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AGRICULTURAL BIOLOGICAL DIVERSITY: ASSESSMENT OF ONGOING ACTIVITIES AND INSTRUMENTS

Note by the Executive Secretary

I. INTRODUCTION

1. At its third meeting held in Buenos Aires in 1996, the Conference of Parties (COP), through decision III/11, requested the Secretariat of the Convention on Biological Diversity (CBD) and the Food and Agriculture Organization of the United Nations (FAO), in collaboration with other relevant organizations, to conduct an assessment of ongoing activities and instruments at international and national levels based on case-studies and other contributions from Governments, and international and regional organizations. The assessment would assist the Conference of Parties, upon the advice and recommendations of SBSTTA, in setting priorities for its multi-year programme of work on agricultural biodiversity, while avoiding unnecessary duplication of efforts. At its fourth meeting held in Bratislava in 1998, the Conference of the Parties reiterated these requests through decision IV/6.

2. The present document has been jointly prepared by the Secretariat of the Convention on Biological Diversity and FAO. It provides a synthesis of the assessment of ongoing activities and instruments in agricultural biodiversity at international and national level. The main conclusions derived from the assessment are provided in a note by the Executive Secretary prepared for the fifth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (UNEP/CBD/SBSTTA/5/10) as a basis for the identification of proposed elements for the further development of the programme of work on agricultural biodiversity.

II. METHODOLOGY AND SCOPE OF THE ASSESSMENT

3. The Secretariat and FAO have carried out the assessment of ongoing activities and existing instruments for the conservation and sustainable use of agricultural biodiversity, based on:

* UNEP/CBD/SBSTTA/5/1.

(a) National reports from countries submitted to the Secretariat of the Convention;

(b) National reports on the implementation of agreed strategies and plans of action, such as Agenda 21, the Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (GPA/PGR), and the Global Strategy for the Management of Farm Animal Genetic Resources;

(c) A survey of international organizations, inviting them to provide information on their activities, and to help identify issues that need to be addressed and possible case-studies;

(d) Reports from international organizations on their policies, programmes and activities on agricultural biodiversity to the Commission on Genetic Resources for Food and Agriculture (CGRFA) at its seventh and eight sessions;

(e) Results of workshops such as the Workshop on Sustaining Agricultural Biodiversity and Agro-Ecosystem Functions, held in Rome in December 1998, and the International Workshop on the Conservation and Sustainable Use of Pollinators in Agriculture, with an Emphasis on Bees, held in Sao Paulo, Brazil, in October 1998; and

(f) Research and updating through the Internet and a literature search, including an FAO background paper on agricultural biodiversity prepared for the Netherlands/FAO Conference on the Multifunctional Character of Agriculture and Land, held in Maastricht, the Netherlands, in September 1999.

A draft of the present assessment was reviewed in September 1999 by a liaison group consisting of experts drawn from international organizations covering the main disciplines of relevance. A list of the major information sources for this assessment is provided in annex I below.

4. Agricultural biodiversity is a broad term that includes all components of biological diversity of relevance to food and agriculture. As noted at the Workshop on Sustaining Agricultural Biodiversity and Agro-ecosystem Functions, it encompasses 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 for, and in support of, food production and food security. For the purposes of the assessment, the following dimensions of agricultural biodiversity were identified: 1/

(a) Genetic resources for food and agriculture (species, breeds and varieties, their wild relatives, harvested wild foods), including:

1/ These correspond, approximately, to the three dimensions identified at the Workshop on Sustaining Agricultural Biodiversity and Agro-Ecosystem Functions:

(a) Sustainable production of food and other agricultural products emphasizing both strengthening sustainability in production systems at all levels of intensity and improving the conservation, sustainable use and enhancement of the diversity of all genetic resources for food and agriculture, especially plant and animal genetic resources, in all types of production systems;

(b) Biological or life support to production emphasising conservation, sustainable use and enhancement of the biological resources that support sustainable production systems, particularly soil biota, pollinators and predators;

(c) Ecological and social services provided by agro-ecosystems such as landscape and wildlife protection, soil protection and health (fertility, structure and function), water cycle and water quality, air quality, carbon sequestration, etc.

(i) Plant genetic resources including pasture and rangeland species and forest genetic resources;

(ii) Animal genetic resources, including fishery genetic resources; 2/

(iii) Microbial genetic resources (including rhizobial bacteria, fungi such as yeast, mushrooms, etc.); 3/

These constitute the main units of production in agriculture. Cultivated species, including domesticated species, belong essentially to category of "planned agricultural biodiversity". Managed wild plants and animals may also be included here. 4/ Diversity is important at both species and genetic levels. The latter allows for evolution or deliberate improvement through breeding. 5/ New biotechnologies offer ways to expand the use of genetic resources;

(b) Components of agricultural biodiversity that provide ecological services. These mainly fall under the heading "associated agricultural biodiversity" and include:

(i) "Functional biodiversity" in agricultural production systems themselves, provided by a diverse range of organisms, that contribute inter alia to: 6/

a. Nutrient cycling, including decomposition of organic matter and maintenance of soil fertility (notably soil bacteria and other micro-organisms, earthworms and termites, and the associated microflora; as well as crop and farm animal symbionts);

b. Pest and disease regulation (notably insects and other arthropods as natural enemies of plant herbivores; genetic diversity of crops may also contribute to limit plant disease);

c. Pollination (notably bees and other insects, also some birds, bats and other species);

(ii) Biodiversity that provides ecological services at larger scale. These include services important to agriculture at the landscape or farming system level for: water catchment and infiltration; recycling of water between the soil and the atmosphere; maintaining water quality; watershed protection, regulation of

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2/ Many aspects of fishery genetic resources may be considered also under the work programmes on inland waters and marine and coastal biodiversity. For the purposes of the present note, the focus is on aquaculture and mariculture, including fish production that is an integral part of farming systems.

3/ Probably the most significant contribution of micro-organisms is through the provision of services in nutrient cycling.

4/ Many species and populations that have been considered wild are actually managed by people, albeit less intensively than cultivated or domesticated species, and are often very important for food and livelihood security.

5/ The interaction between the environment, genetic resources and management practices that occurs in situ within agro-ecosystems ensures that a dynamic portfolio of agricultural biodiversity is maintained. At the local level, it results in genetic material (landraces or animal breeds) that is adapted to the local abiotic and biotic environmental variation, and to the socio-economic context of the production system, as well as being adaptable to changing conditions in the future. This is complemented by formal crop and animal breeding programmes, including the use of new biotechnologies, that draw largely upon genetic resources maintained ex situ.

6/ Agro-ecosystems vary in the extent that this biological support to production is replaced by external inputs: in more industrial-type agricultural systems, they have been displaced to varying extents by inorganic fertilizers and chemical pesticides and herbicides.

run-off; soil and water conservation and management; local climate regulation; carbon sequestration; and the maintenance of local wildlife and habitats;

(c) Abiotic factors, which have a determining effect on these aspects of agricultural biodiversity and, in line with decision III/11, were also addressed in the assessment;

(d) Socio-economic and cultural dimensions, which were also considered, as cross-cutting issues, since agricultural biodiversity is largely shaped by human activities and management practices. These include:

(i) Traditional and local knowledge of agricultural biodiversity, cultural factors and participatory processes; and

(ii) Socio-economic environment, including trade and marketing practices, and property rights.

5. The main findings of the assessment have been summarized in the form of a matrix, presented in table 1 below. The columns of the matrix are arranged in line with the dimensions of agricultural biodiversity described in the document UNEP/CBD/SBSTTA/5/10. In each of these areas, the assessment requested information concerning the following types of ongoing activities and instruments, which are covered in the rows of the matrix:

(a) Identification, monitoring and assessment;

(b) Research and best practices;

(c) Strategies, programmes, plans and capacity-building;

(d) Policies and legislation.

6. Further details are provided in the following sections and sub-sections of this document, which are organized in the same way.

Table 1	General	Goods: Genetic Resources for Food and Agriculture (planned agricultural biodiversity)					Services: Ecological and Ecosystem Functions (associated agricultural biodiversity)					Socio-economic Dimensions	
		Plant		Animal		Microbial	Support to Production			Wider Ecosystem/ Landscape	Abiotic Resource Base	Local Knowledge	Trade and Marketing
		Crop	Forest	Farm Animal	Fishery		Soil Biota/Nutrient	Pest & Disease Control	Pollination				
Overall Situation		Strategies and priorities well developed, implementation in progress and need support	Strategies well developed, implementation in progress and need support	Strategic approach being developed, implementation initiated, support required to progress.	Strategies being developed, realization of its importance is steadily increasing.	Few initiatives and very specific focus					Well developed		
Identification, Monitoring and Assessment	Need for indicators Need for complementary programmes of ongoing and planned assessments of components of agricultural biodiversity and agro-ecosystems Need for tools to assist in monitoring & assessment Need for taxonomic expertise	Periodical reports on the State of the World's PGR in place. Good data on ex situ collections, though weak on evaluation. In situ programmes need strengthening. Minor crops less well documented. Indicators of genetic diversity and genetic erosion required.	Global Forest Resources Assessment 2000 underway. Database on forest genetic resources (REFORGEN) Criteria and indicators for forest biological diversity under development	First Report on the State of the World's AnGR planned. Global information system(DAD-IS) operating through country-identified focal points. Most ongoing work aimed at characterization of breeds and their environments.	Biennial reports on the State of the World's Fisheries and Aquaculture Indicators to be developed Focus is on Species-level diversity	No planned, global assessment. Current initiatives limited to few species of relevance to food processing, health and N fixation	Identified as priority issue. Could provide indicators of healthy agro-ecosystems. Need for assessment of status in various production systems	No comprehensive databases. GPPIS ecoport is being developed	Priority areas identified ; e.g. linkages pollinator-pollination processes, non bee species, etc.	Need to apply agro-ecological zoning for assessment. Need to look at inter-actions at all levels, role of landscape features Indicator.	Numerous comprehen-sive databases, information and mapping systems: e.g. GIS, AEZ, etc. Links with agricultural biodiversity components needed	Need to incorporate local indicators and knowledge	Need to understand relationship between biological diversity and trade
Research, Best Practices and Technologies* ***See also Codes of Conduct**	Need for improved understanding of agricultural biodiversity Research on impacts of agricultural systems, practices and technologies on biological diversity Expand R&D away from focus and specialization on major species Need for building capacity in Taxonomy	Research priorities identified in GPA include: understanding diversity and molecular tools; in situ and complementary conservation strategies; conservation and use of tropical underutilized crops	Needs for further understanding of intraspecific variation and variation patterns of tree species targeted for genetic management	Guidelines and decision support tools needed for country use in characterization, sustainable use and conservation; more robust, low cost ex situ technologies required for developing country use; need for development of adapted AnGR for each production environment.	Ongoing programme to develop adaptive management practices and technologies for aquaculture and culture based fisheries	Research on specific soil microorganisms, pathogens and microbes for food technologies	Need for understanding of linkage between soil biota and productivity Need for awareness of importance of soil biota and nutrient cycling	Many case-studies on IPM, through farmer field schools	International workshop in Sao Paulo determined research priorities Need for awareness and capacity building	Need for land management options that meet goals of CBD, FCCC and CCD Capacity building to work at ecosystem levels	Linkages between soil degradation and water quality and biological diversity needed Application of tools for biological diversity monitoring and assessment	Need to incorporate local and indigenous knowledge innovation and practices.	Valuation of agricultural biodiversity essential as well as internalization of environmental costs. Research on impact of globalization
Strategies, Programmes Plans and capacity building	Need for integration of agricultural biodiversity in sectoral strategies and for mainstreaming in agricultural and economic plans and policy making Need to involve all stakeholders and promote awareness and capacity building, especially at local level Need to focus on specific ecosystems	Large increase in national PGR programmes in recent years, and in links with biological diversity planning Global Plan of Action (GPA) agreed by 150 states and progressively being implemented in line with country priorities.	Regional action plans being developed through regional workshops with a view to developing a global framework for action. Networks well developed, efforts in capacity building to be continued	Global Strategy provides for development of country, regional and global networks, and includes a Stakeholder Mechanism. Need for training. Global Strategy needs to be further developed.	Guidelines for the Implementation of the Code of Conduct for Responsible Fisheries International Fishery Associations, International Network for Genetics in Aquaculture		Some programmes ongoing e.g. Tropical Soil Biodiversity and Fertility Programme Ongoing programmes for nitrogen fixation	Few countries have national IPM programmes in place Global IPM facility supporting farmer education in many countries		Many natural resources management programmes could incorporate agricultural biodiversity	Linkages with biological diversity programmes needed	Design, develop and implement with local and indigenous communities	Identify niche markets, use of underutilized species and opportunities for diversification Capacity building needed at policy and decision making levels
Policies and Legislation	Need for creation of an enabling environment through supporting policies and legislation Need for coherent and synergetic agricultural and environmental policies	International Undertaking under revision in harmony with CBD. Many countries have legislation governing variety release and seed certification. Few have legislation on access though work ongoing	Action guided i.e. by non-legally binding "Forest Principles"	Intergovernmental mechanism for AnGR being developed by the Commission on Genetic Resources for Food and Agriculture.	Code of conduct for responsible fisheries being implemented		World Soil Charter does not address soil biota/health	IPPC Rotterdam Convention Some changes in national policies concerning pesticide use		Need for complemen-tary agricultural and environmental legislation and policies		Need to address ownership, land rights and access issues, and incorporate traditional practices into policy & legislation	Need for agricultural biodiversity friendly trade and marketing policies and legislation e.g. as with organic agriculture

7. This assessment should be considered in the context of the other ongoing programmes under the Convention. To avoid duplication with the programmes on marine and coastal biological diversity and on biological diversity of inland water ecosystems, consideration of aquatic agricultural biodiversity in this assessment is focused primarily on aquaculture systems. Genetic resources of trees and shrubs form an integral part of agricultural biodiversity in a broad sense. 7/ Thus, while forest biological diversity and forest genetic resources are discussed in more detail in the note by the Executive Secretary prepared for the fifth meeting of SBSTTA (UNEP/CBD/SBSTTA/5/8), some aspects of the management of these resources, including their conservation, enhancement and sustainable utilization, are highlighted also in the present paper.

