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IN-DEPTH REVIEW OF THE PROGRAMME OF WORK ON AGRICULTURAL BIODIVERSITY

Note by the Executive Secretary

1. In paragraphs 2 and 4 of decision VIII/23 D, the Conference of the Parties invited the Convention on Biological Diversity to collaborate with the Food and Agriculture Organization of the United Nations (FAO) in order to prepare a full review of the programme of work on agricultural biodiversity for consideration by the Conference of the Parties at its ninth meeting.

2. Accordingly, the Executive Secretary is circulating herewith, for the information of participants in the thirteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, the review prepared by FAO, as part of the requested collaboration, entitled "The International organizations' Contribution to the Implementation of the Programme of Work on Agricultural Biodiversity: How Far Have We Come?".

3. The document is being circulated in the form and language in which it was received by the Secretariat.

* UNEP/CBD/SBSTTA/13/1.

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IN-DEPTH REVIEW OF THE PROGRAMME OF WORK ON AGRICULTURAL BIODIVERSITY

THE INTERNATIONAL ORGANIZATIONS' CONTRIBUTION TO THE IMPLEMENTATION OF THE PROGRAMME OF WORK ON AGRICULTURAL BIODIVERSITY:

HOW FAR HAVE WE COME?

NOVEMBER 2007

FAO

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LIST OF ACRONYMS

ACRONYMS

ADB	Asian Development Bank
AgBD	Agricultural Biodiversity
ALARM	Assessment of Large Scale Environmental Risks with Tested Methods
AnGR	Animal Genetic Resources
ANPE	National Association of Ecological Producers
API	African Pollinators Initiative
AVRDC	World Vegetable Center - the Asian Vegetable Research and Development Center
BEFS	Bioenergy and Food Security Project
BRC	Biological Resources Center
BUCAP	Biodiversity Use and Conservation in Asia Program
BWARS	*Bees, Wasps and Ants Recording Society*
CABI	International Centre for Agriculture and Biosciences
CABI	CAB International (Knowledge Management)
CBA	Capture-Based Aquaculture
CBD	Convention on Biological Diversity
CBF	Culture-Based Fisheries
CGIAR	Consultative Group on International Agricultural Research
CGRFA	Commission on Genetic Resources for Food and Agriculture
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
CINE	Centre for Indigenous Peoples' Nutrition and Environment
COHAB	Co-operation on Health and Biodiversity
CONDESAN	Consorcio para el Desarollo Sostenible de la Ecorregión Andina
COP	Conference of Parties
DAD-Is	Domestic Animal Diversity Information Service
DAF	DNA Amplification Fingerprinting
DNA	Deoxyribonucleic acid
DSD	United Nations Division for Sustainable Development
ECABREN	Eastern and Central Africa Bean Research Network
ECOWAS	Economic Community of West African States
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
EP	Ecoagriculture Partners
ETC	ETC Group – Action Group on Erosion, Technology and Concentration
EU	Eurposean Union
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field Schools
FIVIMS	Food Insecurity and Vulnerability Information and Mapping Systems
GBIF	Global Biodiversity Information Facility
GEF	Global Environment Facility
GFRA	Genetic Resources for Food and Agriculture
GIAHS	Globally Important Agricultural Heritage Systems
GMO	Genetically Modified Organism
GPA	Global Plan of Action
GRAIN	Genetic Resources Action International
GRIN	Germplasm Resources Information Network

GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
GURTs	Genetic Use Restriction Technologies
IAASTD	International Assessment on Agricultural Science and Technology for Development
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICIPE	International Centre of Insect Physiology and Ecology
ICUC	International Centre for Underutilized Crops
IFDC7	7th International Food Data Conference
IFPRI	International Food Policy Research Institute
IFOAM	International Federation Organic Agriculture Movement
IIASA	International Institute for Applied Systems Analysis
IIASTD	International Assessment on Agricultural Science and Technology for Development
IICA	Instituto Interamericano de Cooperación Para la Agricultura
IIED	International Institute for Environment and Development
IK	Indigenous Knowledge
ILEIA	Centre for Information on Low External Input and Sustainable Agriculture
ILRI	International Livestock Research Institute
INESP	International Network for Expertise in Sustainable Pollination
IPCC	International Panel on Climate Change
IPI	International Pollinators Initiative
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRD	Institut pour la Recherche et le Développement
IT-PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	The World Conservation Union
LEISA	Magazine on Low External Input and Sustainable Agriculture
LPP	League for Pastoral Peoples
MDG	Millennium Development Goals
MEA	Multilateral Environmental Agreements
MEA	Millennium Ecosystem Assessment
MYPoW	Multi-Year Programme of Work
NABP	National Agricultural Biodiversity Programme
NBSAP	National Biodiversity Strategy and Action Plan
NIMS	National Information Sharing Mechanisms
NGOs	Non-Governmental Organizations
OECD	Organisation for Economic Cooperation and Development
OIE	International Office of Epizootics
PAN	Pesticide Action Network International
PGRFA	Plant Genetic Resources for Food and Agriculture
PoW	Programme of Work
REFORGEN	FAO Worldwide Information System on Forest Genetic Resources
SADC	Southern African Development Community
SADC ICOSAMP	Southern African Development Community - Information Core for Southern African Migrant Pests
SAPA	FAO Sub-Regional Office for the Pacific Islands
SBI	Soil Biodiversity Initiative
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice

