in sloped areas of Nepal, Cameroon, Thailand and Indonesia. They provide
more niches for ‘wild’ biodiversity to coexist with crops and livestock and more opportunities for people to harvest a variety of biodiversity-based products (such as medicinal plants or building materials) alongside, or in conjunction with, their main crops. Sustainably managed agricultural systems can contribute to the maintenance of healthy ecosystems and support high levels of biodiversity.

2.5 Predicted future changes in pressures on biodiversity in agricultural ecosystems

The MA predicted that over the next 50 years (likely to be the final period of rapid agricultural expansion) demand for food by a wealthier and 50 per cent larger global population will be a major driver of global environmental change. The anticipated doubling of food production will result in an approximately three-fold increase in rates of nitrogen and phosphorus fertilization, a doubling of the irrigated land area, and an 18 per cent increase in cropland. It has been calculated that across the developing countries the area under 23 key crops will need to increase by 23 per cent by 2050.

Such projected changes would have a dramatic impact on the diversity, composition, and functioning of the world’s remaining natural ecosystems, and on their ability to provide essential ecosystem services. It is predicted that the largest impacts will be on freshwater and marine ecosystems, which will become severely eutrophied by high rates of nitrogen and phosphorus from agricultural run-off. This would in turn lead to loss of biodiversity, outbreaks of pest species and impairment of fisheries. Due to aerial redistribution of various forms of nitrogen, agricultural intensification would eutrophy many natural terrestrial ecosystems, which would contribute to the atmospheric accumulation of greenhouse gases (MA 2005) (Box 2.6).

Box 2.6 Future challenges of climate change, agricultural production, and food security

Climate change is an emerging challenge to agricultural production and food security. Agricultural production could benefit from the rise in global temperatures through an increase in area suitable for cropping, an increase length of growing periods, a reduction in costs for over-wintering livestock, improvement of crop yields, and forests that may grow more quickly. However, these gains are offset by the losses such as a reduction of fertile land to flooding along coastal plains.

Those groups who will disproportionately feel the greatest adverse impacts of climate change are the poor, such as the small-scale farmers and low-income groups in developing countries prone to drought, flooding, fire, saltwater intrusion and sea surges. It is these countries, where food production is already insufficient, and agricultural yield varies and a further decline will result in further malnutrition and famine. Hence climate change will affect the availability and distribution of food production and people’s access to food.

Agricultural production is not only a victim of climate change, but also part of the cause. The agriculture sector is a major source of greenhouse gas emissions, releasing large quantities of carbon dioxide and half of all methane emissions. Livestock production and irrigated rice farming are the two highest contributors of methane gas.

However, agriculture can play an important role in mitigating the impacts of climate change. Crop farming can be a carbon sink, although agricultural soils (like other biological sinks such as vegetation) have an inherent upper limit for storage. The total amount of carbon stored is dependant on the crop and location. Moreover, the rate of sequestration declines after a few years of crop growth. Other measures could include cultivation patterns, reduction of fertiliser use, improvement of livestock diet, improved manure management, alternatives to slash and burn land expansion, and more efficient uses of water.


It has been observed that with trade liberalisation, there is a trend towards the intensification of agriculture. In many places intensification is being achieved in an unsustainable way, through the excess use of chemical inputs and energy. A move towards programmes and policies such as
sustainable intensification will assist in overcoming many of these drivers of change. Intensification generally means increasing non-land inputs to generate an increase in agricultural yield. While increasing agriculture can come about by increasing chemical input, an increase in the level of knowledge on managing natural resources can also contribute to a higher agricultural yield. Therefore, improved productivity (yield) can occur with a minimal and sustainable use of agro-chemicals.

The FAO (2002) has identified a need to move toward the further use of sustainable agriculture in the future, and has identified possible sustainable agricultural practices including:

1. *No-till/conservation agriculture.* This involves minimum disturbance of the soil, maintenance of a permanent cover of live or dead plant material, and crop rotation.

2. *Integrated pest management.* This aims to minimise the amount of pesticides applied by using other control methods more effectively, such as pest-resistant varieties, bio-insecticides and traps, and the management of crop rotations, fertiliser use, and irrigation, in ways that minimise pests.

3. *Integrated plant nutrient systems.* These use a range of practices that include recycling vegetable and animal wastes, and the use of legumes, to fix atmospheric nitrogen. Limited fertiliser is applied.

4. *Sustainable intensification.* This uses technologies such as nutrient recovery, water recycling, and hydroponics as a way of meeting rising demand while minimising environmental costs.

### 2.6 Agriculture, poverty and human health

Crop production (mostly cereals) is the world’s most important source of food for both direct human consumption and, indirectly, for livestock production. Despite this, growth levels in crop production have slowed. This is the result of several factors, some of which are ongoing and widespread (world population growth has been slowing and many large countries, such as China, are reaching high consumption levels) and others of which are transient (for example, the use of cereals for animal feeds in the EU declined until the early 1990s) (MA 2005). However, persistent poverty has prevented hundreds of millions of people from meeting their food needs. The FAO estimated that between 2000 and 2002, 852 million people worldwide did not have enough food to meet their basic needs, with a majority (815 million) living in developing countries (FAO 2002).

Poverty curtails livelihood opportunities and, from the perspective of agricultural production, poverty limits access to inputs (such as credit and new technologies), which can improve farm management. Poverty is also often associated with a lack of security in terms of access to, or title to, land and other natural resources. Lack of land security reduces the incentive and ability of farmers to choose agricultural practices with long-term benefits, resulting in practices that achieve short-term gains and degrade land. Once agricultural land is degraded it is often abandoned, with poor rural communities migrating to areas of marginal production. Agricultural intensification and simplification of agricultural landscapes can also limit the availability of, and access to, wild food. This includes food plants growing as weeds that may be of nutritional importance, particularly to the landless poor and to vulnerable groups within households.

Over one billion people survive on an income of less than one US dollar per day. A majority of these people live in rural areas where they are dependant on agriculture activities for subsistence. These rural areas are characterised by poor health and high levels of infant mortality. To protect human health, responses are required outside the health sector, particularly in agriculture.

There are many linkages between biodiversity loss from the agricultural landscape and poverty. Tekelenburg and Kessler (2005), identify some of these as follows:
• There are people in the world who, because of limits on their physical, economic and social situation, do not have access to enough food. Prevalence of hunger is very high among small landholder farmers, herders, traditional fishermen and forest dwellers.

• The rural poor are most dependent on products obtained from their direct surroundings, either through cultivation, collecting, hunting or fishing.

• The rural poor, particularly those in drought-prone areas, depend upon products and services directly obtained from ecosystems. Ecosystems provide a high diversity of food products that help overcome food shortages. This natural resource can be degraded, causing biodiversity loss by over-exploitation.

• Poor nutrition is most frequently found in areas with high soil degradation. Cropland degradation has been identified as having strong links with hunger and ongoing biodiversity loss.

• Poor people can also suffer from a loss of ecosystem services as a consequence of actions by other groups when more powerful individuals exploit ecosystem services at the cost of access by other stakeholders.

Poor nutrition is not the only health issue linked to agriculture. The clearance and irrigation of land is often responsible for an increase in the incidence of malaria and other waterborne diseases. Better ecosystem management is necessary to respond to this problem (MA 2005). Other health issues, such as breathing difficulties, the build up of toxins within individuals and/or populations and pollution of drinking water, can result from the use (and over use) of fertilisers, herbicides and pesticides. Air pollution is one result of slash-and-burn agricultural practices that were employed in many parts of Asia during the 1990s.

These poverty and health issues can be magnified through trade policies that favour large landowners and can result in the migration of the rural landless poor to marginal areas. These marginal areas are less suited to agriculture, are usually drought prone, and have low levels of soil fertility. These communities are then dependant on the resources from the surrounding area for food, which places pressure on the ecosystems services (MA 2005).
3. Trade Measures and the Trade Policy-Making Process

**Key points**

- Agricultural trade policies are a major influence on land use patterns and are a driving force behind agricultural practices and, ultimately, on biodiversity.
- Integrated assessment can assist countries in recognising not only the social, economic and broader environmental impacts a trade policy may have, but also to consider its impacts on biodiversity and ecosystem services. Using such a tool can assist countries (including developing countries) to use trade to maximise development opportunities while minimising impacts on biodiversity.

People and countries have traded with each other for thousands of years, originally to exchange local goods for imported goods, specialities, and luxuries that were not available domestically. For some goods, such as diamonds, various minerals, coffee and oil, this still remains the principal reason for international trade, as many countries do not have, or cannot produce, these items. With most trade, however, in particular merchandise (which comprises about 80 per cent of world trade), factors such as market demand, economies of scale, marginal price differences, efficiency gains, perceived value and quality, fashion, and styling are increasingly important. In addition, many companies now have re-organised their research, development and manufacturing sites and their marketing, shipping and distribution networks across many borders, so their location and investment decisions also drive significant growth in cross-border shipping and trade.

In order to pay for imports a country needs to export. Those with specialities of their own can export them, but others must export more readily available agricultural produce, manufactured goods, or services, which other countries might be able to produce, but less efficiently or with a higher opportunity cost.

Governments regulate the flows of trade with trade policies. These policies cover many areas, including market access agreements, product definitions, intellectual property rights, tariff levels and health, safety and phytosanitary standards. Some countries try to use trade policy to secure a competitive advantage in either domestic or foreign markets, or to protect locally-important firms or sectors. Other countries see trade policy as a means to provide the regulatory and legal context needed to reduce barriers to liberalised trade and competition.

Many developing countries try to reduce their dependency on commodity exports and low-cost labour, and build the technology and skill levels needed to compete with higher added value goods and services. Greater participation in international trade can facilitate inward investment and technology transfer and help countries acquire these capabilities, while satisfying consumer demand for imports. Some governments feel that uncompetitive domestic industries need protection to survive for long enough to acquire the skills and technologies needed for their long-term development. In practice, relatively closed markets, a reliance on preferential terms of trade, an emphasis on import substitution and the use of tariff barriers have protected particular industries and favoured domestic companies. However, in some cases this comes at the cost of insulating them from normal competitive pressure and removing incentives to change, innovate and develop. As a result, some of these industries and companies have fallen further behind global standards and become even less competitive. This is further exacerbated where governments have resisted modernisation in industries that are major employers.

As a result of this plethora of trade-offs, trade policies and agreements are usually the result of protracted and complex negotiations. Concessions in one area are used to secure reciprocal concessions in other areas as countries try to maintain preferences or preserve their competitive advantages. This process has become increasingly fluid, as the process of global economic
development and growth has widened dramatically in recent decades, bringing both additional competition and a range of new business opportunities onto the market and thereby transforming the global economy.

3.1 Types of trade measures and agreements

The WTO (with some 150 members) is the principal forum for negotiating international trade agreements. In addition to this multilateral forum, regional and bilateral trade agreements enable countries to make greater commitments to each other than those required by the WTO (although they must be consistent with WTO rules). Such agreements may also include non-WTO members. They may be characterised as:

- **Bilateral free trade agreements.** Special tariff arrangements and agreements to reduce or eliminate other trade barriers (for example, the United States-Singapore Free Trade Agreement).
- **Bilateral association agreements.** Providing for a greater degree of integration, such as for standards and investment provisions (for example, such as exist between the EU and neighbouring countries).
- **Plurilateral free trade agreements.** Agreements between three or more partners (such as the North American Free Trade Agreement).
- **Customs unions.** Common external tariffs for most products (such as MERCOSUR).
- **Common markets or economic unions.** Further integration to include free movement of labour and capital, common standards and regulations, and supranational economic management (such as the EU).

It is estimated that there are between 250 and 300 bilateral and regional trade agreements throughout the world. Some of the principal regional agreements are listed in Table 3.1.

<table>
<thead>
<tr>
<th>Trade agreements</th>
<th>% world exports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major blocs</strong></td>
<td></td>
</tr>
<tr>
<td>Asia-Pacific Economic Cooperation forum</td>
<td>45.3</td>
</tr>
<tr>
<td>European Union</td>
<td>35.5</td>
</tr>
<tr>
<td>North American Free Trade Agreement</td>
<td>18.4</td>
</tr>
<tr>
<td>ACP (Cotonou Agreement, including the EU)</td>
<td>&gt;30.0</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td></td>
</tr>
<tr>
<td>Association of South-East Asian Nations</td>
<td>6.1</td>
</tr>
<tr>
<td>Bangkok Agreement</td>
<td>4.8</td>
</tr>
<tr>
<td>Economic Cooperation Organisation</td>
<td>1.1</td>
</tr>
<tr>
<td>South Asian Association for Regional Co-operation</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Middle East and North Africa</strong></td>
<td></td>
</tr>
<tr>
<td>Gulf Cooperation Council</td>
<td>1.7</td>
</tr>
<tr>
<td>Arab Maghreb Union</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Latin America and the Caribbean</strong></td>
<td></td>
</tr>
<tr>
<td>Latin American Integration Association</td>
<td>4.7</td>
</tr>
<tr>
<td>MERCOSUR</td>
<td>1.5</td>
</tr>
<tr>
<td>Andean Group</td>
<td>0.8</td>
</tr>
<tr>
<td>Central American Common Market</td>
<td>0.3</td>
</tr>
<tr>
<td>Caribbean Community</td>
<td>0.1</td>
</tr>
<tr>
<td>Organisation of Eastern Caribbean States</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
</tr>
<tr>
<td>Trade agreements</td>
<td>% world exports</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Southern African Development Community</td>
<td>0.8</td>
</tr>
<tr>
<td>Common Market for Eastern and Southern Africa</td>
<td>0.4</td>
</tr>
<tr>
<td>Economic Community of West African States</td>
<td>0.4</td>
</tr>
<tr>
<td>Economic Community of Central African States</td>
<td>0.2</td>
</tr>
<tr>
<td>Economic and Monetary Community of Central Africa /Customs and Economic Union of Central Africa</td>
<td>0.1</td>
</tr>
<tr>
<td>West African Economic and Monetary Union</td>
<td>0.1</td>
</tr>
<tr>
<td>Economic Community of the Great Lakes Countries</td>
<td>0.0</td>
</tr>
<tr>
<td>Mano River Union</td>
<td>0.0</td>
</tr>
<tr>
<td>East African Community</td>
<td>-</td>
</tr>
</tbody>
</table>


UNEP’s *Handbook on Integrated Assessment of Trade-related Measures - the Agricultural Sector* (2005) discusses some trade measures that are relevant for biodiversity. These include market access for agricultural products, export subsidies, domestic support, standards and conformity assessment, investment, and intellectual property rights (Box 3.1). For example, developing countries increasingly engaged in international trade in agricultural products must be able to adapt to standard-setting initiatives in such agreements as the WTO’s Agreements on Technical Barriers to Trade or Sanitary and Phytosanitary Issues. Given the fact that many developing countries have limited technical, financial and legal capacities, they may encounter difficulties in fully participating in defining these standards, and generally find it hard to adopt, enforce, and promote them.

**Box 3.1  TRIPS Agreement, the CBD and biodiversity**

The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is based on a recognition that increasingly, the value of goods and services entering into international trade resides in the know-how and creatively incorporated into them. The agreement holds WTO members to minimum standards of protection over intellectual property through instruments such as copyright for books and patents for industrial design. By protecting the innovators right to sell their innovation TRIPS encourages innovation, including the development of new technologies and processes that will benefit sustainable development. On the other hand, such innovation might be slower to make a contribution if new, more environmentally benign technologies or pharmaceuticals become so expensive as to be inaccessible by the countries and people most in need.

It is believed that TRIPS and the CBD have different and non-conflicting objectives and purposes and deal with different subjects. In fact, some believe that TRIPs supports the implementation of the obligations of the CBD more effectively, for example, patents can be instruments in the sharing of benefits and the conservation of biodiversity based on voluntary contracts. However, there is evidence that conflicts between the two instruments exist, especially in relation to traditional knowledge of indigenous peoples and local communities (Article 8j of the CBD). TRIPs allows for patents to be granted in respect to genetic materials. This is inconsistent with the CBD as this limits access to such genetic material and conflict with the sovereign rights of countries in particular indigenous groups, over their genetic resources (WTO, 2006). However, the actual impact TRIPs has on biodiversity conservation has yet to be quantified.

While these are the principal measures that have a direct influence on biodiversity, all other measures in a trade negotiation agenda can have a significant indirect influence. The WTO agenda is the most comprehensive, but a regional or bilateral trade agreement may include the equivalents of any or all of its measures. Other measures which might arise include the following: market access for non-agricultural products; trade in services; trade facilitation; government procurement; competition policy; rules of origin; anti-dumping and countervailing measures; preferences for developing and least developed countries; and dispute settlement mechanisms.
Non-agricultural products in the WTO classification include forest products, for which an impact assessment has to take account of the strong interactions with agriculture in biodiversity issues. Non-agricultural products also include fisheries, with direct biodiversity impacts, as well as manufacturing, which can have indirect impacts on biodiversity through effects on extraction and pollution of water and other resources.

Trade in services has become increasingly important for developing countries in general. Services generally represent 60 per cent of global output and, in many countries, an even larger share of employment. However, developing countries have not become fully engaged in the provision of services, which is dominated by countries belonging to the Organisation for Economic Cooperation and Development (OECD). A minority of developing countries having made commitments under the WTO’s General Agreement on Trade in Services and there is room for potentially larger gains from services trade for these countries than from trade in goods. This may come with significant impacts on biodiversity. For example, the liberalisation of distribution services for example has major effects on sources of supply of food products, and hence on agricultural production levels and techniques.

Trade facilitation has an impact on market access for all products, both agricultural and non-agricultural. It refers to ways in which the administrative and regulatory burden on companies seeking to import or export can be relieved through measures such as transparency and access to information (of other countries’ importing and exporting regulations), and the administrative issues associated with customs procedures and other formalities. It is the simplification and harmonisation of international trade procedures, where trade procedures are activities, practices and formalities involved in collecting, presenting, communicating and processing data required for the movement of goods in international trade. This relates to a wide range of activities such as import and export procedures (such as customs); transportation formalities; and payments, insurance, and other financial requirements.

The other rules governing trade may also have significant indirect effects on biodiversity, and the details of proposals need to be examined carefully to identify potential impacts. For example, rules of origin, which are the criteria needed to determine the national origin of a product, can be designed so as to encourage, or discourage local processing of agricultural commodities, thereby having an impact on production, land-use and biodiversity.

Each component of the trade-related agenda presents its own challenges. While the potential for tariff reduction is significant in some countries, much of the emphasis has now moved on to trade in services, trade facilitation, and investment, as discussed above. The effects of changes in these areas tend to be understood even less fully than for tariff changes. The economic analysis used in forming trade policy tends to be fairly simple, and may for example go no deeper than the assumption that the attraction of foreign investment will accelerate growth and generate employment. The analysis may take no account of the nature of the development, its long-term potential, and its social and environmental effects.

In general, it is particularly important to ensure that public institutions are strong and effective before introducing major structural change to an economy. Many of the problems at this stage are associated with inadequate government regulation and weak supervision. In the financial sector, this can result in various problems ranging from money laundering to unmanageable financial volatility. It can also result in negative impacts on the environment, such as illegal construction and unauthorised trade in hazardous waste.

### 3.2 Trade policy in the agriculture sector and biodiversity

In around 25 per cent of countries, the share of agricultural exports exceeds two-thirds of total exports, while in a further 20 per cent the share exceeds one-third. Low-income countries remain most heavily dependent on agricultural trade, often still relying on one or a few agricultural exports for the bulk of
their foreign exchange earnings. The general global trend has been away from traditional, family-based and small-scale production with an emphasis on self-sufficiency, towards larger-scale production with a focus on production for markets and export.

Since 1994, developing countries (whose share of world industrial exports has been steadily increasing) have not increased their share of agricultural exports. Many developing country exports still face tariffs and other barriers in developed country markets and, in particular, attempts to develop processing industries for export are sometimes hampered by tariff escalation, the erosion of tariff preferences, and reciprocal reductions in tariffs which means that domestic industries are subject to increasing competition from products that can be produced more cheaply elsewhere. This is particularly problematic for the least developed countries where agriculture often constitutes the single most important sector in the economy and where exports are typically not diversified but based on one or two primary products for which global demand or international prices are often declining. Developing countries remain net food importers of major agricultural commodities. For example, wheat is the most important cereal traded on international markets, and developing countries generally account for nearly 80 per cent of all wheat imports.

Trade and trade-related policies have a major influence on patterns of land and resource use. Agricultural trade policy drives changes in agricultural production and distribution by altering markets for products and through levels of subsidy. Farmers make production decisions in the light of the changes in revenue and cost structures. These decisions in turn change land use and ultimately affect the compatibility of land and farming practices with the conservation and sustainable use of biodiversity. Changes in agricultural production patterns as a result of changes in trade policy vary depending on the initial conditions in a country in terms of production, trade and consumption of agricultural commodities (for example, whether there have been high or low levels of protective subsidy, or whether the country is a net importer or exporter of food) (Table 3.2).

Trade and trade policy are a major force driving changes in agricultural practice and it is therefore important to ensure that proposed changes are compatible with a sustainable, productive environment and with global goals for biodiversity. Avoidance of agricultural impacts on biodiversity has to be incorporated at a policy and strategic level to avoid impacts at source. One of the main challenges is to distinguish between the impacts of trade liberalisation and other influences on the agriculture sector, including changes in product demand, production methods and transportation-related costs.

### Table 3.2 Possible trade-related issues and impacts on biodiversity

<table>
<thead>
<tr>
<th>Issue</th>
<th>Direction of change</th>
<th>Possible trade-related issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cerrado in Brazil has relatively low levels of protection for biodiversity. Soybean cultivation is a significant cause of direct habitat loss in biodiversity-rich areas. Increased soybean cultivation also displaces cattle production, sometimes causing further land conversion.</td>
<td>Negative</td>
<td>Further liberalisation of trade may increase rates of conversion of pastureland to soy cultivation and catalyse further forest conversion to pasture for displaced cattle production.</td>
</tr>
<tr>
<td>Sugarcane has known adverse effects on important biodiversity, including some global biodiversity hotspots.</td>
<td>Positive</td>
<td>The removal of tariffs may reduce production in inappropriate environments or locations.</td>
</tr>
</tbody>
</table>

### 3.3 Formulating trade policy

Trade policy in all countries is primarily a component of economic policy, influenced by technology policy and development policy, where these exist separately. Wider social and environmental considerations may also be taken into account when domestic concerns are high enough to influence top-level government decisions, such as in the EU and in the United States. In most other areas, trade policy typically aims to maximise economic performance, and leaves social and environmental issues to be dealt with separately in domestic policy-making.
A country’s negotiating position in multilateral, regional or bilateral agreements has to take into account the interests of all economic sectors, which may complement or conflict with each other. Extensive consultation therefore normally takes place with the main economic interest groups, but the transparency of consultation is usually fairly limited.

The main stages of developing policy and formulating a negotiating position include:

- consultation with main economic interest groups;
- commissioning economic studies;
- consultation with other influential groups;
- review of other countries’ proposals;
- inter-departmental meetings to develop a negotiating position;
- negotiations;
- further consultation and ongoing negotiation; and
- inter-departmental meetings to accept/reject final proposals.

In most countries, the mechanisms through which civil society influences trade policy directly are relatively weak or non-existent. In the EU a clear distinction is drawn between two parallel impact assessment processes. A Sustainability Impact Assessment (SIA) is conducted publicly, and considers social, environmental and economic impacts of prospective trade liberalisation negotiations in the EU and in its trading partner(s). A parallel Impact Assessment is conducted under EU procedures, which apply to all major policy proposals, as part of the development of a negotiating position. The SIAs involve extensive public consultation and full public access to assessment reports. For trade policy however, the assessments are conducted internally and access to the reports is restricted. If the development of a negotiating position were done publicly, it would reveal the hand of the negotiators and weaken their position. Therefore, although the publicly conducted SIA process is intended to inform negotiating positions, it does not define them. It does however make trade negotiators more fully aware of public concerns, and also facilitates a greater degree of dialogue between trade officials and other government departments in the formulation of trade policy.

The United States and Canada adopt a different approach, in which strategic impact assessments of trade policy are directed primarily towards environmental impacts, and concentrate on impacts in the country itself and not in trading partners. The impact assessment can therefore play a more direct role in the formulation of a negotiating position, alongside the contributions of separate economic and social analyses. In these cases, the impact assessment does not itself integrate the three spheres of sustainable development.

For a developing country, integrated assessment offers considerable potential for strengthening the decision-making process. Civil society is generally weaker than in high-income countries, which adds to the difficulties of enhancing its voice, but at the same time, trade ministries themselves lack the capacity to fully understand the effects of alternative policies on their own economic objectives. Neither the North American approach nor the European approach is directly applicable, but elements of either may be incorporated into an assessment process that is designed to meet the country’s needs and be compatible with its own decision-making structures. Even more than in high-income countries, decisions tend to be influenced most strongly by a fairly small group of key economic actors. The prime need is therefore to understand fully the economic effects, and the effects that social and environmental impacts can have on them.

Typically, a reduction in tariffs (in exchange for reduced protection by other countries) has two immediate effects: domestic firms are exposed to greater competition, and government revenues fall. In some countries both of these effects are small, but in others, particularly low income ones, they can be highly significant. Domestic production and employment will both decline, and some firms will become unprofitable and close. In those economic sectors where new export opportunities arise, production will expand, but usually with a time lag, associated with the need for investment, land acquisition and training the necessary workforce. Carefully designed domestic policies will be needed
in parallel with the trade reforms, in order to avoid potentially serious adverse impacts while the economy adjusts, and to fully capitalise on the longer-term opportunities. The impacts and opportunities for some economic actors are obvious, and they will therefore play a strong role in influencing the negotiating position and parallel domestic policies. For others the impacts are less clear. Potentially influential actors will lack both the ability and the motivation to influence policy unless they have a deeper understanding of the interacting social, environmental and economic effects.

Non-economic actors can also have a significant influence on policy. However, except when non-economic objectives over-ride economic ones, their greatest influence tends to come from demonstrating that social or environmental impacts can have a significant economic effect, while also elucidating what the economic effects are likely to be. Integrated assessment can play a key role in this. Trade policy tends to be based on fairly simple economic analyses, which give a reasonable indication of the likely changes in imports, exports and production levels in different sectors, once an economy has adjusted to the change in tariffs or trade rules. However, information is often lacking on the economic effects that will occur during the period of adjustment, on the likely magnitude of the loss in government revenues, on the influence of the changes on exchange rates, and on the mechanisms through which the changes might accelerate or decelerate pressures on land and water availability, rural-urban migration, technology transfer and long-term economic growth.

Additionally, information is often lacking on the economic costs of social and environmental effects. In sectors where production rises, domestic policy measures will need to be introduced or strengthened in order to contain unacceptably adverse environmental impacts, and these will have associated costs. The magnitude of these costs is rarely known at the time the decision is made. Similarly, as production moves between sectors, unemployment will rise, unless action is taken to smooth the transition. In either case there will be economic costs, associated with the social costs of rising unemployment, or the action taken to prevent it. Again these costs are rarely known when the decisions are made and can often only be predicted in broad terms.

As well as being among the most important of the economic effects, all of these can have a major influence on social and environmental issues. The ability of integrated assessment to provide fuller information of this type may be particularly influential in helping to formulate trade policy more effectively.