8. The assessment is not intended to be a final and comprehensive summary of all global activities, but rather the initial step in a continuously evolving process to identify gaps in activities and instruments; and assess future needs and directions for research and action relevant to the conservation and sustainable use of agricultural biodiversity at national and international levels. It does not elaborate on the main causes of loss of agricultural biodiversity.

III. FINDINGS OF THE ASSESSMENT

A. Identification, monitoring and assessment

9. The threats to, and severity of loss of, agricultural biodiversity have been recognized world-wide. This section of the assessment addresses the tools and methods available, and those needed, to assess the status and trends of agricultural biodiversity.

10. The Conference of the Parties to the Convention on Biological Diversity identified specific areas requiring attention with regards to identification, monitoring and assessment in decision III/11 (paragraphs 9, 15 (a) and 15 (m)), and in decision IV/6, (paragraph 6), requesting inputs by Parties, Governments and international organizations.

1. Genetic resources for food and agriculture

Crop genetic resources, wild relatives, and harvested wild food plants

11. Comprehensive general information on the genetic resources of crops and their wild relatives stored in ex situ collections is available. The FAO World Information and Early Warning System (WIEWS) provides summary information on these collections and the related institutions, while the CGIAR System-wide Information Network on Genetic Resources (SINGER) provides more detailed information, at accession level, of collections held by the international agricultural research centres (IARCs). Some national programmes have well developed information systems, notably the Genetic Resources

7/ Trees grown in farmers' fields or on-farm, in shelterbelts, for shade, shelter and land-stabilization, and for the provision of a range of wood and non-wood products, help maintain and enhance variation of the natural gene pools of which they form part and on which, conversely, they are dependent for further development in response to changing needs and requirements. In addition to directly contributing to food security through the provision of edible fruits, seeds, leaves and roots for human consumption and fodder and browse for domestic animals, the contribution of trees in natural forest stands and in forest plantations and farm woodlots contribute to food security through the provision of jobs, income and revenue, and through the protection and stabilization of soil and water.

Information Network (GRIN) of the United States. In Europe, many central crop databases have been developed under the auspices of the European Cooperative Programme for Genetic Resources (ECP/GR), through collaborative efforts between individual institutions. Development of such information systems in other regions is seen as a priority need, as is capacity-building at national level.

12. Information on under-utilized crops and some locally or regionally important staples (so called "orphan crops" such as yams, bambara groundnut and even cassava), as well as wild species of interest for food and agriculture, is scarce compared with major crops. A number of countries in several regions have underlined this point in their national reports. A number of agencies are cooperating to improve information about the genetic resources of wild plants of interest to food and agriculture. A recent ad hoc inter-agency consultation on wild plants, co-sponsored by DIVERSITAS, FAO, the Secretariat of the Convention on Biological Diversity, the International Plant Genetic Resources Institute (IPGRI) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), and held in Rome in May 1999, highlighted the need for inter-agency action on the conservation and use of wild and medicinal plants, with particular reference to sustainable production, benefit-sharing and community participation. Local and national assessment of the contribution of wild plants to household nutrition, food security, health and income generation was also proposed. The inter-agency consultation recommended that the guidelines for national reports should include monitoring of useful wild plants.

13. Even where information systems are well advanced, there is often a lack of information on the status of ex situ collections. Much less information is available on in situ resources, and on the extent to which they are under threat. Despite the recognition in the Global Plan of Action for Plant Genetic Resources for Food and Agriculture (GPA/PGR) of the importance of in situ conservation for the continued evolution and adaptation of the germplasm to the environment and farmer’s needs, there is still a focus on ex situ conservation for major crops in many countries. Surveying and inventorying plant genetic resources for food and agriculture is a priority area of the GPA/PGR.

14. The first comprehensive global assessment of the state of the world’s plant genetic resources for food and agriculture was prepared on the basis of country reports and expert information through the preparatory process for the FAO International Technical Conference on Plant Genetic Resources held in Leipzig, Germany, in 1996. It covers the state of the resources per se, the state of capacity to conserve and use them, and the state of the art for relevant methodologies, technologies and economic and legal measures. It will be updated periodically and provide the basis for the regular assessment of the state of plant genetic resource by CGRFA and its Intergovernmental Technical Working Group on Plant Genetic Resources, which also monitor implementation of the GPA/PGR. Gaps or areas where further assessment is required, as identified by the Commission, include: access and benefit-sharing, the impact of national regional and global policies on plant genetic resources conservation and use, methodologies for on-farm conservation, the use of new approaches to plant breeding and the new biotechnologies, as well as more detailed crop-specific studies, including coverage of forage and rangeland species.

15. There is a need to develop indicators of genetic diversity, genetic vulnerability and genetic erosion, as well as systems for monitoring changes and to provide early warning of likely genetic resource loss. FAO and IPGRI are jointly developing methodologies to address these gaps.

Forest genetic resources

16. A wide range of organizations are working on forest genetic resources. Information on forest genetic resources is stored and regularly updated through the FAO world-wide Information System on Forest Genetic Resources (REFORGEN). SINGER provides detailed, complementary information on those tree species that are used widely in agroforestry systems; these species are the special focus of research by the International Centre for Research on Agroforestry (ICRAF). The World Conservation Monitoring Centre (WCMC) manages information on the extent, location and status of protection of many forest types. Ongoing work by CIFOR and FAO includes the development of criteria and indicators for sustainable forest management, and examination of the factors contributing to risk of forest loss or degradation from agricultural expansion and other pressures.

17. The biennial State of the World's Forests report published by FAO, includes a review of a range of issues of relevance to forest biological diversity. The FAO global forest resources assessment programme maintains a continually updated data base on forest areas and quantitative and qualitative changes in forests and forest cover. Availability of such data is essential to underpin sound programmes on the wise management of forest genetic resources, including their sustainable utilization. An updated global assessment of the world's forests, "FRA 2000", to be published next year, will include special studies on issues such as protected areas, changes in forest biomass, and sustainable management of forest resources for the provision of wood and non-wood forest products and environmental services.

Animal genetic resources

18. A wide range of countries in several regions have identified gaps in baseline data on animal genetic resources, in particular on wild/endemic and indigenous animal species. A global, country-driven assessment of the state of the world's farm animal genetic resources is planned under the guidance of the CGRFA and its Intergovernmental Technical Working Group on Animal Genetic Resources, and resources are being sought to enable it to be carried out. This would provide the basis for setting priorities for the Global Strategy for the Management of Farm Animal Genetic Resources and mobilize international-level commitment.

19. The FAO Domestic Animal Diversity Information System (DAD-IS) constitutes a global scientific and technical database, a network and communication tools for the coordination of work on animal genetic resources; and to assist countries in monitoring and assessing the conservation and sustainable use of indigenous and exotic breeds and races, and their production environments. DAD-IS will be used in the elaboration of the State of the World's Farm Animal Genetic Resources report, and includes the development of an early warning system through global surveys of important animal species. Inventories are also planned on the conservation and sustainable use of domestic animal diversity, and the third edition of the World Watch List for Domestic Animal Diversity is now in preparation. Together, these form some elements of a global early warning system for animal

genetic resources. Efforts to complete such a system should be encouraged within the framework of the Global Strategy, and the system implemented for country use, in order to better respond to emergency situations that occur with the decimation of indigenous animal genetic resources.

20. Organizations collaborating with FAO on animal genetic resources include the International Livestock Research Institute (ILRI), which provides information on the distribution and characteristics of indigenous animal genetic resources and genetic relationships; and UNEP, which assists in the dissemination and use of information on endangered animal genetic diversity including the joint FAO/UNEP publication of the World Watch List for Domestic Animal Diversity. Regional contributions include a survey of the status of animal breeds in Europe, conducted by the European Association for Animal Production (EEAP); the resulting computerized databank will be incorporated into DAD-IS and regularly updated.

21. For the sustainable management of animal genetic resources in any particular production system, it is necessary to understand how the animals will respond to the primary stressors in the system, i.e., the impact on biological resources of localized factors such as extremes of temperature, drought, disease organisms, and feed and water quantity and quality. Genetic resources adapted to local ecosystems are very important in terms of sustainability and the ability of the production system to provide farmers and communities with low-cost food and agricultural products. Animal production systems have collapsed in the past, at great expense, due to the use of inappropriate and non system-specific genetic resources, for example through a lack of resistance to local diseases, intolerance to drought conditions or the inability to digest available feed. As identified by the CGRFA Intergovernmental Technical Working Group on Animal Genetic Resources, a globally accepted set of indicators is required for the characterization of genetic resources for their environmental adaptation in particular production systems, providing critical assessment information for sustainable development and to assist parties to determine their potential contributions to other food and agriculture production systems. FAO is thus developing a set of criteria and indicators for animal genetic resources building on the results of an international workshop held in Armidale, Australia, in January 1998, together with staged field-testing based on results from a broad spectrum of agro-ecosystems.

Aquatic genetic resources

22. Summary information on genetic resources in aquaculture can be found in the FAO State of World's Fisheries and Aquaculture report, which focuses primarily on the species level. Specialized publications are being produced on intra-specific genetic diversity and its use in genetic improvement programmes. A searchable database on introductions of aquatic species (DIAS), with basic information on exotic species has also been developed by FAO and is available on the Internet. FISHBASE, covering 80 per cent of the 25,000 known fish species is released annually by the International Center for Living Aquatic Resources (ICLARM) in cooperation with FAO, and contains intra-specific designations for two key aquaculture species, carp and tilapia. Other ongoing efforts include the development of information systems and databases on fisheries and aquaculture at the global level through the Fishery Global Information System and through regional priorities in the Mediterranean, southern Africa (the ALCOM programme), and Asia (Information Systems for the Responsible Movement of Live Aquatic Animals in Asia).

23. With increasing number of genetically improved species, and growing interest in genetic engineering, efforts are under way to analyse new farmed or fished species and their genetic characteristics, to document new techniques, and elaborate legislation required for sustainable use and equitable benefit-sharing. The need for assessments of risks and benefits is underlined by countries in many regions. An improved Aquatic Animal Diversity Information System (AADIS) is being developed through a partnership of FAO, ICLARM and the CGIAR's System-wide Genetic Resources Programme (SGRP). In the Mekong river basin, an assessment of indigenous species is ongoing to determine both their potential in aquaculture and the likely risks to them through the farming of exotic species in the region. Further to the Ad Hoc Expert Meeting on Indicators and Criteria of Sustainable Shrimp Culture, held in Rome in April 1998, a meeting is planned on indicators of sustainable aquaculture development, to be held from 28 February to 2 March 2000, at the FAO regional office in Bangkok.

Microbial genetic resources

24. To date, there has been no global assessment of the status and trends of microbial genetic resources important to food and agriculture. Micro-organism taxonomy and ecology is a vast area of study for which comprehensive data and information is limited. Specific micro-organisms may also be important as indicator species. Many countries in different regions have identified large gaps in baseline data on microbial genetic resources such as viruses, micorrhizae, fungi, and soil bacteria.

25. Assessment of micro-organisms is generally limited to very few species of direct relevance to food additives, fixation of nitrogen and other nutrients, and plant and animal health. Some ongoing assessment activities include:

(a) Evaluation of food enzymes expressed by micro-organisms and used in food processing, by the Joint FAO/WHO Expert Committee on Food Additives (JECFA);

(b) Collecting, evaluating, maintaining, and disseminating biofertiliser germplasm as support for research on biological nitrogen fixation aiming at reducing fertilizer inputs and improving soil fertility, for example nitrogen fixation for rice are working and by the International Rice Research Institute (IRRI) and other institutes;

(c) Characterization of rumen micro-organisms for improved ability to utilize fibrous feeds and detoxify anti-nutritional factors and identification of specific strains or genotypes of rumen bacteria, fungi or protozoa for further use in tropical ruminants by ILRI.

26. Existing data and information is largely derived from collections held by interested organizations, and to a great extent, related to biotechnology and other areas with commercial potential (nitrogen fixation, fermentation and some aquaculture). These include: a large collection of fungi and plant bacteria held by CABI, and the culture collections of the MIRCEN network of research centres in environmental, applied microbiological and biotechnological research. The MIRCEN centres participate in a global collaborative network effort to harness the beneficial applications of the microbial world for human progress. The network includes centres on aquaculture, biotechnology, bioinformatics, culture collections and patents, mycology, rhizobium, and fermentation.

27. The CGIAR is developing a system-wide microbial genetic resources database. Some specific collections of Rhizobium spp, Bradyrhizobium spp. and micorrhizae accessions are held by various CGIAR centres, notably the International Center for Tropical Agriculture (CIAT) and ICARDA, for which passport and evaluation information is available. There is also information available on plant pathogens, such as the IRRI databases, which contain information on rice plant-rice blast disease interactions.

28. An aim of the DIVERSITAS special target area of research on microbial biodiversity is to build a microbial inventory, including sequences of the genome of a species from each of the major kingdoms of microbial life. In assessing microbial genetic resources there is a need to identify and document the range of beneficial functions of micro-organisms in food and agriculture, and to prioritize those of interest. These will include those which provide ecological functions as well as those with direct commercial applications.

2. Ecological and ecosystem functions

Support to agricultural production systems

29. Despite the increasing scientific knowledge and understanding of the importance of sustainable functioning ecosystems and of the ecological functions of biodiversity, there are no reported examples of comprehensive information systems on these matters. Some relevant databases and information systems exist which could be used and developed for exchanging information on functions of agricultural biodiversity, such as the ECOPORT which is being developed from the FAO Global Plant Protection Information System (GPPIS), and contains information on crops, insects, fungi, bacteria, weeds and viruses, including assessment of species for biological control. Practitioners and researchers could use such a tool to collect and exchange information on beneficial organisms such as pollinators, predators and soil biota. A number of countries have identified the need for tools to assess ecosystem functions. The International Centre of Insect Physiology and Ecology (ICIPE) is documenting the associated biodiversity of crop genetic resources.

30. It is generally recognized that good land and water management practices and healthy and functioning soil biota go hand in hand. Earthworm populations, for example, are indicators of good land and water management, as they are inhibited by excessively dry, very acidic, poorly drained or compacted soils. However, there is little ongoing research, expertise or knowledge of the precise relationships between certain management practices and technologies and the conservation and functioning of different soil biota. Some countries in western Europe have highlighted the need for research on invertebrates and other lower groups.