SEARICE	South East Asia Regional Initiatives for Community
SoW	State of the World
SPAS	Squash Pollinators of the Americas Survey
TK	Traditional Knowledge
ToT	Training of Trainers
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
	Development (CBTF)
UNESCO	United Nations Educational, Scientific and Cultural Organization
WB	World Bank
WBCSD	World Business Council for Sustainable Development
WIEWS	FAO's World Information and Early Warning System
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development

PREFACE

Objective

In its decision VIII/23, the Conference of Parties to the Convention on Biological Diversity (COP) requested the Executive Secretary, in partnership with the Food and Agriculture Organization of the United Nations (FAO) and in consultation with other relevant international organizations, to prepare a full review of the Programme of Work on Agricultural Biodiversity, for consideration by the Conference of Parties at its ninth meeting in May 2008. The primary aim of the review is to determine progress made in advancing the objectives of the Convention within the thematic area of agricultural biodiversity. In addition to reviewing progress made, the review also identified barriers and gaps in implementation and assessed, where relevant, how the Programme addresses major challenges and emerging issues.

This review specifically focuses on the activities undertaken by international organizations in the implementation of the Programme of Work on Agricultural Biodiversity. It is primarily based upon the inputs received following a survey competed by international institutions, and internet research on activities of international institutions. Hence, limitations associated with survey approaches apply. While part of the mandate of many international organizations is to assist national governments in implementing the Programme of Work on Agricultural Biodiversity (PoW AgBD), it is not the scope of this review to analyse national reports.

Background

Recognizing the "...special nature of agricultural biodiversity, its distinctive features, and problems needing distinctive solutions", the Programme of Work on Agricultural Biodiversity (PoW AgBD) was developed by FAO in collaboration with the CBD Secretariat, at the invitation of the Conference of the Parties (COP). The PoW AgBD was endorsed by the CBD Conference of Parties (COP) in 2000 (decision V/5). The PoW AgBD defines the scope of agricultural biodiversity is a "broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agro-ecosystem: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes..". By definition, agricultural biodiversity is complex, and involves a range of components. The PoW was structured in such as way as to address this complexity. It is mainly composed of four elements (assessment, adaptive management, capacity building and mainstreaming), and three International Initiatives (on pollinators, soil biodiversity and biodiversity and nutrition) were subsequently developed to address these issues considered as requiring specific attention.

The four elements of the Programme of Work do not act in isolation; rather, they are closely linked to each other and are intended to be mutually reinforcing. The linkages between and among elements taking into account spatial and temporal scales and management levels is a reflection of the main approach within which the PoW AgBD operates, namely the Ecosystem Approach[1].

[1] The Ecosystem Approach provides a basis for the implementation of the Programme of Work. (Decision V/5, Annex, paragraph 4), and is particularly relevant to the second programme element, as adaptive management is a core concept in the implementation of the Ecosystem Approach.

PART I: STATUS AND TRENDS OF, AND THREATS TO, AGRICULTURAL BIODIVERSITY

CHAPTER 1: Status and Trends of, and Threats to, Agricultural Biodiversity[2]

The following chapter presents a general overview of the status and trends of different components of agricultural biodiversity, as well as potential and/or identified threats. In order to achieve a comprehensive vision of the status and trends, and threats to, agricultural biodiversity, it is necessary to look at: (i) all components of agricultural biodiversity; and (ii) at all levels of biodiversity, including at the ecosystem level. As part of its expanded mandate, the Commission on Genetic Resources for Food and Agriculture is currently undertaking studies on different components of agricultural biodiversity, including micro-organisms and invertebrates. In addition, work undertaken by the Commission, as indicated also in its Multi-Year Programme of Work (discussed at the 11th Regular Session of the Commission), will include consideration of the internalization of the ecosystem approach to biodiversity management in agriculture, forestry and fisheries (envisaged for the 15th Regular Session of the Commission), and at the 16th Regular Session of the Commission, will present *The State of the World's Biodiversity for Food and Agriculture.*

1.1 Plant Genetic Resources for Food and Agriculture (PGRFA)

The State of the World's Plant Genetic Resources for Food and Agriculture

The first *State of the World's Plant Genetic Resources* was published by FAO in 1998. The primary source of information was 154 country reports.[3] The purpose of *The State of the World's Plant Genetic Resources* was to provide an analytical basis for the rolling *Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture*, which the International Technical Conference adopted. Currently, the second *State of the World's Plant Genetic Resources* is being prepared.