3.4 Some linkages between agricultural trade and biodiversity

The current global trend is towards trade liberalisation within the agriculture sector. This is characterised, *inter alia*, by a planned/projected reduction of incentives (subsidies). In theory, if full liberalisation of agricultural trade took place, there would be a reduction in over production and an increase in world market prices. With a reduction in agricultural production, the impacts of agriculture would likely be reduced in a majority of countries. The key issues affecting the relationship between agriculture and various aspects of biodiversity are the relative intensity of various factors of agricultural productions (such as land and other forms of natural capital including climate, soil quality and water resources), labour, human knowledge and management, and external capital inputs (such as fertilisers and pesticides). It can be expected that these issues will be affected, with varying degrees of intensity, by liberalisation of trade in agriculture. Table 3.3 indicates some questions and explanations that can help begin to develop the linkages between sustainability, agricultural trade policies, and biodiversity.
Table 3.3 Understanding the relationship between sustainability, agricultural trade policies and biodiversity

<table>
<thead>
<tr>
<th>Sustainability Goals</th>
<th>Key Questions</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>To maintain productive and sustainable food production</td>
<td>Does the policy recognize the fundamental role of biodiversity in supporting productive and sustainable food production?</td>
<td>Biodiversity provides a range of services to agriculture. Loss of biodiversity undermines the capacity of ecosystems to support agriculture and a sustained stream of income.</td>
</tr>
<tr>
<td>To ensure food security</td>
<td>Does the policy recognize the need for biodiversity and sustainable ecosystem management as the basis for food security?</td>
<td>Food security requires genetic diversity as the means of adaptation to new environments. Agro-biodiversity also buffers production (e.g., against drought).</td>
</tr>
<tr>
<td>To support livelihoods, including environmental income</td>
<td>Does the policy make provision for maintaining biodiversity-based ‘environmental income’ and food security? Does the policy recognize the importance of ecosystems (and biodiversity) as a key source of additional environmental income, allowing the poor to increase their income security?</td>
<td>Many of the rural poor rely on ‘other’ biodiversity (outside the agro-ecosystem) for food (especially in scarce times) and to meet other needs. People relying on biodiversity, as a source of environmental income may not benefit from new opportunities associated with commercial agriculture.</td>
</tr>
<tr>
<td>To support delivery of the Millennium Development Goals (MDG)</td>
<td>Is the policy compatible with MDG7 targets, including area protected for biodiversity? E.g., ‘Maintain at least 60% of the country under forest cover in perpetuity (Bhutan); increase areas protected for biological diversity from 8% in 1990 to 12% in 2015 (Senegal).</td>
<td>Biodiversity is fundamental to delivery of most, if not all, of the MDG.</td>
</tr>
<tr>
<td>To contribute to achievement of the 2010 targets</td>
<td>Will the policy result in increased agricultural production? Will this result in an increased area under production and in increases in either area under production or intensity of production? Are there implications for: • Status and trends of biodiversity? • Sustainable use of biodiversity? • Levels of threat to biodiversity? • Ecosystem integrity and the provision of ecosystem services? • Access and benefit sharing?</td>
<td>Agriculture is a major cause of biodiversity loss worldwide and there is steadily increasing demand for food. Any changes in the area under production, the intensity and methods of production or rates of land conversion associated with trade policies or agreements could have implications for achievement of all the 2010 targets.</td>
</tr>
<tr>
<td>To ensure sustainable use of biodiversity</td>
<td>What are the impacts of economic growth on environmental sustainability, maintenance of critical ecosystem functions, biodiversity resources needed by the poor for their livelihoods?</td>
<td>The impacts of biodiversity decline due to increasingly intensive agriculture, geared primarily towards commercial production are rarely addressed.</td>
</tr>
<tr>
<td>To support access to biodiversity and benefit sharing</td>
<td>Does the policy address issues of natural resource access, traditional and cultural uses of biodiversity?</td>
<td>Expansion in commercial agriculture can reduce the availability of ‘wild’ biodiversity and also reduce access to biodiversity and curtail traditional uses.</td>
</tr>
<tr>
<td>To promote effective legislation and regulation and good governance</td>
<td>Does the policy make provision for stewardship and wise use of biodiversity? Does the policy make provision for building capacity in good governance and environmental regulation? Does the policy support community-based natural resource management and cater for its recognition in law?</td>
<td>Necessary to ensure that biodiversity is protected and its use regulated. This is an effective form of local empowerment and has had demonstrable and documented benefits in raising the incomes of poor rural populations.</td>
</tr>
<tr>
<td>To reduce poverty</td>
<td>Is the policy based on quantifiable targets for improving outcomes with respect to biodiversity-based income? Does it include indicators for both biodiversity and poverty?</td>
<td>Biodiversity is critical for sustainable agriculture, and for poverty alleviation.</td>
</tr>
</tbody>
</table>

In addition, some recently developed scenarios (Brink et al. 2006) indicate that trade liberalisation could lead to acceleration in the rate of biodiversity loss in some regions and countries in the short term, for example as agriculture production shifts from the United States, Japan and the EU to Latin America and Southern Africa. In Latin America it is predicted that biodiversity will decline from 66 per cent in 2000 to 59 per cent in 2050 (GLOBIO consortium’s model). The strong loss that has been documented prior to 2000 has been due to infrastructure development, fragmentation and effects of climate change (Figure 3.1).
It is predicted that trade liberalisation has by far the strongest effect in Latin America, further reducing biodiversity by 5.4 per cent. Liberalisation will induce ‘south-south-trade’ in agricultural products, driven by low production costs and an ample supply of productive land. This model predicts a 40 per cent expansion in the area used for food crops, grass and fodder by 2050.

**Figure 3.1  Spatial distribution and change in the mean abundance of the original species present (2000, 2050 baseline and trade liberalisation)**

<table>
<thead>
<tr>
<th>Mean abundance of the original species</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
</tr>
<tr>
<td>10 - 20</td>
</tr>
<tr>
<td>20 - 30</td>
</tr>
<tr>
<td>30 - 40</td>
</tr>
<tr>
<td>40 - 50</td>
</tr>
<tr>
<td>50 - 60</td>
</tr>
<tr>
<td>60 - 70</td>
</tr>
<tr>
<td>70 - 80</td>
</tr>
<tr>
<td>80 - 90</td>
</tr>
<tr>
<td>90 - 100</td>
</tr>
</tbody>
</table>

**Note:** the dark green areas indicate a high level of the original species occur in that area. These areas are usually less fragmented

Liberalisation option
4. Stakeholder Participation and Consultation

**Key Points**

- Stakeholders should be identified at the outset of an integrated assessment.
- Stakeholders can fall into different categories, depending on whether they will be affected by the plan or policy, whether they are intermediaries, or whether they have an influence on the planning process.
- It is important to identify the most relevant stakeholders to involve, ensuring a representative group for the purpose of the assessment.
- It is vital to understand the positions, perceptions, and interests of the identified stakeholders to be aware which stakeholders may be hostile to the process, which are vital for the success of the project, and how to generate and maintain interest in the assessment with respect to a core group of stakeholders.
- The assessment should consider the most effective and efficient methods for consultation, taking into account the characteristics of the main stakeholders, the availability of technology, the budget of the project, and other factors that will help determine whether face-to-face meetings, written comments, or internet consultations would be most effective and/or most feasible, and when those consultations should be held.

Effective participation is a tool that can be employed to make decision-making processes more inclusive (UN CRIS, 2005). The plurality of (and often conflicting) views and values related to trade policy is a reflection of the particular interests that stakeholders bring to the table, such as economic, financial, social or environmental interests. These interests are often unequally represented. It is thus desirable to establish a process that is as inclusive as possible, to ensure that all values and opinions are represented in a balanced way. Indeed, few would contest the importance of multi-stakeholder-based processes. However, there are several challenges to ensuring effective stakeholder participation in an integrated assessment. This chapter presents some of these challenges and provides some guidance on ways to start addressing them.

### 4.1 Identifying stakeholders

The first challenge is to identify who the stakeholders are with respect to a specific issue under investigation, and to understand the differences among various stakeholders. There are at least three categories of stakeholders. At a general level, stakeholders can be defined as the people, groups or institutions with specific rights and interests in an issue/policy or sector, and related powers, knowledge and skills. Integrated assessment can assist countries to assess the environmental, social...

It may be useful to categorise stakeholders as follows:

- **Primary stakeholders** are those likely to be affected, positively or negatively, by the issue/policy or plan. Here it may be important and relevant to pay special attention to the poor and marginalized, and those communities whose voice and opinion have traditionally been muted (such as landless farmers).

- **Secondary stakeholders** are intermediaries in the planning process and its implementation. They generally have a critical interest, knowledge and expertise (such as an important landowner).
• **Key stakeholders** are those who can significantly influence the planning, policy or decision-making process, and generally have power and influence (such as a government trade negotiator involved in WTO agricultural trade negotiations).

In considering these categories, one can further distinguish between:

• Stakeholders involved in the integrated assessment project (such as members of the project implementation team) and stakeholders likely to be affected by the project or policy under consideration;

• Stakeholders with primary (direct) and secondary (indirect) dependence on, and interest in, a certain sector or sub-sector. For example, in the context of integrated assessment in the agricultural sector, farmers would have a direct interest in the outcome of the project while a researcher from an agricultural institute may have a more secondary or indirect interest; and

• Stakeholders coming from different societal organisations such as government, non-governmental organisations (NGOs), industry/private sector and other representatives of civil society (such as labour groups, parliamentarians, indigenous communities and academics).

**Box 4.1  Checklist for identifying stakeholders**

- Have all primary and secondary stakeholders been listed?
- Have all potential supporters of opponents of the assessment project and/or the trade policy under consideration been listed?
- Have the interests of vulnerable/marginalised groups been identified?
- Has gender analysis been used to identify different types of female stakeholders?


To identify the range of potential stakeholders, it may be useful to conduct a stakeholder analysis. This can be done by developing a ‘stakeholder table’ comprised of: (i) a comprehensive list of possible stakeholders, and, based on that list (ii) a list of stakeholders classified by primary, secondary and key stakeholder categories. Each stakeholder can be allocated a score (rank) using the following criteria: their position, their interests, their level of power, their role in the planning process and the potential negative and positive impacts. This can be done through brainstorming, semi-structured interviews, use of existing data and information, or analysis of past events or policies. The shortlist can be established by clustering and highlighting critical values for above criteria. Table 4.1 presents an example, adapted from an integrated assessment process in Uganda.

**Table 4.1  Stakeholder table adapted from a proposed project on integrated assessment of trade in the horticulture sector in Uganda**

<table>
<thead>
<tr>
<th>Primary stakeholders</th>
<th>Interests</th>
<th>Potential impact of export-led horticulture policy</th>
<th>Relative priorities of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horticulture producers</td>
<td>Successful implementation of new policy, increased revenues</td>
<td>(+)</td>
<td>1</td>
</tr>
<tr>
<td>Traders</td>
<td>New export opportunities, profits</td>
<td>(+)</td>
<td>2</td>
</tr>
<tr>
<td>Cash crop farmers</td>
<td>Loss of resources because of horticulture expansion, loss of income, new work</td>
<td>(-)</td>
<td>1</td>
</tr>
</tbody>
</table>

Draft (June 2007) - Not for citation
<table>
<thead>
<tr>
<th>Stakeholder Category</th>
<th>Opportunities</th>
<th>(+/-)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity community</td>
<td>Water and soil problems, biodiversity loss, increased revenue for research</td>
<td>(-)</td>
<td>1</td>
</tr>
<tr>
<td>Secondary stakeholders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade negotiators</td>
<td>New export markets, new trading partners</td>
<td>(+)</td>
<td>2</td>
</tr>
<tr>
<td>Treasury department</td>
<td>Increased budget revenue, taxes</td>
<td>(+)</td>
<td>3</td>
</tr>
<tr>
<td>Service providers</td>
<td>New business opportunities, more employment, foreign competition</td>
<td>(+/-)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Explanatory Note:** The table identifies the relative priorities to be given to each stakeholder according to the project’s objectives. This example assumes that high priority is given to biodiversity conservation and livelihood opportunities for small farmers.

Once potential stakeholders have been identified, the next step is to decide whom to involve. Participation and consultations are costly and time-consuming, so it is important to determine which stakeholders are the most critical to involve. This question may be further elaborated with the following classifications:

- Stakeholders to be represented in the national steering committee;
- Stakeholders to be consulted in view of their expertise and interests;
- Stakeholders to be involved as partners or co-researchers;
- Stakeholders to be directly involved and kept well-informed in view of their major power/influence; and
- Stakeholders to be considered as potentially affected (both positively and negatively) by the new plan or policy.

The group(s) of relevant stakeholders will vary with the issue being discussed as the interest and capacity of various groups will depend upon the topic at hand. In addition, the scope (geographic and sectoral), budget and timing of the project must be taken into consideration to decide who to involve, how, and when, by deciding on the number and geographic distribution of participants.

One should strive to find a middle ground between a very narrow set of stakeholders, which would imply a restricted number of views and opinions taken into consideration (such as those of one or two ministries) and a broad, open list of stakeholders reflecting a wide (and potentially un-manageable) range of perspectives. An integrated assessment should attempt to strike a balance between the different categories of stakeholders described above and between the different stakeholders from societal organisations (UNEP, 2005).

### 4.2 Defining the perceptions, positions and interests of stakeholders

The next step in stakeholder analysis consists of clarifying and defining the positions, perceptions and interests of identified stakeholders. It is also important to raise stakeholders’ interests in the assessment project. There are different ways to determine the level of interest in, perception, and knowledge of stakeholders in the project and policy under consideration, as well as their respective influence and power.

#### 4.2.1 Determine which stakeholders have influence and/or are important for the project success

Analysing stakeholders who may have an influence on a policy or plan (organisations such as unions, business associations or NGOs) is critical to understanding the likely support or opposition of various
groups to the policy. Box 4.2 indicates some of the variables that might be taken into account when considering their relative power and influence.

**Box 4.2 Variables affecting the relative power and influence of stakeholders**

<table>
<thead>
<tr>
<th>Within and between formal organisations</th>
<th>For informal interest groups and primary stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal hierarchy (command and control, budget holders)</td>
<td>Social, economic and political status</td>
</tr>
<tr>
<td>Authority of leadership (formal and informal, charisma, political, familial or cadre connections)</td>
<td>Degree of organisation, consensus and leadership in group</td>
</tr>
<tr>
<td>Control of strategic resources for the project</td>
<td>Degree of control of strategic resources</td>
</tr>
<tr>
<td>Possession of specialist knowledge (agro-economist)</td>
<td>Informal influence through links with other stakeholders</td>
</tr>
<tr>
<td>Negotiating position (strength in relation to other stakeholders involved in integrated assessment)</td>
<td>Degree of dependence on other stakeholders</td>
</tr>
</tbody>
</table>

In considering stakeholders, importance is distinct from influence. There will often be stakeholders, (especially primary stakeholders such as the biodiversity community, resource-poor farmers or women) upon which the assessment project places great priority. These stakeholders may have weak capacity to participate in the project, and limited power to influence decisions. It may nonetheless be crucial to have their views represented in the assessment process.

**Box 4.3 Checklist for assessing which stakeholders are most important for the project’s success**

- Which problems affecting which stakeholders does the assessment process seek to address or alleviate?
- For which stakeholders does the assessment process place priority on meeting their needs, interests, and expectations?
- Which stakeholder group are most closely aligned with the policy and project objectives?

### 4.2.2 Identify information needs

The interest of stakeholders in the assessment project will depend on the concrete benefits that such participation may bring. This in turn is largely determined by the level and relevance of information provided to stakeholders. In identifying information needs, the accessibility and complexity of information, issues of language, resource issues and other practical considerations related to the characteristics of specific stakeholders need to be taken into account. This includes attention to different types of knowledge and information, such as scientific and indigenous, objectively verifiable and subjective, qualitative and quantitative, implicit and explicit. For example, consulting women’s groups operating in a distant district may require a contribution from a village intermediary who speaks their language. Similarly, ensuring that a key trade negotiator is engaged may involve holding face-to-face meetings every two or three months.

### 4.2.3 Analyse the relationship between stakeholders and power relations

Understanding the relationships between critical stakeholders is important, to know how they influence each other, and thus provide insight into potential coalitions and conflicting interests. It might also be useful to analyse in greater detail the power relations in order to know who is in charge and how best the planning/decision-making process can be influenced. Various types of power exist including, *inter alia*, managerial power, executive power, bargaining power, and positional power. Next, an overview may be made that indicates for each stakeholder: their numbers, their potential to
influence the planning process in a positive manner, and their power to influence the planning process in a negative manner.

4.3 Methods and tools for consulting stakeholders

An additional challenge relates to the identification of the type of consultation/participation process that will be employed. There are a number of possible mechanisms for consultation and which one is used depends largely whether the aim is active participation or more passive consultation.

Whatever the method chosen, the process must clearly establish:
- **Objectives**: Reasons for consultation/involvement and expected outcomes
- **Topic**: The nature and scope of the issue
- **Participants**: Who is affected, interested or can positively contribute
- **Time**: Amount of time available and the frequency of consultation
- **Budget**: Availability of resources

It is also useful to draw a distinction between:
1. **Analytical techniques**, which seek stakeholder participation for the analysis of the problem or issue at hand; and
2. **Facilitation techniques**, which aim to facilitate the interaction of stakeholders/groups during the assessment process in order to gather their views and opinions.

Possible consultation methods (which are discussed in UNEP, 2001) include the following:

**Face-to-face meetings.** This approach has the advantage of providing direct access for stakeholders to those undertaking the assessment, but meetings are costly and only allow for limited participation.

**Written comments.** This approach provides a broad range of inputs over a longer period of time but is less direct. Moreover, resource limitations may dictate the extent to which documentation can be made available.

**Internet consultations.** This approach has been growing in popularity in recent years, where policy documents have been posted on the internet. This method enhances access to information and requires minimal resources. However, it assumes widespread access to computers and technology, which is not available in many countries.

In the context of integrated assessment in the agriculture sector, consultation methods should be developed taking into consideration that rural populations are often among the poorest, and in some regions have limited access to education and technology, making the solicitation of input in written form (using the internet for example) of limited value. Face-to-face meetings should be organised to take into account the fact that many of the stakeholders directly concerned with agricultural production are located in rural areas. Therefore, a number of small meetings in remote locales might be more useful than large meetings in urban centres.

Timing is also an important issue. Decisions need to be taken regarding the best time for consultation during the assessment process and the frequency of consultations. In addition, a participatory process is not likely to have a strong impact upon policy-making if conducted just after negotiations or when legislation has been passed. Identifying opportunities to enhance the influence and impact of consultations must be kept in mind when planning such consultations.
5. A Conceptual Framework for Integrated Assessment

<table>
<thead>
<tr>
<th>Key points</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A conceptual framework can be used to ensure that there is a common understanding between different stakeholders of the issues involved and the links between the issues.</td>
</tr>
<tr>
<td>• A generic conceptual framework is included to illustrate the links between trade policies, agriculture, biodiversity and ecosystems, and human well-being. The framework is adapted from the conceptual framework of the MA.</td>
</tr>
<tr>
<td>• Countries are encouraged to adapt the conceptual framework presented in this Manual to their own domestic situations.</td>
</tr>
</tbody>
</table>

A conceptual framework is a framework or representation of the main components of a system or issue of interest, showing their inter-relationships or linkages. It serves to develop a common understanding of which issues should be included in an assessment and how they relate to each other. It provides a basis for different groups to contribute their analyses of specific issues and linkages, and for these analyses to combine in a logical manner in an overall assessment. For example, the MA conceptual framework was designed with the following considerations:

A well-designed conceptual framework for either assessment or action provides a logical structure for evaluating the system, ensures that the essential components of the system are addressed as well as the relationships among those components, gives appropriate weight to the different components of the system, and highlights important assumptions and gaps in understanding (MA 2005).

There is no universal conceptual framework for conducting an integrated assessment, and many frameworks have been developed to meet specific assessment needs. In choosing or developing a conceptual framework for an assessment a key requirement is to have first defined the purpose and scope of the assessment. If an existing conceptual framework is being adapted for an integrated assessment it is important to understand the original purpose for which it was designed, to ensure it meets the needs of the assessment being planned.

5.1 Employing a conceptual framework

The conceptual framework for an assessment can guide both quantitative and qualitative analytical techniques in the assessment. Quantitative techniques usually rely on the use of computer models, with the conceptual framework providing guidance on how the components of the model are linked. Examples of such techniques are Computable General Equilibrium (CGE) models, Partial Equilibrium (PE) models, and Cost-Benefit Analysis (CBA), which are described in the UNEP’s 2005 Handbook. Qualitative assessment techniques are, by nature, more descriptive but the analysis is still guided by the logic of a conceptual framework.

A conceptual framework should contain components that address the main issues being covered by the assessment, such as trade policy, agricultural production, biodiversity values, and human well-being. It can be developed with increasing levels of detail for each of its main components and the links between and among them. As the level of detail increases, the issues become more case-specific. In the analytical stage of an integrated assessment it is necessary to develop an understanding of the processes of change between the components. Assessing the impact of policy changes requires estimating the direction and strength of these links, which involves selecting several criteria and indicators.

The following conceptual framework and sample indicators (Chapter 6) are presented as a proposal for countries to adapt to their specific objectives and capacities for conducting an integrated assessment.
The framework focuses on the potential impacts on biodiversity, ecosystem services and human well-being of changes in agriculture brought about by changes in trade agreements. The framework does not detail all the aspects of an integrated assessment concerning the social and economic impacts of changes in trade agreements, which should be further developed within the component of human well-being. This should be developed according to the criteria and indicators appropriate to each country’s situation.

5.2 A proposed conceptual framework

The proposed framework for this Manual is adapted from the conceptual framework of the MA (Figure 5.1), which represents the interactions between biodiversity, ecosystem services, human well-being, and drivers of change in ecosystem services. This framework was selected because it aids in the understanding and analysis of impacts on biodiversity. The framework can also assist in assessing the role of biodiversity as part of the system of agricultural production.

Figure 5.1 indicates that changes in drivers that indirectly affect biodiversity (such as population, technology, and lifestyle) can lead to changes in drivers directly affecting biodiversity (such as the catch of fish or the application of fertilisers to increase food production). These result in changes to biodiversity and ecosystem services, thereby affecting human well-being. These interactions can take place at more than one scale and can cross scales. For example, an international demand for timber may lead to a regional loss of forest cover, which increases flood magnitude along a local stretch of a river. Similarly, the interactions can take place across different time scales. Actions can be taken either to respond to negative changes or to enhance positive changes at almost all points in this framework. Local scales refer to communities or ecosystems and regional scales refer to nations or biomes, all of which exist within global scale processes.

The frameworks presented are examples of a static representation of the issues and linkages, rather than a dynamic model. They could form the basis for a more sophisticated ‘systems dynamics modelling approach’ in the future, allowing for greater identification of driving forces, key issues and sensitivity analysis of options.

The MA conceptual framework is based on the widely used ‘causal chain analysis’ framework of ‘Driving Force-Pressure-State-Impact-Response’. For the framework developed in this Manual, the causal chain of analysis can be depicted at its most general level (Figure 5.2). Response measures are not included in the conceptual framework because they depend on the context-specific analysis, with responses (such as altered policies and mitigation measures) resulting from the analysis. A general approach to policy responses in an integrated assessment is discussed in Chapter 9. This general level framework is also presented in Figure 5.3.
The development of the conceptual framework and its use in conducting an integrated assessment involves an iterative process of conceptualising and analyses, starting with the most general of issues and increasing in complexity and detail. Figures 5.2 and 5.3 demonstrate the broadest level of conceptualisation of the main issues when assessing agricultural trade policies and their impact on biodiversity and ecosystem services. The integrated assessment process requires understanding how each of these issues are influenced and the degree to which change occurs resulting from these influences.

**Figure 5.2 Simple analytical framework for linking change in trade policies to change in agriculture, biodiversity and ecosystem services, and human well-being**

<table>
<thead>
<tr>
<th>Driving Force</th>
<th>Pressures</th>
<th>State</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Agreements</td>
<td>Agricultural Activities</td>
<td>Agricultural Biodiversity</td>
<td>Farmers’ income &amp; food security</td>
</tr>
<tr>
<td>Other influences on Agriculture</td>
<td>Intensity of land use</td>
<td>Ecosystem Services</td>
<td>Other aspects of human well-being</td>
</tr>
</tbody>
</table>

A more detailed representation of this conceptual framework and analysis is depicted in Figure 5.4. This level of detail further specifies the components and chain of analysis, such as the influence of a trade agreement on agricultural prices, and change in farmers’ choices of products and intensity of inputs. In Figure 5.4 the arrows represent the influence of one factor on another. The process of
conducting an assessment includes determining the strength and the direction of these causal links in a particular context. For example, a change in an agricultural trade agreement (such as reduced tariffs) may actually have little influence on the price that farmers receive for their produce compared to many other factors influencing prices. Similarly, any changes in product prices are only one factor influencing a farmer’s decisions on intensification or extensification of production.

**Figure 5.3** General conceptual framework for the assessment of linkages between trade policies, agriculture, biodiversity and ecosystem services, and human well-being

Figures 5.5 and 5.6 present a third level of detail in conceptualising the components and linkages for analysing changes in agricultural activities, state of land, biodiversity and ecosystem services, and human well-being. At this level some of the indicators of key parameters are included, such as crop choices, agricultural inputs, and crop production.

It is apparent from the many issues and linkages in the conceptual framework, that determining the outcome on biodiversity and ecosystem services of a change in an agricultural trade agreement is very context specific. A change in any one of the linkages or modifying factors could alter the outcome of the analysis. In some cases, data deficiencies and other constraints on analysis may not allow for a clear determination of the linkages and impacts. However, the development of a conceptual framework and consideration of the components and linkages can still improve understanding of a policy and the design of any complementary policy and/or institutional reforms.

Since changes in agriculture are a direct driver of changes in ecosystem services and biodiversity, this component is distinguished for analysis. Changes in both the extent and intensity of farming are identified as key processes for analysis. These changes in agriculture directly alter the amount of land in a natural or modified state and the capacity of the landscape to maintain ecosystem services and biodiversity. The integrity or fragmentation of areas of land in a natural state has also been identified as a key feature influencing biodiversity and ecosystem services. Similarly, these aspects of the
landscape alter natural environmental processes such as patterns of fire and flooding, which can be of great importance for biodiversity and ecosystem services.

**Figure 5.4** Conceptual framework of the principal components for assessment of linkages between trade policies, agriculture, biodiversity and ecosystem services, and human well-being

The area and condition of protected areas and other areas of biodiversity importance is important to consider in an assessment. This component is affected by changes in farming inside and adjacent to these areas, as well as the changes in the landscape.

The drivers of change and decision-making in agriculture are identified at three scales. One scale is at the farm level, where the types of farms (such as large, small, owner, or tenant) and their objectives of production (such as cash income, subsistence needs, cultural values) directly determine the type of farming. Second, the types of farms and their choices of farming are greatly influenced by the regional and national socio-economic context, including national development objectives and agriculture and trade policies. Third, international trade policy is also a focus of the assessment and is a driver of change in national development objectives and policies.
Figure 5.5  Components and factors for analysis in change of farm-level choice of agricultural products and intensity of inputs, and change in the state of land

![Diagram of farm-level choice analysis]

Figure 5.6  Components and factors for analysis in change of agricultural biodiversity and ecosystem services

![Diagram of biodiversity and ecosystem services analysis]
6. Indicators for Assessment

Key points

- The selection and calculation of indicators is central to an integrated assessment as indicators provide measurements and aid understanding of the criteria against which an impact can be determined to be important and acceptable.
- Indicators also need to be developed to assist in the process of exploring and analysing the issues and likely impacts of the proposed policy, guided by the conceptual framework.

6.1 What are indicators?

Indicators are measurements or expressions that convey information, beyond the specific measurement that defines the indicator. For example, the price of wheat in a country could be an indicator of the wheat harvest or of the demand for wheat products. Indicators are always purpose-dependent and open to interpretation and should be presented in conjunction with an explanation of their purpose and the issue for which they have been selected as a measurement.