31. The International Workshop on Pollinators in Agriculture identified the need for indicators for the monitoring and evaluation of pollinators and pollination processes for different agro-ecosystems, to determine, inter alia:

(a) The magnitude and causes of the decline of pollinator species and effect on pollination, reproductive processes and populations of different wild and domesticated pollinator species;

(b) The effects of well managed and improved agro-ecosystems; and

(c) The priority pollinator species, crops and agricultural systems requiring urgent attention.

Wider ecosystem and landscape levels

32. There is, as yet, no standard global system for addressing agricultural-ecosystems or agricultural production environments and there is limited specific coverage of agricultural biodiversity per se in existing data and information systems. However, there are many different tools, systems and methodologies for classifying agriculture in terms of the main enterprises and farming systems, intensity of use, use of external inputs and management practices. The FAO agro-ecological zones (AEZ) framework provides a widely accepted land-resources planning and management tool that is used for assessing and mapping the status and trends in land and water resources and agricultural production systems, including productivity, capability, land use pressures, land degradation, and comparison of land use options. Support is provided for its application at country level. The global land-information system of the United States Geological Survey is another example of a global - scale tool with potential agricultural biodiversity applications. Improving access to existing data could have important short- and long-term benefits. Well designed metadata information systems can help identify gaps in coverage and facilitate data-sharing and exchange. The terrestrial ecosystem monitoring sites (TEMS) meta-database, which is operated by GTOS, is one example.

33.. With increasing use and applications by many organizations and institutions of geographical information systems (GIS) and global positioning systems (GPS), there is an increased capacity and trend to construct scalable databases with comprehensive biophysical and socio-economic parameters. These allow planners to analyse specific factors at a range of scales and for different end-users, and will be valuable for agricultural biodiversity assessments; which require attention to interlinkages between and among genetic resources and abiotic components and processes, as well as human management practices at different scales (i.e., field or pond, community, watershed, farming system, agro-ecosystem and eco-region). To date the work on monitoring of environmental conditions for purposes through remote-sensing and GIS applications, such as land cover and food security, does not substantively address agricultural biodiversity. A need has been identified for general assessment of vegetation types to assist in zoning and decision-making. This would help, for instance, to identify and prioritize threatened species and ecosystems in areas of high diversity. There are examples of ongoing efforts at country level to inventorize and assess resources at landscape, species and genetic levels, for example in Mongolia and Canada.

34. Many organizations are working to develop indicators for sustainable development and for biological diversity. However, few of them address agricultural biodiversity, and there is a need to identify a core set of indicators for this area. Ideally key indicators facilitate monitoring at various spatial scales. They would contribute to efforts to identify cost effective biodiversity-friendly practices to avoid costs of, for example, pest outbreaks, soil erosion, additional fertilizers and pesticides, and pollution. A useful contribution is the initiative under the OECD Joint Working Party on Agriculture and the Environment, which is developing a set of 13 agri-environmental indicator areas. Ten of these areas — soil quality, water quality, water use, land conservation, biodiversity, wildlife habitats, landscape, farm management, farm financial resources, and rural socio-cultural issues — are covered in the recently published book Environmental Indicators for Agriculture,- volume 2: Issues and Design - The York Workshop, the result

of the OECD workshop held at York in the United Kingdom. This book is part of a series of publications entitled "Environmental Indicators for Agriculture".

The abiotic resource base

35. A wide range of data and information systems are available for the abiotic resources which provide the basis for agriculture, including global, regional and national classification systems and maps at different scales. These include more qualitative parameters that have a direct influence on agricultural biodiversity, such as soil productivity (e.g., the fertility capability classification system (FCCS)), vulnerability to soil erosion, and land degradation (e.g., the Global Assessment of the Status of Human Induced Soil Degradation (GLASOD)). Many are being developed and applied through partnership arrangements such as the joint FAO/UNEP/ISRIC (International Soil Reference and Information Center) soil and terrain (SOTER) database, and the world network of scientists contributing to the World Overview of Conservation Approaches and Technologies (WOCAT) inventory of soil conservation and rehabilitation techniques. Diagnostic kits and tools are also being developed and made available at farmer level, to assist in resource-management decision-making. Increasingly integrated and multidisciplinary tools are being developed, however in some cases, differences in the basis of compilation may hinder linkages between thematic databases and information systems. The use of geographic information systems (GIS) can help to overcome this problem.

36. Many countries and organizations are interested in the research and development of sustainable land management options that contribute to all three environmental conventions, addressing climate change (UNFCCC), desertification (CCD), and biodiversity (CBD). This will require integrated approaches looking at the physical and biological diversity resources, land management practices and systems, as well as the ecological functions provided over a range of spatial and temporal scales.

3. Socio-economic considerations

Local and indigenous knowledge and cultural practices

37. With the enhanced focus on participatory processes during the last decade , there are examples world-wide of ongoing documentation, diffusion and promotion of local information on local and indigenous management practices. Nonetheless, traditional and local knowledge remains an under-utilized and inadequately valued resource with considerable potential. Work on data collection, information dissemination, monitoring and assessment of agricultural biodiversity (including the performance and impacts of policies, programmes and actions), will benefit from mechanisms and processes that allow continuous contribution and feedback on local and indigenous knowledge, innovations, practices and systems from the full range of stakeholders (men and women farmers, non-governmental organizations, extension agents, local council officials, technical officers, policy and decision makers). Where possible, information should be made available in formats and languages that make them accessible to local farmers and communities.

4. Trade, marketing and incentives

38. There is some useful work under way on trade and agriculture that could contribute to an understanding of the relationship between trade and agricultural biodiversity. However this information is dispersed and there is

a need for efforts to identify ways and means to promote a positive relationship between trade and agricultural biodiversity. UNEP is gathering data on the environmental consequences of international economic policies, including the removal of price-distorting subsidies in agricultural, fisheries and forestry sectors. UNEP has also recently published a working paper with the International Institute for Sustainable Development (IISD) entitled "A framework for assessing the relationship between trade liberalization and biodiversity conservation". The two case-studies within highlight the effects on intensification of monoculture on biodiversity.

39. In assessing the feasibility of certain land management options and enterprises, international statistical services such as FAOSTAT and those provided by regional trading arrangements such as MERCOSUR and NAFTA may provide valuable information on market trends including pricing and subsidies. Information on markets, the socio-economic contribution of alternative production systems and practices, as well as cost-benefits of different scenarios for maintaining agricultural biodiversity, may facilitate the decision making process for promoting biodiversity friendly and sustainable agricultural systems and practices. Examples of such information and assessments by FAO and CGIAR include the market analysis and appraisal of the socio-economic contribution of certain products, such as non-wood forest products; the economic valuation of the conservation of different components of agricultural biodiversity, such as plant genetic resources or soil biota, and of certain techniques and management practices, such as the traditional management of small scale fishing techniques, natural resources management in dry areas and techniques for soil fertility enhancement or the restoration of genetic resources. Consumer demand has been shown to be an important factor in promoting environmentally friendly agricultural practices, such as organic agriculture.

5. Concluding remarks on needs for identification, monitoring and assessment

40. Comprehensive data and information systems exist for the main genetic resources components (farm animal, crop plants, aquaculture, and tree species, as well as some specific microbial species used directly in agriculture and agro-industries) and for the different abiotic resources that provide the basis for agriculture (water, land and use, climatic). These are being further developed through a range of global assessments.

41. There are, however, gaps in these assessments and information systems, as outlined above, in particular for many plant and animal genetic resources which are important to livelihood security at local levels. Moreover, species that provide essential services to agriculture such as pollinators, predators and soil biota, and a vast array of microbial species that contribute indirectly to food and agriculture, are inadequately assessed. Ecological functions of agricultural systems that contribute environmental benefits, such as wildlife habitats, watershed protection, landscape value, water quality and human-health need to be also incorporated in monitoring and assessment processes. Once identified and valued, these can provide the basis for agri-environmental policies that encourage productivity and sustainability.

42. Very little is being done to systematically bring together the data, information and associated tools required to address agricultural policy and management issues at the national, regional and global levels. There is an urgent need to promote the further development and application of indicators

and assessment methodologies for the assessment, monitoring and improved understanding of the status and trends of agricultural biodiversity and for the identification of biodiversity friendly agricultural practices. There is also a need to coordinated ongoing and planned assessments of different components, in order to provide a comprehensive analysis of the global status and trends of the world's agricultural biodiversity.

B. Research, best practices and technologies

1. Genetic resources for food and agriculture

Crop genetic resources, wild relatives, and harvested wild food plants

43. The following priorities for research on PGRFA conservation and use were identified in the Global Plan of Action, for the conservation and sustainable use of PGRFA (GPA/PGR) and now guide the research priorities and ongoing work of IPGRI and other organizations:

(a) Assessment tools: methodologies for surveying and assessment of diversity; use of modern technologies in characterization and evaluation, including use of quantitative trait loci (QTLs); and role of remote-sensing;

(b) Understanding diversity: underlying causes and dynamics of genetic erosion; and ethnobotanical and socio-economic research to understand farmer management of genetic resources; population and conservation biology to understand the structure and dynamics of diversity in farmers' varieties; identification of the extent of wild crop relatives in protected areas; and determination of the effects of disasters on in situ diversity;

(c) In situ conservation practices and incentives: crop-improvement methods that maintain diversity and priorities and methodologies for broadening the genetic base of crops; plant breeding methods and farming practices that maintain diversity on farm; post harvest processing and marketing of under-utilized crops. Some reported research on plant genetic resources includes indigenous species in Asia, Pacific and the Near East and Western, Eastern and Central Europe regions;

(d) Ex situ conservation: improved and low-cost ex situ methodologies, particularly for non-orthodox seeded crops and under-utilized species; identification of duplication in ex situ collections; technologies for regeneration and ex situ collections.

44. Many new initiatives have been launched recently concerning the on-farm management and improvement of plant genetic resources for food and agriculture. For example, Zambia has surveyed farmers with a view to integrating on-farm conservation into the national conservation strategy. Burkina Faso, Hungary, Morocco, Mali, Mexico, Turkey, Zimbabwe and others are developing on-farm conservation programmes, with the support of FAO, IFAD (the International Fund for Agricultural Development) or IPGRI. The CGIAR now supports many participatory plant breeding activities, through its system-wide programme for participatory research and gender analysis. In south-east Asia, non-governmental organizations such as the South East Asia Regional Institute for Community Education (SEARICE), are using "farmer field schools", pioneered by FAO to promote integrated pest management, to strengthen community plant genetic resources management. Non-governmental organizations generally play a key role in supporting farmer and local-community management activities, for example, through the Community Biodiversity Development and Conservation Programme.

Forest genetic resources

45. The GPA/PGR is complemented by action in forest genetic resources, guided by the FAO Panel of Experts on Forest Gene Resources. It has been widely recognized that the most efficient and feasible strategy for the conservation of forest genetic resources is conservation in situ, conserving targeted species, populations and genetic resources as parts of the ecosystems in which they naturally occur. The conservation of forest genetic resources is compatible with their utilization, provided sound forest management practices are implemented. Conservation in situ is, in practice, carried out through placing forest ecosystems under forest management of varying degrees of intensity, ranging from strict protection (mainly in national parks and other reserves and protected areas) to intensive utilization and targeted regeneration of forest resources.

46. Most countries, in all regions, mentioned conservation of genetic resources through protected areas, although the extent of protected areas varies considerably. Programmes such as FAO's non-wood forest products (NWFP) activities, and the programme of the International Center for Under-utilized Crops (ICUC) on indigenous fruit trees, promote the sustainable use of forest genetic resources and under-utilized species. Community forestry programmes and programmes for the sustainable utilization of protected area "buffer zones" are also being successfully implemented by a number of organizations. A number of countries, for example Nepal and the Philippines, have developed very successful community-forestry programmes. These programmes integrate local management with the utilization of natural resources and provide an excellent incentive for their conservation and sustainable use. Further information on research, best practices and methodologies in forest genetic resources may be found in the note by the Executive Secretary.

Animal genetic resources

47. Most ongoing research on farm animal genetic resources is directed at the characterization of breeds and assessment. Some national and regional activity is under way for some species, for example research on local animal breeds (in many countries), and genetic distancing of animal genetic resources for sheep, pigs and cattle species (within the European and African regions). The CGIAR System-wide Livestock Programme (CGIAR-SLP) aims to improve livestock feed resources and natural resource management in crop–livestock agriculture, and will be closely co-ordinated with ILRI research. ICARDA, in conjunction with FAO, is also involved in work on small ruminants in West Asia and North Africa, and which will be expanded to central Asia.

48. Although microbial processes are integral to the life of both monogastric and ruminant animal species, currently very little work is being done in this area, except for specific pathogens. These areas of research are becoming more feasible as the range of effective molecular biological tools increases.

49. Research priorities include: (i) the development of more effective and robust, low cost ex situ technologies for developing country use, (ii) the development of adapted animal genetic resources for each production environment, and (iii) the characterization of all of the small number of remaining domestic animal breeds, their production environments, and their respective contributions to domestic animal diversity. Comprehensive guidelines and decision support for country use in characterization,

sustainable use and conservation need to be completed and made widely available.

50. Planned conservation action should be given priority, with some 30 per cent of remaining animal genetic resources at high risk. For those animal genetic resources of current interest to farmers, wise use, in situ, is the most effective form of conservation; emphasizing the complementary nature of sustainable use and conservation in this sector of agricultural biodiversity.

51. Frequently this century, best practices concerning the sustainable use of farm animal genetic resources have not been followed. There is limited knowledge and a need for research on ecosystem interactions at farm level, including interactions between animal - feed - disease and production environments. Farmer knowledge in this area is currently underutilized. There is a need to bring about a shift in focus from high producing, short life-cycle exotic breeds that require high-cost maintenance, towards more cost-effective improvement of locally adapted breeds and races.

52. There is a need for better understanding of the broad range of indigenous technologies. A useful way to catalyse increased support for indigenous local breeds would be to collect and disseminate cases-studies of successful experiences and lessons learned, including, for example, matching nutritional needs with availability of fodder and feed resources. To respond to the food and agriculture imperatives throughout the range of input levels and capacities, there is also a need for the development of appropriate modern technologies for particular production environments, based on the advancing genetic, reproductive and information tools.