A number of main issues emerged from the first *State of the World's Plant Genetic Resources* – some examples include that a much larger group of plants than the major staples are important, from a local, national or regional perspective – a greater focus on minor and under-utilized crops was needed. It was noted that the loss of PGRFA was substantial, and genetic erosion was continuing (an example was given of large-scale genetic erosion of local varieties of native crops and crop wild relatives in Andean countries). Considerable genetic uniformity was also noted (e.g. in sunflowers).

It was also noted that there was a need for integrated conservation strategies for PGRFA, based on the complementarity of *in situ* and *ex situ* conservation, especially in developing countries.

With regards to *ex situ* conservation, as of 1996, a total of over 1,300 collections were recorded in the WIEWS database. Approximately 6.1 million accessions were stored world-wide in field genebanks. Over 40% of all the accessions in genebanks were cereals, followed by food legumes (15%). However, it was also noted that there was a lack of characterization and evaluation data.

In terms of plant breeding, it was noted that the success of modern plant breeding was uneven regionally. For example, the large increases in wheat, rice and maize production in Asia was not replicated in Africa. More than a quarter of countries (and over half of the reports from Africa) indicated that poor seed production and distribution systems constrain the dissemination of improved crop varieties.

[2] All documentation related to the 11th regular Session of the CGRFA can be found at: http://www.fao.org/ag/cgrfa/cgrfa11.htm
[3] Some 159 countries and many international and non-governmental organizations participated in a series of regional and sub-regional preparatory meetings, over a period of three years.

In November 2004, a document on the "Country Progress Report of the GPA" was prepared for the 10th Regular Session of the CGRFA[4], describing the status of the implementation of the twenty priority activity areas of the GPA. An extract of the main outcomes are presented below:

In situ Conservation and Development (Activity areas 1-4)
There was general improvement in the implementation of all four Activity areas, with some important exceptions. Of note, in this regard, is that in the African region implementation in some Activity areas has not improved, and in fact, has worsened. Countries gave high priority to inventory activities, funded almost solely by national budgets, while international support tended to concentrate on activities related to on-farm management covering mainly crop improvement in all regions, and improvement of on-farm seed supply in African countries. Promoting conservation of wild crop relatives is receiving increasing attention at the national level in the European, Africa, and Asia and the Pacific regions, with stronger support from donors.

Ex situ Conservation (Activity areas 5 – 8)
Countries continue to give priority to ex situ collection activities, reporting a high number of projects and activities. However, long-term funding for ex situ conservation remains an issue with countries reporting budget cuts and staff reductions. With the exception of the European and the Asia and the Pacific regions, countries reported concerns for their ability to regenerate their collections, especially in the absence of external support. Micro-propagation appears to be the new technology most widely applied for conservation purposes, which is reflected by the large number of projects applying molecular methods for germplasm conservation and characterization.

Utilization of plant genetic resources (Activity areas 9 – 14)
Despite significant efforts in characterization in the Asia and Pacific and the European regions, overall investment in characterization of ex situ collections remains rather low. It appears that more emphasis is currently given to the establishment of collections, rather than to active utilization. Genetic enhancement and base-broadening activities increased since 2001, resulting from both national and external support. In spite of the potential to enhance the use of locally underutilized or biodiversity-rich products reported by countries, there appears to be inadequate incentives and flexible policy frameworks for commercialization of local varieties and diversity-rich products. There are also reports of increasing difficulties in accessing germplasm, which countries mention as drawback to realizing the objectives of the GPA.

Institutions and Capacity-building (Activity areas 15 – 20)
Despite strong deep regional differences overall, some progress was achieved in enhancing institutional frameworks and building capacity. There were continuing efforts to build strong national programmes on PGRFA during the reporting period, with legislation being passed on PGRFA access, seed and phytosanitary issues. Assistance for capacity building may be required to help countries in the implementation of new legal frameworks. The important role of networks was recognized by many reporting countries. From the data reported, strengthening some regional and crop networks may be necessary to ensure good coverage of important crops in all regions, particularly in the Near East. Although some progress was observed, much remains to be done to strengthen the development of national information systems on PGRFA. Given the importance of documenting PGRFA, external support will be required to succeed in this endeavour. The need for systems to monitor early genetic erosion, reported in particular by African countries, also deserves to be mentioned in this context. Training in this Activity area increased slightly during the current reporting period, although it focused in a few areas. Positive trends were reported in the level of public awareness of the values of PGRFA.