Indicators can serve two purposes in an integrated assessment. First, an indicator can assist in understanding, and provide a measurement for, selected criteria to determine whether a potential impact is significant. The assessment should include a limited number of indicators for this purpose. A second purpose of indicators is to provide information on, and an understanding of, the components of the conceptual framework. Indicators selected for this purpose will assist in the process of exploring and analysing relevant issues and likely impacts of a proposed policy. It is likely that a sub-set of these indicators would be used for the purpose of assessment against the criteria.

An issue will often require more than one indicator to provide an understanding of its status and change. For example, the issue of poverty could include indicators that are income-based, nutrition-based, and gender-based. The selection of indicators should be guided, in the first instance, by the conceptual understanding of the issue, taking into account how the indicator reflects the issue. In another example, indicators can reflect on more than one issue. Crop productivity could be an indicator of soil condition or the degree of investment in weeding and care of the crop.

Indicators are most frequently based on quantitative data, but may also be based on qualitative information and judgement. In some cases it may be sufficient to report that an indicator is increasing or static, based on expert opinion.

If a quantitative model is being employed in an assessment, variables in the model can be used as indicators (such as crop harvested area, crop yield, ratio of erosion area to total land area, per capita food demand). Once the indicators have been selected, the data available for their calculation needs to be determined. This is often a limiting factor in assessments and the ultimate selection of indicators may depend, in part, on data availability.

While indicators should be selected to meet a specific purpose, the choice of indicators can be guided by reference to indicators used in other assessments. Another factor to consider when selecting indicators is their suitability for comparison between different localities and scales of analysis. In addition, the selection of indicators for a particular assessment will be dependent on, *inter alia*, its objectives, criteria and focus.
6.2 Sample indicators

This section provides an introduction to the issues and concepts for the components of the conceptual framework presented in Chapter 5, along with the reasoning for their linkages. Examples of indicators are provided for these key issues.

6.2.1 Agriculture trade agreements

New international trade agreements in the agricultural sector are likely to result directly in changes in tariffs, quotas and subsidies at the national level. These may then result in changes in product prices at the national level, although these may be outweighed by other influences on prices (such as changes in costs of agricultural inputs and market substitution effects).

New international trade agreements may also affect the conditions for foreign direct investment in a country, resulting in, *inter alia*, changes to the national market standards for products and how they are produced. The FAO (2003) report *Trade Reforms and Food Security - Conceptualizing the Linkages* provides a conceptual framework and methodological guidelines for these issues, including the impact of changes in trade policies on agricultural prices and production.

As identified in Chapter 3 and discussed in UNEP’s *Handbook on Integrated Assessment of Trade-related Measures - the Agricultural Sector* (2005), the main biodiversity-related trade measures include market access for agricultural products, export subsidies, domestic support, standards and conformity assessment, investment, and intellectual property rights. Below, some sample indicators are presented for a selection of trade-related issues related to agriculture.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxes affecting export of agricultural</td>
<td>Difference between export tax burden on raw materials versus tax burden on processed products</td>
</tr>
<tr>
<td>products</td>
<td></td>
</tr>
<tr>
<td>Availability of credit for export crop</td>
<td>Amount of loans issued per region per year for export crop production</td>
</tr>
<tr>
<td>production</td>
<td></td>
</tr>
<tr>
<td>Standards for export products (e.g., levels</td>
<td>Value and proportion of agricultural production meeting importer’s standards</td>
</tr>
<tr>
<td>of pesticides, labelling)</td>
<td></td>
</tr>
<tr>
<td>Domestic support/subsidies</td>
<td>Subsidy levels for agrochemicals</td>
</tr>
<tr>
<td></td>
<td>Subsidised access to credit for farmers</td>
</tr>
<tr>
<td>Market access</td>
<td>Tariffs, tariff rate quotas, tariff quota administration, special safeguards</td>
</tr>
<tr>
<td>Export subsidies</td>
<td>Direct subsidies per commodity, including marketing, transport</td>
</tr>
<tr>
<td></td>
<td>Indirect subsidies (e.g., export credit guarantees, food aid)</td>
</tr>
<tr>
<td>Intellectual Property Rights (IPR)</td>
<td>Level of IPR protection on use of new crops</td>
</tr>
<tr>
<td>Foreign Direct Investment (FDI)</td>
<td>Amount and percentage of FDI in the agricultural sector, compared to tertiary</td>
</tr>
<tr>
<td></td>
<td>(services) sector and the manufacturing sector</td>
</tr>
</tbody>
</table>

6.2.2 Price and market for agricultural products

It is likely that the principal effect of changes in trade measures in the agricultural sector will be changes in the price for agricultural products in a country. These price changes can occur at both the national borders and at the point of purchase of the products from producers. Government agricultural and statistical agencies and commercial trading and marketing bodies may compile statistics on the price of agricultural products. Prices may vary between regions in a country, as well as between border points and local markets.

The market for agricultural products may change due to altered quotas by importers, or as a consequence of price changes stimulating or reducing demand. Below some sample indicators are presented to measure issues related to the price of agricultural products.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product border prices</td>
<td>Monthly price series at point of export</td>
</tr>
</tbody>
</table>
6.2.3 Other influences on agriculture

There are many other factors that influence directly the prices of, and markets for, agricultural products. Some of these factors have a clear economic influence (such as the prices of agricultural inputs) while others are part of a wider context for determining prices and agricultural activities (such as transportation infrastructure).

These other influences also affect the choice of agricultural products and intensity of inputs. The appropriate level of detail required to identify and analyse these ‘other’ influences will have to be determined during the initial phase of the integrated assessment. In the conceptual framework presented in Chapter 5, ‘non-agriculture income options’ and ‘availability of land and capital for agriculture’ have been identified as influences of particular importance. The scales at which these influences on agriculture are determined can be broadly classified as national and sub-national, depending on a country’s size and geographic variability.

National development objectives and policies, which should be considered include:

- agricultural policies (including, inter alia, subsidies for production and export, technical support for production);
- land use (including, inter alia, different categories of protected areas for biodiversity protection, colonization of unpopulated areas, land ownership redistribution);
- economic and sustainable development (such as the tax regime); and
- infrastructure development (including, inter alia, transport, communications, health and education, and which is closely linked to land use policy).

Below, some sample indicators are presented to measure a selection of other potential issues that, in addition to trade policy, will influence the price of, and markets for, agricultural products.

### Key issue/factor | Sample indicators
--- | ---
Agricultural development policies and support | Subsidies for production (e.g., subsidised fertiliser price), Government technical support (e.g., extension service availability), Tax regime for agricultural enterprises
Taxes on farm products and income | Taxable values, Thresholds
Access to farming technology and technical support | Size of commercial farm machinery and input suppliers, Size of government agricultural extension service
Transport infrastructure for farm products and inputs | Average travel time from farm to first point of sale, or nearest surfaced road
Security of land tenure | Percentage of farm land with undisputed legal registration documents
Governance and legal framework | Restrictions on sale or use of land (e.g., federal or communal property), Corruption index
Human population density and demography | People living per km² in rural and urban areas, Rate of change in population density/year, Percentage of population under 16 or over 50 years of age

6.2.4 Non-agriculture income options

A significant influence on farmers’ decision-making with respect to their choice of agricultural products and their degree of investment in agriculture is the availability of alternative sources of income and employment. This is influenced by the productivity and profitability in the agricultural
sector and the extent to which it supports a wider economy. Non-agricultural income options are likely to be important aspects of the social and economic analysis in an integrated assessment. Below, sample indicators are presented to assist in assessing these issues.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment options</td>
<td>Wages for non-agricultural activities in rural areas and cities ($/day)</td>
</tr>
<tr>
<td></td>
<td>Availability of remunerative wages in industrial or services sector</td>
</tr>
<tr>
<td>Skills and training options</td>
<td>Availability of government and NGO programmes for training of former farmer producers</td>
</tr>
</tbody>
</table>

### 6.2.5 Availability of land and capital for agriculture

A key variable for determining whether there is an increase in the extent of agriculture is the availability of land and capital for expansion. This availability may arise from conversion of land in a natural state (such as primary forest) or the re-use of land formerly used in agriculture which has been left to rest or abandoned. The availability of land for expansion by farmers will depend on the physical existence of suitable land, the land tenure system, and farmers’ access to financial and political resources to secure use of the land. Similarly, the availability of financial capital for investment in agriculture is often a key issue that limits agricultural opportunities or promotes them, leading to intensification and/or extensification. This may be affected by trade negotiations where, for example, they result in increased investment by foreign companies or the liberalisation of financial services. Some sample indicators are presented below to measure access to financial capital and land availability.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to financial capital</td>
<td>Loan interest rates, grants, availability of loans for small, medium and large producers</td>
</tr>
<tr>
<td>Farm and non-farm land prices and availability</td>
<td>Price of land in dollars/ha</td>
</tr>
<tr>
<td></td>
<td>Percentage of total land as farm land</td>
</tr>
</tbody>
</table>

### 6.2.6 Protected areas and other biodiversity policies

The extent of farming and the spatial integrity of natural areas can be affected by the existence of protected areas and policies and institutions for the conservation and sustainable use of biodiversity. Protected areas for biodiversity conservation can have a range of management and protection objectives, from strict protection to regulated use of natural resources. Many protected areas include within them farming activities, as part of activities to maintain their biodiversity, livelihood and cultural values. However, changes in the extent and intensity of farming within and outside of protected areas can result in illegal encroachment and degradation. Land-use zoning and restrictions on use that include biodiversity conservation objectives can affect options for agricultural expansion. Some sample indicators are presented below to assess impacts of protected areas and other policies aimed at the conservation or sustainable use of biodiversity.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected areas negatively affected by changes in farming</td>
<td>Area of protected area encroached or degraded by agriculture (ha)</td>
</tr>
<tr>
<td>Coverage of protected areas of ecosystems and vegetation types</td>
<td>Area of protected area per ecosystem and vegetation types and by IUCN PA Management Categories I to VI (ha)</td>
</tr>
<tr>
<td></td>
<td>Proportion of protected area per ecosystem and vegetation types and by IUCN PA Management Categories I to VI (ha)</td>
</tr>
<tr>
<td>Enforcement of protected area legislation</td>
<td>Number of punitive measures taken by Government if encroachment of protective areas</td>
</tr>
</tbody>
</table>
6.2.7 Change in farm-level choice of agricultural products and intensity of inputs

The choice by farmers of what to produce and how they grow their crops and raise livestock is the key determinant of the intensity of modification of land and water resources in agricultural areas. The intensity of land modification is considered in turn the dominant factor influencing the amount and functioning of agricultural biodiversity and ecosystem services.

The choice of agricultural products and intensity of inputs is complex and is influenced by many social, economic and environmental factors. The sale price of products is a key factor, but the decision also involves consideration of the costs of inputs and availability of resources, including labour, land and financial capital. Socio-cultural values are also significant in making production choices, with tradition and exchange of goods and services with the local community often being important.

Figure 5.5 provided a detailed view of the key factors involved in the farm level choice of agricultural products and intensity of inputs. One choices involves the mix of crops and livestock and how these areas are managed as part of a farming system and its multiple objectives of production. Farmers’ perceptions of risk and profitability will influence decisions on whether to produce to meet their household (subsistence) needs, or to focus on production for trade, and whether to undertake diversification or monoculture production. These decisions are also influenced by farm size, with larger farms tending to be commercial and having greater access to additional land and financial credit resources if they wish to expand. Farm ownership can also be a factor influencing choice of crops, with tenant farmers less likely to cultivate perennial crops (such as coffee) which require several years to produce a harvest.

Different crops and varieties will vary in their requirements for inputs of labour and machinery, and the conditions of the land will determine whether drainage or irrigation is required. These activities will have a major impact on the land and water resources and how much they are modified from their natural state. Inputs of fertilizers (particularly inorganic fertilizer) can result in major modifications to land and water ecology. The use of pesticides and herbicides leads to simplification of the agricultural ecosystem, with the desired crop species being favoured in the short term at the expense of likely negative impacts on pollinators, predators of crop pests, soil micro-fauna, and soil nutrient cycling.

At the farm household level there are several responses to price changes and many other factors influencing livelihood strategies. Such responses could include the following:

- intensification of agriculture;
- farm diversification of products;
- expansion of the extent of agriculture;
- increased off-farm income; and
- abandoning farming.

Below are several sample indicators which could assist in the analysis of issues related to change in farm-level choice of agricultural products and intensity of inputs.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size</td>
<td>Percentage of farms per main size classes (e.g., up to 50 ha, 50 –300 ha, 300 – 5,000 ha, above 5,000 ha)</td>
</tr>
<tr>
<td>Farm ownership</td>
<td>Percentage of farms as tenants, owner-occupier, absent landlord, corporate, communal</td>
</tr>
<tr>
<td>Crops and livestock produced and traded</td>
<td>Per crop – total area used in production (ha), total production ( tonnes), value traded ($)</td>
</tr>
<tr>
<td></td>
<td>Per livestock class – total production (tonnes or head), value traded ($)</td>
</tr>
<tr>
<td>Agricultural productivity</td>
<td>Crop harvest (tonnes/ha/yr)</td>
</tr>
<tr>
<td></td>
<td>Livestock sales (kg/farm/yr)</td>
</tr>
<tr>
<td>Intensity of technology inputs</td>
<td>Area cultivated with machinery (ha)</td>
</tr>
<tr>
<td></td>
<td>Area with drainage system (ha)</td>
</tr>
<tr>
<td>Key issue/factor</td>
<td>Sample indicators</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Area under irrigation (ha)</td>
<td></td>
</tr>
<tr>
<td>Inorganic fertiliser intensity (kg/ha/yr)</td>
<td></td>
</tr>
<tr>
<td>Pesticide intensity (kg/ha/yr)</td>
<td></td>
</tr>
<tr>
<td>Herbicide intensity (kg/ha/yr)</td>
<td></td>
</tr>
<tr>
<td>Crop and livestock diversity</td>
<td>Average number of crops and varieties per farm</td>
</tr>
<tr>
<td>Average number of livestock types and breeds per farm</td>
<td></td>
</tr>
<tr>
<td>Farming land use intensity</td>
<td>Percentage of farm land not cultivated per year (such as fallow and field boundaries)</td>
</tr>
<tr>
<td>Harvesting of natural products</td>
<td>Yield of non-cultivated wild products (kg/ha) (such as mushrooms, nuts, medicinal plants and game meat)</td>
</tr>
</tbody>
</table>

6.2.8 Change in extent of agriculture

The two main ways that agriculture can change land are through: changes in the intensity and changes in the extent of land use. These two dynamics are related but need to be distinguished. Changes in the extent of agriculture can be due directly to change in the actual area under cultivation or livestock grazing, but may also occur due to indirect effects, such as people displaced by agricultural expansion and intensification migrating to colonize new areas. A sample indicator is presented below to help measure changes in the extent of agriculture.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of agriculture</td>
<td>Change in area cultivated or as pasture (ha)</td>
</tr>
</tbody>
</table>

6.2.9 State of land and water bodies

The extent of land modified from its natural state and the intensity of this modification is a key determinant of the biodiversity present and the functioning of ecosystem processes, and the consequent provision of ecosystem services. The degree of modification is a continuum but for the purposes of assessment some categories need to be assigned. A first level of categorisation could be whether the natural state of the land has been slightly or highly modified by farming. Slight modification means the principal features (such as domestic livestock grazing on natural grassland or selective logging of a forest) remain. A highly modified area is one that has been transformed to a different type of agriculture ecosystem (such as to grassland from forest or to cropland from grassland or a drained wetland).

Natural water bodies, such as lakes, rivers and marshes, can also be categorised as being in a natural state or being slightly or highly modified. For example, a lake could be used for fishing and aquaculture or it could be drained.

Highly modified land can be further categorised as agriculture with low or high external inputs. The amount of external inputs results in significant differences in the impacts of agriculture on biodiversity and ecosystem services, as well as the sustainability of the production system.

Low external input agriculture. In a low external input system the agricultural production largely relies on human and animal labour, and is likely to use traditional crop and livestock breeds adapted to the local agro-ecosystem. The livelihoods depend directly on the functioning of the supporting ecosystem services of primary production by plants, soil formation and nutrient cycling, and water cycling and its availability in the soil for plants and decomposition. These supporting ecosystem services sustain not only the agricultural production (provisioning ecosystem services), but also the delivery of regulating ecosystem services such as water supply, pollination and erosion control.

The agricultural biodiversity in low external input agriculture is likely to be simplified and reduced in comparison with the biodiversity of the natural state of the land. However, many species have adapted to agricultural landscapes (especially if some elements of original habitats remain) and the greater diversity of habitats can increase some measures of biodiversity, such as species richness.
**High external input agriculture.** Under high external input agriculture the functioning of the supporting ecosystem services is supplemented and altered to a significant extent by inputs external to the agro-ecosystem. These external inputs can include chemical fertilisers, herbicides, pesticides, and machinery using external energy sources (usually non-renewable). Cultivation and land management practices are also likely to include investment in maintaining regulating ecosystem services that have been altered by the intensity of agriculture, such as control of soil erosion and flooding and pest control. High external input agriculture is likely to have increased the productivity of a few products, with a greater proportion of the supporting ecosystem services producing these products. The simplification of the agro-ecosystem is likely to result in less associated and other biodiversity in the agro-ecosystem, which will mean less primary productivity and other supporting ecosystem services and a consequent reduction in regulating and cultural ecosystem services.

The agricultural biodiversity in a high external input agricultural system tends to be considerably simplified due to:

- reductions in solar energy captured in the non-agricultural food chain, due to reduced primary productivity by smaller populations of non-cultivated plants;
- high nutrient inputs from inorganic fertilisers favouring the growth of a few plant species;
- simplification of food chains, including fewer predators due to poisoning, loss of habitat and prey; and
- greater fluctuations in species populations, due to variability in nutrient flows, changes in herbivore and predator populations, and conditions favouring species adapted to colonising disturbed environments.

Different cropping and livestock production systems could be classified as causing slight or high modification to the natural state of the land. The extent of these cropping and livestock production areas could then be used as an indicator of the degree of modification of the land. Sample indicators are presented below to help assess changes in the intensity of modifications to the natural landscape.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in intensity of modification of natural land state</td>
<td>Area of land and water bodies in natural state, slightly modified, highly modified and low input, highly modified and high input (ha, % total land, change/year) Mapped presentation of states or use of land Area of land and water bodies of high value for regulating and cultural ecosystem services</td>
</tr>
</tbody>
</table>

### 6.2.10 Fragmentation of natural land

Fragmentation of natural land can affect biodiversity in three major ways:

**Area effects.** These occur when large patches of natural land are divided and not all species are included in the remaining smaller patches. Rare species and those requiring large areas of habitat are especially vulnerable. Research from isolated islands suggests that reducing the size of a patch of habitat by 90 per cent will result in 50 per cent of its species vanishing, with predator species especially vulnerable. The species that disappear first are the ones that require interior habitats (such as forests).

**Edge effects.** These occur when fragmentation of natural areas creates greater edges adjacent to other land cover types, such as farmland. The edges generate environmental gradients that affect vegetation, animal populations, ecological processes and species composition along the edges.

**Isolation effects.** These occur when fragmentation creates gaps between blocks of natural land that reduce movement of species, increase the chances of local extinctions and may reduce the genetic diversity within populations.
Indicators that address each of these three effects of fragmentation can be derived from spatial data on natural areas using computer Geographic Information Systems (see Chapter 8). Measures of patch size, shape and isolation can be combined to provide a single index of spatial integrity. Such indicators can be presented in both mapped and statistical formats by identifying the land belonging to different classes and reporting the total area in each class. Their usefulness is dependent on the resolution and accuracy of the source data. The appropriate scale of the analysis also needs to be determined. The scale of effects of fragmentation on a large mammal will be very different to a sedentary species of beetle, for example. Indicators relating to the area and configuration of natural land should generally be expressed as absolute areas, rather than as percentages or proportions, which can give a misleading impression. Sample indicators are presented below to help measure changes in the fragmentation of natural land.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fragmentation of natural land</td>
<td>Patch size (km$^2$)</td>
</tr>
<tr>
<td></td>
<td>Isolation of fragments – distance to nearest natural patch (km)</td>
</tr>
<tr>
<td></td>
<td>Length of edge of natural patch fragments (km)</td>
</tr>
<tr>
<td></td>
<td>Spatial integrity index</td>
</tr>
</tbody>
</table>

### 6.2.11 Biodiversity and ecosystem services

Biodiversity forms the foundation and the medium for the vast array of ecosystem services that contribute to human well-being. The conceptual framework in this Manual is adapted from the framework of MA, which described four types of ecosystem services: supporting, provisioning, regulating and cultural. They are presented in this sub-section along with agricultural biodiversity and biodiversity outside agricultural areas.

#### 6.2.11.1 Agricultural biodiversity

Agricultural biodiversity (Box 2.1 above) is often divided into planned/cultivated biodiversity, associated biodiversity, additional biodiversity, and wild biodiversity outside agricultural ecosystems (biodiversity that occurs beyond that which is used or is directly supporting the production system). This latter category of additional/other agro-biodiversity is addressed in subsection 6.2.11.2. Sample indicators are presented below to help assess changes in issues related to agricultural biodiversity.

<table>
<thead>
<tr>
<th>Key issue / factor</th>
<th>Example indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned / cultivated agro-biodiversity</td>
<td>Extent and quantity of cultivation of domesticated biodiversity - crops, livestock, and freshwater aquaculture fisheries (ha, kg)</td>
</tr>
<tr>
<td>Associated agro-biodiversity (supports agricultural production through, <em>inter alia</em>, nutrient cycling, pest control, pollination)</td>
<td>Populations of crop pollinators (insects, birds, mammals) Abundance and diversity of soil fauna (or proxies such as soil organic matter levels)</td>
</tr>
</tbody>
</table>

#### 6.2.11.2 Biodiversity outside agricultural areas

Since biodiversity includes the diversity within species, between species and of ecosystems, there are many potential measures of biodiversity. The number of species in a given area (species richness) is a common measure, but this does not take into account the contribution of species to ecosystem properties. Species composition and abundance matters as much, or more than, species richness in terms of ecosystem services. Ecosystem functioning, and hence ecosystem services, is strongly influenced by the ecological characteristics of the most abundant species, not by the number of species.

The extinction of local species or the depleting of populations to a level where they can no longer contribute significantly to ecosystem functioning can have dramatic impacts on ecosystem services. Changes in the biotic interactions between species (such as levels of predators, herbivores or parasites) can lead to large alterations of ecosystem processes. The integrity of the food chain (plants,
herbivores, predators and decomposers) and the amounts of biomass at each level is also a key aspect of the functioning of ecosystem processes and the supporting ecosystem services. The loss of multiple components of biodiversity will lead to lowered ecosystem stability and resilience to stresses and disturbance (such as changes in rainfall, fire or harvesting of species). Components of biodiversity could include whole functional groups (such as predators) or even the loss of whole ecosystem types from a landscape.

The distinction between biodiversity and the four types of ecosystem services is not a clear or simple one, but some useful measures of biodiversity and the properties of ecosystems can be identified as indicators. Some indicators are relevant to the functioning of more than one ecosystem service. Sample indicators are presented below to help measure changes in issues related to biodiversity outside agricultural areas.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance of original species composition, to meet biodiversity conservation objectives and maintenance of ecosystem services</td>
<td>Number of locally and nationally threatened and extinct species Number of species with rapid population declines (these indicators could be for separate types of species, such as mammals, birds, trees)</td>
</tr>
<tr>
<td>Conservation of valued species (such as exploited, listed as threatened, cultural value)</td>
<td>Total counts or sample census of populations, or indicators of abundance such as harvest levels per unit of effort</td>
</tr>
<tr>
<td>Productivity and integrity of the food chain</td>
<td>Annual peak biomass of plant and woody matter (kg/ha) Annual peak biomass of mammal and bird herbivores and omnivores (kg/ha) Annual peak biomass of mammal and bird carnivores (kg/ha) Population levels of major wild vertebrate carnivores and herbivore species within viable limits</td>
</tr>
<tr>
<td>Genetic and biomass reserve for future use</td>
<td>Area of land in a natural state</td>
</tr>
</tbody>
</table>

6.2.11.3 Supporting ecosystem services

The functioning and productivity of supporting ecosystem services determines the functioning and productivity of provisioning, regulating and cultural ecosystem services. One way of seeing agriculture could be the management of supporting ecosystem services to obtain the other ecosystem services, of which the provision of food, fibre and fuel are the most tangible.

Primary production by plants through photosynthesis provides the molecules and energy on which all other biodiversity and ecosystem processes and services depend. The amount of primary production determines the amount of biomass an ecosystem can sustain, through the food chain of herbivores, predators and decomposers. Agriculture uses cultivated/planned biodiversity to capture primary production for products of value to people. This capture of primary production is either directly in the form of useful plants, or indirectly through livestock.

Plants and their ability to photosynthesise depend on the availability of nutrients and water, which are principally determined by the properties of soils and the soil biodiversity. The living processes of decomposition and cycling of nutrients form soils and organic molecules by soil biodiversity, including bacteria, fungi, protozoa, nematodes and earthworms. This soil biodiversity also influences the structure of the soil to provide the air spaces and porous structure for the infiltration of rainwater and its retention in the soil, providing the conditions for healthy plant root growth and nutrient cycling. Sample indicators are presented below to help measure changes in issues related to supporting ecosystem services.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary production by planned / cultivated biodiversity</td>
<td>Biomass of cultivated plants (kg/ha) Growth rate of cultivated plants (kg/ha/yr)</td>
</tr>
</tbody>
</table>
### 6.2.11.4 Provisioning ecosystem services

Provisioning ecosystem services are probably the most straightforward of the aspects of biodiversity and ecosystem services amenable to measurement. Tangible products for human use are the focus of agriculture ecosystems. Sample indicators are presented below to help measure changes in issues related to provisioning ecosystem services.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops</td>
<td>Production per ha per year</td>
</tr>
<tr>
<td>Livestock</td>
<td>Production per ha per year</td>
</tr>
<tr>
<td>Wild plant and animal products</td>
<td>Harvest per sq km per year</td>
</tr>
<tr>
<td>Timber</td>
<td>Harvest per sq km per year from natural forests and plantations</td>
</tr>
<tr>
<td>Fresh water</td>
<td>River flow volumes and maxima and minima</td>
</tr>
<tr>
<td></td>
<td>Water table depth (m)</td>
</tr>
<tr>
<td>Construction materials and fuel source</td>
<td>Percentage of household fuel needs met from fuel wood</td>
</tr>
<tr>
<td></td>
<td>Percentage of household and farm material needs met from local timber and fibre</td>
</tr>
<tr>
<td>Diet and income from non-cultivated biodiversity</td>
<td>Percentage of household dietary calories from locally harvested wild meat, fish and plant products</td>
</tr>
<tr>
<td></td>
<td>Percentage of household income from sale of locally harvested wild meat, fish and plant products</td>
</tr>
<tr>
<td>Presence of key wild species for construction materials (such as fibre, fuel, food, commerce and tourism)</td>
<td>Population levels and/or harvest levels of key species within viable limits</td>
</tr>
<tr>
<td></td>
<td>Extent and connectivity of habitat features for key species</td>
</tr>
</tbody>
</table>

### 6.2.11.5 Regulating ecosystem services

The scale at which regulating ecosystem services are functioning may often be larger than an individual farm and may include, for example, landscape and regional processes of water and climate regulation. Populations of crop pollinators or predators of crop pests may extend over areas larger than a single farm for at least part of their lifecycle. In this way biodiversity outside agricultural areas is part of, and influencing, the biodiversity and ecosystem services in agricultural landscapes. Sample indicators are presented below to help measure changes in issues related to regulating ecosystem services.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional and local climate</td>
<td>5 year moving average of length of climate conditions unsuitable for crop growth (days/yr)</td>
</tr>
</tbody>
</table>
### Key issue/factor Sample indicators

<table>
<thead>
<tr>
<th>Water regulation</th>
<th>Change in the timing and magnitude of river flows, flooding and aquifer recharge</th>
</tr>
</thead>
</table>
| Soil erosion regulation | Soil organic matter content in croplands (average percentage of organic matter [dry weight] in the upper soil profile [4–6 inches]/farm/yr)  
Soil erosion or formation rates (tons/hA/yr) |
| Water purification and waste treatment | Nitrate and phosphate concentration in rivers and wetlands |
| Pest regulation | Crop losses due to insect pests (kg/ha/yr) or percentage of expected harvest  
Crop losses due to vertebrate pests (kg/ha/yr) or percentage of expected harvest |
| Crop pollination | Percentage of crop requiring pollination by human intervention |
| Frequency and intensity of fires | Area burnt (ha/year)  
Frequency of fires – average interval between last 5 fires – years  
Areas of forest affected by surface fires burning only near the ground, fires consuming the crowns of some of the trees, continuous crown fires |

#### 6.2.11.6 Cultural ecosystem services

Cultural ecosystem services are culture specific and must be classified and assessed on a location- or country-specific basis. Issues of non-economic valuation are relevant to the assessment of cultural ecosystem services (see Chapter 7). Sample indicators are presented below to help measure changes in issues related to cultural ecosystem services.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation of valued species</td>
<td>Total counts or sample census of populations, or indicators of abundance such as harvest levels per unit of effort</td>
</tr>
<tr>
<td>Spiritual and religious values from biodiversity and landscape</td>
<td>Number of sacred sites</td>
</tr>
</tbody>
</table>
| Recreation and ecotourism values | Number of visitors per year  
Percentage of farm or regional income from expenditure by tourists |

#### 6.2.12 Human well-being and poverty

There are several dimensions to human well-being. The conceptual framework in the MA identified broad categories of basic material for a good life, health, good social relations, security, freedom of choice and action. For an assessment focusing on the links among trade, agriculture and biodiversity the most relevant aspects of socio-economic well-being need to be selected, taking into account the priorities of the country involved and the availability of existing indicators and data. A farmer’s income and food security are two measures of human well-being that are directly linked to agricultural production (provisioning ecosystem services).