Aquatic genetic resources

53. The 1998 State of the World's Fisheries and Aquaculture report, and the fisheries country profiles on which it is largely based, inter alia, the need for more information and evaluation of aquaculture-biodiversity relationships in order to identify opportunities and needs for action to conserve existing resources, and promote the sustainable use of aquatic genetic resources adapted to their environments.

54. To complement case-studies on mariculture addressed under the programme of work on marine and coastal biodiversity under the Convention on Biological Diversity, case-studies on aquaculture in inland waters are available or could be readily compiled. One aim is to improve recognition of local species through documenting what local species exist; identify which ones can be bred in captivity and have market appeal; and to determine the implications of exotic species introductions. Case-studies on marine stock enhancement are also being prepared under the support of the Government of Japan and will be published next year (2000).

55. Research is required to document better a number of issues regarding aquaculture biodiversity including: species diversity and intra-specific genetic diversity; the ecological effects of aquaculture on wild genetic diversity; the effects of inbreeding; how to quantify inbreeding genetically; genetics of disease diagnosis and resistance; species selection for polyculture and other farming systems; and to determine how to combine genetic technologies for increased production and increased environmental safety.

56. Tools for the promotion of better management of inland water resources and use of improved techniques and systems for the culture of fish and other aquatic organisms include guidelines on the FAO Code of Conduct for Responsible Fisheries, research guidelines from SIFAR (the FAO/ICLARM Support Unit for International Fisheries and Aquatic Research), and guidelines for sustainable aquaculture/environmental guidelines for aquaculture intensification. An information kit on farm-proven integrated agriculture-aquaculture farming technologies which was prepared in 1992 by International Institute for Rural Reconstruction (IIRR) and ICLARM, is currently under review by FAO. FAO is developing responsible stock-enhancement practices with the World Aquaculture Society and has published general guidelines on genetic and biodiversity concerns with stocking and other enhancement programmes. Several FAO publications are being produced on genetic improvement strategies and on genetic characterization of important species. In addition, the, first regional workshop of the programme for the development of technical guidelines on quarantine and health certification, and establishment of information systems for the responsible movement of live aquatic animals in Asia, were organized in Bangkok in January 1998 in conjunction with the Network of Aquaculture Centers in Asia, and the International Office of Epizootics.

Microbial genetic resources

57. There is generally a lack of information on microbial genetic diversity in agriculture. Brazil, Canada and India are among the few countries with research programmes in this area.

58. Most microbial research related to agriculture is focused on biopesticides (CABI) and nitrogen fixation (CIAT). Some research is also taking place on tropical fish bacteria (FAO) and rumen microbiology (ILRI). There is also a strong focus on biotechnology applications (e.g., 12 of the MIRCEN centres are working in this area). It is recognized by organizations such as CABI that the importance of genetic and biological pest control will increase considerably in the future, and developments in the field of molecular biology will also open up new possibilities for biological pest control.

59. The few case-studies that have been made available, for example those submitted by the Government of Canada on microbial biodiversity and grass seed cropping systems and the biodiversity of mycorrhizal fungi, emphasize the importance of microbial genetic resources for agriculture. There are also initiatives to develop case-studies and best practices for the future, such as the UNEP studies on biological nitrogen fixation (BNF) by bacteria with a number of MIRCEN centres. In more general terms, the DIVERSITAS special target area of research on microbial biodiversity aims to develop a knowledge base of microbial genomes, employing non-cultivable approaches, as well as microbial cultivation. The functions of microbial genetic resources in ecosystems, particularly in soil and water resources, is still for the greater part unknown and probably underestimated. A greater emphasis is needed on improving knowledge through in-depth research and case-studies, in different agro-ecosystems and under different management practices, to illustrate and quantify the dynamic role of micro-organisms in maintaining agro-ecosystem functions at different spatial and temporal scales.

2. Ecological and ecosystem functions

Support to agricultural production systems

60. The ecological functions provided by different agro-ecological systems, although the subject of increasing and important scientific and academic research, appears to be the area that is the least well known and understood by practitioners and by those at decision-making and technical levels in the agricultural and environmental sectors. There is a need for substantial improvement in our knowledge of the interactions between components of agricultural biodiversity and the functioning of the different agricultural production systems on which the human population relies for its food security and livelihood. Progress in these areas will be needed to meet the objectives of the Conference of the Parties to the Convention on Biological Diversity laid down in decision III/11, to promote the positive effects and minimize negative impacts of agricultural practices on biological diversity.

61. The Netherlands/FAO/Convention on Biological Diversity Workshop on Sustaining Agricultural Biodiversity and Agro-Ecosystem Functions considered that biodiversity-friendly and sustainable agricultural systems and practices, can be promoted through the conduct and dissemination of case-studies of cost-effective and productive diversified systems. A wide range of best practices and technologies are already available and used in certain agricultural systems and regions. Some ongoing initiatives are outlined in the following paragraphs.

62. The project on people, land management and environmental change (PLEC) is a collaborative effort between scientists and small-scale farmers to identify appropriate conservation practices that sustain biodiversity, while also improving production and income. PLEC is executed by the United Nations University through a network of locally based clusters, and involves activities in 12 developing countries. These activities include identifying successful resource-management patterns and establishing demonstration sites, carrying out on-farm experiments, and promoting awareness and training.

63. The tropical soil biology and fertility project (TSBF), supported by UNEP (CABI, SCOPE and others) and GEF, was initiated in 1984 under the aegis of the Decade of the Tropics of the International Union of Biological Sciences (IUBS) and the MAB programme of UNESCO, to identify techniques for the better use of soil biodiversity to enhance productivity in smallholder farming systems. Other activities in the area of soil fertility include the Soil Fertility Initiative, a joint initiative by FAO, IFPRI, ICRAF, the International Fertilizer Association (IFA), the International Fertilizer Development Center (IFDC), USAID and the World Bank, and programmes of FAO and CGIAR to: maintain soil productivity and fertility through soil biota; promote the targeted use of fertilizers; promote safer use of pesticides; improved land and crop husbandry (cover crops, crop mixes, annual and perennial, organic matter recycling, including manures, crop residues and green mulch); and the use of Rhizobium bacteria for nitrogen fixation and mycorrhizal fungi to help phosphorous uptake.

64. There are also examples of national efforts to conserve soil resources, such as the Canadian soil and water environmental enhancement and national soil conservation programmes. Particular expertise in the macro-culture of soil fauna exists in Italy, and world-wide there is much specific research ongoing and knowledge on specific micro-organisms. Some countries in Western

Europe have highlighted the need for research on invertebrates and other lower groups. Conservation tillage practices can significantly help to maintain soil functions, a striking example of which is provided by the improvement of the Brazilian cerrados through farmer-organized minimum-tillage programmes that resulted in the rehabilitation of previously damaged soils and substantial increases in agricultural productivity. India has case-studies on soil-fertility improvement, e.g., through nitrogen fixation by Rhizobium and phosphate solubilizers.

65. Many countries now promote integrated pest management, using "farmer field schools" (FFSs) participatory action learning approaches pioneered by FAO in Asia. Improved crop and agro-ecosystem management has resulted in higher and more stable yields, as well as dramatically reduced inputs. The FFS approach has been used essentially for the development and promotion of integrated pest management (IPM), and they have proved to be effective for testing and developing systems and technologies based on agro-ecological principles that are adapted to local conditions and farmers' needs and take into account local knowledge and experiences. To date, over one million Indonesian farmers have graduated from FFSs, over 400,000 in Vietnam, and over 170,000 in the Philippines. The programme has been extended to several other Asian countries, and now, through the Global IPM Facility, to many countries in Africa and elsewhere. The impact at community level is extended and sustained through "community IPM clubs" formed spontaneously by the FFS graduates themselves after the formal FFSs have ended. In many countries support of local government and extension services also guarantees the sustainability of the approach. The programme has also had major policy impacts at national level, for example, in terms of reduced subsidies for and increased taxes on pesticides. The value of such approaches is being recognized, and they are now also being used to develop and promote appropriate land husbandry and soil and water management approaches. Such holistic and dynamic approaches could play a key role in promoting the research and development of locally adapted and biodiversity-friendly farming systems and technologies throughout the world.

66. CABI is developing approaches for safer weed management techniques for problem weeds such as water hyacinth, witch weed, and Striga. As part of the OECD biological resources management programme, Japan is conducting research on the use of threshold levels of agrochemicals. There are many CGIAR programmes to improve pest management through judicious use of intercropping, rotations and fallows for crops, and for biological control of vectors of animal diseases (e.g., screwworm, tsetse fly), and CGIAR has recently introduced a system-wide initiative on functional agrobiodiversity.

67. The importance of pollination by bees and other animals and the "pollinator syndrome" of many of the classical or temperate region food plants are becoming more widely recognized. The International Workshop on the Conservation and Sustainable Use of Pollinators referred to above identified the need for research support and improved taxonomic capacity to improve knowledge and understanding through an inventory and the conduct of case-studies in different agro-ecosystems. Case-studies are needed to assess the impact of current biodiversity conservation and restoration efforts on pollinator diversity and processes, and to identify improved agricultural practices and systems to enhance the conservation and sustainable use of native and managed pollinators for agriculture including:

(a) Status of pollinator diversity and decline including the potentiality of non-bee pollinators, stingless bees and others. Latvia has

developed a project proposal on pollinator diversity, which may provide an interesting future case-study;

(b) Identification of threats to natural and other pollinators (including habitat fragmentation and degradation, introduced species, cropping patterns, agrochemicals, cultivar differences). Countries in Central and Eastern Europe mentioned introduced bees as a factor in the decrease of bee colonies;

(c) Effects of alternative or new management practices and technologies (e.g., multi-cropping, zero-tillage, crop rotation, organic farming, biotechnologies, etc.);

(d) Pollination biology and requirements of key tropical crops, cultivars and recent transgenic varieties (including fruits, perennial species, minor food crops);

(e) Pollinator–plant relationships for key species, farming systems and cropping patterns (e.g., identification of which pollinator species and guilds are effective pollinators of which crops and wild plants, including fodder and forage crops and pasture species);

(f) Identification of improved pollination techniques that complement plant-breeding techniques (e.g., natural pollinators, sustainable bee-keeping, required plant species/habitats). India, for example, has described techniques for increasing the production of certain agricultural crops for cross-pollination by honey bees.

68. The aim of such research is to develop recommendations and technical guidelines and, as appropriate, regulations, based on local and regional experiences, for enhancing the restoration and use of pollinator diversity and effective pollination processes, including:

(a) Migration patterns and needs of pollinators, especially from natural ecosystems into small agricultural plots and mosaic environments;

(b) Adverse effects of invasive species and introductions of exotic species and of the use of different agrochemicals (including application modality);

(c) Appropriate breeding systems and techniques for target pollinator species in different regions/farming systems to promote effective use and management of pollination in agriculture (e.g. stingless bees, Xylocapa spp., Megachile spp., Apis spp. for Asia).

Wider ecosystem and landscape levels

69. There are many traditional integrated production systems, such as home gardens, agroforestry systems; agro-silvo-pastoral systems, agro-aquaculture systems (such as rice-fish), and the use of features such as hedgerows as ecological corridors along watercourses and roads, etc., that can provide for high levels of diversity at the landscape level with mosaics of land-use types.

70. The international agricultural research centres(IARCs) are conducting research on integrated modern systems such as intensive-sequential cropping systems, more intensive intercropping, mixed systems such as crop-animal systems and integrated crop-aquaculture systems, as well as the use of new alternative crops in dryland cropping systems. There are many examples of integrated system-level development programmes supported by international

organizations, such as integrated pastoral development, integrated coastal area management, integrated watershed management, participatory land-use planning and promoting traditional landscapes such as terracing for sustainable agriculture in mountain environments; and integrated technologies that address specific issues and constraints (e.g., integrated plant nutrient systems and integrated pest management). There are likewise several case-studies of the impact of agricultural practices and technologies and the development of environmentally-friendly practices, such as ICRAF's research in Latin America, South-East Asia and West Africa on the impacts of slash-and-burn and development of technological and policy options to alleviate its negative effects. Research on impacts of agricultural practices on agro-ecosystems also includes the development of models, by ICRISAT and ILRI for example, for assessing the impact of farm animals, and of farming systems, on the environment.

71. National initiatives towards sustainable and agricultural biodiversity farming systems include: the development in China of the sustainable agricultural village concept for maintaining and restoring environmental conservation functions and natural ecosystem and landscapes; development of environmental farm plans by Canada, a voluntary programme to identify areas of potential environmental concern and minimize these concerns; integrated farming systems in Thailand; and comparative analysis of different farming methods, including organic agriculture, in Western and Central Europe.

72. In the activities of non-governmental organizations, a focus has often been placed on low external input agriculture which incorporates biodiversity-friendly practices that include local institution strengthening and the development of technology options to strengthen capacities for sustainable and productive agriculture building on local knowledge and research strategies of men and women farmers, foresters and fishermen (for example, by the Intermediate Technology Development Group (ITDG) and the International Institute for Environment and Development (IIED)).

The abiotic resource base

73. There is much information available on certain abiotic parameters such as soil productivity, organic-matter content and land-degradation parameters, which, through the modelling of relationships with agricultural biodiversity, could lead to the identification of useful indicators for natural resources management. The need to illustrate and quantify the relationship between biodiversity and atmospheric exchanges, for example, water cycling and quality; carbon sequestration, and greenhouse gas exchanges has also been noted.

3. Socio-economic dimensions

General awareness

74. The agricultural sector and the general public are still, in general, inadequately informed of the nature and scope of agricultural biodiversity and why it is crucially important to society. Many countries identify the lack of public awareness of agricultural biodiversity as a key constraint (e.g., in Central Europe) and the need to develop adapted public awareness programmes/ campaigns on environment and agricultural biodiversity issues. Public-awareness campaigns could help to demonstrate the inter-relationships between the conservation and sustainable use of biological diversity and the

management of agricultural systems and natural resources, as well as the value and important contribution of agricultural biodiversity, including the life-support functions and ecosystem services.