The *Second State of the World's Plant Genetic Resources for Food and Agriculture* is currently under preparation, and will be presented to the 12th Regular Session of the Commission on Plant Genetic

[4] CGRFA-10/4/Inf 6

Resources for Food and Agriculture, at the end of 2009. Assessments have started in 60 countries, and to date, 28 Country Reports have been received by FAO. To facilitate these PGRFA assessments, assistance has been provided to 57 countries to establish National Information Sharing Mechanisms on PGRFA (NISM), comprising a permanent participatory monitoring framework with a web-portal and database addressing all aspects of the Global Plan of Action for the Conservation and Sustainable Utilization on Plant Genetic Resources for Food and Agriculture (GPA). To date, this process has been completed in 32 countries.

It was noted that, in the context of the preparation of the *Second State of the World's Plant Genetic Resources for Food and Agriculture* there was a need for additional information on grasslands and forage species, and to this effect, a background paper was prepared and presented at the 11th Regular Session of the Commission on Plant Genetic Resources for Food and Agriculture[5]. The main conclusions from the study indicated that to meet the demand for livestock products there will be increased reliance on forage based production systems. In many smallholder mixed farming systems fodder crops are increasingly used to supplement crop residues as the basis of ruminant rations. The importance of fodder crops is highlighted for both dryland systems for livestock productivity and drought mitigation and to meet the growth in livestock intensification to satisfy expanding urban markets.

1.2 Animal Genetic Resources for Food and Agriculture

The preparation of *The State of the World's Animal Genetic Resources for Food and Agriculture*
In 1999, the Commission on Genetic Resources for Food and Agriculture during its Eighth Regular Session agreed that FAO should coordinate the preparation of a country-driven report on *The State of the World's Animal Genetic Resources for Food and Agriculture* (SoW-AnGR) (FAO, 2007). Subsequently, 169 Country Reports, reports received from international organizations, and 12 thematic studies commissioned by FAO, contributed to the preparation of the SoW-AnGR. The final version of the SoW-AnGR was presented to, and adopted by, the CGRFA at its Eleventh Regular Session in June 2007[6].

Status and trends of animal genetic resources[7]
The following analysis is based on FAO's Global Databank for Animal Genetic Resources for Food and Agriculture (the backbone of the DAD-IS[8] system), which is the most comprehensive global information source for livestock genetic diversity.

Assessing the status of animal genetic resources on a global scale presents some methodological difficulties. In the past, analysis of the Global Databank to identify breeds that are globally at risk was hampered by the structure of the system, which is based on breed populations at the national level. To address this problem, and to enable *The State of the World's Animal Genetic Resources for Food and Agriculture* to offer a more useful assessment, a new breed classification system was developed. Breeds are now classified as either local or transboundary, and further as regional or international transboundary.

Box A new classification system for breed populations

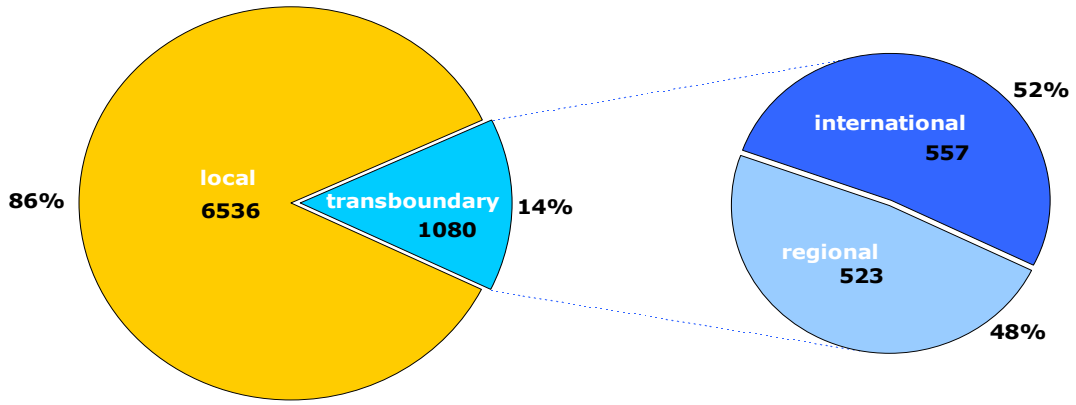
Under the new system of breed classification developed for *The State of the World's Animal Genetic Resources for Food and Agriculture*, the primary distinction is between breeds that occur in only one country, which are referred to as "local" breeds, and those that occur in more than one