The UNDP Human Development Reports provide further information and data on indicators of human development (http://hdr.undp.org/hd/). Sample indicators are presented below to help measure changes in issues related to human well-being and poverty.

<table>
<thead>
<tr>
<th>Key issues/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
</table>
| Economic | Total income/farm and locality or district  
Proportion of subsistence farmers compared to market farmers |
| Farm income and profit | Rural jobs/ha  
Farm wages ($/day)  
Estimate of unemployed (per age class, each sex, and total)  
Rural unemployment levels (structural versus seasonal)  
Ratio of subsistence farmers to waged agricultural labourers |
<p>| Employment | |</p>
<table>
<thead>
<tr>
<th>Key issues/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life expectancy</td>
<td>Average life expectancy for rural areas, urban areas and country</td>
</tr>
<tr>
<td>Income equality</td>
<td>GINI index</td>
</tr>
<tr>
<td>Poverty</td>
<td>Population living below national poverty line (%)</td>
</tr>
<tr>
<td>Access to water</td>
<td>Percentage of population with access to safe drinking water</td>
</tr>
<tr>
<td></td>
<td>Percentage of population with access to water for agricultural activities</td>
</tr>
<tr>
<td>Health</td>
<td>Proportion of population with sustainable access to an improved water source</td>
</tr>
<tr>
<td></td>
<td>Proportion of population with access to affordable essential drugs on a regular basis</td>
</tr>
<tr>
<td></td>
<td>Percentage of rural population with access to health services</td>
</tr>
<tr>
<td></td>
<td>Infant mortality rate</td>
</tr>
<tr>
<td></td>
<td>Under 5 mortality rate</td>
</tr>
<tr>
<td></td>
<td>Average daily per capita calorie supply, 1999 (kilocalories)</td>
</tr>
<tr>
<td></td>
<td>Average daily per capita calories from animal products, 1999 (kilocalories)</td>
</tr>
<tr>
<td></td>
<td>Underweight children under age 5 (%)</td>
</tr>
<tr>
<td></td>
<td>Prevalence of malnutrition among children under age 5</td>
</tr>
<tr>
<td></td>
<td>Undernourished people (as a % of total population)</td>
</tr>
<tr>
<td></td>
<td>Proportion of population below minimum level of dietary energy consumption</td>
</tr>
<tr>
<td></td>
<td>Percentage of illness and injuries associated with agricultural activities</td>
</tr>
<tr>
<td>Food security</td>
<td>Food aid levels</td>
</tr>
<tr>
<td>Gender</td>
<td>Gender Development Index (GDI)</td>
</tr>
<tr>
<td></td>
<td>Ratio of female to male farm household heads</td>
</tr>
<tr>
<td></td>
<td>Ratio of male to female time inputs to farming</td>
</tr>
<tr>
<td></td>
<td>Ratio of estimated male to female earned income</td>
</tr>
<tr>
<td></td>
<td>Female economic activity rate (% for age 15+)</td>
</tr>
<tr>
<td></td>
<td>Female economic activity rate (as % of male rate)</td>
</tr>
<tr>
<td></td>
<td>Female employment in agriculture (% of female labour force)</td>
</tr>
<tr>
<td></td>
<td>Share of women in waged employment in the non-agricultural sector</td>
</tr>
<tr>
<td>Human development (index)</td>
<td>The Human Development Index (HDI) is an index composed of longevity, education and standard of living</td>
</tr>
<tr>
<td>Conflicts over land and water</td>
<td>Number/yr</td>
</tr>
<tr>
<td></td>
<td>Proportion of households with access to secure tenure</td>
</tr>
<tr>
<td>Autonomy of indigenous peoples</td>
<td>Land titles for indigenous communities</td>
</tr>
<tr>
<td>Demographics</td>
<td>Total population, and per district</td>
</tr>
<tr>
<td></td>
<td>Annual population growth rate (%)</td>
</tr>
<tr>
<td></td>
<td>Immigration/emigration rate</td>
</tr>
</tbody>
</table>
7. **Approaches to Valuation**

**Key points:**
- Assigning values to biodiversity resources, functions and associated ecosystem services has the potential to improve decision-making as most resource management and investment decisions are strongly influenced by considerations of the monetary costs and benefits of different policy choices.
- Valuation should address the relevant components of the Total Economic Value (TEV) of non-marketed ecosystem services to provide information on changes in the value of ecosystem services that result (or could result) from policy decisions or other human activities.
- The choice of the valuation tool or tools will be informed by the characteristics of the case, including the scale of the problem, the types of value deemed to be most relevant, and data availability and the availability of human and financial resources.
- In general, tools based on observed behaviour (revealed-preference techniques) are preferred to tools based on hypothetical behaviour (stated-preference techniques) and cost-based approaches are particularly useful when a specific decision-making problem calls for a comparison of the costs of different replacement or restoration options. Benefits transfer can provide reliable estimates under certain conditions with the potential to alleviate challenges posed by poor data and limited funds, which are often encountered in valuation.

7.1 **Assigning value to biodiversity**

Valuation is an important component for undertaking an integrated assessment of trade policy. Such policies may include amongst others: increased market access for agricultural products; economic incentives for agricultural products (such as export subsidies and domestic support); export credits; food aid; intellectual property rights on agricultural plants and genetic resources, and; certification and labelling of traded products. All of these policies have impacts on biodiversity. Economic valuation of the impact of such policies on biodiversity would be required if their assessment (on a cost-benefit efficiency grounds) were to be undertaken. Getting a biased value of biodiversity would lead to less than optimal levels of biodiversity conservation while at the same time it may also lead to distortions in market prices of complementary or competing agricultural products (Randall 2002).

This chapter is based on decision VIII/25 of the eighth meeting of the Conference of the Parties to the CBD, on the application of tools for valuation of biodiversity and biodiversity resources and functions, and on SCBD (2007): *An Exploration of Tools and Methodologies for Valuation of Biodiversity and Biodiversity Resources and Functions*, Technical Series no. 28, Montreal, Canada, which was itself based on the review and assessment of valuation tools in chapter 2.3.3.1 of volume 1 of the MA, which has been extensively peer-reviewed by governments and experts.

Different disciplines define and use the term ‘value’ different ways. In economics, value and utility are unambiguously anthropogenic. For instance, in the case of marketed goods and services, humans reveal value in terms of their so-called willingness-to-pay (WTP), through a process of exchange. Similarly utility is derived by humans. Even the concept of importance is only meaningful if assigned by, and inferred from, human choices or decisions on behalf of other living organisms. But other

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3 A distinction is made in philosophy between anthropocentric and anthropogenic value. Something has anthropocentric value when it is good for a human subject. Foods and other goods used by humankind have anthropocentric (and instrumental) value. Anthropogenic value, on the other hand, is value that is attributed by a human subject, but not necessarily value for a human. So, for example, many people take an old growth forest to have value whether or not it is actually used or appreciated firsthand by a person. See Hiller 2005, Callicott and Baird 1999. Because of the concept of existence value, the term anthropogenic is used here.
disciplines may assign different interpretations to value or importance, which may or may not be linked to values ascribed by human beings. For example, anthropology may infer value from cultural norms and practices that are in some sense non-negotiable (such as sacred groves). Theologians and ethicists may base importance on moral or spiritual criteria that are neither observed nor measurable, and may also point out that the predominant role of humans in utilitarian thinking displaces intrinsic value and the right of other species to exist. Ecologists will be interested in the importance of attributes or functions of a system to maintain ecosystem resilience. This is an objective criterion that exists, irrespective of its relevance to humans. It is important to bear in mind these disciplinary distinctions and the fact that different perspectives on value lead to a range of views on the practicality of measurement and use in policy making.

While there is growing awareness of the value and importance of diversity *per se*, there is a lack of consensus on how diversity can be defined and measured. For example, species richness is frequently the only accessible indicator of species diversity, although it is well known that a head count of the number of apparently different species in an area may not be a good proxy for the portfolio effect of genetic distance between them. Some context-sensitive index or set of indices of biodiversity change would be fundamental to any economic valuation of diversity. Indices could in theory be based on phylogenetic data. In practice this data is not readily available as a basis for prioritization. However, other prioritization devices, discussed below, employ non-monetary measures of value that may encompass genetic distance.

Valuation does normally not entail measuring the economic value of biodiversity *as such* (Pearce and Moran, 1994; Pearce 2001). Instead, it typically focuses on the economic values of the goods and services generated by biodiversity resources and/or functions – the so-called ecosystem services. A comprehensive assessment of the values of ecosystem services has recently been undertaken by the MA, which adopted a wide understanding of ecosystem services, which includes goods under the concept of “provisioning services”. While this understanding departs from the usual economic distinction between “goods” and “services”, it is adopted here to ensure consistency with the terminology in the MA.

The term “economic” is to be understood in a broad sense. Based on welfare economics, economic valuation recognizes that individuals may assign value for different reasons and not only for the immediate benefits of commercial exploitations of a resource (as a narrow interpretation of the term “economic” may suggest).

Economics generally assigns value on the basis of direct or indirect tradeoffs, that is, actions that show people making sacrifices in favour of specific goods and services, thus revealing their WTP for these goods and services by exchanging them on markets. These actions can be explained by a robust theory of demand that posits specific axioms or rules about the consistency in which these choices are made. It is the consistency of the predictions of this theory that enables economists to infer what people value based on what they actually do.

Environmental economics has extended demand theory to goods and services that are not traded on markets, including most ecosystem services (which include goods according to the understanding of the MA). As they are not traded on markets, their value is not captured in market prices. The reason is that many ecosystem services bear characteristics of what economists call “public goods”. One important characteristic of public goods is that nobody can be excluded from their use. For this reason, markets cannot spontaneously develop for public goods, and the value of these public goods will therefore not be reflected in a market price. This has also the consequence that the prices of many marketed goods and services will not adequately reflect the essential role of these services in their production, which, in turn, will lead to distorted decisions by consumers and producers. Public decision-making and its allocation of public funds will also be distorted if the repercussions of governmental activities on these biodiversity resources and functions, and the associated ecosystem services, are not adequately factored in. As a result, undertaking valuation not only raises awareness of the hidden benefits of biodiversity conservation in terms of maintaining critical ecosystem services, it also has the potential to improve public decision-making.
Since the 1960s, considerable efforts have been made by economists to develop methods that can elicit the “hidden” value of non-marketed natural resources. These methods use the aforementioned sacrifice or WTP\(^4\) based on actual or hypothetical behaviour, to infer the value of the resource. There are many reasons why people are indirectly observed to, or directly state that they are willing to, make tradeoffs between their endowment (in terms of time, labour effort, monetary income or wealth) and safeguarding non-marketed natural resources, including safeguarding specific levels of ecosystem services. The framework commonly used for describing the different types of economic value ascribed to natural resources is known as the TEV and is presented below.

Valuation usually attempts to measure the value of ecosystem services in monetary terms, in order to provide a common metric in which to express the benefits of the variety of services provided by ecosystems. This explicitly does not mean that only monetary sacrifices, or only services that generate monetary benefits, are taken into consideration. What matters is that people are willing to make tradeoffs. If the relevant people are, for example, subsistence farmers, these tradeoffs could be initially measured by the labour time they are willing to provide for achieving some environmentally-friendly outcome. In order to have a common metric, this effort could be transformed into a monetary figure by applying the local or domestic wage rate.

The economics profession is divided on whether valuation is adequate or sufficient to deal with the more fundamental issues that are also involved in biodiversity management. It is in particular suggested that some biodiversity functions are key to the survival of global ecosystems including humans (the so-called life support function) and should therefore be treated as a fundamental constraint and not as an element of the set of possible economic choices. There has been debate on how much biodiversity is necessary to keep the basic services of the planet intact. There is however a consensus that a more diverse ecosystem can provide services more reliably (Peterson \textit{et al.} 1998). And all economic choices must be made within some ecological constraints otherwise the global system may collapse. The standard toolbox of economic valuation is said to be of limited if any use for the identification of these global constraints. Alternative approaches such as setting a safe minimum standard may be more suitable for those cases, in particular when changes are irreversible (Pagiola \textit{et al.} 2004).

In consequence, valuation usually focuses on the value of comparatively small (incremental or “marginal”) changes in ecosystem services that result (or would result) from management or policy decisions, or from other human activities (Costanza \textit{et al.} 1997). Some recent efforts have been made to derive the global (as opposed to incremental) value of ecosystems at a given time (Boumans \textit{et al.} 2002) and to simulate the value of ecosystem services in an integrated Earth system model (MA 2005). However, the methodologies underlying these efforts, and the figures they produced, remain controversial and, as the MA notes, their usefulness for policy is limited, as it is rare for all ecosystem services to be completely lost and even then, such a complete loss would usually happen only over time. For these reasons, and consistent with the approach chosen by the MA, this chapter focuses on methods for assessing the value of changes in ecosystem services.

### 7.1.1 Total Economic Value (TEV)

The framework commonly used for describing the different types of economic value ascribed to natural resources is the TEV. It comprises use values (direct, indirect and option value) and non-use values.\(^5\)

**Direct use value** is the value derived from direct use or interaction with environmental resources and services (for example, timber, fuel wood, and recreation are direct use values of a forest). They involve commercial, subsistence, leisure, or other activities associated with a resource.

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\(^4\) Depending on the question that is to be investigated, focus is sometimes given to the so-called “willingness-to-accept.” For instance, if an area is to be protected and people who have the legal title to use that area would be no longer allowed to do so, they might be asked for how much compensation they are willing to voluntarily give up their right to use the area. Willingness-to-accept generally raises important problems with biases, which is why the concept of willingness-to-pay is generally preferred. See Hanemann 1991.

\(^5\) Option value is sometimes classified as a non-use value.
**Indirect use value** relates to the indirect support and protection provided to economic activity and property by the ecosystem’s natural functions. For example, carbon sequestration is a function of forest ecosystems whose value can be derived from the avoided costs of having to sequester by other means, or from avoiding the actual effects of warming. Similarly, the watershed protection function of a tropical forest may have indirect use value through controlling water quality and flood drainage that affect downstream agriculture, fishing, water supplies and other economic activities. While these functions have in principle long been recognized, precise field experimentation has often been lacking in order to show more precisely the relationships between ecosystem functions and the services generated.

There is an indirect use value of agro-biodiversity, as it provides financial savings to, or increases the productivity of, the farmer. Capital-led intensification (through greater reliance on the use of agrochemicals) undermines key agro-biodiversity functions. For example, more intensive agricultural land management relative to less intensive systems (such as organic farming) can increase the cost of pollination to farmers. This is a cost that is seldom accounted for when estimating the returns from capital-intensive farming. Such associated biodiversity may be found in neighbouring habitats and is thus susceptible to changes in land management off the farming areas.

One example is the biodiversity in forest habitats that abut farmlands. Such habitats supply biodiversity services (such as pollination services) to agriculture. Pollination by wild bees increases agricultural yields near forest patches and the economic cost of the reduction of pollination services originating from off-farm forest habitats to agricultural production can be estimated. A study in 2002-2003 estimated that the value of such associated biodiversity regarding its pollination services for coffee production in a single Costa Rican farm is approximately seven per cent of total farm income (when coffee prices were substantially depressed). This estimate incorporates both increased income from greater production and net increased costs from harvesting the larger crop (Ricketts et al 2004). It shows the potential economic value of habitat conservation in neighbouring farmland. There are, however, more services provided by off-farm biodiversity, which are valuable to farmers. For example, it provides biological control against pests and invasive species. This translates into savings in the cost of pest and disease control to the farmer (Perrings, 2005).

**Option value** is a type of use value in that it relates to future use of the environment or biodiversity resources and functions. Option value arises because individuals may value the option to be able to use the natural resource some time in the future. For example, there may be an additional premium placed on preserving a forest system and its resources and functions for future use, particularly if prospects of future value are high and if current exploitation or conversion is irreversible. The logic of the option motive is to maintain a diverse portfolio of resources as a means to reducing the risk of large fluctuations in value. A more diverse ecosystem also tends to be considerably more resilient. This has been researched under the term “insurance value” as well (Baumgaertner 2007).

Quantification of option value is often complex. For instance, several attempts have been made to evaluate the expected benefits of bio-prospecting of genetic resources of naturally occurring wild plants and organisms for pharmaceutical use. These attempts are controversial for several reasons, including: the role and extent of previous knowledge and its impact on probabilities of finding a resource of actual value; and the role and extent of potential replacement by human-made diversity (Simpson, Sedjo and Reid 1996; Rausser and Small 2000; Firn 2003; Costello and Ward 2007). The lack of knowledge is also reflected in the concept of a quasi-optional value referring to the value of having more time to learn about the extent or possible uses of biodiversity, thereby making it possible for future decisions to be based on better information (Weikard 2002). Decisions should always take into account that the results of an interference with an ecosystem can never be fully predicted, making “ignorance a strong motivation for conservation” (Weikard 2002).

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According to some ecological approaches on biodiversity, the value of a species could greatly vary, depending on the time of its loss. A species lost while others can still provide a given service and fill the gap might have a relatively low value, one lost later when it is the only one providing the service could cause the collapse of an ecosystem. Biodiversity becomes more valuable as it becomes scarce.
Non-use values such as existence value (sometimes also dubbed passive value) are derived neither from current direct or indirect use of the environment. For example, there are individuals who do not use the tropical forest but nevertheless wish to see it preserved because they simply derive utility from the ongoing existence of the ecosystem, or because they wish to conserve it for future generations (bequest value). A similar observation applies to some species, in particular charismatic mega-fauna such as whales or tigers. The concrete reasons why they derive utility may vary and may be based on, for instance, religious, spiritual, or ethical motives. In particular, a non-use motive may coincide with the recognition of an intrinsic right of existence. In this sense, valuation that is based on the concept of total economic value will also capture, at least to some extent, non-utilitarian values (MA 2003).

Of all the value categories, existence or passive value is most complex in terms of quantification and its role in decision-making. Yet, it is a type of economic value that is significant in defining both national and global biodiversity management priorities.

There exist a variety of taxonomies and classifications of the components of TEV. A commonly used approach is that which first divides values them into the two main categories of ‘use’ and ‘non-use’ and then proceeds with their decomposition into sub-categories of value. Figure 7.1 presents an illustration of this classification approach.

**Figure 7.1 Total Economic Value: Values that can be assigned a monetary metric**

<table>
<thead>
<tr>
<th>TOTAL ECONOMIC VALUE (TEV)</th>
<th>USE VALUE</th>
<th>NON-USE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct use value</td>
<td>Indirect use value</td>
<td>Option value</td>
</tr>
<tr>
<td>Existence value</td>
<td>Bequest value</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXAMPLES FOR BIODIVERSITY</th>
<th>COMMONLY USED VALUATION METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output that is consumed directly</td>
<td>Change in productivity, cost-based approaches, hedonic prices, travel cost, stated preference methods</td>
</tr>
<tr>
<td>• Fish</td>
<td>Change in productivity, cost-based approaches, stated preference methods</td>
</tr>
<tr>
<td>• Wood</td>
<td>Change in productivity, cost-based approaches, stated preference methods</td>
</tr>
<tr>
<td>• Meat</td>
<td>Stated preference methods</td>
</tr>
<tr>
<td>• Non-timber forest products</td>
<td>Genetic resources</td>
</tr>
<tr>
<td>• Biomass</td>
<td>Potential bio-prospecting values</td>
</tr>
<tr>
<td>• Recreation</td>
<td>Old-growth forest</td>
</tr>
<tr>
<td>Ecological functions that support and protect economic activity elsewhere</td>
<td>Knowledge of continued existence or that others will enjoy benefits of biodiversity; for future generations</td>
</tr>
<tr>
<td>• Watershed protection (flood control, storm protection)</td>
<td>• Charismatic mega-fauna (whales, great apes)</td>
</tr>
<tr>
<td>• CO2/O2 stabilisation, etc.</td>
<td></td>
</tr>
<tr>
<td>Uncertainty over further demand or availability of biodiversity flows; irreversibilities</td>
<td></td>
</tr>
<tr>
<td>• Genetic resources</td>
<td></td>
</tr>
<tr>
<td>• Potential bio-prospecting values</td>
<td></td>
</tr>
<tr>
<td>• Old-growth forest</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output that is consumed directly</th>
<th>Change in productivity, cost-based approaches, hedonic prices, travel cost, stated preference methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existence value</td>
<td>Bequest value</td>
</tr>
<tr>
<td>Knowledge of continued existence or that others will enjoy benefits of biodiversity; for future generations</td>
<td></td>
</tr>
<tr>
<td>• Charismatic mega-fauna (whales, great apes)</td>
<td></td>
</tr>
</tbody>
</table>
7.2 Overview of valuation methods

In the past decades, valuation methods have reached a considerable degree of sophistication and there has been a gradually emerging consensus on the state-of-the-art of the range of valuation methods at hand. This is reflected by the fact that recent handbooks and manuals on the topic provide very similar overviews and assessments of the individual tools, with differences remaining essentially on the level of terminology and classifications (IUCN 1998; OECD 2002; Pagiola et al. 2005; de Groot et al. 2006).

Valuation methods are increasingly applied not only in developed countries, but also in developing countries and countries with economies with transition. Rietbergen-McCracken and Abaza (2000) present several valuation studies undertaken in Africa, Asia, Latin America and Central and Eastern Europe, some of which also deal with biodiversity resources and functions, and the related ecosystem services. The IUCN guidelines for protected area managers on economic values of protected areas also provide summaries of a number of valuation studies in developing countries (IUCN 1998). A survey on the use of contingent valuation studies in developing countries, some of which address biodiversity-related issues, was conducted by FAO in 2001. Humavindu (2002) presents an analysis of valuation studies addressing nature-based tourism in Namibia.

Many methods for measuring the values of ecosystem services are found in the resource and environmental economics literature. Some techniques are based on data from observed behaviour, including some methods that deduce values indirectly from behaviour in surrogate markets, which are hypothesized to have a direct relationship with the ecosystem service of interest. Other techniques are based on hypothetical rather than actual behaviour data, where a person’s response to questions describing hypothetical markets or situations is used to infer value. These are generally known as “stated preference” techniques, in contrast to those based on behaviour, which are known as “revealed preference” techniques. Some techniques are broadly applicable, some are applicable to specific issues, and some are tailored to particular data sources. As for private-market goods, a common feature of all methods of economic valuation of ecosystem services is that they are founded in the theoretical axioms and principles of welfare economics. These measures of change in well-being are reflected in people’s willingness to pay or willingness to accept compensation for changes in their level of use of a particular service or bundle of services (Hanemann 1991; Shogren and Hayes 1997). These approaches have been used extensively in recent years, in a wide range of policy-relevant contexts.

Any one valuation method is unlikely to cover all of the different types of value given in the concept of TEV (Nunes and van den Bergh 2001). Different techniques may also be required for the same biodiversity resource evaluated at different scales. For example, the range of services of a forest, the type of value of those services, and their actual value to a local community living at the fringe of the forest, may differ significantly from the types of value and the value that the national and/or international community may assign to different services of the same forest. The selection of the method or methods should therefore depend on the types of value and levels are deemed the most important (or likely) in a given situation, although many valuation studies use several methods.

When applying different techniques to address different impacts on biodiversity resources and functions, or different types of relevant TEV, care must be taken to avoid the problem of “independent piecewise value” estimation (Randall 2002). Because of the complementarities and multiplier effects associated with different impacts, an estimate of the TEV of a particular biological resource should not be based on a piecewise independent valuation of each impact or TEV type and a simple addition of those individual figures, as this would probably lead to double-counting. For example, if a dose-response approach to the value of agro-biodiversity is estimated and then simply added to the value assigned by farmers’ themselves using a state preference technique, it is very likely that double counting would occur. This is a common problem given the multi-attribute nature of agro-biodiversity and its multifaceted services that it provides both on- and off-farm.

Valuation is a process involving several steps. First, the services being valued have to be identified. This includes understanding the nature of the services (noting that under the MA services may also include goods), their scale (local, regional and/or global, on-site or off-site), how they would change if the ecosystem changed, who makes use of the services (in what way and for what purpose), alternatives, and establishing trade-offs that might exist between different kinds of services an ecosystem provides. The bulk of the work involved in valuation concerns quantifying biophysical relationships. In many cases, this requires tracing through and quantifying a chain of causality. Valuation in the narrow sense only enters in the second step in the process, in which the value of the impacts is estimated in monetary terms.

7.2.1 Changes in productivity

One technique that is widely used (due to its broad applicability and flexibility in using a variety of data sources) is the change in productivity technique. It consists of tracing through chains of causality so that the impact of changes in the condition of an ecosystem can be related to various measures of human well-being. Such impacts are often reflected in goods or services that contribute directly to human well-being (such as production of crops or clean water) and are relatively easily valued, depending on the type of impact.

The impact of hydrological changes on use of water for human consumption, for example, begins by tracing through chains of causality to estimate the changes in the quantity and quality of water available to consumers. This is often difficult. For instance, the relationship between tree cover and water productivity in a watershed is complex and not well understood. Further scientific research into chains of causality is a precondition for this type of valuation.

In the case of marketed goods, the actual valuation is relatively straightforward. For instance, the net value in reductions in irrigated crop production resulting from reduced water availability is easy to estimate, as crops are often sold (although a common error is to use the reduction in the gross value of crop production, which omits the costs of production and overestimates the impact rather, than the net value).