Local and indigenous knowledge

75. There are an increasing number of examples of research on specific technical issues that take into account socio-economic dimensions. Many non-governmental organizations are active in research and development in rural areas throughout the world, these include SEARICE, Via Campesina, GRAIN, and ITDG. Work by intergovernmental organizations includes:

(a) Case-studies for awareness raising on gender, indigenous knowledge and agricultural biodiversity issues, prepared by the regional FAO LINKS project in southern Africa;

(b) Research by the CGIAR centres on farmer participatory breeding and evaluation of local food crops, particularly with women farmers, studies of pest-control practices seed management and the dynamics of *in situ* conservation and their genetic implications, as well as ethno-botanical research and restoration of local cultivars; and,

(c) Development of methods for the identification and assessment of cultural landscapes taking into account biodiversity and traditional knowledge (UNESCO).

76. Case-studies show that some of the best solutions for reaching viable research results for conserving and ensuring the sustainable use of agricultural biodiversity come from a combination of formal scientific research and local experimentation. This requires improved communication between researchers, extensionists and farmers, foresters and fishermen, as well as a strengthening of communication among the producers themselves. A number of networks exist that facilitate this type of work, such as the Indigenous People's Biodiversity Network (IPBN); Indigenous Peoples Biodiversity Information Network (IBIN); the Honey Bee network (SRISTI); and FAO's Forests, Trees and People, Rural learning networks, and LINKS networks.

77. Valuable work on gender issues pertaining to agricultural biodiversity has been conducted by various bodies in collaboration with national institutes, for example, the CGIAR Systematic Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation; IFRI's USAID/WID-sponsored project on "Strengthening Development Policy through Gender Analysis" to link researchers at CGIAR centres, including the Gender Research Network; work by IPGRI and FAO on gender and genetic resources; and IDRC's cross-cutting incorporation of gender issues, including a strong gender element in its programme on the sustainable use of biodiversity.

Trade, marketing and incentives

78. The OECD Expert Group on Economic Aspects of Biodiversity has been working since 1994 on economic incentives for conserving biological diversity and held an international conference on the subject in Cairns, Australia, in 1996. It has recently published a handbook of country case-studies on the implementation of incentive measures, including conceptual and legal issues and economic mechanisms regarding the sharing of benefits from the use of wild genetic resources. In addition, UNEP is compiling case-studies on incentive measures for the conservation and sustainable use of biodiversity in the Latin

American and Caribbean and the Eastern and Central European regions. Examples of support for more sustainable agriculture are common in Western Europe. A case-study on direct payments in Swiss agriculture concluded that it is possible and cost effective to establish a financial incentive programme to promote the use of agricultural land for conservation and sustainable use of wild species. There is also a need to remove perverse incentives. However, such examples are little documented.

79. More work is needed on the valuation of ecosystem functions and services provided by agricultural biodiversity, and to determine how to internalize costs and benefits in agriculture. An IUCN/UNEP/Swiss Government supported workshop on biodiversity loss, held in Gland in April 1996, focused on the appropriate role for economic valuation and incentives in developing a framework for biodiversity impact assessment, and a further regional workshop, on economic valuation of biodiversity, was held in Santiago in May 1996 (UNEP/IUCN/WRI/WWF). UNEP has also carried out a workshop on economic valuation of biodiversity for the African managers of the national biodiversity strategies and action plans (NBSAPs) and, later in 1999, will carry out a similar workshop for the managers of NBSAPs in Asia and the South Pacific. Some countries, for example China, are carrying out countrywide evaluations of the economic value of biodiversity.

80. Benefit-sharing and property rights issues are beginning to be addressed by a number of organizations: UNEP, the World Intellectual Property Organization (WIPO) and others, in addition to the work under FAO on Farmers' Rights and access in the context of the International Undertaking on Plant Genetic Resources. The CGIAR System-wide Initiative on Collective Action and Property Rights, lead by the International Food Policy Research Institute (IFPRI), examines the formation and effectiveness of voluntary, community-level organizations and property institutions as they relate to natural resources management, while the Commonwealth Secretariat and the World Bank support the development of in situ conservation projects with the participation of local and indigenous communities, including traditional knowledge and protection of intellectual property, ownership of germplasm by local communities, and agreed protocols for granting access to scientific institutions. UNEP submitted two case-studies, on benefit-sharing arrangements for Ancistrocladas korupensis and Prunus africana, to the Conference of the Parties to the Convention on Biological Diversity at its fourth meeting and, with the M.S. Swaminathan Foundation, prepared a paper with a number of case-studies on a conceptual framework for promoting benefit-sharing in the area of conservation and use of plant genetic resources. There is a need for more successful case-studies and experiences in this area.

81. The organic-agriculture movement, has helped to substantially promote ecologically sound approaches. This success story provides an interesting model of the ways and means to promote certain agricultural systems and practices which may in many areas provide useful lessons for promoting biodiversity-friendly agriculture. Guidelines for organic agriculture have been developed to promote its adoption, and incentives are provided through consumer demand that supports higher prices for organic-labelled products as well as by market outlets, such as supermarkets, favouring organic products.

82. The FAO Committee on Commodity Problems (CCP) undertakes regular assessments of the linkages between agricultural production and environment and of the implications of technical change, including biotechnology, for agricultural commodities. These assessments evaluate the production, trade

and food security implications of such innovations. The most recent study, "Report on Activities Related to Trade and Environment, Biotechnology and SPS/TBT Measures", is available as CCP document 99/15.

4. Concluding remarks on needs for research, best practices and technologies

83. In many cases, a wide range of case-studies are already available on best practices and lessons learned from past experiences and experiments. These valuable experiences, both positive and negative, should be learned from and taken into account for future research initiatives. However, more understanding is needed concerning the multiple functions of biodiversity in production systems. A greater focus on the ecosystem approach is needed, including in-depth coordinated research in different agro-ecosystems, and under different management practices, to quantify the direct and indirect contributions of agricultural biodiversity.

84. Efforts are required to conduct research and compile case-studies for the identification and promotion of cost effective practices and technologies, that enhance the positive and mitigate the negative impacts of agriculture on biological diversity, productivity and capacity to sustain livelihoods.

C. Strategies, programmes and action plans

85. In its decision III/11 the Conference of the Parties to the Convention on Biological Diversity encouraged Parties to develop national strategies, programmes and plans, and provided substantial guidance on their coverage and objectives.

86. Most Parties to the Convention on Biological Diversity have developed national biodiversity strategies and action plans (NBSAPs). Some have reported separately on agricultural biodiversity. However, only a few countries have developed comprehensive strategies and action plans for the conservation and sustainable use of agricultural biodiversity, including, for example, Bhutan, India, Canada and some countries in Western Europe.

87. Overall, the nature, scope and quality of the information contained in NBSAPs and other submissions more comprehensively address the main animal and plant genetic resources components of agricultural biodiversity and less attention is paid to the biological support system and the different production systems and agro-ecosystems. Guidelines would assist countries in reporting more completely on the various functions of agricultural biodiversity.

88. The Global Environment Facility (GEF), through its enabling and operational programmes, provides assistance to countries in the design and development of their national biological diversity strategies and action plans. The GEF implementing agencies — UNEP, UNDP and the World Bank — provide country assistance through projects in the development of NBSAPs. There are examples in each region of ongoing programmes and projects on agricultural biodiversity that have been elaborated and have received GEF funding support. The number of approved projects and funding volume for agricultural biodiversity has, however, remained low in comparison to the other thematic areas under the Convention. A framework for GEF activities concerning the conservation and sustainable use of biological diversity important to agriculture was adopted by the GEF Council in October 1998 and an

operational programme on agricultural biodiversity is now being developed. Countries can take this new opportunity to formulate and present relevant agricultural biodiversity programmes.

1. Crop genetic resources, wild relatives, and harvested wild food plants

89. The Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (GPA) provides the main global framework for action at all levels: local, national, regional and global. It was adopted by 150 countries at the International Technical Conference on plant Genetic Resources, held in Leipzig in 1996, and subsequently supported by the FAO Council and Conference and the World Food Summit, as well as by the Conference of Parties to the Convention, which, through decision III/11, urged countries to implement the GPA according to their national capacities. The GPA provides an agreed comprehensive framework for action for the conservation and sustainable use of plant genetic resources for food and agriculture, comprising 20 priority actions.

90. The 20 priority actions are grouped in four theme areas, as follows:

In situ conservation and development

1. Surveying and inventorying PGRFA
2. Supporting on-farm management and improvement of PGRFA
3. Assisting farmers in disaster situations to restore agricultural systems
4. Promoting in situ conservation of wild crop relatives and wild plants for food production

Ex situ conservation

5. Sustaining existing ex situ collections
6. Regenerating threatened ex situ accessions
7. Supporting planned and targeted collecting of PGRFA
8. Expanding ex situ conservation activities

Utilization of plant genetic resources

9. Expanding the characterization, evaluation and number of core collections to facilitate use
10. Increasing genetic enhancement and base-broadening efforts
11. Promoting sustainable agriculture through diversification of crop production and broader diversity in crops
12. Promoting development and commercialization of under-utilized crops and species
13. Supporting seed production and distribution
14. Developing new markets for local varieties and "diversity-rich" products

Institutions and capacity building

15. Building strong national programmes

16. Promoting networks for PGRFA

17. Constructing comprehensive information systems for PGRFA

18. Developing monitoring and early warning systems for loss of PGRFA

19. Expanding and improving education and training

20. Promoting public awareness of the value of PGRFA conservation and use

91. The Global Plan of Action (GPA) is to be implemented by all stakeholders at all levels. Implementation of the GPA is guided and monitored by the Commission on Genetic Resources for Food and Agriculture. FAO, in collaboration with its partners, in particular, IPGRI, provides technical and policy support at country, regional and international levels to facilitate implementation. The CGIAR supports the implementation of the Global Plan of Action through its System-wide Programme for genetic Resources (SGRP).

92. Through CGRFA, countries and institutions have reported on the status of implementation of GPA-related activities. While some are a continuation of earlier activities (in particular under activities 1, 4, 5, 7 and 9), others have been initiated or adjusted in response to the GPA. In particular, there has been substantial progress in strengthening national programmes (activity 15) and regional networks (activity 16), and a large number of initiatives have been launched to promote on-farm conservation and development (activity 2), though these are largely isolated projects. Important work is under way in respect of seed security (activity 13), but the needs are also very large. There has been relatively little progress with in situ conservation (activity 4), ex situ conservation of species with non-orthodox seeds and minor species (activity 8), regeneration (activity 6), genetic enhancement and base-broadening (activity 10), and early-warning systems (activity 18). Further details are provided in the reports to the eighth session of CGRFA, held in Rome in April 1999 (CGRFA-8/99/3 and 5).

93. Countries have reported much progress in the area of strengthening of national programmes, despite reductions in funding to national agricultural research systems. Several countries have held national workshops on plant genetic resources for food and agriculture, which has helped further define national priorities, and stimulate the formation of national committees. The number of countries with national committees (or similar coordinating mechanisms) has roughly doubled since 1995. Countries report an increasing involvement of a wider range of stakeholder groups (farmers, breeders, non-governmental organizations, universities and the private sector) in such committees, and national programmes generally. Increasingly, national committees have been involved in preparing national plans or strategies for plant and animal genetic resources for food and agriculture conservation and use.

Forest genetic resources

94. Forest-genetic-resource priorities are regularly reviewed by the FAO Panel of Experts on Forest Genetic Resources. The work of the Panel includes identification of priority tree species, and recommendations on specific activities in each of those in which action is needed (taxonomic and genetic exploration, in situ and ex situ conservation, evaluation of levels and distribution of genetic variation of species targeted for attention through testing/evaluation, sustainable utilization). Following recommendations of

the Panel, subsequently endorsed by the Committee on Forestry, FAO is assisting countries in the organization of a series of regional and subregional workshops on the management of forest genetic resources, including their conservation, enhancement and sustainable utilization. Priorities for action are defined in this country-driven and action-oriented process, which is aimed at the development of regional and subregional action plans. National forest genetic conservation programmes will constitute the building blocks of plans, which could later, if countries so wish, be placed within a larger context, contributing to a comprehensive, international framework. Such a coherent global framework for action on forest genetic resources could decisively help promote overall co-ordination of action and help further cooperation between and among geographical regions.

95. Forest biological diversity is, to larger or minor degrees, addressed in national forests action programmes. The Tropical Forestry Action Plan, precursor of the national forests programmes, was launched in 1985, and some 127 countries have developed or updated their national forest programmes during the past 13 years.

96. These activities are complemented by other initiatives such as the preparation of national biodiversity strategies and action plans within the framework of the Convention on Biological Diversity. The overall status and progress are regularly reviewed in global meetings, such as the World Forestry Congresses, held every six years, and IUFRO consultations, such as the IUFRO/FAO consultation on forest genetics and tree improvement held in Beijing in August 1998).

97. In collaboration with a national institutes in member countries and a number of international partners (including UNEP, UNESCO, the Secretariat of the CBD; IUFRO and relevant CGIAR centres, in particular IPGRI, CIFOR and ICRAF), FAO supports networking to promote the conservation, development and sustainable use of targeted priority tree species.

Animal genetic resources

98. A comprehensive framework for the characterization, sustainable use and conservation of farm animal genetic resources is being developed as the FAO Global Strategy for the Management of Farm Animal Genetic Resources. Development of this Strategy was supported by the World Food Summit and the Conference of the Parties to the Convention on Biological Diversity. The country-driven development of this strategic framework provides for national focal points and networks at the country, regional and global levels; a stakeholder mechanism; a virtual structure, known as DAD-IS, to support this networking; an intergovernmental mechanism through the Commission on Genetic Resources for Food and Agriculture; the development and implementation by countries of national farm animal genetic resources management plans, utilizing technical guidelines; and a reporting and evaluation mechanism incorporating a global early-warning system.

99. FAO, in collaboration with partners such as ILRI, ICARDA, UNEP and UNDP, and a small number of non-governmental organizations, provides technical and policy support at country, regional and international levels to implement the Global Strategy and initiate the assessment of status and trends of farm animal genetic resources. The key actions of the Strategy aim at understanding, wise use, and further development of farm animal genetic resources adapted to the world’s major medium- and low-input production

environments; sustainably intensifying agricultural systems; and overcoming the threat of genetic erosion in the remaining 5,000 breed resources of the 14 main farm animal species, about 30 per cent of which are currently at high risk. Country-level guidelines are being drafted by FAO, for developing and implementing action plans for country use. Some guidelines have been distributed for field testing, assisted by UNEP.