[5] Background Study Paper No 40 "Plant Genetic Resources of Grassland and Forage Species". This paper is also one of the Thematic Background Studies requested by the 9th Regular Session of the CGRFA as part of the Second SoW-PGRFA (all Thematic Background Studies are listed in *Annex 2* of CGRFA-9/02/8)
[6] *The State of the World's Animal Genetic Resources for Food and Agriculture*is available at http://www.fao.org/docrep/010/a1250e/a1250e00.htm http://www.fao.org/docrep/meeting/011/ah834e/ah834e00.htm
[7] This section is extracted from FAO. 2007. *The State of the World's Animal Genetic Resources* – in brief, edited by D. Pilling & B. Rischkowsky. Rome.
[8] http://www.fao.org/dad-is

country, which are referred to as "transboundary" breeds. Within the transboundary breed category, a further distinction is drawn between "regional" transboundary breeds – those that occur in more than one country within a single region, and "international" transboundary breeds – those that occur in more than one region. The decision as to which national-level breed populations should be considered as belonging to a transboundary breed was taken on the basis of expert judgment and reviewed by National Coordinators for the Management of Animal Genetic Resources from the relevant countries. Although some refinements are still required, the new classification has proved to be very useful as a framework for assessing breed diversity at global and regional levels.

A total 7 616 breeds are recorded in the Global Databank; 6 536 are local breeds and 1 080 are transboundary breeds. Among the transboundary breeds, 523 are regional transboundary breeds, and 557 are international transboundary breeds (Figure 1).

Figure 1. Share of local and transboundary breeds in the world total



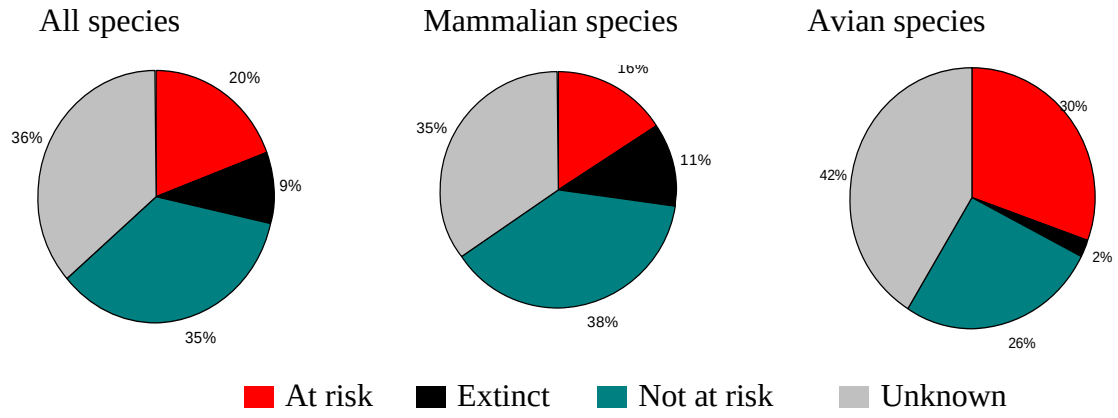
There are some regional differences in terms of the relative importance of the different breed categories. In most regions – Africa, Asia, Europe and the Caucasus, Latin America and the Caribbean, and the Near and Middle East – local breeds make up more than two-thirds of all breeds. Conversely, international transboundary avian and mammalian breeds dominate in the Southwest Pacific and North America. Regional transboundary mammalian breeds are relatively numerous in Europe and the Caucasus, Africa, and to lesser extent Asia, while it is only in Europe and the Caucasus that there are many regional transboundary avian breeds. It should be noted that extinct breeds are excluded from these figures.

For most species, the Europe and Caucasus region has a far higher share of the world's total number of breeds than it has of the world's total animal population. This is partly because in this region many breeds are recognized as separate entities even when they are closely related genetically. It also reflects the advanced state of breed inventory and characterization in this region. In many other regions, work in these fields is restricted by a lack of technical resources and trained personnel.

Breed risk status

A total of 1 491 breeds (20 percent) are classified as being "at risk"[9]. The true figure will be even higher, as population data are unavailable for 36 percent of breeds. Figure 3 summarizes the proportion of breeds falling into each risk status category.

Figure 3. Proportion of the world's breeds by risk status category



The regions with the highest proportion of their breeds classified as at risk are Europe and the Caucasus (28 percent of mammalian breeds and 49 percent of avian breeds) and North America (20 percent of mammalian breeds and 79 percent of avian breeds). These two regions have highly specialized livestock industries, in which production is dominated by a small number of breeds. In absolute terms, Europe and the Caucasus have by far the highest number of at-risk breeds. Despite the apparent dominance of these two regions, problems elsewhere may be obscured by the large number of breeds with unknown risk status. In Latin America and the Caribbean, for example, 68 percent and 81 percent of mammalian and avian breeds, respectively, are classified as being of unknown risk status. The figures for Africa are 59 percent for mammals and 60 percent for birds. This lack of data is a serious constraint to effective prioritization and planning of breed conservation measures. The problem is particularly significant in some species – 72 percent of rabbit breeds, 66 percent of deer breeds, 59 percent of ass breeds and 58 percent of dromedary breeds lack population data. There is an urgent need for improved surveying and subsequently reporting of breed population size and structure, and of other breed-related information.