Where the impact is on a good or service that is not marketed or where observed prices are unreliable indicators of value, the valuation can become more complex. In the example above, the prices charged to consumers for water consumption are typically not reliable measures of the value of the water to consumers, as they are often set administratively, with no regard for supply and demand (indeed, in most cases water fees do not even cover the cost of delivering the water to consumers, let alone the value of the water itself). The value of an additional unit of water can then be estimated in various ways, such as the cost of alternative sources of supply (cost-based measures) or asking consumers directly how much they would be willing to pay for it (contingent valuation). It is very important to use the value of an additional unit of water, since some amount of water is vital for survival. Thus an additional unit of water will be very valuable when water is scarce, but less so when water is plentiful, rendering averages misleading.

When the impact is on water quality rather than quantity, the impact on well-being might be reflected in increased morbidity or even mortality. Again, the process begins by tracing through chains of causality, for example by using dose-response functions that tie concentrations of pollutants to human health and value the impact on health.

In some cases, the impact is on relatively intangible aspects of well-being, such as aesthetic benefits or existence value. Since the 1960s, particular efforts have been made to develop techniques to value such impacts. These techniques include hedonic price, travel cost, and contingent valuation methods.

7.2.2 Cost of illness and human capital

The economic costs of an increase in morbidity due to increased pollution levels can be estimated using information on various costs associated with the increase. These include any loss of earnings resulting from illness, medical costs (such as for doctors, hospital visits and medication), and other related out-of-pocket expenses. The estimates obtained in this manner are interpreted as lower-bound
estimates of the presumed costs or benefits of actions that result in changes in the level of morbidity, since this method disregards the affected individuals’ preference for health versus illness and restrictions on non-work activities. Also, the method assumes that individuals treat health as exogenous and does not recognize that individuals may undertake defensive actions (such as using special air or water filtration systems to reduce exposure to pollution) and incur costs to reduce health risks.

When this approach is extended to estimate the costs associated with pollution-related mortality, it is referred to as the human-capital approach. It is similar to the change-in-productivity approach in that it is based on a damage function relating pollution to productivity, except that in this case the loss in productivity is that of human beings, measured in terms of expected lifetime earnings. Because it reduces the value of life to the present value of an individual’s future income stream, the human-capital approach is extremely controversial when applied to mortality. Many economists prefer, therefore, not to use this approach and to simply measure the changes in the number of deaths or in the probability of death (without monetary values), or measures such as disability-adjusted life years.

### 7.2.3 Cost-based approaches

The cost of replacing or restoring the services provided by the environmental resource is sometimes relevant in decision-making. For example, if ecosystem change reduces water filtration services, the cost of treating water to make it meet the required quality standards could be used. The major underlying assumptions of these approaches are that the nature and extent of physical damage expected is predictable (there is an accurate damage function available) and that the costs to replace or restore damaged assets can be estimated with a reasonable degree of accuracy. It is further assumed that the replacement or restoration costs do not to exceed the economic value of the service, bearing in mind the potential externalities generated by the replacement options. These assumptions may not be valid in all cases. It simply may cost more to replace or restore a service than it was worth in the first place—for example, because there are few users or because their use of the service was in low-value activities.

Even while there is not necessarily any relationship between the replacement (or restoration) cost and the value of the service, cost-based approaches can provide useful guidance in a number of cases, in particular when the specific decision-making problem calls for a comparison of the costs resulting from all different replacement or restoration options. For instance, in an often-quoted case, the New York City water authority avoided spending US $6-$8 billion on water purification plants by investing US $1.5 billion for the protection and restoration of the upstate watershed in the Catskills Mountains (Postel and Thompson 2005). Here, the decision-making problem was simply to minimize the cost of meeting an objective, by comparing the costs resulting from replacement and from restoration options. The priority given to the objective itself (a reliable supply of drinking water meeting certain quality standards) was unquestionable and not part of the decision-making problem.

An important effect of trade on biodiversity in agricultural landscapes is the increased costs through invasive species, which are recognized as one of the most pervasive and insidious threats to biodiversity in agricultural landscapes by deepening international trade liberalization. The growth of the international trade system has involved a substantial increase in the number of alien species being introduced to ecosystems and the frequency with which such introductions are made (Jenkins, 1996; McNeely, 2001). While in some cases, the introduced species are themselves the object of trade, indirectly trade itself can become a vector for alien species by stowing away in ships, planes, trucks, shipping containers, and packing materials, or by ‘hitchhiking’ on nursery stock, fruits, vegetables, seeds, and other import products (Jenkins, 1996).

Invasive species, whether pests or pathogens have important effects on agriculture, including: (i) interference with crop growth through competition for biotic and abiotic resources, (ii) the production of toxins that inhibit the growth of other plants, (iii) contamination of harvested crops, (iv) provision

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8 See as examples studies II, III, IV, V, and X provided in SCBD (2007).
of vectors for pests, (v) interference with harvesting and (vi) requirement for additional cleaning and processing (Perrings, forthcoming). All of these have direct economic implications. While some clearly increase the cost of production, others reduce the value of harvested crops or result in their exclusion from international markets.

Although there are no precise estimates of the impact of invasive species on yields in poorer countries, since the agricultural sector has a significantly higher share of GDP than in developed countries, the impact of invasive species on overall economic performance is proportionately larger. In India for example, Pimentel’s (1999) estimates imply that annual invasive species control and damage costs were 20 per cent of GDP in 1999, compared to less than one per cent in the United States (Perrings, forthcoming). The issue of invasive species could be addressed through institutional mechanisms. There is a question of the extent to which one should blame this on trade.

The resulting costs from such introduction of alien species are clear externalities of trade and the values of such externalities have risen sharply over the past few years (Pimentel et al. 2005). Such cost estimates involve the identification of damage that those species might have caused in agricultural landscapes by affecting plant/crop health, and the amenity or cultural value lost in addition to the funds used for the eradication or control of such invasive species. Box 7.1 provides an example of how such costs can be assessed from the supply perspective based on the ‘damage costs’, ‘loss of earnings’, ‘remediation costs’ or the ‘preventive expenditure’ approaches.

Box 7.1 Estimating the costs of invasive species

The *ex-ante* assessment calculation of the net costs of a given invasive species is not an easy task. It involves estimating (i) the likelihood of the invasiveness of the species, (ii) the invasibility of the agricultural system, (iii) the effectiveness of any given control programme, and (iv) the responses of those whose life and livelihoods are affected by invasive species and their control, who are the ones which values count. Economic valuation of the effects of invasive species in agricultural systems mainly arise by the calculation of ‘gross’ direct damage costs and may not appropriately approximate ‘net’ costs. The reason is that there are no estimates of any benefits that may have accrued from the economic activities that led to the introduction of invasive species (Perrings, in press). For instance, in the United States, crop areas affected by invasive weeds and arthropod and microbial pests are estimated to be causing an estimated annual loss of about US $60 billion of which, most are in direct damages. For instance, weeds alone cause a reduction 10 per cent in crop yields annually (about US $24 billion in lost crop production plus another US $3 billion in herbicides). (Pimentel et al. 2001)

It is interesting to consider the relative severity of the estimates in rich and poor countries. Taking agricultural GDP in 1999 as the numeraire, the invasive species caused damage costs equal to 53 per cent of agricultural GDP in the United States, 31 per cent in the United Kingdom and 48 per cent in Australia. By contrast, damage costs in South Africa, India and Brazil were, 96 per cent, 78 per cent and 112 per cent, respectively, of agricultural GDP. (Perrings, in press).

An alternative valuation approach is to take into account the ‘public expenditure’ on invasive species control. This follows the idea of the ‘remediation cost approach’. In this case, a lower bound estimate of the cost of the problem of invisibility is obtained. While this financial data is not available for most countries, in the United States, for example, such expenditure on invasive species in 1999 was less than US $0.5 billion, or 0.5 per cent of the estimated damage costs in agriculture. This figure contrasts with that based on the ‘direct damage cost’ approach outlined above. This also suggests that the cost of invasive species in agriculture due to increased international trade needs to go beyond the financial costs of controlling the problem (i.e., using the so-called ‘preventive or mitigation expenditure approach’). Furthermore, while most of the estimates have been obtained through the ‘loss of earnings approach’, these valuation studies fail to obtain the ‘net’ cost.

When the true net costs are taken into account it is not always clear that eradication or control is the optimal strategy. An example of Ghana is illustrative of this. The siam weed (*Chromoleana odorata*) was introduced into Ghana in the 1960s and in about four decades had spread to approximately 60 per cent of the land area. While it has led to major ecological costs, the users themselves when asked about such costs in a survey, highlighted that few would support its eradication since it also confers significant benefits in terms of fuel, fibres, building materials and medicinal products. (Rangi 2004)
7.2.4 Hedonic analysis

The prices paid for goods or services that have environmental attributes differ depending on those attributes. Thus, a house in a clean environment will sell for more than an otherwise identical house in a polluted neighbourhood. Hedonic price analysis compares the prices of similar goods to extract the implicit value (“shadow price”) that buyers place on the environmental attributes. This method assumes that markets are transparent and work reasonably well, and it would not be applicable where markets are distorted by policy or market failures. Moreover, this method requires a very large number of observations, so its applicability is limited.

7.2.5 Travel cost

The travel-cost method is an example of a technique that attempts to deduce value from observed behaviour in a surrogate market. It uses information on visitors’ total expenditure to visit a site to derive their demand curve for the site’s services. From this demand curve, the total benefit visitors obtain can be calculated (the value of the site is not given by the total travel cost, which is only used to derive the demand curve; the total benefit is expressed as the area under the demand curve minus the costs [the sum of the consumer surplus and the producer surplus]). This method was designed to assign a value to the benefits of sightseeing or recreation at particular sites, but has limited relevance to other scenarios.9

7.2.6 Contingent valuation

Contingent valuation is an example of a stated preference technique. It is carried out by asking consumers directly about their WTP to obtain an environmental service (or, in some circumstances, their willingness-to-accept). A detailed description of the service and how it will be delivered is provided. The valuation can be obtained in a number of ways, such as asking respondents to name a figure (classical CV), asking them whether they would pay a specific amount (dichotomous or polychotomous choice) or having them choose from several options (choice modelling).

By phrasing the question appropriately, CV can be used to value any environmental benefit. Moreover, since it is not limited to deducing preferences from available data, it can be targeted to address specific changes in benefits that a particular change in ecosystem condition might cause. Because of the need to describe in detail the service being valued, interviews in CV surveys are time-consuming. Moreover, in designing CV surveys it is important to identify the relevant population to ensure that the sample is representative, and to pre-test the questionnaire to avoid bias.

A potentially important limitation when applying these methods to ecosystem services is that respondents cannot typically make informed choices if they have a limited understanding of the issue in question. Choosing the right approach to improve the understanding of biological complexity of the sample group, and determining the intensity of effort necessary, is a challenge for stated preference methods.

CV methods have been the subject of severe criticism by some analysts, in particular because of the danger of bias resulting in distorted results whereby CV studies may not reflect true preferences. A “blue-ribbon” panel was organized in the United States following controversy over the use of CV to value damages from the 1989 Exxon Valdez oil spill. The panel’s report (which is generally regarded as authoritative on the appropriate use of CV) concluded that CV can provide useful and reliable information when used carefully, and it provided guidance to help to reduce, or avoid, potential bias (Arrow et al. 1993).

Choice modelling (also referred to as contingent choice, choice experiments, conjoint analysis, or attribute-based stated choice method) is a newer approach to obtaining stated preferences. It consists of asking respondents to choose their preferred option from a set of alternatives where the alternatives are defined by attributes (including price). The alternatives are designed so that the respondent’s

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9 See studies I, VII, VIII, XII in SCBD (2007).
choice reveals the marginal rate of substitution between the attributes and the item that is trade off (for example, money). These approaches are useful in cases where an investigator is interested in the valuation of the attributes of the situation or when a decision lends itself to respondents choosing from a set of alternatives described by attributes.

Choice modelling has several advantages. One advantage is that the control of the stimuli is in the experimenter’s hand, as opposed to the low level of control generated by real market data. Second, the control of the design yields greater statistical efficiency. Third, the attribute range can be wider than found in market data. Finally, the introduction or removal of products, services and attributes is easily accomplished (Louviere et al. 2000; Holmes and Adamowicz 2003; Bateman et al. 2004, Columbia, 2002). The method also minimizes some of the technical problems (such as strategic behaviour of respondents) that are associated with CV. The disadvantages associated with the technique are that the responses are hypothetical and therefore suffer from problems of hypothetical bias (similar to CV) and the choices can be complex when there are many attributes and alternatives. The econometric analysis of the data generated by choice modelling is also relatively complex.

7.2.7 Benefits transfer

A final category of approach is benefits transfer (BT), which refers to the use of estimates obtained (by whatever method) in one context to estimate values in a different context. For example, an estimate of the benefit obtained by tourists viewing wildlife in one park might be used to estimate the benefit obtained from viewing wildlife in a different park. Alternatively, the relationship used to estimate the benefits in one case might be applied in another, by using adjusted data from this case in conjunction with some data from the site of interest (‘benefit function transfer’). For example, a relationship that estimates tourist benefits in one park, based in part on their attributes such as income or national origin, could be used in another park, but with data on income and national origin of that park’s visitors.10

BT has been the subject of considerable controversy in the economics literature (Brouwer 2000; Christie et al. 2004) as it has often been used inappropriately. The MA suggests that a consensus is emerging that BT can provide valid and reliable estimates under certain conditions, which include the requirement that the commodity or service being valued is very similar at both the site where the estimates were made and the site where they are applied, and that the affected populations have similar characteristics.11 The original estimates being transferred must themselves be reliable in order for any attempt at transfer to be meaningful. However, as conditions at the two sites are unlikely to be identical, some transfer error is to be expected.

Nevertheless, BT is useful in decision-making because estimates based on BT can be generated with considerably less time and resources than primary studies and decision makers may be willing to trade quick (and cheaper) numbers against some loss in accuracy, provided that minimum quality standards are met. They may even be more ready to do so when the alternative is to have no estimate at all. Moreover, BT may be attractive when decision makers request quick (but not necessarily final) answers from administrators. It may thus play a role in rapid assessment methodologies.12

7.2.8 Summary of valuation methods

Each of the approaches reviewed above has seen extensive use in recent years, and considerable literature exists on their application. These techniques can and have been applied to a very wide range of issues (Rietbergen-McCracken and Abaza 2000), including the benefits of ecosystems such as forests (Bishop 1999; Kumari 1995; Pearce et al. 2003; Hanley et al. 2002, Merlo and Croitoru 2005),

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10 See in particular study XI in SCBD (2007).
11 Up to a limit, differences in the population’s characteristics can be addressed by using benefits functions transfer.
12 Christie et al (2004) note that: “Finding acceptable BT methods is essential to the wider use of environmental valuation in policy. However, the standards of accuracy required in academic work may exceed those viewed as tolerable by policy-makers. (...)The key question is: how close is close enough for policy purposes?”
wetlands (Barbier et al. 1997; Heimlich et al. 1998; de Groot et al. 2006), and watersheds (Aylward 2004; Kaiser and Roumasset 2002).

Other studies have focused on the value of particular ecosystems services such as water (Young and Haveman 1985), non-timber forest benefits (Lampietti and Dixon 1995; Bishop 1998), recreation (Bockstael et al. 1991; Mantua at al. 2001; Herriges and Kling 1999; Humavindu 2002), landscape (Garrod and Willis 1992; Powe et al. 1995), biodiversity for medicinal or industrial uses (Simpson et al. 1996; Barbier and Aylward 1996), natural crop pollination and cultural benefits (Pagiola 1996; Navrud and Ready 2002). Many valuation studies are catalogue in the Environmental Valuation Reference Inventory Web site maintained by Environment Canada (www.evri.ca) or the ENVALUE environmental valuation database developed by the New South Wales Environmental Protection Agency of Australia (http://epa.nsw.gov.au/envalue).

When applied carefully and according to best practice, valuation tools can generally provide useful and reliable information on the changes in the value of non-marketed ecosystem services that result (or would result) from management decisions or from other human activities. Data requirements and technical expertise may be demanding for several tools and conducting primary valuation studies is typically time-consuming and costly.

The MA suggested that measures based on observed behaviour are generally preferred to measures based on hypothetical behaviour, and more direct measures are preferred to indirect measures. However, it also notes that the choice of valuation technique in any given instance will be dictated by the characteristics of the case (including its scope) and by data availability.

Several techniques have been specifically developed to cater to the characteristics of particular problems. The travel-cost method, for example, was specifically developed to measure the utility derived by visitors to sites such as protected areas, and could also be applied to similar areas of interest, but is of limited applicability outside that particular case. The change in productivity approach, on the other hand, is applicable to a wide range of issues.

CV is potentially applicable to any issue (by phrasing the questions appropriately) and as such has become very widely used. However, it is easy to misapply and, based on hypothetical behaviour, it is inherently less reliable than measures based on observed behaviour. If the focus is on the quantification of indirect use values, the application of other valuation tools is preferable. For some types of value, however, stated preference methods may be the only alternative (existence value can only be measured by stated preference techniques). Guidance on the appropriate use of the technique exists and should be followed closely.

BT has often been used inappropriately but can provide valid and reliable estimates under certain conditions. Given the cost of undertaking primary valuation studies, BT, when used cautiously, could be an appealing way to extent the use of valuation to developing countries. Table 7.2 provides a summary of selected valuation techniques discussed in this manual, along with information to assist a user in determining which technique to employ, depending on the types of impacts to be valued.

### Table 7.2 Selected valuation techniques

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Applications</th>
<th>Data requirements</th>
<th>Potential challenges/limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revealed-preference methods</td>
<td>Change in productivity</td>
<td>Trace impact of change in ecosystem services on produced goods.</td>
<td>Any impact that affects produced goods.</td>
<td>Change in service; impact on production; net value of produced goods.</td>
</tr>
<tr>
<td>Cost of illness, human capital</td>
<td>Cost of illness, human capital</td>
<td>Trace impact of change in ecosystem services on morbidity and mortality.</td>
<td>Any impact that affects health (e.g., air or water pollution).</td>
<td>Change in service; impact on health (dose-response functions); cost of illness or value of life.</td>
</tr>
<tr>
<td>Cost-based approaches</td>
<td>Cost-based approaches</td>
<td>Use cost of replacing or</td>
<td>Any loss of goods or services.</td>
<td>Extent of loss of goods or services.</td>
</tr>
<tr>
<td>Method</td>
<td>Approach</td>
<td>Cost Components</td>
<td>Benefits</td>
<td>Costs</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>(replacement/restoration costs)</td>
<td>restoring the service</td>
<td>Identification of least cost option to meet given objective</td>
<td>and cost of replacing or restoring them</td>
<td>identified costs</td>
</tr>
<tr>
<td>Travel cost (TCM)</td>
<td>Derive demand curve from data on actual travel costs</td>
<td>Site-specific recreation; sightseeing (e.g., protected areas)</td>
<td>Survey to collect monetary and time costs of travel to destination, distance travelled</td>
<td>Limited to described applications; difficult to use when trips are to multiple destinations</td>
</tr>
<tr>
<td>Hedonic prices</td>
<td>Extract effect of ecosystem service on price of goods that include those factors</td>
<td>Air quality, scenic beauty, cultural benefits</td>
<td>Prices and characteristics of goods</td>
<td>Requires transparent and well-working markets, and vast quantities of data; very sensitive to specification</td>
</tr>
</tbody>
</table>

**Stated-preference methods**

- **Contingent valuation (CV)**: Ask respondents directly their WTP for a specified service. In particular in cases where non-use values are deemed to be important. Survey that presents scenario and elicits WTP for specified service. Ensuring sample is representative is important but large survey is time-consuming and costly; knowledge of respondents may be insufficient; potential sources of bias in responses; guidelines exist for reliable application.

- **Choice modelling**: Respondents choose preferred option from alternatives with particular attributes. In particular in cases where non-use values are deemed to be important. Survey of respondents. Similar to CV, but minimizes some biases; analysis of the data generated is complex.

**Other methods**

- **Benefits transfer**: Use results obtained in one case in a different, but very similar case. Any where suitable comparison studies are available; applicable in cases where savings in time and costs outweigh certain loss of accuracy (e.g., rapid assessments). High-quality valuation data from similar sites. Can be very inaccurate when not used cautiously, as many factors may still vary even when cases seem 'similar'.

Source: adapted from MA (2005)

### 7.3 Valuation and decision-making

Undertaking valuation has the potential to improve public decision-making on projects, regulations, or policies. Existing methods to support decision-making use valuation information to a greater or lesser extent. Economic frameworks such as cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA) involve explicit monetary valuation. An important advantage of the valuation tools reviewed in the last section is that they provide numbers in a common (monetary) metric, which can easily be incorporated into these standard appraisal methods. In contrast, multi criteria analysis (MCA) typically avoids using a monetary unit of account. Other non-economic approaches to prioritization include deliberative processes, scorecard approaches, expert judgment and satisficing.

All of these approaches are tools to support decision-making. They all have advantages and limitations, and it cannot be claimed that one tool is generally superior, or that it should be used as an exclusive tool in decision-making. For instance, with respect to CBA, economic efficiency is seldom the sole criterion for public investment decisions. The distributional impacts of decisions are often also important. While CBA can be helpful in clarifying distributional impacts, it does not deliver recommendations

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13 For example, many direct use values in developing countries arise in the context of subsistence activities that are crucially important to rural populations. A range of studies has concentrated on the links between poverty alleviation and the sustainable exploitation of naturally occurring products. See Cavendish 1999 and 2003.
with regard to preferable decisions from a distributional perspective. Nevertheless, different methods may be used in a complementary manner in order to support decision-making.

7.3.1 Economic frameworks

7.3.1.1 Cost-benefit analysis and cost-effectiveness analysis

CBA compares monetary costs and benefits. This comparison is sometimes expressed as a cost-benefit ratio, where benefits are the numerator and costs are the denominator. Alternative options can then be ranked in accordance with their cost-benefit-ratio. Depending on the specific activities under investigation, the value associated with ecosystem services will be included as a cost or as a benefit. For instance, if the cost-benefit-ratios of different conservation projects were compared, the value of improved ecosystem services would be included as benefits of the individual projects. If, however, different development projects were considered (for example, different options to invest in public infrastructure with negative impacts on biodiversity) the value of the associated loss of ecosystem services would be included as a cost to the individual option. It may not be necessary to explore the full range of services of a given ecosystem to have an influence on a policy outcome. This will be the case when, in the context of CBA, the benefits associated with the most important ecosystem services are already high enough to tip the balance against a specific development option.

As costs and benefits typically occur at different points in time it is necessary to collapse the recognized cost and benefit flows to a commensurate basis. This is done through a conventional economic process called ‘time discounting’ and the outcome of the process is called the ‘present value’ of costs and benefits. A crucial variable in the calculation of present value is the choice of a discount rate (the value that is used to collapse future values to their present equivalents). A positive discount rate is tantamount to saying that the future (costs and benefits) are worth less in relative terms than costs and benefits that are realized immediately.

For conventional investment purposes, the rate of discount is simply the relevant market interest rate. But when it comes to choosing the appropriate rate for making a judgment on government projects or policies with important social and environmental impacts, important ethical and philosophical issues arise that relate to the status of present versus future (possibly unknown) preferences. Aspects of intergenerational justice play an important role in that discussion, since the value of future benefits is only smaller to the current generation, whereas biodiversity will be of importance for many generations to come. While most commentators tend to agree that the rate of discount should be positive, the correct number is the subject of much debate.

Discount rates used in public decision-making vary between three and 15 per cent across different countries. The choice of discount rate is guided, in the first instance, by the rate that is used by the public sector for appraising its other investments (implying that biodiversity-related “investments” would be treated like all other investments). In many cases, however, lower rates are used. One important reason why not to accept a standard discount rate for biodiversity has been advanced in the shape of the so-called Krutilla-Fisher method (Pearce and Turner 1990; Krutilla and Fisher 1975; Hanley and Craig 1991). Even if future preferences for biodiversity are uncertain, current trends mean that the future of many biodiversity components and resources is bleak, implying that they will be increasingly scarce, or more valuable, in the future. As future generations will place a higher value on

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14 For example, while the benefits of conservation occur at the national and international levels (such as carbon sequestration or the existence value associated with charismatic mega-fauna) the costs associated with conservation (such as foregone exploitation of resources or of use of land) are often borne by local populations. On the other hand, local ecosystem services (those that benefit local communities) are severely undervalued in many cases. By disaggregating the numbers obtained, valuation studies and CBA can help quantify the shares of local vs national vs regional or international benefits and costs under different options.

15 This procedure captures the “opportunity cost” of the individual development project, that is, the cost in terms of the most valuable opportunity foregone and the benefits that could be received from that opportunity. The consideration of opportunity costs is a key difference between the concepts of economic cost and accounting cost.
scarcer resources than do current generations, this reasoning gives rise to a positive premium on the future, which offsets the discounting process described above.

Cost-effectiveness analysis (CEA) leaves the numerator in qualitative terms and simply compares the different costs of attaining some objective stated in the numerator. Different options that deliver the same objective are then compared and prioritized based on their cost-effectiveness-ratio. CEA, therefore, does not ask (or attempt to answer) the question of whether the goal of the policy is justified, in the sense that the social benefits expected from this goal exceed the costs necessary to reach the goal. Indeed, none of the options may be economically efficient, in the sense of monetary economic costs outweighing economic benefits. Hence, CEA is appropriate whenever there are good reasons to believe that the benefits of meeting the objective outweigh the costs, and the priority given to meet the objective is therefore not under doubt (such as in the Catskills example discussed above). In other cases, however, CEA may only be helping to select the least-worst option among a list of potentially inefficient options. Even in those cases, CEA is sometimes used as a second-best option when a full-blown CBA would be desirable, but many benefits cannot easily be monetized.

Both CBA and CEA are common governmental appraisal methods in OECD countries and among international organizations. While the methods were originally developed for appraising basic infrastructure, many government guidance documents now include advice on the inclusion of environmental and social costs and benefits.\(^1\)

### 7.3.1.2 National income accounts

While CBA and CEA are decision-making tools relevant to projects and regulations, national income accounts are a key indicator framework for setting priorities in domestic macroeconomic policies, possibly including trade policies. National income accounts are a long-standing economic convention by which economic performance are measured. The accounts measure national output from all sources (gross domestic product [GDP]), and then deduct a measure of depreciation, which is the amount of (typically) man-made capital that is used up in production. The result is a figure that depicts, in economic terms, how well off a country is year to year. While conventional accounts already include many biological products (such as the production of timber and fish products), in the past two decades there have been several attempts at national and international levels to include environmental externalities and, more importantly, some measure of environmental depreciation to reflect the environmental losses that occur as a result of economic activities. The United Nations Statistics Division, together with other organisations, has developed the System of Economic and Environment Accounting, which was introduced in 1993 and revised in 2003. It consists of a satellite system to the UN System of National Accounts, in which changes in important natural assets are accounted for in physical terms (http://unstats.un.org).

Due to the problems involved in assessing values in a comprehensive manner, most work in this area focus on types of value that can be measured relatively easily. It includes mainly direct use values traded on markets, opportunity costs for protected areas, and sometimes the impact of pollution. Some methods focus on the use of natural resources (renewable and non-renewable) as an indicator for the use of nature. For instance, recent work by the World Bank on an adjusted GDP and adjusted measurements of national capital stocks (based on Pearce and Atkinson) adopted the concept of genuine savings or adjusted net savings, which measure the true rate of savings in an economy after taking into account investments in human capital, depletion of natural resources and damage caused by pollution. The work shows that several countries that perform well on conventional grounds were actually performing less well once the new measure of depreciation was included. Under a more comprehensive valuation exercise (including most indirect and non-use values) the number of countries with this sobering feature could be higher.