100. National focal points are being identified and are developing their country networks, and regional focal points are operational, while FAO supports the global focus. Countries are increasing their involvement in the development of the DAD-IS system and have begun to characterize their animal genetic resources. Some countries, for example 12 countries in Asia, have developed the first stage of national action plans.

Aquatic genetic resources

101. The FAO Code of Conduct on Responsible Fisheries and the priorities identified on the basis of The State of World Fisheries and Aquaculture report provide a framework for the conservation and sustainable use of fisheries and aquaculture. The FAO programme on the promotion of responsible fisheries and aquaculture supports implementation of the Code of Conduct and the Convention on Biological Diversity, through participation in specialized meetings, publication of technical guidelines on fisheries and aquaculture (for example, on the precautionary approach to the use of new species in aquaculture), and the organization of international forums on fishery genetic resources. In addition, the European Inland Fisheries Advisory Commission in association with the International Council for the Exploration of the Sea (ICES) has developed codes of practice on species introductions that have been adopted in principle by other regions.

102. Relevant regional aquaculture programmes include the community-based aquatic resource management for local communities (ALCOM) programme collaborating with all SADC members. Pilot projects support fieldwork, training and workshops on small-scale fisheries, integrated irrigation-aquaculture; water resource management issues, as well as SADC water resources data and information.

103. A number of networks and partnerships exist, such as the Asian and American fishery societies, ICES, and the International Network of Genetics in Aquaculture (INGA). INGA is involved in collaborative regional research on the conservation of fish genetic resources and increasing fish production through genetic enhancement, for example through a project on local tilapia strains currently in progress through the IDRC-funded project on collaborative research and training for documentation and characterization of tilapia genetic resources for aquaculture in Africa. Côte d'Ivoire, Egypt, Ghana and Malawi are participating in this project.

Microbial genetic resources

104. There is no global programme for the conservation and sustainable use of microbial genetic resources. Coordinated efforts will be required through linkages between MIRCENs and other institutions holding relevant databases and information systems and collections, to collect and characterize those priority groups and micro-organisms. This will require resources and possibly also the strengthening of taxonomic expertise for microbial genetic resource assessment.

2. Ecological and ecosystem functions

Support to agricultural production systems

105. Many countries have adopted national IPM programmes, with the support of the Global IPM Facility (co-sponsored by FAO, UNDP, UNEP and the World Bank), and the FAO inter-country programme for community IPM in Asia. Concepts and approaches are also being developed through the CGIAR system-wide programme on IPM.

106. The Global Invasive Species Programme (GISP) is an international initiative coordinating work by IUCN, CABI and UNEP. Work on alien species eradication *in situ* is also supported by the World Bank. Most national quarantine services, which provide the main means of controlling pests and invasive species, operate within the framework of the International Plant Protection Convention.

107. In modern agricultural systems, ecosystem services are often supplemented by external inputs. Overuse of external inputs can be both unsustainable and inefficient by harming the environment and impeding the activities of beneficial organisms in providing ecosystem services. The FAO programme for the safe and efficient application of agro-chemicals and bio-products includes awareness-raising, technical and policy advice for country studies and assessments and the formulation of standards for safer and more efficient application equipment. It complements the FAO Code of Conduct on the Distribution and Use of Pesticides and supports the FAO programme on safe management of pesticides. OECD also has a programme on biological resource management for sustainable agricultural systems, which emphasizes more efficient use of input factors in the production processes of plants, animals and on the quality of ground and surface water, and includes the pesticide risk reduction programme. The programme strives to reinforce international scientific cooperation to facilitate exchange of latest information on current research, through exchange of scientists or symposia on specific themes. A notable effort is made to enhance research of value to developing countries.

108. There are no comprehensive programmes on pollinators in agriculture. Work has tended to focus on honey production and the provision of improved pollinator bees and those with resistance to Varroa mites and other diseases. The International Workshop on Pollinators in Agriculture drew attention to the need for monitoring and evaluation of pollinators and pollinator processes for different agro-ecosystems, and proposed a major initiative in this area.

Wider ecosystem and landscape levels

109. A number of countries have developed programmes to promote sustainable agriculture which could provide the basis for promoting the conservation and sustainable use of agricultural biodiversity. In some cases, biological diversity issues are also being integrated into land-use planning and sectoral agricultural, forestry and fisheries policies and programmes (e.g., Bhutan, Mozambique, and several countries in Western Europe). In the forestry field, biological diversity considerations are presently being included as integral parts of forest management plans, aimed at harmonizing sustainable utilization of forest products and services with conservation. Some countries (e.g., Namibia, Eritrea, Canada and Western Europe) have already established linkages between national environmental and agricultural programmes and strategies to integrate biological diversity considerations, including

community-based natural resources management programmes. Uganda and some countries in Western Europe provide examples of the establishment of environmental liaison units in all lead agencies to link sectors involved in biological diversity conservation including tourism, wildlife, trade and industry. Negative impacts on agricultural biodiversity of development projects have been reported, for example, the effect of hydrological and irrigation projects on fish populations and migrations (Asia and Pacific region). This indicates the need for the evaluation of development projects from a biological diversity perspective, for example through the incorporation of biological diversity issues in environmental impact assessments (EIA). Some countries in Africa and Central Europe have identified a need to develop procedures for addressing agricultural biodiversity in environmental impact assessments.

110. A range of strategies are being proposed by countries for particular attention in the management of agro-ecosystems and agricultural biodiversity, for example:

(a) The introduction of natural resources accounting to help maximize revenues from natural resources and ensure best use of biological diversity, soil and water resources (Brazil, Africa, Western Europe);

(b) Agricultural diversification, especially for small island developing States (Mauritius);

(c) Development and commercialization of under-utilized species and the development of new markets for local varieties and diversity rich products (Bhutan);

(d) National programmes and actions that incorporate benefit-sharing arrangements (Asia and the Pacific) and integrate more fully indigenous/traditional knowledge practices (Saint Lucia);

(e) A focus on alien species and local indigenous species and the development of a weed strategy (Australia);

(f) The rehabilitation of degraded terrestrial ecosystems (Africa and Western Europe);

(g) The creation of an observatory of agricultural practices on specific farms to support management and monitoring and improve understanding and economics of different systems as well as a management centre for participatory research (Tunisia).

111. Biological corridors are important not only for in-situ conservation of genetic resources, but also for the provision of habitats for transient species, some of which are important to agriculture (e.g., pollinators). The GEF-sponsored World Bank Meso-American biological corridor project, for example, is an initiative to conserve the biological and socio-cultural richness still remaining in essentially intact strips of natural habitat joining Mexico to Colombia, known collectively as the Meso-American biological corridor (MBC), and ensure their sustainable use. In addition to having their own unique ecosystems, Central America continues to be a critical link between the northern and southern biotas of the Americas.

112. The UNESCO Man and the Biosphere (MAB) programme aims to achieve a sustainable balance between conserving biological diversity, promoting economic development and maintaining associated cultural values. A number of field research activities include attention to genetic resources for food and agriculture, more particularly in a number of sites contributing to the World

Network of Biosphere Reserves. The Network comprises 352 sites in 87 countries.

113. The Global Terrestrial Observing System (GTOS), aims to provide policy makers, resources managers and researchers with access to the data they need to detect, quantify, locate, understand and warn of changes (especially reductions) in the capacity of terrestrial ecosystems to support sustainable development. GTOS is sponsored by FAO, ICSU, UNEP, UNESCO and WMO, and focuses on five issues of global concern: changes in land quality; availability of freshwater resources; loss of biodiversity; impacts of pollution and toxicity; and climate change.

114. Several countries have reported recent initiatives to address biodiversity at the landscape level and to draw attention to the benefit of mosaics of different land uses. An example is provided by the Council of Europe's Pan European Biological and Landscape Diversity Strategy (PEBLDS), as well as supportive legislation, for example set-aside lands and hedgerows. Attention at the landscape level needs to address the interaction between features and components of agricultural biodiversity, including ecological functions and ecosystem services. Since the late 1980s there are many examples of agri-environmental policies (AEP) within OECD. Methodologies are being developed in the United Kingdom, for example, for the combined ecological and economic assessment of the efficiency (cost benefit analysis) and effectiveness (adoption and ecological outcome) of such agri-environmental policies and schemes.

115. FAO provides support to member countries in promoting sustainable agricultural policies and programmes, through its agriculture, forestry and fisheries strategies and programmes including, inter alia, the improved management and development of:

(a) Drylands, rangelands and grasslands including integrated pastoral management, participatory processes and drought management strategies,

(b) Watersheds (catchments) and valley bottoms, with specific attention to mountain ecosystems, including soil and water conservation and management, participatory land-use planning and where appropriate wildlife management and aquaculture.

116. Such programmes are supported by research, especially by the CGIAR centres, which target both the policy instruments for and constraints to the adoption of sustainable agriculture, as well as the specific technical constraints, for example, the ICRAF natural-resources strategy, the ILRI crop-farm animal programmes and the IFPRI programmes addressing food policy issues.

117. FAO and the CGIAR system provide technical support in the use of farming systems development (FSD) approaches for the development of sustainable production systems and farm-household systems. Constraints and opportunities are analysed with a view to making optimal use of scarce resources including production/farm inputs, with attention to economic and ecological issues. These approaches are applied, by FAO in cooperation with partners, through the regional FARM programme in Asia and FARMESA programme in southern Africa that promote sustainable agricultural resource management initiatives by key stakeholders.

118. National agricultural research stations (NARs) and other relevant technical institutes, extension and research services and decision makers at policy levels should be in position to assist farming communities, as well as local and national level planners and decision makers, to develop and implement biodiversity-friendly agricultural strategies and actions aiming at sustainable agricultural systems, technologies and practices. This requires the updating and mobilization of the agricultural sector, including agricultural research and extension services, with a view to enhancing scientific knowledge and understanding. In this light, a number of countries identified the need to:

(a) Update training institutions, their curricula and training courses to integrate agricultural biodiversity;

(b) Improve the capacities and involvement of national agricultural research systems and increase the number of trained scientists and other personnel in the field of biological diversity in the agricultural service sector;

(c) Refocus agricultural extension services and training of farmers, extension agents and technical personal as a means to promote agricultural biodiversity; and

(d) Brief decision makers and planners.

The abiotic resource base

119. A broad range of technical assistance is provided to countries by international organizations such as FAO, on the planning and management of abiotic resources, including land, water and plant nutrients. This includes the development of policy, organizational and institutional approaches for: land-use planning and management, including land-tenure issues; for water allocation policy and use including improved irrigation or aquaculture systems; as well as for soil-productivity management and soil-erosion control. Such programmes could provide the forums for increasing awareness and capacities and for identifying requirements and best practices for the conservation and sustainable use of agricultural biodiversity. They also provide a range of guidelines for decision makers and planners that can be used at the national level, including through international programmes that assist countries to address major issues of concern.

120. Some examples of ongoing activities and instruments include:

(a) The World Soil Charter (1982, since proposed for updating), supported by World Conservation Technologies (WOCAT) case-studies and guidelines; and UNEP/FAO guidelines for mapping and measurement of rainfall-induced erosion processes in Mediterranean coastal areas;

(b) International and regional strategies for the conservation, management and rehabilitation of lands (ISCRAL, CORTALC, CLASP), including technical support, database generation and the management of applications at farm, community, watershed and country levels;

(c) FAO guidelines for environmentally sound tillage practices for the protection of soils (drafted at Harare in 1998) which could be further developed into a code of conduct for sustainable land management;

(d) Strategies for soil fertility such as tropical soil biology and fertility project (TSBF) and the multi-partner Soil Fertility Initiative (SFI). The SFI aims to develop, at country level, a soil fertility strategy

for the restoration and enhancement of soil fertility in a medium and long term perspective. In addition to technological aspects of enhancing and restoring soil productivity, it will address policy issues to ensure that the soil fertility measures adopted are profitable to farmers;

(e) The joint FAO-IAEA division subprogramme on soil and water management and crop nutrition.

(f) The IFAD-FAO programme to address synergies between the desertification, biological diversity and climate change conventions;

(g) A wide range of programmes to support water resources management including the UNESCO International Hydrological Programme (IHP), the World Bank water environment programme, the IDRC people, land and water programme the and the WMO hydrology and water resources programme; and CGIAR initiatives such as the system-wide initiative on water management (SWIM) and the ICARDA eco-regional programme on on-farm water husbandry in West Asia and North Africa;

(h) The soil, water, and nutrient management (SWNM) initiative of CGIAR and work by Centres such as IWMI and CIAT on strategies that better enable Governments and non-governmental organizations to address issues in soil, water, and nutrient management.

3. Socio-economic dimensions

Local and indigenous knowledge

121. The use of participatory approaches has generally been well integrated into development approaches over the last decade. Many programmes especially by international organizations and non-governmental organizations are now testing and developing ways and means to improve recognition and use of local and indigenous knowledge of agricultural biodiversity. Examples of relevant initiatives by FAO include the forests, trees and people programme and a decentralized, international programme on farming systems development involving rural people in farming systems analysis. A pilot regional project in southern and eastern Africa on gender, biological diversity and local knowledge systems (LinKS) for strengthening agricultural and rural development, addresses farmer, technical and policy levels including communications, feedback and information flow including learning from case-study experiences. Local and indigenous issues are also mentioned as a priority in the biodiversity strategies of a number of countries.

122. CIFOR, through the adaptive co-management of forests programme, and other CGIAR centres, incorporate local socio-economic considerations and knowledge into research programmes. Policies and other interventions are being formulated and implemented with CIFOR assistance to improve the human welfare of forest dependent communities. The CGIAR system-wide initiative on collective action and property rights (CAPRI) examines the formation and effectiveness of voluntary, community-level organizations and property institutions as they relate to natural-resource management.