A comparison at species level reveals that horses (23 percent), followed by rabbits (20 percent), pigs (18 percent) and cattle (16 percent), are the mammalian species that have the highest proportions of at-risk breeds. Among widely kept avian species, 34 percent of turkey breeds, 33 percent of chicken breeds, 31 percent of goose breeds and 24 percent of duck breeds are classified as at risk. Figure 4 summarizes breed risk status for the five most internationally important livestock species.

Cattle are the species with the highest number of breeds reported as extinct (209). Large numbers of extinct pig, sheep and horse breeds are also reported. This is probably not a complete picture of breed extinctions, as it is likely that numerous breeds have been lost without being documented.

Trends in genetic erosion

Trends in genetic erosion can be identified by comparing the current risk status of a set of breeds with their status in the past. The most straightforward assessment can be achieved by comparing the figures for

[9] A breed is categorized as at risk if the total number of breeding females is less than or equal to 1 000 or the total number of breeding males is less than or equal to 20, or if the overall population size is greater than 1 000 and less than or equal to 1 200 and decreasing and the percentage of females being bred to males of the same breed is below 80 percent.

local breeds. An analysis of trends in the risk status of these breeds over the period between 1999 and 2006 presents a mixed picture. Some breeds became more secure – 60 breeds that were classified as at risk in 1999 were classified as not at risk in 2006. However, almost as many (a total of 60) moved into the at-risk category over the same period. Even more worryingly, despite increasing awareness and action, breeds continue to be lost. Sixty-two extinctions were recorded between December 1999 and January 2006 – amounting to the loss of almost one breed per month.

Risk status figures based on population data may not reveal the full extent of genetic erosion. Within-breed diversity is also important. A weakness of the current monitoring of breed status, and one that is difficult to overcome, is that it gives little indication of the extent of genetic dilution caused by indiscriminate cross-breeding[10] – a problem that is considered by many experts to be a major threat to genetic diversity. Risk status figures also fail to show the inbreeding that may occur, even within breeds that have large total populations, as a result of the use of a limited number of breeding animals. Neither do the figures allow an assessment of the extent to which subpopulations within breeds are genetically isolated from each other – an important consideration for management decisions.

Threats[11]

A number of threats to genetic diversity can be identified. Probably the most significant is the marginalization of traditional production systems and the associated local breeds, driven in large part by the rapid spread of intensive livestock production, often large-scale and utilizing a narrow range of breeds. Global production of meat, milk and eggs is increasingly based on a limited number of high-output breeds – those that are most profitably utilized in industrial production systems. The intensification process has been driven by rising demand for animal products and has been facilitated by the ease with which genetic material, production technologies and inputs can now be moved around the world. Intensification and industrialization have contributed to raising the output of livestock production and to feeding the growing human population. However, policy measures are necessary to minimize the potential loss of the global public goods embodied in animal genetic resource diversity.

Acute threats such as major disease epidemics and disasters of various kinds (droughts, floods, military conflicts, etc.) are also a concern – particularly in the case of small, geographically concentrated breed populations. Threats of this kind cannot be eliminated, but their impacts can be mitigated. Preparedness is essential in this context as ad hoc actions taken in an emergency situation will usually be far less effective. Fundamental to such plans, and more broadly to the sustainable management of genetic resources, is improved knowledge of which breeds have characteristics that make them priorities for conservation, and how they are distributed geographically and by production system.

Policies and legal frameworks influencing the livestock sector are not always favourable to the sustainable utilization of animal genetic resources. Overt or hidden governmental subsidies have often promoted the development of large-scale production at the expense of the smallholder systems that utilize local genetic resources. Development interventions and disease control strategies can also pose a threat to genetic diversity. Development and post-disaster rehabilitation programmes that involve livestock should assess their potential impacts on genetic diversity and ensure that the breeds used are appropriate to local production environments and the needs of the intended beneficiaries. Culling programmes implemented in response to disease outbreaks need to incorporate measures to protect rare breeds; revision of relevant legislation may be necessary.

Needs and challenges [12]

[10] Indiscriminate cross-breeding refers to a spectrum of actions ranging from upgrading or cross-breeding to complete replacement of a local breed with imported animal genetic resources in an unplanned manner and without adequate assessment of the performance of the respective breeds under relevant production conditions.