Identification of this environmental drag on economic growth can serve as a basis for prioritizing national environmental policies and a focus on mitigation or reversal of environmentally damaging activities. Hence, while valuation is central to the exercise of environmental adjustment of national accounts, many theoretical and methodological challenges remain with regard to the adequate

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\(^1\) Chapter 4 of the UK Treasury Green Book on public appraisal, http://greenbook.treasury.gov.uk.
incorporation of biodiversity values in conventional macroeconomic indicators of growth (Nordhaus and Kekkelenberg [eds] 1999). For instance, many of the valuation tools available are too costly and demanding to apply a scale needed for a comprehensive valuation of the annual changes in domestic biodiversity resources (Nordhaus and Kekkelenberg 1999). Nevertheless, depending on the scope of the national trade policy to be gauged by an integrated assessment, and on data availability, adjusted measurements based on national accounts, as described above, might be a useful element of the integrated assessment exercise elements.

7.3.2 Non-economic frameworks

The following approaches are more qualitative in nature but may occasionally use valuation information in the decision process.

7.3.2.1 Multi criteria analysis

Multi-criteria analysis (MCA) is a family of methods that use different scoring approaches to weigh the different attributes of a decision. They are used to structure a policy problem in terms of possible policy alternatives and to assess each alternative under various criteria. Most of the variants of MCA are structured approaches used to determine overall preferences among different policy measures, where each measure may pursue several objectives. Participants in the analysis are typically given the criteria that define different options and are asked to score or weigh these criteria using some predetermined points system.

MCA is mainly applicable to cases where a single-criterion approach is insufficient. An MCA may accommodate a range of social, environmental, technical, economic, and financial criteria. MCA is therefore applicable especially where significant environmental and social impacts are present, which cannot (easily) be expressed in monetary terms. MCA are often integrated with deliberative and participatory approaches and are said to facilitate such input to a larger degree than the monetary assessment tools CBA and CEA (Nichols et al. 2000).

There are very few applications of MCA in developing countries and it can be difficult to use and understand. Most variants require an expert to explain how the method works, and to help users to define options, criteria and weights, as well as to choose the appropriate aggregation procedure. The method makes no claim to be searching for economically efficient outcomes. Like CEA, all options under consideration may be inefficient.

CBA and MCA are not mutually exclusive. CBA can be used to define a set of efficient options where net benefits are positive (that is, gross benefits are greater than costs). Options with net economic benefits of similar magnitude could be further assessed by MCA, to identify non-economic trade-offs associated with alternative courses of action.

7.3.2.2 Deliberative and inclusionary approaches

Deliberative and inclusionary approaches (DIPs) include participatory appraisal, focus groups, the Delphi approach, consensus conferences and citizen’s juries. These methods are aimed at creating better informed decisions that are owned by, and have the broad consent of, all relevant actors and stakeholders. They stand in contrast to the more ‘technocratic’ approaches such as CBA, CEA, or MCA. DIPs seek to build a process of defining and redefining interests that stakeholders introduce as the collective experience of participation evolves. As participants become more empowered (i.e., more respected and more self-confident) it is assumed they may become more able to adjust to, listen to, and learn from others, and accommodate to a greater consensus.¹⁷

In many countries, the benefits of some ecosystem services are well known to local and indigenous communities and captured by their traditional knowledge. As long as these communities are adequately included in economic valuation exercises (for instance, by ensuring that they are adequately represented in the population sample for a stated preference study), the value they put on these ecosystem services would be captured by economic valuation.

¹⁷ Ramsar/CBD 2006 p.19 describes in detail the process of identifying and involving relevant stakeholders.
However, traditional knowledge of ecosystem services is often not adequately received by the wider public and DIPs may play an important role to promote the wider recognition of this knowledge and contribute (with the approval and involvement of these communities) to its wider application, including within economic valuation studies. DIPs can also complement other techniques. For instance, one limitation of stated preference techniques is that respondents cannot typically make informed choices if they have a limited understanding of the issue in question, by disseminating pertinent knowledge, DIPs may play an important role to broaden the understanding on the issue for all stakeholders.18

The adoption of such methods vary among countries, with some having formal processes for undertaking participation in the formulation of public policy. The use of economic information in these methods is at the group’s discretion. Therefore, valuation data may not consistently inform the outcome of such processes, which cannot guarantee that outcomes represent an efficient use of public resources. Moreover, in many countries, the relative weight that the outcome of these processes is given in final decisions is unclear.

7.3.2.3 Satisficing

A satisficing approach can be described as an assessment procedure to obtain an outcome that is good enough, rather than seeking the best solution. The approach can be contrasted with an optimizing approach, which seeks to identify the “best” solution (such as with CBA or MCA). For the implementation of a satisficing approach, one or more criteria need to be identified that the measure is expected to fulfil. The subsequent analysis can investigate all possible measures to achieve this objective(s) and list the successful options without ranking them, or it can be terminated once the first option has been identified that fulfils the requirement(s).

In decision theory, the term satisficing is also used to refer to an optimization process where all costs (including the cost of the optimisation calculations and the cost of getting information for use in those calculations) are considered. This takes account of the fact that, in some cases, the costs of gathering and processing information may not be justified by the improvements in decision-making that can be achieved through the improved information. This is likely to be the case in decision-making situations with a low level of complexity, where only few well-defined options are available, where the targets are clearly specified, and where few or no trade-offs between targets are necessary.

One difficulty associated with such an approach is that the added value of better information for the decision-making process may only be apparent if this information is available. It the information is not available it may be hard to assess how better information might have changed the results of the decision, and what the impact would have been.

7.3.3 Linking a participatory approach with economic valuation techniques

Despite the anthropocentric importance of ecosystem services with regard to social well-being, not enough is known about their recognition and identification by local users themselves. Because not all ecological services provided by biodiversity are known (or where they are ignored) they are often not properly assessed when eliciting local users’ values and preferences with regard to biodiversity. For this reason, conventional economic valuation techniques can be fused with participatory approaches. For example, Rodriguez et al (2006) have recently attempted to estimate the use-value of the Opuntia scrublands in Peru by initially exploring the ‘cultural domain’ of Opuntia by local communities in order to identify their perception of the ecosystem goods and services. Semi-structured surveys were used to gather information from a randomized sample of 113 households under a voluntary participation scheme. This information was both qualitative and quantitative. A focus group involving a subset of these households (comprising 26 voluntary ones), supplied valuable information about their own perceptions of the uses of Opuntia scrubland. This information was applied within a ‘cultural domain’ analysis for subsequent valuation. Cultural domain analysis provides a set of techniques to

18 SCBD (2007) provides case study examples of the application of deliberative approaches within economic valuation – see cases IV and IX.
investigate knowledge structure. Borgatti (1998) ‘freelisting’ and ‘triad’ techniques can be applied to elicit the elements of the cultural domain and the attributes that local land-users apply to distinguish among the different uses of a particular biological resource.

The information obtained by this analysis by Rodriguez et al (2006) was then used to characterize the different services provided by Opuntia from the point of view of the users themselves. The first category of value provided by Opuntia was found to be a direct use value, in terms of providing food through the use of fruits (marmalade, salads and fruits), the second identified benefit was also found to be a use value, albeit an indirect one, in the form of benefits from agro-pastoral system such as food security, cattle raising and soil protection. The other type of benefit identified is given by the supply of cochineal which is the cash-crop derived from the Opuntia. In addition, such use values that have been identified via participatory techniques can be subsequently monetised using different economic techniques.

In many cases, several of these different valuation techniques will be used together to address the various values of the biodiversity under consideration. Box 7.2 provides an example from Peruvian Opuntia scrubland of the potential problem of the ‘independent piecewise value’ approach can be avoided by first identifying the separate services provided by agro-biodiversity. It shows how to value and then aggregate the ecosystem services of agro-biodiversity. Here the different types of ‘functions’ are scientific constructs. That is, while they are linked to farmers’ perspectives and experience of the problem of the degradation of the Opuntia scrubland, these functions have been arbitrarily demarcated. In reality, there might be overlap in these functions. Therefore, aggregating the individual values from all such functions would produce a ‘double counting’ problem. What these values indicate is the approximate weights of the importance to the local agricultural sector of the degradation of the multi-attributed Opuntias.

Box 7.2 Avoiding independent valuation: Opuntia scrubland from Ayacucho, Peru

The Opuntia scrublands are especially important because they are host for cochineal insects, which are the source of carminic acid, a natural dye used in the food, textile, and pharmaceutical industries. Although the direct use value of the Opuntia scrubs includes mainly the value of cochineal exports and manufactured dyes, its total use value, includes other indirect use values to the local farming community. The Opuntia scrubland performs a major environmental role protecting slopes against erosion and flooding, as well as rehabilitating marginal lands by improving the levels of humidity and soil retention capabilities. In addition, the scrublands are used for animal grazing all year round (and can become an emergency feedstock in case of drought) and its fruits and young cladodes have a considerable nutritional value and provide food for Andean farmers.

The direct use value of Opuntias in terms of their production of food, fruit, cochineal, fodder, fuel and ornamental goods can be derived using direct market prices and, if necessary, the value of the closest substitute goods. The habitat function value of its nursery and refugium services can be assessed using a supply-side approach by applying the avoided cost analysis. An estimate of the indirect use value regarding the regulation function of the on-farm erosion control service can be provided through a CV method. This illustrates how various values associated with different ecological functions can be assessed applying methods from the demand-and-supply-side toolkits.

Valuation of provisioning services (food, feedstock and fuel wood). Once the yearly quantity and quality of yields of scrubland products (e.g., cochineal and fruit) and the area used in the collection is calculated, market prices can be used to derive the direct use value of the products collected in a given year. These prices can be obtained from a representative selection of stakeholders and traders to be employed in the valuation approach. Also, since livestock feed on Opuntias, its feedstock role can be calculated by multiplying the yearly livestock profits by the percentage of Opuntias of the total feedstock intake used in the diet of the cattle. The use value of Opuntia scrublands as a source of fuel can be quantified considering the wage rate as a broad approximation of the opportunity cost of time employed by households in periodic working hours that generate supply of fuel.

Value of regulating services. The value of the Cochineal cash-crop is a sessile parasitic insect living on Opuntia plants which allow farmers to collect the cochineal by withdrawing them from their host plants. Those not harvested are used to repopulate the scrub for later harvests. This ‘nursery’ function is valuable as it represents
an investment in future crops. The value of the service of nursery and refugium is quantified based on the costs avoided by farmers if the host plants should be infested by hand at the prevailing labourers’ wages that represent the opportunity cost of time.

*Value of supporting services* (soil erosion control). This is a key function that is valuable for farmers in the high sloped Andean area. Soil loss affects productivity of crops, but any change in productivity will be evident only after many years of severe soil loss. Farmers’ interest in soil erosion is primarily concerned with on-farm impacts such as increased production costs, decreased profitability owing to soil fertility decline, and financial costs of implementing needed soil conservation measures. One way of eliciting such value is by the employment of state preference techniques. This allows obtaining a broad monetary idea of the households’ WTP for the service of soil erosion control provided by the Opuntia scrubland.

Even if only some of the intangible benefits are considered, the value of these ecosystem services provided by Opuntia scrubland is relatively higher than the computable direct financial revenues from agriculture. The valuation analysis shows that the share of direct use value through the collection of items from the scrubland on farmers’ income is as high as 36 per cent. With the indirect use value (regulation of soil erosion), the value of Opuntia scrubland for farmers accounts for over 55 per cent of their income. The following table provides a summary of valuation methods and estimates in this Peruvian case study.

Source: Adapted from Rodríguez *et al* (2006).

### Function, goods and services of Opuntia scrublands in Ayacucho, Peru

<table>
<thead>
<tr>
<th>Functions</th>
<th>Ecosystem Processes And Components Involved</th>
<th>Valuation method</th>
<th>Total annual value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Function</td>
<td>Production of natural resource commodities for sale or subsistence consumption</td>
<td>Replacement cost approach</td>
<td>1,475 NS/ha (US$450/ha)</td>
</tr>
<tr>
<td>Food</td>
<td>Cochineal production; Fruit and young cladodes for human consumption, fodder for cattle, traditional fermented and non-fermented beverages, syrups, and conserves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other raw materials</td>
<td>Conversion of solar energy into biomass diverse uses: Fuel wood source, biogas obtention; Cladodes used for obtain organic fertilizer by composting process Building material (adobe making), ornamental (crafting)</td>
<td>Replacement cost approach</td>
<td>1,590NS/ha (US$490/ha)</td>
</tr>
<tr>
<td>Habitat Functions</td>
<td>Providing habitat (suitable living space) for wild plant and animal species</td>
<td></td>
<td>1,590NS/ha (US$490/ha)</td>
</tr>
<tr>
<td>Refugium function</td>
<td>Maintenance of cochineal stock. Avoids the cost of manual infestation of Opuntia plants. Opuntia scrublands cladodes provide breeding and nursery areas to cochineal insects that later are collected for commercial purposes</td>
<td>State Preference: Contingent valuation method</td>
<td>16NS/ha (per person) (US$5 per person)</td>
</tr>
<tr>
<td>Regulation Functions</td>
<td>Maintenance of essential ecological processes and life support systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil retention</td>
<td>Role of vegetation root matrix and soil biota in soil retention: Land rehabilitation, prevention of damage from erosion, conservation of soil fertility</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Non-economic valuation methods can be pursued in parallel with economic ones. The non-economic methods will provide measures of non-economic values such as cultural or non-monetised ecosystem service values. They can also provide information that would be needed in the design and implementation of economic valuation studies. Table 7.2 offers a different approach to selecting a valuation method. This table allows a user to select an ecosystem services that they wish to value and then decided on the most appropriate method for valuation.

### Economic methods of valuation for ecosystem services

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Amenability to economic valuation</th>
<th>Most appropriate method for valuation</th>
<th>Transferability across sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning services</td>
<td>High</td>
<td>M, P</td>
<td>High</td>
</tr>
</tbody>
</table>
The use of formal appraisal methods and the nature of decision-making processes generally vary among countries. Even when formally documented procedures are in place it is impossible to generalize how and when different methods are most appropriate. In general, methods such as CBA seem to be less controversial and are commonly applied when financial costs and benefits are relatively clear and when social impacts are relatively small. There seems to be a need to include decision-making tools that are more consensual and participation-oriented, in particular when external costs have significant social consequences, when they are captured by traditional knowledge that is not widely available, and/or when the local socio-cultural systems pose a serious limitation to valuation based solely on economic terms. The combination of different decision making tools may be useful.  

Mirroring the research progress made in developing reliable tools and methodologies, valuation studies in many countries play an increasing role in contemporary environmental policies as they provide additional knowledge to support better decision-making. However, the integration of valuation information into decision-making frameworks is still unsatisfactory in many countries.

Conducting primary valuation studies is time-consuming and costly and can pose a strain on available human and financial resources. Capacity to prepare, oversee, and conduct valuation studies and to ensure their quality is often limited. Problems are exacerbated when the rationale for valuation is

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19 See as examples studies IV and IX in SCBD (2007).
poorly conveyed to higher-level administrators. In many cases, high-level decision makers can be left with the impression that new research will not produce added value for the quality of decision-making. More commonly, poorly conducted studies with limited follow-up, can leave officials with an impression that valuation studies only tell them what they already know and resources to dedicate to the studies become harder to justify.

It is therefore important to apply and interpret valuation results in their appropriate context and to be aware of pitfalls. However, this applies to most methods and techniques, whether in economics or in any other field. Many basic criticisms levelled at valuation can be avoided when best practices are followed. For example, a CV study can be integrated with, and extended into, a public participation exercise. The main challenge is, given their high costs and the expertise required, to target valuation studies to cases where they improve decision-making.

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20 Resistance to the use of valuation in OECD countries has been addressed by the production of valuation guides and protocols and standard environmental values for use in BT. These efforts have increased the credibility and acceptability of valuation methods and simplified and reduced the cost of undertaking policy appraisal.
8. Other Tools Used in Integrated Assessments

<table>
<thead>
<tr>
<th>Key points</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Integrated assessment uses a range of tools and techniques to provide information to decision-makers on actual impacts of trade policy.</td>
</tr>
<tr>
<td>• Tools include CGE models, Cross Impact Matrix (CIM), Root Cause Analysis (RCA), Stakeholder Analysis and Mapping (SAM), poverty measure and analysis, and scenario building.</td>
</tr>
</tbody>
</table>

8.1 Selecting a tool

It is advisable to select the simplest tools that will provide the necessary information for assessment. In most cases a combination of quantitative and qualitative analysis, consultations and expert judgement. When selecting a tool, consideration should be given to the following questions:

• Is the data available that the tool requires?
• Can the tool deal with the uncertainties in the dataset?
• Is the tool fit-for-purpose?
• Is the tool acceptable by decision-makers and stakeholders involved in the assessment process?
• Is the tool complementary to other tools already used in the assessment process?
• Is the tool applicable? That is, does the assessment team have experience or access to someone with experience in using the tool selected?
• What are the costs and time required to use the tool?
• Will the tool contribute to the transparency of the process and the outputs of the integrated assessment?

8.2 Tools for integrated assessment

The process for integrated assessment is constantly evolving as existing tools and techniques are refined and new tools are developed. As a result, a large body of literature has been produced, which outlines and compares the relevant tools and methods. A complete set of the different tools is not reproduce here although Table 8.1 outlines selected tools which might be considered by those undertaking an assessment. No specific tools have been developed specifically for the integrated assessment of biodiversity. However, spatial analysis is increasingly being used to assess the impacts of human activities on biodiversity and ecosystem services. Spatial analysis allows for an understanding, for example, where agricultural land exists in relation to threatened species and other key biodiversity values and how this changes over time. Spatial analysis can be a powerful tool for assessing policy objectives. Despite its relevance for biodiversity, however, it costly and labour intensive and requires large amounts of data. Chapter 11 contains a comprehensive list of resources and tools for integrated assessment.
### Table 8.1 Examples of different tools that may be used to assist in carrying out an integrated assessment

<table>
<thead>
<tr>
<th>Tool</th>
<th>Purpose</th>
<th>Main advantages</th>
<th>Main disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUANTITATIVE ANALYTICAL TOOLS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CGE models</td>
<td>General equilibrium refers to a situation where supply meets demand in all markets of an economy simultaneously. A CGE model computes changes in supply and demand in all markets as a result of policy changes before a new equilibrium is reached. The aim is to enable a decision maker to see the overall effects of policy changes on the total economy.</td>
<td>Provides a comprehensive coverage of effects from a policy change.</td>
<td>Is data intensive, time consuming, no consensus on appropriate indicators for many environmental and social variables, and depends on the assumptions made in the model.</td>
</tr>
<tr>
<td>Cost-Benefit Analysis (CBA)</td>
<td>CBA estimates and compares the equivalent monetary value of the total benefits and costs associated with a project. It aims to enable a decision maker to determine whether the project is worthwhile. Including environmental and social costs and benefits require special valuation techniques.</td>
<td>Relatively easy to undertake and little interpretation of the results necessary.</td>
<td>Facing difficulties in the valuation of environmental and social impacts and uncertainties associated with discounting over future generations.</td>
</tr>
<tr>
<td>Cross Impact Matrix (CIM)</td>
<td>CIM creates and assesses different scenarios for the development of a policy, taking into account multiple factors. It aims to reveal the likelihood of an event given that various events have or have not occurred.</td>
<td>Multiple events and trends can be thought and analysed together, allowing for the identification of enhancing and inhibiting developments and policies. It is based on expert consensus.</td>
<td>Relatively demanding in terms of data, time, and human resource requirements.</td>
</tr>
<tr>
<td>Regression Analysis (RA)</td>
<td>RA identifies the relationship between two or more factors (or variables) and how this relationship can be characterized. It aims to enable a decision maker to take necessary actions in order to effect desired changes.</td>
<td>Widely accepted, can be done relatively cheaply with easy to use software like MS Excel or SPSS, and results are instantaneously available. Is used more for ex-post analysis, but it can diagnose past experiences and then inform ex-ante analysis.</td>
<td>Requires knowledge in econometrics and statistical treatment of data. Data have to fulfil certain conditions to allow the application. Quantification of qualitative aspects tends to reduce the multidimensionality of the qualitative phenomenon. Correlation is not causation.</td>
</tr>
<tr>
<td>Causal Chain Analysis (CCA)</td>
<td>CCA identifies significant cause-effect links between a proposal and its economic, social, and environmental outcomes in a qualitative manner. It aims to enable a decision maker to consider the chain of effects that may be triggered by his or her decision. It can be used at the assessment stage.</td>
<td>CCA is flexible with respect to depth and scope of analysis and thus can meet the varying analytical needs.</td>
<td>There is a danger of drawing of cause-effect links that are not well-grounded, and overloading the analysis with potentially negligible factors.</td>
</tr>
<tr>
<td>Multi-criteria analysis (MCA)</td>
<td>MCA evaluates alternative options against several, often conflicting, criteria, and combine the separate evaluations into one overall evaluation. It can be used to identify</td>
<td>MCA takes into account different criteria at the same time, which is impossible with the usual decision making</td>
<td>By presenting quantitative information (aggregated scores), it may create a false impression of accuracy even though application of MCA</td>
</tr>
<tr>
<td>Tool</td>
<td>Purpose</td>
<td>Main advantages</td>
<td>Main disadvantages</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>a single most preferred option, to rank options, to short-list a limited number of options for subsequent detailed appraisal, or simply to distinguish acceptable and unacceptable options.</strong></td>
<td>process based on only one criterion; if accepted by wider community, may be used to bring together the views of different stakeholders; open and explicit – the scores and weights are recorded, providing a basis for external audits. Also open to analysis and change if they are felt inappropriate; and may facilitate communication with decision maker and sometimes with the wider community.</td>
<td>heavily depends on value judgements; disputed MCA may direct public discourse on the proposal towards ineffective discussions on how were weights of criteria established and how was performance of each option against these criteria measured; does not facilitate consensus on very controversial decisions; and results may be manipulated by those who master the techniques.</td>
<td></td>
</tr>
<tr>
<td><strong>Objective-led appraisal (OLA)</strong></td>
<td>OLA evaluates consistency of a proposed policy or project with its proclaimed objectives. OLA is an appraisal method that aims to ensure that relevant objectives (in the case of IAP those would be sustainable development objectives) are considered at all stages of the policy process. It can be used when the objectives of the target for assessment are questioned, when alternatives are compared against established objectives, and when specific actions are evaluated.</td>
<td>OLA enables early reviews and an early opportunity for discussing objectives. OLA also breaks consultations into more easily manageable separate discussions on proposed objectives and implementation arrangements.</td>
<td>Quality may be significantly limited by ill-defined objectives; poorly defined objectives, if directly used as the main reference points for the appraisal, will generate poor or misleading results; and OLA offers only a preliminary analysis, which does not capture all the specific effects of proposed actions.</td>
</tr>
<tr>
<td><strong>Root Cause Analysis (RCA)</strong></td>
<td>RCA is a structured investigation that aims to identify the true causes of a problem, and the options or actions necessary to eliminate it. It is seldom properly done and often considered an academic exercise, as it does not directly lead to solutions. However, knowing the root causes and the actors involved is an essential starting point for designing sustainable solution strategies. It can be used in integrated assessment preparation stage when the target for assessment is described. Specifically, when examining the objectives of a project, programme, or policy, RCA can be used to analyse whether it addresses the root causes or mere symptoms of a problem. RCA can also be used when recommendations need to be justified for their potential to address the root causes.</td>
<td>Simple, and yet provides important insight and can be used simultaneously to raise awareness and involve stakeholders.</td>
<td>May become an academic exercise as the list of possible root causes is potentially very long.</td>
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<tr>
<td><strong>Scenario Building</strong></td>
<td>Scenario building is a process of designing hypothetical situations that incorporate the most uncertain and</td>
<td>Scenarios provide a simplified version of reality against which to</td>
<td>Scenario development requires relatively high levels of technical skill for their</td>
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<td>Tool</td>
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<tr>
<td>Tool</td>
<td>important driving forces affecting future development in a given sector or territory. This tool can be used focusing on developing and describing alternative scenarios.</td>
<td>test ideas and explore consequences. The development of scenarios also provides a way of creating a shared understanding of complex systems among those that work in them. This shared understanding can be of great value as an aid in collaboration.</td>
<td>construction and interpretation. Quality of the analysis resulting from scenario is no better than the model itself and the data on which it is based. Careful testing and validation are necessary to avoid conclusions or actions based on a flawed model. Scenarios may involve complex mathematical operations or graphic images that are hard to understand and explain to non-technical audiences. A well-designed interpretation and presentation must accompany explanation of scenario to non-technical audiences and policymakers.</td>
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<tr>
<td>Stakeholder Analysis and Mapping (SAM)</td>
<td>Stakeholders are individuals, groups or institutions with specific rights and interests in an issue or sector, and related powers, knowledge, and skills. SAM identifies and analyses stakeholders to enable decisions on who to involve in addressing particular issues. It can be used when key stakeholders need to be identified. It is also an essential input to gender analysis and poverty analysis.</td>
<td>SAM is a well-established approach and is frequently used. Various tools and schemes exist for portraying the results of a stakeholder analysis in a visible and simple manner and one can get good preliminary insights with limited time.</td>
<td>Every classification of stakeholder may be criticised, there is no perfect fit; conflicting interests and power relations may be too sensitive to assess or discuss; one can easily spend too much time on SAM; SAM does not provide any solutions and more detailed information requires social or cultural expertise.</td>
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<tr>
<td>Sustainability Framework and Benchmarks (SFB)</td>
<td>Sustainability frameworks present indicators and benchmarks to enable measuring of sustainability performance and assessing impacts of projects and policies against a reference framework. To be practical, general sustainability principles must be translated into concrete indicators and benchmark. Generally, sustainability frameworks can enable decision-makers to identify problems, track trends, set priorities, understand policy trade-offs and synergies, target investments, and evaluate policies and programmes. In the integrated assessment process, SFB can identify existing sustainability frameworks, assist in developing these, and evaluate options and assess subsequent trade-offs against established frameworks.</td>
<td>Sustainability frameworks are one way of putting sustainability into practice and designing a sustainability framework through a participatory process enhances awareness. There are many new initiatives and examples for inspiration, within private and public sector and at different levels of scale.</td>
<td>A sustainability framework is just a decision-support tool, without any obligation. The focus is on quantitative measurements, while some sustainability issues are difficult to measure. Threshold values and bottom-lines are extremely difficult to define and many systems tend to be system-oriented instead of performance-oriented.</td>
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<tr>
<td>Analysis of Strengths, Weaknesses, Opportunities and Threats</td>
<td>SWOT aims to raise key issues for consideration in assessing the current situation. It can be used in the integrated assessment preparation stage when contextual</td>
<td>SWOT reduces a large quantity into simple overview of key issues that could be considered during an integrated</td>
<td>There is a tendency for SWOT to oversimplify issues. SWOT also does not explain why strengths and weaknesses occur and whether there are</td>
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<tr>
<td>(SWOT Analysis)</td>
<td>information is provided.</td>
<td>assessment and is a useful tool for obtaining various viewpoints on the current situation and can be used in participatory processes.</td>
<td>any linkages between them. Classification of external factors as opportunities or threats is somewhat arbitrary - the same point may feature both as strength and as a weakness. For example, ‘increased exports’ may be presented as a strength and ‘reliance on exports’ as a weakness.</td>
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<tr>
<td>Trend Analysis</td>
<td>Trend analysis is a basic requirement for any assessment or planning exercise. It is “an analysis of the variation in data or values over time, with the major purpose of extracting relevant information about changes in time, and where possible expressing this quantitatively”. It can be used in an integrated assessment preparation stage when basic data and contextual information are generated and presented. It can provide data and information to support the application of other tools in an integrated assessment stage, such as forecasting and scenario development. Trend monitoring is a related tool aimed at systematic collection of data on well-defined indicators, to assess progress and raise awareness on undesirable changes.</td>
<td>Trend analysis is a basic tool that can be used in a simple and qualitative manner; trend lines can be a powerful awareness-raising tool; trend analysis can structure a large set of available data and information; and trend analysis can raise awareness on the need for proper monitoring.</td>
<td>Extrapolation and forecasting of trend lines are not always reliable, statistical analyses are tedious, yet necessary in many cases to draw firm conclusions; trend lines are often established based on poor data sets, without mentioning the uncertainties involved; the variable methods used to collect data are a major problem in establishing trends and expert judgements on trends should be backed by quantitative data, because human memory is unreliable.</td>
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<tr>
<td>Expert Panel (EP)</td>
<td>EP is a form of organizing expert opinions. It aims to synthesize complex information and provide a vision or recommendations for future possibilities for the topic(s) under analysis.</td>
<td>Relatively easy to organize (low cost and time requirements).</td>
<td>Result dependent on composition of EP and availability of relevant experts.</td>
</tr>
<tr>
<td>Focus Groups</td>
<td>A focus group is a form of organizing a planned discussion among a small group (4-12 persons) of stakeholders facilitated by a moderator. It aims to obtain information about a range of preferences and values pertaining to a defined topic by observing the structured discussion of an interactive group in a permissive environment. A focus group can be seen as a combination between a focused interview and a discussion group. Focus groups can also be conducted online. They are not designed to provide information to the general public or respond to general questions, nor are they used to build consensus or make</td>
<td>Relatively simple and easy to organize.</td>
<td>The multiple voices of the participants and the flexibility may result in limited control over the focus group process. Sometimes group expression can interfere with individual expression and the results may reflect “groupthink”.</td>
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<tr>
<td>Tool</td>
<td>Purpose</td>
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<tr>
<td>Household Surveys</td>
<td>A survey generates detailed information. The purpose is to enable investigating and describing a topic of interest. It describes phenomena in the original language of those surveyed in rich descriptive detail, establishes personal contact with stakeholder groups and enhances stakeholder participation in the process. It can be used when stakeholders need to be mobilized and basic qualitative data and information needs to be gathered.</td>
<td>Stakeholder participation with detailed analysis of an issue (possibility to establish personal contacts and outreach to wider audience) and the opportunity to gather data in a structured manner on complex and sensitive topics, including opinions and feeling.</td>
<td>Data needs to be compiled and analysed to find entry into the decision-making process; interview-based surveys require a lot of time and depending on circumstances and can be costly; and results of the survey depend on the selection of the sample and the willingness of participants to cooperate.</td>
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**ASSESSMENT APPROACHES**