123. Examples of other international programmes supporting the recognition and use of traditional knowledge include

(a) Promotion of sustainable and equitable use of plant genetic resources by the People and Plants Initiative of WWF (1992), UNESCO-MAB and the Royal Botanic Gardens, Kew, which supports ethnobotanists from developing countries;

(b) Promotion of more effective methods for conservation and sustainable use of tropical forest resources by the Commonwealth-Secretariat-supported Iwokrama programme in Guyana, including a participatory survey of the agricultural biodiversity used by indigenous Amerindian populations and the development of a comprehensive intellectual property rights (IPR) system aimed at ensuring that Amerindian knowledge of forest and biological diversity is protected and rewarded; and

(c) The people and forests and reefs project, of the Biodiversity Support Programme (a USAID-funded consortium of WWF, The Nature Conservancy, and WRI) works with indigenous peoples to manage biological diversity, focusing on biologically diverse areas where traditional ethnic identities and institutions are still strong. The project supports the rights of indigenous people and promotes sustainable economic and social development;

(d) The IDRC programme on sustainable use of biodiversity emphasizes the importance of facilitating direct representation of indigenous and local peoples in international discussions, and encourages the incorporation of their perspectives and values into these debates. The programme is intended to provide support to activities such as the development of appropriate exchange and networking strategies among indigenous and local peoples, and research on covenants, guidelines and protocols developed by indigenous peoples and local communities to negotiate their relationships with outside groups. The programme also recognizes the integral role of gender in the sustainable use of biodiversity by supporting research on evolving gender roles in biodiversity management.

124. Gender issues are recognized as being important in addressing the conservation and sustainable use of biological diversity, in view of the often distinct roles and responsibilities of men and women in farming household, for example, seed selection and storage, pest control, soil management. The development of a strategy for addressing gender considerations through implementation of the GPA/PGR was the subject of an IPGRI/FAO working group meeting held in Rome in October 1996. The M.S. Swaminathan Research Foundation will organize an international technical consultation on gender dimensions in biodiversity management and food security in November 1999.

Trade, marketing and incentives

125. Financial and other incentives are needed to reduce chemical inputs and promote soil conservation, to promote stewardship and responsible use of natural resources, and to protect border and wildlife habitats. Economic valuation of natural resources can help provide incentives to conserve them. The economic impact of soil erosion in Canada, for example, is estimated to be between $484 and $707 million per year (Agriculture Canada, 1994). Canada is developing an environmental valuation reference inventory (EVRI), a storehouse of valuation studies that is capable of matching current policy requirements with previous studies.

126. Despite the significant efforts ongoing that address farming systems and abiotic resources, and in accordance with the outcome of the CBD-FAO workshops supported by the Government of the Netherlands (June 1997 and December 1998), agricultural biodiversity issues at system level deserve more attention, including resource interactions and synergies in mixed production systems and ecosystem services.

4. Concluding remarks on needs for strategies, programmes and action plans

127. A concerted and coordinated effort that addresses the various components of agricultural biodiversity depends upon a coherent framework to guide national strategies and actions for the conservation and sustainable use on agricultural biodiversity, as well as a dynamic process that ensures country level flexibility and updating of regional and international priorities and actions. Mainstreaming of agricultural biodiversity considerations into national agricultural strategies and action plans, including forestry and fisheries, is necessary, as well as into environmental programmes, such as national environmental action plans (NEAPs) and environmental strategies and policies addressing specific resources such as forest and wildlife resources

128. The agricultural sector is very complex and there are many different stakeholders that need to be involved in the planning and development process, including farmers, foresters and fishermen (the producers); community leaders the technicians and policy makers in the diverse sectors including the agri-business; non-governmental organizations and development agencies; as well as the consumers that influence market demand. The sustainable management of agricultural biodiversity by farmers and their communities, in particular, is a prerequisite to achieving sustainable increases in food and livelihood security and to protecting natural resources. Consumer organizations are also increasingly influential in this regard. Transparent consultative processes are required to allow exchanges, negotiation and, as required, conflict resolution between different stakeholders and also to provide effective feedback mechanisms between producers and researchers and the technical and policy levels. This is crucial in the identification of issues and priorities, the design of appropriate strategies and actions, and the monitoring and evaluation of the performance and impacts (cost effectiveness and impact) of programmes and actions. Hence, the importance of coordinating mechanisms between relevant organizations and bodies to ensure the elaboration of coherent policies, strategies and actions at international, regional and national levels and their continual appraisal. The establishment of policy and technical-level committees and working/expert groups at different levels will allow systematic consultation between relevant sectoral institutions in the implementation, monitoring and evaluation of strategies and action plans.

129. There is a need to strengthen the capacities of farmers, their communities, and other stakeholders, including producer organizations, to manage agricultural biodiversity so as to increase their benefits, and promote awareness and responsible action by producer organizations and agro-enterprises.

D. Policies and legislation

130. The Convention itself provides the main international framework for policies and legislation concerning the conservation and sustainable use of agricultural biodiversity, and the sharing of benefits derived from its use. There are, however other important instruments, including on the one hand, legal instruments such as the world trade agreements which may impact on agricultural biodiversity, and on the other hand, specific agreements which concern particular components. The extent to which specific national policies and legislation has been developed varies greatly between countries.

1. Genetic resources for food and agriculture

131. The International Undertaking on Plant Genetic Resources for Food and Agriculture (IU-PGRFA) is currently under revision under the Commission on Genetic Resources for Food and Agriculture. It will provide a binding international agreement for the conservation and sustainable use of PGRFA in harmony with the Convention on Biological Diversity, including a multilateral system of access and benefit-sharing. Some countries have legislation governing access to genetic resources, but most are awaiting completion of the International Undertaking. Meanwhile, many countries and institutions use the FAO Code of Conduct on Germplasm Collection and Transfer to guide their approach.

132. CGRFA is currently examining the needs for further policy development in the context of the Global Strategy for the Management of Farm Animal Genetic Resources. Some countries (e.g., 12 countries in the Asian region) are developing national policies for animal genetic resources characterization, conservation and sustainable use.

133. Policy and legislative measures relevant to plant and animal genetic resources are being developed by many countries, such as the development of biotechnology and biosafety regulations, seed policy to encourage traditional varieties; semen and embryo policy for zoosanitary and zootechnical purposes; food policy to increase marketing of local food crops and animal products; intellectual property, access to plant genetic resources; as well as germplasm collection and exchange. Phytosanitary policy under the International Plant Protection Convention (IPPC) enables safe international transfer of plant genetic resources and safe transfer of animal genetic resources is facilitated by the OIE guidelines. Most countries have legislation concerning seed certification and variety release. Reviews of such regulatory and policy frameworks have suggested that there is a need for a more flexible approach concerning the use of farmers' varieties and farm-produced seed.

134. The FAO Code of Conduct for Responsible Fisheries (FAO Conference, 1995) provides a guiding framework for all countries and for international efforts to ensure the sustainable exploitation of aquatic living resources in harmony with the environment. It includes the protection of living aquatic resources and their environments as well as responsible development of aquaculture within transboundary aquatic ecosystems and the use of aquatic genetic resources for the purpose of aquaculture, including culture-based fisheries. The Code establishes principles and standards applicable to the conservation, management and development of all fisheries, including post-harvest practices and trade.

135. There are currently no codes of conduct or legislation specific to microbial genetic resources.

136. Policies for the use of genetic resources associated with best practices in utilizing modern technologies, e.g., biotechnologies, are required to enable countries to more effectively and efficiently respond to the food and agriculture imperative. Many countries report changes since 1995 in legislation on matters such as plant breeders' rights and other relevant intellectual property rights, and access legislation. In particular, the need for members of the World Trade Organization to develop legislation consistent with Article 27.3(b) of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) has been highlighted. Many countries indicate a continuing need for policy capacity-building. The draft code of conduct for

biotechnologies as they relate to the conservation and use of genetic resources for food and agriculture will be addressed by CGRFA at its next session, in 2001.

2. Ecological and ecosystem functions

137. The following international legal agreements and codes of conduct provide support in various ways to the maintenance of ecosystem functions and services. Many address certain harmful agricultural practices such as the use of pesticides, biological control agents and the introduction of plant pests.

138. The International Plant Protection Convention (IPPC) aims at cooperation in the control of introduction and spread of plant pests (or "alien invasive species"), and in the promotion of appropriate measures for their control. It includes the protection of cultivated and wild plants from direct and indirect effects of pests and weeds. In support of this Convention, the Secretariat, hosted by FAO, has prepared: guidelines for pest risk analysis; a code of conduct for the import and release of exotic biological control agents; requirements for the establishment of pest-free areas; principles of plant quarantine as related to international trade; and guidelines for surveillance and export certification systems.

139. The Convention for the Application of the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1999) is jointly administered by FAO and UNEP, and with WHO makes recommendations for maximum residue levels. The FAO International Code of Conduct on the Distribution and Use of Pesticides **(**as adapted to reflect the PIC principle) sets out responsibilities (between government, industry and others) and voluntary standards of conduct for all public and private entities concerned. It provides a point of reference to assist developing countries until they have an adequate regulatory infrastructure. Supporting technical guidelines have been developed.

140. The Codex Alimentarius Commission (CAC), was set up to implement the Joint FAO/WHO Food Standards Programme, and aims to ensure consumers' health and fair practices in the food trade. Codex Standards includes all food safety considerations, inter alia, food quality, labelling, systems for inspection and certification. The Commission also outlines codes of practice and maximum limits for residues of agricultural and veterinary chemicals and conducts risk assessments to human health. Its guidelines and recommendations, as well as those of OIE and IPPC, are used in applying the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS), which permits Governments to impose trade restrictions and measures to protect human, animal or plant heath, including wild flora and fauna as well as commercial species, from the spread of pests and diseases.

141. Many countries also have national legislation on factors affecting ecosystem functions and services, such as the reduction of chemical inputs; conservation farming practices and organic agriculture; and introduction and control of alien invasive species.

142. Legal arrangements that address the landscape and ecosystem level have been addressed most substantively by the European region. Agenda 21 is a strategic document outlining a package of measures adopted by the European Commission (July 1997, document 97/6), and setting out how the European Union should develop its common policies beyond the year 2000 including reform of the Common Agricultural Policy (CAP) to integrate environmental concerns into

agriculture. Agricultural-environmental instruments are being utilized to support sustainable development of rural areas and provide environmental services in response to society demand, for example direct payments and targeted measures to address problems such as water quality, soil degradation and erosion, and burning of residues. Measures such as subsidizing set-aside land are being implemented and monitored. It is increasingly recognized that conservation agriculture can effectively contribute to solving environmental problems regarding the agricultural land base and genetic erosion.

143. A number of countries have mentioned a range of legislation that addresses the landscape and ecosystem level including, inter alia: catchment protection, i.e., through forest management and conservation, soil conservation; environmental pollution and waste management; and environmental impact assessment (EIA) legislation including a strategies for evaluating programmes that encourage ecological compensation.

144. There are several examples of international codes of conduct and legislation that support biological diversity-friendly farming, such as the FAO Code of Conduct for Responsible Fisheries, guidelines for environmentally sound tillage practices for the protection of soils, and the International Code of Conduct on the Distribution and Use of Pesticides.

3. Socio-economic factors

Trade-related policies and legislation

145. A number of countries note that conducive trade and marketing policies are needed to promote biological diversity, such as the increased use of traditional varieties, breeds or under-utilized species. This requires the review of pricing and marketing and trade related policies, for instance farm animal and crop subsidies that provide disincentives to biological-diversity conservation. An effective example is provided by the organic agriculture movement, for which specific needs have been identified for organic and eco-labelling. In many countries, policies aimed at intensive use of resources and economic development may conflict with natural resources management, biological diversity conservation and the sustainability of production systems.

146. The Uruguay Round Agreements (URA) aim to provide greater access to world markets and curb practices that distort production and trade. In the short term, however, some countries/regions may be adversely affected by loss of markets and price increases of some imported products. Many developing countries, particularly the least developed, may have neither the capacity nor the resources to face the challenges or capture export opportunities flowing from the Uruguay Round. There are four main agreements relevant to food and agriculture:

(a) The WTO Agreement on Agriculture establishes basic rights and obligations for governments relating to trade in agricultural products. In particular, it prohibits the use of agriculture-specific import restrictions other than custom tariffs, restricts the use of export subsidies for agricultural products, and disciplines the use of trade-distorting domestic support in favour of agricultural producers. The Agreement is supplemented by specific commitments, on the part of members, to improve market access and reduce export subsidies and trade-distorting domestic support. Publicly funded domestic support measures that have no, or at most minimal, trade distorting effects on production are exempt ("Green Box" measures). The "Green Box" covers a wide variety of measures that are part of a defined

environmental or conservation programme meeting certain criteria and related research programmes. Many programmes to promote the conservation of agricultural biodiversity are covered by the exemption;

(b) The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) concerns the application of measures associated with the protection of human, animal and plant health in such a way that they are not a disguised restriction on international trade. In regard to agricultural biodiversity, it concerns plant and animal quarantine measures and measures taken to ensure food safety, including Codex Alimentarius standards;

(c) The Agreement on Technical Barriers to Trade (TBT) seeks to ensure that technical regulations and standards, inter alia, labelling requirements do not provide obstacles to trade. Of particular interest to agricultural biodiversity are regulations and labelling for organic produce and safety of biotechnology products. The SPS and TBT Agreements both acknowledge the importance of harmonizing standards so as to minimize or eliminate the risk of sanitary, phytosanitary and other technical standards becoming barriers to trade;

(d) The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) provides protection to encourage countries to conduct more research and innovation and to improve access to new technology, including environmental technology. An important provision permits a country to exclude an invention from patent protection if that the commercialization of that invention seriously endangers the environment.

147. Technical assistance is provided by FAO to member countries in implementing the Uruguay Round Agreements, including the booklet, "FAO technical assistance and the Uruguay Round Agreements", which discusses the significance of these agreements for agriculture, forestry and fisheries, and outlines specific areas in which expertise can continue to be provided to help countries take advantage of current and potential export opportunities and minimize possible negative repercussions. Short-term policy advice has been provided to small island developing States to help them analyse URA issues and address policy and trade-related issues. FAO also supports conservation and use of local varieties of food crops and their products through identifying and promoting niche markets, also market research and development to promote the production of diverse local varieties of crops, including the marketing of non-wood forest products programme of the Forest Products Division. Collaboration between those concerned with food and nutrition and with food quality and standards is important for the promotion of species with international marketing potential.