[11] This material is extracted from the executive summary of FAO. 2007. *The State of the World's Animal Genetic Resources for Food and Agriculture*, edited by B. Rischkowsly and D. Pilling. Rome. (for a more detailed discussion of threats see Part 1, Section F of *The State of the World*).

Effective management of animal genetic diversity is essential to global food security, sustainable development and the livelihoods of hundreds of millions of people. The livestock sector and the international community are facing many challenges. The rapidly rising demand for livestock products in many parts of the developing world, emerging animal diseases, climate change and global targets such as the Millennium Development Goals need to be urgently addressed. Many breeds have unique characteristics or combinations of characteristics – disease resistance, tolerance of climatic extremes or supply of specialized products – that could contribute to meeting these challenges. However, evidence suggests that there is ongoing and probably accelerating erosion of the genetic resource base.

Where the evolution of livestock production systems threatens the ongoing use of potentially valuable genetic resources, or to safeguard against sudden disastrous losses, breed conservation measures have to be considered. *In vivo* conservation options include dedicated conservation farms or protected areas, and payments or other support measures for those who keep rare breeds within their production environments. *In vitro* conservation of genetic material in liquid nitrogen can provide a valuable complement to *in vivo* approaches. Where feasible, facilitating the emergence of new patterns of sustainable utilization should be an objective. Particularly in developed countries, niche markets for specialized products, and the use of grazing animals for nature or landscape management purposes, provide valuable opportunities. Well-planned genetic improvement programmes will often be essential if local breeds are to remain viable livelihood options for their keepers.

Implementing appropriate strategies for the low external input production systems of the developing world is a great challenge. Pastoralists and smallholders are the guardians of much of the world's livestock biodiversity. Their capacity to continue this role may need to be supported – for example by ensuring sufficient access to grazing land. At the same time, it is essential that conservation measures do not constrain the development of production systems or limit livelihood opportunities. A small number of community-based conservation and breeding programmes have begun to address these issues. The approach needs to be further developed.

Effective management of animal genetic diversity requires resources – including well-trained personnel and adequate technical facilities. Sound organizational structures (e.g. for animal recording and genetic evaluation) and wide stakeholder (particularly breeders and livestock keepers) involvement in planning and decision-making are also essential. However, throughout much of the developing world, these prerequisites are lacking. Forty-eight percent of the world's countries report no national-level *in vivo* conservation programmes, and sixty-three percent report that they have no *in vitro* programmes. Similarly, in many countries structured breeding programmes are absent or ineffective.

In a time of rapid change and widespread privatization, national planning is needed to ensure the long-term supply of public goods. Livestock-sector development policies should support equity objectives for rural populations so that these populations are able to build up, in a sustainable way, the productive capacity required to enhance their livelihoods and supply the goods and services needed by the wider society. The management of animal genetic resources needs to be balanced with other goals within the broader rural and agricultural development framework. Careful attention must be paid to the roles, functions and values of local breeds and to how they can contribute to development objectives.

The countries and regions of the world are interdependent in the utilization of animal genetic resources. This is clear from evidence of historic gene flows and current patterns of livestock distribution. In the future, genetic resources from any part of the world may prove vital to breeders and livestock keepers elsewhere. There is a need for the international community to accept responsibility for the management of these shared resources. Support for developing countries and countries with economies in transition to characterize, conserve and utilize their livestock breeds may be necessary. Wide access to animal genetic

[12] This material is extracted from the executive summary of FAO. 2007. *The State of the World's Animal Genetic Resources for Food and Agriculture*, edited by B. Rischkowsly and D. Pilling. Rome. (For a more detailed discussion of needs and challenges see Part 5 of *The State of the World*).

resources – for farmers, herders, breeders and researchers – is essential to sustainable use and development. Frameworks for wide access, and for equitable sharing of the benefits derived from the use of animal genetic resources, need to be put in place at both national and international levels. It is important that the distinct characteristics of agricultural biodiversity – created largely through human intervention and requiring continuous active human management – are taken into account in the development of such frameworks. International cooperation, and better integration of animal genetic resources management into all aspects of livestock development, will help to ensure that the world's wealth of livestock biodiversity is suitably used and developed for food and agriculture, and remains available for future generations.

1.3 Aquatic Genetic Resources Managed in the Context of Farming Systems[13]

Types of aquaculture

Aquaculture is as diverse as agriculture in its range of farmed species and wide variety of production systems. The major groups of farmed aquatic organisms are: finfish; crustaceans; molluscs; other aquatic invertebrates such as sea urchins and sea cucumbers; and aquatic plants, including seaweeds and freshwater macrophytes.