<p>| Gender Analysis | Gender analysis considers the relationships between men and women, their access to resources, their roles and activities, and the constraints they face. It reveals the different patterns of involvement and activities that women and men have in economic, social and legal structures. The aim is to enable decision makers to understand the different effects that public projects, programmes, policies may have on men and women because of their different situations. It can also be used in the assessment stage to evaluate the gender effects of various options and make recommendations that integrate gender issues. | Gender analysis is practical and can be done in a participatory manner. A distinction is made between access to and control over resources and can be easily adapted to a variety of settings and situations. | Some gender issues may be highly sensitive and there is a risk of oversimplification based on a superficial ‘tick-the-boxes’ approach to data collection. Results may also give a rather static picture without reference to changes over time in gender relations. |
| Health Assessment (HA) | HA may mean a few different things to different people. First, it can mean an assessment of a population’s health status. Second, it can mean an assessment of the health impact caused by polluting activities. Third, it can mean an approach (not a tool per se) to assess the linkages between the environment and health – the focus of the description here. HA aims to enable decision makers to arrive at decisions based on comprehensive knowledge about health issues. | HA is highly participatory and has a strong focus on process. | HA can be costly and take a long time to implement. |
| Poverty Measurement and Analysis | Poverty measurement is the first step for any decision-maker who seriously wants to reduce poverty. Data can then be used by decision-makers to know what the situation is, to understand the factors determining the situation, to design interventions best adapted to the issues, to assess proposed policies against poverty impacts, and to set a baseline and measure change. It can An essential tool to gain insight on basic social and economic conditions; is easy to do in a participatory manner; both quantitative and qualitative methods are available; and there is a large amount of experience and | Data from household surveys form the basis of poverty analysis, but are time consuming to collect and generate unreliable data if not undertaken with great care; and concepts like vulnerability are difficult to measure. |</p>
<table>
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<th>Tool</th>
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<td>be used when contextual information is provided and the assessment stage when the poverty effects of the policy or project in question are analysed and alternatives are developed.</td>
<td>literature available.</td>
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9. Policy Responses

Key Points

- Policy responses at the national level can help countries mitigate negative impacts or capture the positive impacts trade policies may have on biodiversity and ecosystem services.
- Policy response may be classified as either trade or non-trade related. It is recommended that policy response be based on five key approaches: valuation of ecosystem services, ownership over biodiversity and genetic resources, protection of traditional knowledge, ecosystem approach, and the integration of biodiversity into economic sectors.
- Capacity building is an essential component of developing policy responses and contributes to economic growth and poverty reduction.

9.1 Possible policy responses

This chapter outlines policy responses at the national level that could help mitigate any negative impacts on biodiversity from trade policies in the agricultural sector or harness positive opportunities. It distinguishes between trade and non-trade related responses and between economic, legal and institutional, and technological responses. A range of instruments is available to address trade impacts on biodiversity in the agricultural sector. Most of these are market-based instruments, as opposed to command-and-control measures. Several of the market-based instruments are dependent on the valuation of ecosystem services and on the internalisation of environmental externalities, which takes environmental (and social) costs into account when pricing products.

Most legal and institutional responses to trade impacts on biodiversity in the agricultural sector involve the application of international instruments, the establishment of national legal and policy frameworks (such as strategic and environmental impact assessment), issues of governance and enforcement, stakeholder rights and participation, transparency and decentralization. Technological responses include those that apply technologies and techniques as opposed to economic instruments or legal mechanisms for responding to impacts of trade-related policies on biodiversity. While technological responses (such as farming practices) will be implemented mainly at the local level, some might be applied rather at the national level aimed at stakeholders such as farmers and consumers. Technological require supportive economic and legal policy frameworks at the national or international level.

The distinction between economic, legal and institutional, and technological policies is not always clear and a response can fall under more than one heading. In addition, the different response types are often closely linked and should be applied jointly. The success of a technological response, for example, will depend on a favourable economic and legal policy framework.

The policy responses are based on five key approaches: valuation of ecosystem services, ownership over biodiversity and genetic resources, protection of traditional knowledge, the ecosystem approach, and the integration of biodiversity into social and economic sectors. These approaches should be reflected in all policy responses, across the different types.

Valuation of ecosystem services. It has increasingly been recognised that biodiversity provides significant ecosystem services including the provision of food, fresh water and fuel; climate, flood and disease regulation; nutrient cycling; and primary production. To a large extent, these ecosystem services have not been valued and their use has often been regarded as free. Placing an economic value on these services provides an incentive to protect them from degradation and makes them compete with economic goods.\(^{21}\)

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\(^{21}\) See Chapter 7 for further details on valuation methods.
Ownership over biodiversity and genetic resources. Securing biodiversity values requires ownership over natural resources. It is only when communities and local biodiversity managers participate in decision-making affecting the resources they are involved with, that they become stewards of the resources. Equal participation of local communities, indigenous groups and local managers helps secure the success of policies responding to the trade-related impacts on biodiversity. This is particularly true for genetic resources affected by trade-related policies.

Protection of traditional knowledge. Local and/or indigenous communities’ traditional knowledge of natural resources has proven to be very effective in understanding and conserving ecosystem services. Together with ecosystems and genetic resources, traditional knowledge in itself is being eroded. Its protection is essential and relevant to supporting the outcome of policy activities for biodiversity conservation in the agricultural sector. The protection of traditional knowledge provides an opportunity to give local communities a stake in the outcomes.

Ecosystem approach. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems. The CBD has adopted the ecosystem approach, containing 12 principles and operational guidance for the application of the approach (Box 9.1).

<table>
<thead>
<tr>
<th>Box 9.1</th>
<th>12 Principles of the Ecosystem Approach</th>
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<tr>
<td><strong>Principle 1:</strong></td>
<td>The objectives of management of land, water and living resources are a matter of societal choice.</td>
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<td><strong>Principle 2:</strong></td>
<td>Management should be decentralized to the lowest appropriate level.</td>
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<td><strong>Principle 3:</strong></td>
<td>Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.</td>
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<td><strong>Principle 4:</strong></td>
<td>Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:</td>
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<td></td>
<td>a) Reduce those market distortions that adversely affect biological diversity;</td>
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<td></td>
<td>b) Align incentives to promote biodiversity conservation and sustainable use;</td>
</tr>
<tr>
<td></td>
<td>c) Internalise costs and benefits in the given ecosystem to the extent feasible.</td>
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<tr>
<td><strong>Principle 5:</strong></td>
<td>Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.</td>
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<tr>
<td><strong>Principle 6:</strong></td>
<td>Ecosystems must be managed within the limits of their functioning.</td>
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<tr>
<td><strong>Principle 7:</strong></td>
<td>The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.</td>
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<tr>
<td><strong>Principle 8:</strong></td>
<td>Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.</td>
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<tr>
<td><strong>Principle 9:</strong></td>
<td>Management must recognize that change is inevitable.</td>
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<tr>
<td><strong>Principle 10:</strong></td>
<td>The ecosystem approach should seek the appropriate balance between and integration of, conservation and use of biological diversity.</td>
</tr>
<tr>
<td><strong>Principle 11:</strong></td>
<td>The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.</td>
</tr>
<tr>
<td><strong>Principle 12:</strong></td>
<td>The ecosystem approach should involve all relevant sectors of society and scientific disciplines.</td>
</tr>
</tbody>
</table>

Source: CBD decision V/6.
Integration of biodiversity into economic sectors. There is a danger that responses to the impacts of trade-related policies on biodiversity fail to reach beyond the biodiversity sector. The responses should include all sectors that have an impact on biodiversity and through which trade-related policies are affected, in particular economic sectors. Integration of the conservation and sustainable use of biodiversity into relevant sectoral or cross-sectoral plans, programmes and policies is a requirement for Parties to the CBD (Article 6b).

9.2 Trade policy responses

9.2.1 Economic responses

Subsidies, taxes and financial incentives. Subsidies, taxes and financial incentives have a long history in the management of natural resources. Often, they have supported policies detrimental to biodiversity (perverse incentives). Over US $300 billion are paid annually in the OECD countries in the form of subsidies to the agricultural sector. This has resulted not only in overproduction, threatening the agricultural sector in developing countries, but also leads to an overuse of fertilizers and pesticides. But increasingly subsidies and incentives have been recognised as tools for giving value to natural resources and supporting their accession to markets. Damaging subsidies in the agricultural sector (such as those on pesticide use) could be removed, while positive subsidies (such as subsidies on products produced in an environmentally-friendly way) could help offset the negative environmental impacts of expanded agricultural production due to trade liberalization.

Tax policies may include the following:

- environmental taxes to promote pricing that takes account of the social and environmental costs of an action, the externality, as well as the private costs;
- differential tax structures levied according to the level of the problem the tax is addressing; and
- investment tax incentives (such as tax credits) to raise the private benefits of activities conserving biodiversity.

Incentives might include, inter alia, payments for ecosystem services and compensation for environmentally-friendly measures. They include the creation of alternative incomes through financing of projects that enable local communities to conserve biodiversity by finding markets for goods produced from the sustainable use of biological resources (Box 9.2). In particular, incentives might favour the reduction of biodiversity-damaging pesticide and fertilizer applications and the protection of vulnerable and ecologically significant lands from being converted to agricultural fields or pastures.

Box 9.2 BioTrade Initiative

Biotrade refers to those activities of collection, production, transformation, and commercialisation of goods and services derived from native biodiversity under the criteria of environmental, social and economic sustainability. Since its launch in 1996, the UNCTAD BioTrade Initiative has been promoting sustainable biotrade in support of the objectives of the CBD. Its mission is to stimulate trade and investment in biological resources to further sustainable development in line with the objectives of the CBD.

The BioTrade Initiative has established a number of partnerships with national and regional organisations to set up programmes that enhance the capability of developing countries to produce value-added products and services derived from biodiversity, for both domestic and international markets. Regional BioTrade Programmes currently supported by UNCTAD include the Amazon BioTrade Programme and the Andean BioTrade Programme. National BioTrade Programmes have been created in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Peru, Uganda and Venezuela. Since 2003 the BioTrade Initiative has also hosted the BioTrade Facilitation Programme (BTFP), which focuses on enhancing sustainable bio-resources management, product development, value adding processing and marketing.
The BioTrade Initiative and the BTFP have adopted a set of *biotrade principles* regarding products and services:

- Conservation of biodiversity.
- Sustainable use of biodiversity.
- Equitable sharing of benefits derived from the use of biodiversity.
- Socio-economic sustainability (management, production and markets).
- Compliance with national and international legislation and agreements.
- Respect for the rights of actors involved in BioTrade activities.
- Clarity about land tenure, use and access to natural resources and knowledge.

For further information see [www.biotrade.org](http://www.biotrade.org)

**Certification schemes.** Certification of environmentally-friendly produced goods from natural resources has become a major tool for addressing biodiversity loss in agricultural landscapes. This ranges from organic products to those derived from nature-friendly production methods such as low-intensity farming and protection of natural areas within agricultural landscapes.

**Direct payments.** Direct payments to farmers could support the retention or set-aside of land for conservation purposes such as the restoration of vulnerable habitats or the recovery of threatened species. Such payments are an important part of agri-environmental schemes (see Section 9.3 Non-trade policy responses).

### 9.2.2 Legal and institutional responses

**Applying international mechanisms/instruments/agreements.** Various international agreements can help shape policy responses at the national level. This applies to trade agreements, such as the agreements under the WTO, but also to biodiversity-related agreements. The CBD, with its three objectives of biodiversity conservation, sustainable use, and fair sharing of benefits arising from the use of genetic resources, has developed a range of instruments such as work programmes and guidelines. The CBD’s Programme of Work on Agricultural Biodiversity includes the following activity: identification at international and national levels, in close collaboration with relevant international organizations, of appropriate marketing and trade policies, legal and economic measures which may support beneficial agricultural practices.

**Laws, regulations and policies.** Legal systems form a key part of policy responses. They might consist of laws and regulations that are legally-binding, but ‘soft law’ such as guidelines, codes of conduct and policy frameworks play an important role as well and might in many cases be more appropriate than legally-binding instruments. Customary systems, for example indigenous peoples, which are often powerful tools at the local level, should be fully recognized as part of the policy set addressing trade and biodiversity. They might, for example, secure the application of local and traditional knowledge on biodiversity and its responses to pressure from other sectors. At the national level, the development of legal frameworks for access and benefit-sharing related to the use of genetic resources has been encouraged by the CBD. Those regimes could become significant tools for addressing the trade-related impacts on biodiversity in the agricultural sector.

### 9.3 Non-trade policy responses

#### 9.3.1 Economic responses

**Property rights.** Trade liberalization may impose adverse impacts on local people or resources where the individual or collective property rights are weak or not sufficiently recognized. An important strand of offsetting instruments includes those that either recognize such rights in law, and create or strengthen institutions that may help enforce such rights (Box 9.3). In many cases around the world, when the local community is involved in biodiversity protection, it is most successful when appropriate property rights systems are in place. It has been found that property rights are closely linked to local communities gaining the benefits of biodiversity conservation and hence the incentives
to protect the biodiversity (MA 2005). Where weak property rights exist, the community’s involvement in the protection of biodiversity is undermined as they are unable to restrict external access to local resources and there is little incentive to adopt long term strategies to manage these resources leading to short term and opportunistic decision-making (MA 2005).

Box 9.3  Property rights: a policy response for Bangladesh’s shrimp farming industry

Land use rights favouring local people are one of the pre-requisites for sustainable shrimp culture activity. At present, *khas* government lands are leased out to the shrimp cultivators on flexible terms, leading to inefficient use of land. Expanded programmes in land registration and titling are needed to clarify property rights. Adequate compensation for those people who lose lands to shrimp cultivation should be ensured. The government can introduce a minimum cost for per-unit leasing of agricultural land for shrimp farming. Securing property rights will reduce institutional constraints that prevent ‘buy-outs’ or prevent the mixing of shrimp and rice farming activities. Strengthening of security rights may also be attractive for equity reasons.


9.3.2 Legal and institutional responses

*Increased international cooperation.* Establishing systems of international cooperation can be a very useful tool for exchanging information on experiences and good practices. Those systems can be informal and could be facilitated through regional organizations, such as the UNEP Regional Offices. They might also be established in the framework of regional or global agreements, such as the CBD. In any case, if there is a need, countries should invite organizations, mechanisms or agreements to support the setting up of systems of international cooperation.

*Increased coordination between multilateral environmental agreements and other international policy frameworks.* Lack of coordination between multilateral environmental agreements and other policy frameworks, including those on trade and development has been widely recognized as a stumbling block to successful implementation of international obligations. This coordination is needed at the international level, where governing bodies of agreements need to mandate convention bodies such as secretariats and subsidiary bodies to enhance cooperation. However, coordination is also required at the national level. Ministries, agencies and focal points for different instruments should establish systems of regular communication, with a view to inform each other on significant developments in the respective sectors and to agree on positions that are taken forward to the governing bodies of agreements and other mechanisms.

*Governance.* Governance approaches to address the impacts on biodiversity of trade-related policies in the agricultural sector may be a key part of response options. The ecosystem approach recommends the decentralization of management to the lowest appropriate level, leading to greater efficiency, effectiveness and equity. Such management practices, however, needs to be enhanced and protected by national laws and national and sub-national policies. Institutions should be strengthened at all levels, providing for authority and stakeholder involvement at lower levels. A particularly important aspect of governance is the provision of secure tenure rights to indigenous and local stakeholders. This can enable communities to sustainably use the natural resources and thus become responsible players in the field of agricultural biodiversity.

*Agri-environment schemes.* Agri-environment schemes, supporting the conservation and sustainable use of agricultural biodiversity, are able to contribute to internalise positive external effects of agricultural production on biodiversity (Box 9.4). This provides agri-environment schemes with an advantage compared with other types of domestic support measures in the agricultural sector. Those schemes would benefit from a number of features:

- Specifying clear environmental objectives for the programmes
- Clarifying underlying property rights
• Ensuring transparency in designing and implementing agri-environmental programmes
• Ensuring technical efficiency of the instrument in achieving the objective
• Monitoring and evaluation programmes based on valid scientific research
• Probing for less trade-distorting alternatives as an integral part of the process to design and implement agri-environmental measures.

**Box 9.4  Environmental Stewardship in England (United Kingdom)**

Environmental Stewardship is a new agri-environment scheme within the framework of the national implementation of the CAP in the EU. It provides funding to farmers and other land managers in England (United Kingdom) who deliver effective environmental management on their land. Its primary objectives are to:
• Conserve wildlife (biodiversity);
• Maintain and enhance landscape quality and character;
• Protect the historic environment and natural resources;
• Promote public access and understanding of the countryside; and,
• Protect natural resources.
Within the primary objectives it also has the secondary objectives of:
• Genetic conservation; and,
• Flood management.

Environmental Stewardship has three elements: Entry Level Stewardship, Organic Entry Level Stewardship, and Higher Level Stewardship. The *Entry Level Stewardship* is the most important element for biodiversity and has the following features:
• Open to all farmers and landowners;
• Simple and effective land management;
• The aim is to encourage a large number of farmers across a wide area of farmland to deliver simple yet effective environmental management;
• Requires a basic level of environmental management;
• Payment of £30 per hectare, per year across the whole farm (except in extensively grazed upland areas);
and,
• A wide range of over 50 options to choose from (e.g. hedgerow management, stone wall maintenance, low input grassland, buffer strips, and arable options), to cover all farming types.


**Strategic and environmental impact assessment.** Strategic and environmental impact assessments are significant tools for steering developments associated with changes in the agricultural production induced by trade-related policies. An example is the increased transportation network, resulting from the expansion of agriculture into natural areas. Roads connecting new agricultural areas within tropical and subtropical forests have had an extremely detrimental impact on the conservation of tropical and subtropical biodiversity, through encouraging further deforestation as well as illegal exploitation of wildlife, and illegal logging. Strategic and environmental impact assessments could help to address those concerns at the general and case-specific planning stage.

**Transparency and accountability in decision-making.** Transparent and accountable institutions are a precondition for the successful application of legal responses. They are also key for sustainable efforts in enforcement. Transparency includes the involvement of stakeholders, the establishment of communication lines with stakeholders, and the regular provision of information to stakeholders and the wider public.

Stakeholders include farmers, local landowners and government, the private sector, non-governmental organizations and consumers. Indigenous peoples play a particular important role as they often hold land rights. Any policy response should involve those stakeholders and, to the extent possible, give them ownership in the process. The focus might be on enabling vulnerable and weak stakeholders, and prioritising women, who play a vital role in the agricultural sector (particularly in developing countries) (Box 9.5). Key steps to improve participatory processes include increased transparency,
improving the understanding of issues by stakeholders, engaging them in the development of policy objectives and prioritisation of implementation activities, as well as providing space for deliberation and learning about multiple perspectives.

**Box 9.5 Gender and Agriculture**

A fundamental problem in decision-making and policy development in the agriculture sector is the understanding of the role of gender. In developing countries, rural women are the main producers of staple crops like rice, wheat and maize, which provide up to 90% of the food intake of the rural poor. Women make also a far greater contribution to the production of secondary crops such as legumes and vegetables. Rural women also provide most of the post-harvest labour in activities such as taking responsibility for storage, handling, stocking, processing and marketing. In the livestock sector, women feed and milk the larger animals, while raising poultry and small animals such as sheep, goats, rabbits and guinea pigs. Women are also responsible for firewood and water collection, and cooking; hence, women are the major contributors to the nutrition of the household.

Many FAO studies have demonstrated that while women in developing countries are central to the agricultural sectors, they are the last to benefit from or have been negatively affected by the prevailing economic growth and development processes and policies. Farmers are generally perceived as male by policy-makers, development planners and agricultural extension, which contributes to the persisting gender blindness. This results in women finding it more difficult compared to men to gain access to valuable resources that enhance productivity, such as land, credit, agricultural inputs, technology, extension, training and services.


**Addressing unsustainable consumption patterns.** Addressing unsustainable consumption patterns have long been recognized as a precondition for safeguarding the ability of ecosystems to continue the provision of services. Unsustainable consumption patterns are strong driving forces for the extension of intensive agriculture, putting further pressure on ecosystems. Consumption patterns are particularly relevant in urban populations that are disconnected from but nevertheless highly dependent on agricultural production. On a global scale, the challenge of how to address these patterns has not been well understood. At different scales, it would involve not only issues of educating the public and to raise awareness about the power of consumer choice. Solutions involve a range of economic, legal and technological tools as outlined above and in the next section.

**9.3.3 Technological responses**

**Farming practices.** Favourable farming practices and ‘eco-agriculture’ (Box 9.6) include the reduction of biodiversity-damaging pesticide and fertilizer application and the protection of vulnerable and ecologically significant lands from being taken into agricultural production. Those measures cannot be taken by individual farmers, however, as they depend on economic frameworks, in particular on favourable incentives. Those incentives may also allow the retention of traditional biodiversity-friendly farming with low inputs of fertilizers and pesticides. Without supporting measures, traditional farming in many countries is not able to compete with intensive high-technology farming. Payments to farmers to encourage environmentally-friendly practices, as widely applied within the European Union, help to offset negative impacts of agricultural practices on biodiversity.

**Box 9.6 Eco-agriculture**

‘Eco-agriculture’ is a term coined in 2000 to convey a vision of rural communities managing their resources to jointly achieve three broad goals at a landscape scale - what is referred to as the ‘three pillars’ of eco-agriculture:

- Enhancing rural livelihoods;
- Protecting or enhancing biodiversity and ecosystem services; and,
- Developing more sustainable and productive agricultural systems (crops, livestock, forests, fish).

Eco-agriculture is both a conservation strategy and a rural development strategy. It recognizes agricultural producers and communities as key stewards of ecosystems and biodiversity and enables them to play those roles effectively. Eco-agriculture applies an integrated ecosystem approach to agricultural landscapes to address all three pillars, drawing on diverse elements of production and conservation management systems. Meeting the
goals of eco-agriculture usually requires collaboration or coordination between diverse stakeholders who are collectively responsible for managing key components of a landscape.

Source: [www.ecoagriculturepartners.org](http://www.ecoagriculturepartners.org)

Promotion of sustainable intensification of agriculture. With trade liberalization, a trend towards more concentrated, modern and specialized agricultural production methods, depending on highly developed technologies, have been observed. The tendency towards improved production efficiency is not necessarily detrimental to biodiversity (Box 9.7). In order to keep areas of high significance for biodiversity off the pressure of being converted to agricultural land, the intensification of agricultural production on already existing agricultural land could be supportive. Intensification of existing production systems is a more realistic alternative for enhancing food production than undertaking further extensions. In regions where agricultural expansion takes place, the development, assessment, and diffusion of technologies that could increase the production of food per unit area sustainably, without harmful trade-offs related to excessive consumption of water or use of nutrients or pesticides, would significantly lessen pressure on biodiversity. In many cases, appropriate technologies already exist that could be applied more widely (for example precision agriculture), but countries lack the financial resources and institutional capabilities to gain and use these technologies. Again, accompanying economic and legal policies, such as incentives, could minimize the negative environmental impacts of high-intensity farming.

**Box 9.7  Regenerating Native Pine Forest Habitat in Honduras through Improved Crop Technology**

The central region of Honduras covers about 8,900 square kilometres, of which more than 90 percent is rugged hillside. All of it was originally forested, but today about half of the area is covered by native pine forest, with scattered deciduous forest stands. Significant deforestation occurred prior to the mid-1970s, due to over-logging and frontier agricultural settlement. Since then, commercial logging has been sharply controlled. However, conversion of forest to farmland has continued as a result of a 2.3 percent annual rural population growth rate, agricultural demand from the even faster-growing capital city nearby, and widespread erosion and nutrient depletion in steep fields used for low-value staple food crops. Forest habitat and wild populations of deer, agouti, raccoon, various squirrels (which have traditionally provided an important source of animal protein for local diets), and other native fauna and flora have declined sharply.

But a different pattern of land use has emerged in some of the region’s communities as a result of research and extension by the National Coffee Program of Honduras and the local Pan-American Agricultural School of Zamorano. In the 1980s the Zamorano School identified many fruit and vegetable varieties suitable for local steepland conditions, and developed integrated nutrient and pest management strategies and sprinkler irrigation and conservation practices. The Coffee Program encouraged coffee-growing communities to intensify production of basic grains, in order to free up farmland to expand the area for shade coffee, and to replace traditional coffee with higher-yielding varieties. In the late 1980s and early 1990s, communities occupying a third of the area of the central region adopted and modified these new technologies. Higher incomes from vegetables and coffee enabled farmers to purchase fertilizers to replenish soil nutrients both in their commercial fields and in subsistence staple food crops, thus nearly doubling maize yields on permanent fields. The increases in income also allowed farmers to abandon marginal fallowed fields, which reverted to forest. Aerial photograph analysis shows that the net area under forest cover remained stable during this period in the coffee-growing communities and declined only slightly in the horticultural communities. This contrasts with a decline in the forest cover of at least 13 percent, and in some cases as high as 20 percent, in the basic grains communities. Unlike the extensive farming communities, the latter did not report a decline in wild game over the period.