148. A number of international organizations are working on trade and policy for more sustainable agriculture. Work in OECD, for example, aims to improve the design, implementation and coherence between agricultural and environmental policies. The IIED environmental economics programme (EEP) seeks to develop and promote the application of economics to understand and address the links between natural resource use, environmental quality, economic development and poverty alleviation, and IISD also has a trade and sustainable development programme. With regards to wild plants, TRAFFIC has a programme on use and trade in medicinal and aromatic plants and ornamentals. It has undertaken a great deal of policy analysis and work on the economic evaluation of wild species in trade and co-operated with CITES, and is concerned with transparency of economic benefits and looking at benefit-sharing issues.

Local and traditional knowledge and practices

149. In the development and review of policies and legislation there has been inadequate attention to take into account and to assess the impacts and effectiveness of traditional measures for (agricultural) biodiversity conservation. There is a need for the integration of traditional measures into legislation where possible and appropriate, for instance, basing laws on traditional taboos, seasonality, etc. There is also a need for conflict-resolution mechanisms involving dialogue and consultative processes.

150. Several countries have identified the need for policies and legislation that encourage socio-economic sustainability through providing incentive measures and benefit-sharing arrangements. Land tenure issues and appropriate land-use policies are cited as important issues for conservation and sustainable use to reduce over-exploitation and unregulated access and pressures on biological resources.

151. The issue of Farmers' Rights is being addressed in the ongoing negotiations for the revision of the International Undertaking on Plant Genetic Resources to bring it into harmony with the Convention on Biological Diversity, including national sovereignty and an international fund for the implementation of Farmers' Rights. According to FAO member countries (resolution 5/89), "Farmers' rights mean rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources, particularly those in the centres of diversity/origin".

4. Concluding remarks on needs for policies and legislation

152. There is a clear need to ensure coherence at national, regional and international levels between policies and legislation developed specifically to address the conservation and sustainable use of agricultural biodiversity, access to genetic resources, and the sharing of benefits derived from their use, and other between policies and legislation which impact on these matters. This may require review and, as appropriate, adjustment of such policies and legislation.

Annex I

SOURCES OF INFORMATION

Convention on Biological Diversity

- Text of the Convention on Biological Diversity
- Decision II/15 of the Conference of Parties to the Convention on Biological Diversity
- Decision III/11 of the Conference of Parties to the Convention on Biological Diversity
- Decision IV/6 of the Conference of the Parties to the Convention on Biological Diversity

Plans of action

- Agenda 21 (especially chapters 10 and 14)
- World Food Summit Plan of Action 1996
- Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for food and Agriculture.

Codes of conduct

- FAO Code of Conduct for Responsible Fisheries and guidelines
- FAO International Code of Conduct on the Distribution and Use of Pesticides
- IPPC guidelines for pest risk analysis, code of conduct for the import and release of exotic biological control agents, requirements for the establishment of pest free areas, principles of plant quarantine as related to international trade, and guidelines for surveillance and export certification systems.
- ICES/European Fisheries Advisory Commission Code of Practice on Species Introductions
- OIE International Health Code, Manual of Standards for Diagnostic Tests and Vaccines

Conventions and other agreements

- Convention for the Application of Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1999)
- WTO Uruguay Round Agreements SPS, TBT, TRIPS, Agreement on Agriculture.
- International Undertaking on Plant Genetic Resources

Reports and inventories

- Overviews of agricultural biodiversity -ongoing activities and instruments: national level inventory of agricultural biodiversity -ongoing activities and instruments: international level reports from international organizations on ongoing activities and instruments on agricultural biodiversity submitted to FAO
- Reports from international organizations on their policies, programmes and actions on agricultural biodiversity submitted to the CGRFA (CGRFA-7 and CGRFA-8)
- National reports on the implementation of the Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture, and the global summary (CGRFA-8/99/3)
- Please note: A list of organizations and relevant websites is provided in the Inventory of Agricultural Biodiversity - Ongoing Activities and Instruments: International Level.

Previous documents prepared for the Conference of the Parties to the Convention on Biological Diversity and its Subsidiary Body on Scientific, Technical and Technological Advice

UNEP/CBD/SBSTTA/3/Inf.3 (1997): Compilation of national contributions on agricultural biological diversity.
UNEP/CBD/COP/4/6 (1998): Programme of work on agricultural biological diversity

Global assessments

- The State of the World's Plant Genetic Resources for Food and Agriculture: Food and Agriculture Organization of the United Nations, Rome, 1998
- State of the World's Forests (SOFO 1999)
- The State of World Fisheries and Aquaculture 1998
- Global Forest Resources Assessment 1990
- World Watch List for Domestic Animal Diversity

Workshops/meetings

- Netherlands/FAO/CBD Workshop on Sustaining Agricultural Biodiversity and Agro-Ecosystem Functions (December 1998)
- Workshop on the Conservation and Sustainable Use of Pollinators in Agriculture with an Emphasis on Bees (San Paulo, Brazil, October 1998) (Draft Report)
- FAO Leipzig International Technical Conference on Plant Genetic Resources in 1996
- 13th Session of the FAO Committee on Forestry (COFO)
- ad hoc inter-agency consultation on wild plants convened by DIVERSITAS (Rome, May 1999) (Draft Report)
- 6th World Congress on Genetics Applied to Livestock Production (Armidale, Australia, January 11 - 16, 1998)
- Ad hoc Expert Meeting on Indicators and Criteria of Sustainable Shrimp Culture (Rome, April 1998)
- Regional Workshops on the implementation of the GPA PGRFA
- Workshop on the development of the CGIAR System-wide Microbial Genetic Resources Database (October 1997) (ICARDA)
- First regional workshop of the programme for the Development of Technical Guidelines on Quarantine and Health Certification (Bangkok, January 1998) Network of Aquaculture Centers in Asia, and the International Office of Epizootics.
- Regional workshop on the economic valuation of biodiversity (May 1996, Santiago)
- Harare soil tillage workshop(1998)
- FAO/ICLARM Bellagio Conference: Towards Policies for Conservation and Sustainable Use of Aquatic Genetic Resources (April 1998)
- IPGRI/FAO working group meeting on Plant Genetic Resources (Rome, October 1996)
- International Technical Consultation on Gender dimensions in Biodiversity management and Food Security in November 1999
- Report on Activities Related to Trade and Environment, Biotechnology and SPS/TBT Measures, is available as CCP document 99/15

Case-studies and guidelines

- Case-studies on microbial genetic resources, Government of Canada
- Case-study on direct payments in Swiss agriculture: an incentive measure for the conservation and sustainable use of agricultural biodiversity
- Case-studies provided to the NL/FAO/CBD Workshop on Sustaining Agricultural Biodiversity and Agro-Ecosystem Functions (December 1998)

- FAO guidelines to promote sustainable aquaculture
- Guidelines for environmentally sound tillage practices for the protection of soils (Harare, 1998)
- FAO booklet "Technical Assistance and the Uruguay Round Agreements"
- IPGRI/FAO Paper: National Programmes for plant genetic resources for Food and Agriculture: Coordination and Planning.

Other papers

- Livestock and the environment: finding a balance: http://www.fao.org/WAICENT/FAO/AGA/LXEHTML/tech/contents.htm
- Human Nature: Agricultural Biodiversity and farm-based food security, an independent study prepared by the Rural Advancement Foundation International for the Food and Agriculture Organization of the United Nations.
- Global Biodiversity Forum (IUCN/WRI/UNEP)
- Global Biodiversity Assessment (UNEP, Nairobi, Kenya) published by Cambridge University press, 1995

Annex II

LIST OF ACRONYMS

A

AADIS	Aquatic Animal Diversity Information System
AEP	agri-environmental policies
AEZ	agro-ecological zones
ALCOM	Aquatic Resource Management for Local Communities

B

BNF	biological nitrogen fixation

C

CABI	International Center for Agriculture and Biosciences
CAC	Codex Alimentarius Commission
CAP	Common Agricultural Policy
CAPRI	CGIAR system-wide initiative on collective action and property rights
CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification
CGIAR	Consultative Group on International Agricultural Research
CGRFA	Commission on Genetic Resources for Food and Agriculture
CIAT	International Center for Tropical Agriculture
CIFOR	Centre for International Forestry Research
CITES	Convention of International Trade in Endangered Species of Wild Fauna and Flora
CGIAR-SLP	CGIAR system-wide livestock programme
CLASP	Conservation of Lands in Asia and the Pacific
COFO FAO	Committee on Forestry
COP	Conference of Parties
CORTALC	Conservacion y Rehabilitacion de Tierra en America Latina y el Caribe

D

DAD-IS	Domestic Animal Diversity Information System (FAO)
DIAS	Database on Introductions of Aquatic Species (FAO)

E

ECP/GR	European Cooperative Programme for Genetic Resources
EEAP	European Association for Animal Production
EEP	Environmental Economics Programme (IIED)
EIA	environmental impact assessment
EVRI	Environmental Valuation Reference Inventory (Canada)
EU	European Union

F

FARM	Farmer-centered Agricultural Resource Management Programme (FAO)
FARMESA	Farmer-centered Agricultural Resource Management Programme in Eastern and Southern Africa
FAO	Food and Agriculture Organization of the United Nations
FCCS	Fertility Capability Classification System (FAO)
FFS	farmer field schools (FAO)
FIGIS	Fishery Global Information System
FRA	Forest Resources Assessment (FAO)
FSD	farming systems development

G

GEF	Global Environment Facility
GIS	geographical information systems
GISP	Global Invasive Species Programme
GLASOD	Global Assessment of the Status of Human Induced Soil Degradation (FAO)
GPS	global positioning systems
GPA/PGR	Global Plan of Action for the Conservation and Sustainable use of Plant Genetic Resources for Food and Agriculture
GPPIS	Global Plant Protection Information System (FAO)
GRAIN	Genetic Resources Action Network
GRIN	Genetic Resources Information Network (USA)
GS/AnGR	Global Strategy for the Management of Farm Animal Genetic Resources
GTOS	Global Terrestrial Observing System

I

IAEA	International Atomic Energy Agency
IARCs	international agricultural research centres
IBIN	Indigenous Peoples Biodiversity Information Network
ICARDA	International Centre for Agricultural Research in Dry Areas
ICES	International Council for the Exploration of the Sea
ICIPE	International Centre of Insect Physiology and Ecology
ICLARM	International Center for Living Aquatic Resources
ICRAF	International Centre for Research on Agroforestry
ICRISAT	International Crop Research Institute for the Semi-arid Tropics
ICSU	International Council of Scientific Unions
ICUC	International Center for Underutilized Crops
IDRC	International Development Research Centre
IFA	International Fertilizer Association
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
IIRR	International Institute for Rural Reconstruction
IISD	International Institute for Sustainable Development
ILRI	International Livestock Research Institute
INGA	International Network of Genetics in Aquaculture
IPBN	Indigenous People's Biodiversity Network
IPGRI	International Plant Genetic Resources Institute
IPM	integrated pest management
IPPC	International Plant Protection Convention
IPR	Intellectual property rights
IRRI	International Rice Research Institute
ISCRAL	International Scheme for the Conservation and Rehabilitation of African Lands
ISRIC	International Soil Reference and Information Center
ITDG	Intermediate Technology Development Group
IUBS	International Union of Biological Sciences
IUCN	World Conservation Union
IUFRO	International Union of Forestry Research Organizations
IU-PGRFA	International Undertaking on Plant Genetic Resources for Food and Agriculture
IWMI	International Water Management Institute

J

JECFA	Joint FAO/WHO Expert Committee on Food Additives

L

LinKS	Gender, Biological Diversity and Local Knowledge Systems

M

MAB	Man and the Biosphere programme (UNESCO)
MBC	Mesoamerican Biological Corridor
MERCOSUR	Mercado Común del Sur (Southern Common Market)
MIRCENs	microbial resources centres network in environemental, applied microbiological and biotechnological research

N

NARs	national agricultural research stations
NBSAPs	national biodiversity strategies and action plans
NEAPs	national environmental action plans
NGOs	non-governmental organizations
NWFP	non-wood forest products

O

OECD	Organisation for Economic Co-operation and Development
OIE	International Office of Epizootics

P

PLEC	people, land management and environmental change (UNU)
PGRFA	Plant Genetic Resources for Food and Agriculture
PEBLDS	Pan-European Biological and Landscape Diversity Strategy (Council of Europe)
PIC	prior informed consent procedure

Q

QTLs	quantitative trait loci

R

REFORGEN	World-wide Information System on Forest Genetic Resources (FAO)

S

SADC	Southern African Development Community
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice
SCOPE	Scientific Committee on Problems of the Environment
SEARICE	South East Asia Regional Institute for Community Education
SFI	Soil Fertility Initiative
SGRP	system-wide genetic resources programme (CGIAR)
SID	small island developing States
SIFAR	Support Unit for International Fisheries and Aquatic Research (FAO/ICLARM)
SINGER	System-wide Information Network on Genetic Resources (CGIAR)
SRISTI	Society for Research and Initiatives for Sustainable Technologies and Institutions
SPS	Agreement on the Application of Sanitary and Phytosanitary Measures
SOTER	soil and terrain database
SUB	programme on sustainable use of biodiversity (IDRC)
SWIM	system-wide initiative on water management (CGIAR)
SWNM	Soil, Water, and Nutrient Management (CGIAR)

T

TBT	Agreement on Technical Barriers to Trade
TRAFFIC	Wildlife trade monitoring programme of WWF and IUCN
TRIPs	Trade-Related Aspects of Intellectual Property Rights
TSBF	Tropical Soil Biology and Fertility

U

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNU	United Nations University
URA	Uruguay Round Agreements
USAID	United States Agency for International Development

W

WCMC	World Conservation Monitoring Centre
WHO	World Health Organization
WIEWS	World Information and Early Warning System (FAO)
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
WOCAT	World Overview of Conservation Approaches and Technologies
WRI	World Resources Institute
WTO	World Trade Organization
WWF	World-Wide Fund for Nature
WWL-DAD	World Watch List for Domestic Animal Diversity

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