Source: [http://www.ecoagriculturepartners.org/cases/CSIII.htm](http://www.ecoagriculturepartners.org/cases/CSIII.htm)

Establishment of protected areas and ecological networks. In many countries, the pressures from international agricultural trade have resulted in the expansion of agriculture into areas of specific significance for biodiversity, resulting in the clearing of primary forests, the drainage of wetlands, and the conversion of natural steppes and grasslands. An important policy response to such pressure is the establishment of protected areas. A protected area is defined as an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and of natural and associated
cultural resources, managed through legal or other effective means. It is important to establish effective governance and management systems for protected areas in order to ensure they withstand the pressure from surrounding areas. Increasingly, the involvement of indigenous and local communities in the establishment and management of protected areas has been recognized as a precondition for ensuring the sustained ability of those areas to deliver biodiversity and ecosystem services objectives (Box 9.8). Ecological networks could supplement protected areas. Ecological networks represent an ecologically representative and coherent mix of land and/or sea areas that may include protected areas, corridors and buffer zones, and which provides connectivity for species and ecosystems in order to achieve their satisfactory conservation status. Through the integration of areas of agricultural production, ecological networks allow for the sustainable use of natural resources.

**Box 9.8 Livestock and Wildlife Coexisting In A World Heritage Site: The Ngorongoro Conservation Area, Tanzania**

The grazing ecosystems that are favoured by livestock are also often those especially productive for large mammals (and their predators). The Ngorongoro Conservation Area in Tanzania is one of the few protected areas in eastern Africa. It was established explicitly to promote multiple-land use including grazing of domestic stock, which demonstrates that coexistence is not only possible, but productive. Inscribed on the World Heritage List in 1979, this vast area of 828,800 ha is contiguous to the much larger Serengeti National Park and to Maasai Mara National Park in Kenya. One of the great wildlife spectacles in the world is the annual migration of about 1.8 million wildebeest, 300,000 zebra, and 450,000 gazelles (though the actual numbers vary considerably from year to year), along with their predators (lions, hyenas and cheetahs). The Ngorongoro Crater attracted over 200,000 visitors in 2000, including 125,000 foreigners. Some farms adjacent to the site host tourists for bird-watching, while the rest of the site is shared by wildlife and livestock (cattle, sheep and goats) tended by some 40,000 Maasai herders. Pastoralism is an ancient practice in the Ngorongoro region, stretching back at least 2,000 years, though the Maasai have lived in the area for only two centuries.

Maasai settlements dot the region outside the crater, with the herdsmen actively protecting their livestock from predators. The site is specifically designed under the Ngorongoro Conservation Area Ordinance of 1959, revised in 1975, to ensure that appropriate benefits are provided to the Maasai, along with conserving wildlife populations, and promoting tourism. While permanent agriculture is discouraged, grazing is actively supported. The forested parts of the site also need to be protected to ensure permanent water flow to downstream farmers who grow high-value crops such as coffee.

To ensure that the Maasai have a voice in the management of the protected area, or understanding of its management objectives, and a platform for presenting their interests, the conservation area agency set up an extension unit and a community development department. As a result of negotiations, food security has been improved by subsidizing grain sales, veterinary services have been provided, water resources have been further developed or rehabilitated, employment by tourism agencies (including as guides for walking tours) and income from tourism has also benefited the Maasai.

A livestock marketing system, dairy industry and tsetse fly eradication programmes have been established, all of which are highly popular with the Maasai. This has greatly improved the relationship between the protected area management and the local people, who now help to control poaching, though land ownership by the Conservator of Ngorongoro remains an issue for the Maasai. Lessons learned from Ngorongoro Conservation Area on joint management of wildlife, tourists, indigenous people and domestic livestock are already being applied elsewhere in Tanzania, including around Selous Game Reserve and the Ruaha National Park.

Source: [http://www.ecoagriculturepartners.org/cases/CSI.htm#4](http://www.ecoagriculturepartners.org/cases/CSI.htm#4).

**Set-aside of agricultural land.** Setting areas of agricultural land aside and providing compensation payments to farmers has become a common measure for reducing over-production, in particular within the EU Common Agricultural Policy. Set-aside areas are very important for biodiversity, allowing for recovery of species that have been impacted upon negatively by agricultural intensification. The extent to which set-aside perform positive impacts on biodiversity depends, however, on a number of features, including the choice of areas for set-aside, the timeframe, the ease of reversibility of the set-aside, and the extent of additional conservation management measures. In general, set-aside schemes
are more effective for biodiversity conservation as part of agri-environmental schemes than purely as measures to reduce production.

**Diversification of genetic resources for food and agriculture.** Modern agriculture has resulted in a drastic reduction in the diversity of genetic resources for food and agriculture and the reliance on an ever-smaller number of crop varieties. That brings with it a higher risk of genetic vulnerability as the reliance on widely planted mono-crops, susceptible to pests, pathogens or environmental hazards, is in danger of facing widespread crop losses. Encouraging a wider use of genetic varieties of crops is therefore an important response that needs to be supported by incentives and appropriate legal measures (Box 9.9).

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**Box 9.9 Agricultural Gene Sanctuaries Protect Wild Biodiversity in Turkey**

Agriculture was born over 10,000 years ago in the Fertile Crescent, which encompasses modern-day southeastern Anatolia, the Asian part of Turkey. Today, more than 8,700 species of vascular plants are found in Turkey, about 30 percent endemic. In the early 1990s a project funded under the auspices of the Global Environment Facility (GEF) was established to conserve plant genetic resources in their natural habitats, that is, **in situ**. **In situ** conservation maintains interactions between plants and their natural pests, predators, and environmental conditions, and is thus crucial to efforts to provide resistance to new pest and pathogen mutations as they arise. The GEF project in Turkey was the first of its kind in the world to protect multiple wild crop relatives—both woody and non-woody—using an integrated, multi-species, multi-site approach.

A key feature of the project was the establishment of Gene Management Zones (GMZs) based on ecogeographic surveys and inventories of state-owned land. Protected areas with specific management requirements adapted to individual plant species and environmental conditions, GMZs serve as reserves for one or more endangered or economically important plant species, and are large enough to encompass considerable genetic variation within populations. The GMZ concept was first used in California in the 1960s, but is a new concept to most of the rest of the world. Based on findings on genetic diversity, project planners designated 22 GMZs. Kazdag National Park was home to 10 GMZs covering five target species, including wild plum, chestnut, Turkey red pine, Anatolian black pine, and Kazdagi fir. Seven GMZs were designated at Ceylanpinar State Farm, containing five species of wild wheat relatives. The Bolkar Mountains contained five GMZs covering Anatolian black pine, Turkey red pine, two types of Taurus fir, and Taurus cedar.

A vital element of GMZ management is local community participation, which preserves local people’s access to the GMZ and enables them to practice traditional activities important to local livelihoods. Grazing in many cases can continue with some modifications. During some parts of the year, grazing animals actually enhance a GMZ’s desired vegetation pattern by shattering the seed and trampling it into the soil for germination the following year (‘natural seeding’). Similarly, the local practice of harvesting chestnuts was incorporated into the management plan for the GMZs for this target species. Lessons learned in this project are informing the development of a large GEF biodiversity project in Turkey and other projects elsewhere.

Source: [http://www.ecoagriculturepartners.org/cases/CSI.htm#5](http://www.ecoagriculturepartners.org/cases/CSI.htm#5).

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**9.4 Capacity building**

Capacity building, training and communication, education and public awareness should all be considered when developing policy responses, which are also key components for economic growth and poverty reduction.

The development of capacity of actors and stakeholders supports their effective involvement as well as effective decision-making. Activities addressing the trade-related impacts on biodiversity in the agricultural sector will be more successful if those involved have an improved capacity for participation. Capacity building is much more than training and includes:

- human resource development, the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively;
• organizational development, the elaboration of management structures, processes and procedures, not only within organizations but also the management of relationships between the different organizations and sectors (public, private and community); and
• institutional and legal framework development, making legal and regulatory changes to enable organizations, institutions and agencies at all levels and in all sectors to enhance their capacities.

Further information about capacity building and policy responses can be found in UNEP’s 2005 Handbook on Integrated Assessment of Trade-related Measures: The Agriculture Sector.

Training. Training is related to stakeholder participation and capacity development. It can provide actors at all levels with improved understanding of the issue, experience in dealing with challenging situations and willingness to take up the tasks needed. Training can take various forms and can include, *inter alia*, one-off efforts, regular workshops and seminars and interactive electronic courses.

Communication, education and public awareness. Communication, education and public awareness are significant components of capacity development and training, aimed at informing, educating and empowering stakeholders involved in policy responses. Stakeholders learn not only about the background to the issue, but also about implications of their own choices and actions. Education programmes should be built on sound science, which might involve traditional knowledge.

### 9.5 Selecting a policy response

A range of policy choices are available to policy-makers. Policy-makers should take into the following criteria when selecting a policy response (UNEP 2001):

- **Sustainable development priorities**: Policies should address the country’s sustainable development priorities including development interests, environmental protection priorities, capacity and institutional dimensions, and the impact on poverty.
- **Regulatory consistency**: Policies should be practical and consistent with domestic and international legal regimes.
- **Policy coherence and co-ordination**: Policies should be designed to avoid duplication and be consistent with other measures proposed.
- **Level of resources**: Policies should be cost effective and should be prioritised according to urgency and the level of resources available.
- **Existing capacity**: Policy decisions should reflect the existing regulatory, institutional and financial capacities in the affected areas.
10. Glossary of Terms

Abundance: The total number of individuals of a taxon or taxa in an area, population, or community. Relative abundance refers to the total number of individuals of one taxon compared with the total number of individuals of all other taxa in an area, volume, or community.

Active adaptive management: See Adaptive management.

Adaptation: Adjustment in natural or human systems to a new or changing environment. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Adaptive management: A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, management is treated as a deliberate experiment for purposes of learning.

Agro-biodiversity: The diversity of plants, insects, and soil biota found in cultivated systems.

Agro-forestry systems: Mixed systems of crops and trees providing wood, non-wood forest products, food, fuel, fodder, and shelter.

Alien species: Species introduced outside its normal distribution.

Alien invasive species: See Invasive alien species.

Benefits transfer approach: Economic valuation approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context.

Biodiversity (a contraction of biological diversity): The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species, and between ecosystems.

Biodiversity regulation: The regulation of ecosystem processes and services by the different components of biodiversity.

Biodiversity resources: Biodiversity resources include not just the elements of biodiversity, but also, institutions, the experts, collections, and datasets available.

Biodiversity services: See Ecosystem services

Biological diversity: See Biodiversity.

Biome: The largest unit of ecological classification that is convenient to recognize below the entire globe. Terrestrial biomes are typically based on dominant vegetation structure (e.g., forest, grassland). Ecosystems within a biome function in a broadly similar way, although they may have very different species composition. For example, all forests share certain properties regarding nutrient cycling, disturbance, and biomass that are different from the properties of grasslands. Marine biomes are typically based on biogeochemical properties. The WWF biome classification is used in the MA.

Capacity building: A process of strengthening or developing human resources, institutions, organizations, or networks. Also referred to as capacity development or capacity enhancement.

Carbon sequestration: The process of increasing the carbon content of a reservoir other than the atmosphere.

Choice experiments: Examines human behaviour in relation to changes in policy. It is an individualistic method and deems results of collective behaviour to be the result of individual actions.

Community (ecological): An assemblage of species occurring in the same space or time, often linked by biotic interactions such as competition or predation.

Community (human, local): A collection of human beings who have something in common. A local community is a fairly small group of people who share a common place of residence and a set of
institutions based on this fact, but the word ‘community’ is also used to refer to larger collections of people who have something else in common (e.g., national community, donor community).

**Constituents of well-being:** The experiential aspects of well-being, such as health, happiness, and freedom to be and do, and, more broadly, basic liberties.

**Consumer surplus:** The difference between the price consumers are willing to pay (or reservation price) and the actual price. If someone is willing to pay more than the actual price, their benefit in a transaction is how much they saved when they didn't pay that price. For example, a person is willing to pay a tremendous amount for water since he needs it to survive, however since there are competing suppliers of water he is able to purchase it for less than he is willing to pay. The difference between the two prices is the consumer surplus.

**Contingent valuation:** Economic valuation technique based on a survey of how much respondents would be willing to pay for specified benefits.

**Cost-benefit analysis:** A technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits.

**Critically endangered species:** Species that face an extremely high risk of extinction in the wild. See also **Threatened species**.

**Cultivar** (a contraction of cultivated variety): A variety of a plant developed from a natural species and maintained under cultivation.

**Cultivated system:** Areas of landscape or seascape actively managed for the production of food, feed, fibre, or biofuels.

**Cultural landscape:** See **Landscape**.

**Cultural services:** The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.

**Decision-maker:** A person whose decisions, and the actions that follow from them, can influence a condition, process, or issue under consideration.

**Deforestation:** Conversion of forest to non-forest.

**Degradation of an ecosystem service:** For **provisioning services**, decreased production of the service through changes in area over which the services is provided, or decreased production per unit area. For **regulating and supporting services**, a reduction in the benefits obtained from the service, either through a change in the service or through human pressures on the service exceeding its limits. For **cultural services**, a change in the ecosystem features that decreases the cultural benefits provided by the ecosystem.

**Degradation of ecosystems:** A persistent reduction in the capacity to provide ecosystem services.

**Determinants of well-being:** Inputs into the production of well-being, such as food, clothing, potable water, and access to knowledge and information.

**Direct use value** (of ecosystems): The benefits derived from the services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting goods) and non-consumptive uses (e.g., enjoyment of scenic beauty). Agents are often physically present in an ecosystem to receive direct use value. (Compare **Indirect use value**.)

**Discounting process:** This is the process by means of assigning different weights or values to cost expected to be incurred in different future time periods.

**Diversity:** The variety and relative abundance of different entities in a sample.

**Driver:** Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.
**Driver, direct:** A driver that unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. (Compare Driver, indirect.)

**Driver, indirect:** A driver that operates by altering the level or rate of change of one or more direct drivers. (Compare Driver, direct.)

**Ecosystem:** A dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit.

**Ecosystem approach:** A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use. An ecosystem approach is based on the application of appropriate scientific methods focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

**Ecosystem function:** See Ecosystem process.

**Ecosystem process:** An intrinsic ecosystem characteristic whereby an ecosystem maintains its integrity. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

**Ecosystem resilience:** See Resilience.

**Ecosystem resistance:** See Resistance.

**Ecosystem robustness:** See Ecosystem stability.

**Ecosystem services:** The benefits people obtain from ecosystems. These include **provisioning services** such as food and water; **regulating services** such as flood and disease control; **cultural services** such as spiritual, recreational, and cultural benefits; and **supporting services** such as nutrient cycling that maintain the conditions for life on Earth. The concept “ecosystem goods and services” is synonymous with ecosystem services.

**Ecosystem stability** (or ecosystem robustness): A description of the dynamic properties of an ecosystem. An ecosystem is considered stable or robust if it returns to its original state after a perturbation, exhibits low temporal variability, or does not change dramatically in the face of a perturbation.

**Endangered species:** Species that face a very high risk of extinction in the wild. See also Threatened species.

**Endemic** (in ecology): A species or higher taxonomic unit found only within a specific area.

**Equity:** Fairness of rights, distribution, and access. Depending on context, this can refer to resources, services, or power.

**Eutrophication:** The increase in additions of nutrients to freshwater or marine systems, which leads

**Existence value:** The value that individuals place on knowing that a resource exists, even if they never use that resource (also sometimes known as conservation value or passive use value).

**Exotic species:** See Alien species.

**Governance:** The process of regulating human behaviour in accordance with shared objectives. The term includes both governmental and nongovernmental mechanisms.

**Human well-being:** See Well-being.

**Income poverty:** See Poverty.

**Indicator:** Information based on measured data used to represent a particular attribute, characteristic, or property of a system.

**Indigenous knowledge** (or local knowledge): The knowledge that is unique to a given culture or society.
**Indirect use value:** The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. (Compare Direct use value.)

**Integrated pest management:** Any practices that attempt to capitalize on natural processes that reduce pest abundance. Sometimes used to refer to monitoring programs where farmers apply pesticides to improve economic efficiency (reducing application rates and improving profitability).

**Intrinsic value:** The value of someone or something in and for itself, irrespective of its utility for people.

**Invasive alien species:** An alien species whose establishment and spread modifies ecosystems, habitats, or species.

**Land cover:** The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Related to, but not synonymous with, land use.

**Land use:** The human use of a piece of land for a certain purpose (such as irrigated agriculture or recreation). Influenced by, but not synonymous with, land cover.

**Local knowledge:** See Indigenous knowledge.

**Marginal change:** Is often referred to as the limit producing or consuming a good at the edge of its total production/consumption.

**Market-based instruments:** Mechanisms that create a market for ecosystem services in order to improving the efficiency in the way the service is used. The term is used for mechanisms that create new markets, but also for responses such as taxes, subsidies, or regulations that affect existing markets.

**Mitigation:** An anthropogenic intervention to reduce negative or unsustainable uses of ecosystems or to enhance sustainable practices.

**Nutrient cycling:** The processes by which elements are extracted from their mineral, aquatic, or atmospheric sources or recycled from their organic forms, converting them to the ionic form in which biotic uptake occurs and ultimately returning them to the atmosphere, water, or soil.

**Opportunity cost:** The benefits forgone by undertaking one activity instead of another.

**Option value:** The value of preserving the option to use services in the future either by oneself (option value) or by others or heirs (bequest value). Quasi-option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values society is not currently aware of.

**Organic farming:** Crop and livestock production systems that do not make use of synthetic fertilizers, pesticides, or herbicides. May also include restrictions on the use of transgenic crops (genetically modified organisms).

**Policy failure:** A situation in which government policies create inefficiencies in the use of goods and services.

**Policy-maker:** A person with power to influence or determine policies and practices at an international, national, regional, or local level.

**Pollination:** A process in the sexual phase of reproduction in some plants caused by the transportation of pollen. In the context of ecosystem services, pollination generally refers to animal-assisted pollination, such as that done by bees, rather than wind pollination.

**Population, biological:** A group of individuals of the same species, occupying a defined area, and usually isolated to some degree from other similar groups. Populations can be relatively reproductively isolated and adapted to local environments.
Poverty: The pronounced deprivation of well-being. Income poverty refers to a particular formulation expressed solely in terms of per capita or household income.

Precautionary principle: The management concept stating that in cases “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation,” as defined in the Rio Declaration.

Precision agriculture: is an integrated information- and production-based farming system that is designed to increase long term, site-specific and whole farm production efficiency, productivity and profitability while minimizing unintended impacts on wildlife and the environment.

Property rights: The right to specific uses, perhaps including exchange in a market, of ecosystems and their services.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fibre, and fresh water.

Regulating services: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

Resilience: The level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.

Resistance: The capacity of an ecosystem to withstand the impacts of drivers without displacement from its present state.

Responses: Human actions, including policies, strategies, and interventions, to address specific issues, needs, opportunities, or problems. In the context of ecosystem management, responses may be of legal, technical, institutional, economic, and behavioural nature and may operate at various spatial and time scales.

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technology change, prices) and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a “narrative storyline.” Scenarios may include projections but are often based on additional information from other sources.

Security: Access to resources, safety, and the ability to live in a predictable and controllable environment.

Service: See Ecosystem services.

Shadow price: The opportunity cost to society of participating in some form of economic activity. It is applied in circumstances where actual prices cannot be charged, or where prices do not reflect the true scarcity value of a good.

Species: An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term species is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity, that once described and accepted is associated with a unique scientific name.

Species diversity: Biodiversity at the species level, often combining aspects of species richness, their relative abundance, and their dissimilarity.

Species richness: The number of species within a given sample, community, or area.

Strategies: See Responses.

Subsidy: Transfer of resources to an entity, which either reduces the operating costs or increases the revenues of such entity for the purpose of achieving some objective.
**Subsistence:** An activity in which the output is mostly for the use of the individual person doing it, or their family, and which is a significant component of their livelihood.

**Subspecies:** A population that is distinct from, and partially reproductively isolated from, other populations of a species but that has not yet diverged sufficiently that interbreeding is impossible.

**Supporting services:** Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

**Sustainable use** (of an ecosystem): Human use of an ecosystem so that it may yield a continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.

**Sustainability:** A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

**Tenure:** See *Property rights*, although also sometimes used more specifically in reference to the temporal dimensions and security of property rights.

**Threatened species:** Species that face a high (vulnerable species), very high (endangered species), or extremely high (critically endangered species) risk of extinction in the wild.

**Threshold:** A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behavior, especially at group levels, sometimes exhibits threshold effects. Thresholds at which irreversible changes occur are especially of concern to decision-makers. (Compare *Non-linearity*.)

**Total economic value framework:** A widely used framework to disaggregate the components of utilitarian value, including *direct use value, indirect use value, option value, quasi-option value, and existence value*.

**Trade-off:** Management choices that intentionally or otherwise change the type, magnitude, and relative mix of services provided by ecosystems.

**Travel cost methods:** Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination.

**Trend:** A pattern of change over time, over and above short-term fluctuations.

**Uncertainty:** An expression of the degree to which a future condition (e.g., of an ecosystem) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined terminology or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).

**Utility:** In economics, the measure of the degree of satisfaction or happiness of a person.

**Valuation:** The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on). See also *Value*.

**Value:** The contribution of an action or object to user-specified goals, objectives, or conditions. (Compare *Valuation*.)

**Value systems:** Norms and precepts that guide human judgment and action.

**Vulnerability:** Exposure to contingencies and stress, and the difficulty in coping with them. Three major dimensions of vulnerability are involved: exposure to stresses, perturbations, and shocks; the sensitivity of people, places, ecosystems, and species to the stress or perturbation, including their
capacity to anticipate and cope with the stress; and the resilience of the exposed people, places, ecosystems, and species in terms of their capacity to absorb shocks and perturbations while maintaining function.

**Vulnerable species:** Species that face a high risk of extinction in the wild. See also *Threatened species*.

**Watershed** (also catchment basin): The land area that drains into a particular watercourse or body of water. Sometimes used to describe the dividing line of high ground between two catchment basins.

**Well-being:** A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience.
11. References and Resources

Global Resources

Global Environment Outlook (GEO). A participatory and regionally distributed assessment process with a strong capacity building process. A variety of publications are produced for this process and can be downloaded from: www.unep.org/geo

Millennium Ecosystem Assessment (MA) (2005)
- Ecosystems and human well-being: Current state and trends
- Ecosystems and human well-being: Scenarios
- Ecosystems and human well-being: Policy responses
- Ecosystems and human well-being: Summary for decision makers
Available to download from: www.MAweb.org


Agriculture Resources


Tekelenburg, T and Kessler, J,J. (2005), How Biodiversity relates to poverty, conceptual framework design to support policy making, IFSA GLO 2005 Papers Theme 4: Development Strategies, Pathways and Synergies


Wood, D. and J. M. Lenne (in press) ""Received Wisdom’ in agricultural land use policy: 10 years on from Rio." Land Use Policy.


WWF *Agricultural subsidies, water shortages and poverty alleviation*. Available at: www.panda.org/about_wwf/what_we_do/policy/trade_and_investment.

**Assessment Resources**


IAIA (2005) *Biodiversity in Impact Assessment*. Available at: www.iaia.org/Non_Members/SP3.PDF.


Impact Assessment and Project Appraisal Special Issue on biodiversity and impact assessment, Volume 23(1), March 2005.

*Journal of Environmental Assessment Policy and Management (JEAPM)* Special Issue on Strategic Environmental Assessment and Biodiversity, Volume 7(2), June 2005. Available at: http://worldscinet.com/jeapm.


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Trewearke et al. (2005) Principles for the Use of Strategic Environmental Assessment as a Tool for Promoting the Conservation and Sustainable Use of Biodiversity. Journal of Environmental Assessment Policy and Management. 7(2).


Stakeholder Consultation


Tools for Assessment
AIDEnvironment has developed a systematic approach for analysis of root causes, which can be applied to social or environmental problems. See for guidelines and checklists: http://www.seanplatform.org/products/toolbox/full/Steps/Step%206.htm.


Kemp-Benedict (2003) Traveling along the Environmental Kuznets Curve, IPAT. Available at: http://ipat-s.kb-creative.net/Resources/IPAT-S_CaseStudy_EKC.pdf.


UK Environment Agency’s on Sustainability Appraisal and Integrated Appraisal. Available at: www.environment-agency.gov.uk/aboutus/512398/830672/831980/832188/?lang= e.


**The Role of Integrated Assessment in Trade Policy**

Special Issue on Trade Impact Assessment, Impact Assessment and Project Appraisal (December 2006).


Biodiversity Resources

Prioritisation of Biodiversity Conservation

Indicator Resources


Livelihood/Poverty Alleviation Resources
Clayton, A. Millennium Development Goals in the Caribbean: Goal 7, ensure environmental sustainability International Advisory Group.

Trade Policy and Access to Resources


WWF (2002) Changing the Balance of Trade: WWF Briefing on Sustainability Assessment of EU Trade policy. WWF.


Valuation

Anuradha, R.V. (1998) Sharing with the Kanis: a case study from India. Secretariat to the Convention on Biological Diversity, Fourth Meeting of the Conference of the Parties to the CBD, Bratislava, Slovakia.


IUCN (1998) *Economic Values of Protected Areas. Guidelines for Protected Area Managers*. World Commission on Protected Areas (WCPA), Best Practice Protected Area Guidelines Series No. 2.


Reid, W. V.; R. T. Watson; H. A. Mooney (2005) *Ecosystem Services – Must people pay for these services?* Mimeo.


Benefit transfer information web pages:
Web-based valuation databases:

- EVRI - Environmental Valuation Reference Inventory: http://www.evri.ca/
- Valuation Study Database for Environmental Change: http://www.beijer.kva.se/valuebase.htm
- The New Zealand Non-Market Valuation DataBase: http://learn.lincoln.ac.nz/markval/
- RED Data Base: http://www.red-externalities.net/

Websites

Data Resources

- Biodiversity Economics: www.biodiversityeconomics.org
- Biodiversity Hotspots: www.biodiversityhotspots.org/xp/Hotspots
- Ecosystem Valuation: www.ecosystemvaluation.org/default.htm
- Environmental valuation and Cost-Benefit News: http://envirovaluation.org/
- FAOLEX, a searchable database with MEAs and national laws and regulations on food, agriculture, and renewable natural resources: http://faolex.fao.org/faolex/
- Global Ecoregions: www.worldwildlife.org/science/ecoregions.cfm

Valuation Study Database for Environmental Change: www.beijer.kva.se/valuebase.htm
World Database for Protected Areas: www.unep-wcmc.org/wdpa

Organisations

- Assessments of impacts and adaptations to climate change in multiple regions and sectors: www.aiaccproject.org
- Biodiversity Economics and Valuation Network: www.bioecon.ucl.ac.uk
- BioTrade: www.biotrade.org/
- BirdLife International: www.birdlife.org/index.html
  Agriculture task force: www.birdlife.org/action/change/europe/agric_task_force/index.html
- Economy and Environment Program for Southeast Asia: www.idrc.ca/en/ev-73300-201-1-DO_TOPIC.html
  Biological diversity in food and agriculture programme: www.fao.org/biodiversity
  Trade in agriculture, fisheries and forestry programme: www.fao.org/trade
- International Association for Impact Assessment: www.iaia.org
- National Center for Environmental Economics: http://yosemite.epa.gov/EE/epa/eed.nsf/webpages/btworkshop.html
- OECD: www.oecd.org
  Agri-environmental indicators: www.oecd.org/department/0,2688,en_2649_33795_1_1_1_1_1,00.html
- UNEP Economics and Trade Branch (UNEP-ETB): www.unep.ch/etb/
- UNEP World Conservation Monitoring Centre (UNEP-WCMC): www.unep-wcmc.org
- World Agroforestry Centre: www.worldagroforestry.org
- World database on protected Areas: http://sea.unep-wcmc.org/wdbpa/

Convention Secretariats

- Convention on Biological Diversity (CBD): www.biodiv.org
International Plant Protection Convention (IPPC): www.ippc.int/IPP/En/default.jsp
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar): www.ramsar.org/
World Heritage Convention: http://whc.unesco.org/