The contribution of aquaculture to world fish production (excluding plants) has grown from 3.9% in 1970 to about 35% and this growth is continuing. Aquaculture also provides increasing proportions of the world's supply of ornamental aquatic organisms, retail sales of which were valued at US$ 3 billion in 2000. About 84% of aquaculture production currently comes from Asia but aquaculture has high scope for growth in all developing regions. About 90% of world aquaculture production comes from developing countries and are a vital source of food security and employment for the rural and urban poor.

Aquaculture takes place in fresh-, brackish- and marine waters; in lakes, rivers reservoirs, farm ponds, rice fields, lagoons, coastal waters and the open sea. Production systems range from natural, modified or artificial systems where populations use natural feeds, to semi-intensive aquaculture systems and intensive ponds, pens, cages, tanks and other containments. There is also the integration of fisheries and aquaculture where modification of habitats, such as brush parks or enclosing water bodies, turn common property into owned sites where fish are husbanded and often bred. The integration of fishing and aquaculture into rice paddies is especially beneficial. Rice fields typically contain several hundreds of species other than rice, many of which are directly used by rural communities.[14] Fish farms and hatcheries range in size from small-scale/backyard to large scale corporate ventures, some resembling broiler poultry farming operations.

Fish production from culture-based fisheries (CBF) is usually included in aquaculture production statistics because these fisheries rely upon the release of large numbers of hatchery-reared fish. These are released to water bodies for subsequent harvest as adults. Successful CBF include the stocking of carps in lakes and reservoirs, the release of salmon that can be harvested on their return migrations, and the stocking of some marine finfish and invertebrates in relatively enclosed coastal waters.

In capture-based aquaculture (CBA), fish seed of species for which mass production in captivity is not yet practical are taken from the wild and then fattened in fish farms. This type of aquaculture is currently enjoying success with species such as eels, groupers and tunas, but faces some constraints from overexploitation of the wild seed fisheries, high feeding costs and the need to avoid adverse environmental impacts.

[13] Information extracted from FAO (2006) *The State of World Fisheries and Aquaculture*; and FAO (2007) *State of World Aquaculture 2006;* CGRFA-11/7/15.2 "The World's Aquatic Genetic Resources: Status and Trends".
[14] Halwart, M. 2006. Biodiversity and nutrition in rice-based aquatic ecosystems. Journal of Food Composition and Analysis 19: 747-751.

Status of Aquatic Genetic Resources in Aquaculture[15]

Some aquaculture-specific data extracted from FAO reviews of world aquaculture and fisheries[16] indicate that:

- approximately 236 species of fish, invertebrates and plants were farmed in 2004;
- fish provide more than 2.6 billion people with at least 20% of their animal protein intake and that an additional 40 million tonnes of fish per year will be required by 2030;
- in 2004, world aquaculture production of fish and aquatic plants was 59.4 million tonnes, valued at US$ 70.3 billion;
- in 2004, total world export of fish and fish products trade was 52.8 million tonnes worth US$ 71.5 billion.

Fish genetic resources management merits high emphasis in ecosystem approaches to the development of responsible aquaculture[17]. Fish genetic resources help determine the performance of the farmed fish and their interactions, including genetic interactions, with aquatic biodiversity. Aquatic genetic resources encompass also the genetic diversity of farmed and harvested aquatic plants, which are plant genetic resources.

The most important fish genetic resources for aquaculture are carps, catfishes, milkfish, salmon, tilapias, mussels, oysters and shrimps, as well as their wild relatives. Important plant genetic resources for farmed aquatic plants include those for marine seaweeds and freshwater macrophytes.

With few exceptions, substantial domestication and genetic improvement of farmed fish is not as advanced as in the crop and livestock sectors. This is now changing for some widely farmed aquatic species, with rapid benefits to fish farmers and fish consumers.

Fish genomics is also developing rapidly and is seen as having many potential applications including marker-assisted selection for the genetic improvement of farmed fish, accurate identification of fish genetic resources for their conservation and use, and the diagnosis and prevention of fish diseases. The farming of distinct strains, hybrids, mono-sex populations, polyploids, is increasing, bringing increased needs for effective biosecurity procedures. Private sector research for the development of biotechnological products and processes in aquaculture is increasing.

Technical guidelines on genetic resource management in aquaculture will be produced in late 2007 to support the implementation of the FAO Code of Conduct for Responsible Fisheries. Other projects on characterization and development of genetic resources and biodiversity in African aquaculture will be implemented in 2008 with partners such as the WorldFish Centre in West Africa. FAO along with the Network of Aquaculture Centres in Asia and the Pacific has and continues to develop training materials and workshops on characterization of aquatic genetic resources. A similar network has been developed in Eastern Europe and additional networks are being developed in Africa and Latin America; one key aspect of these networks is to facilitate improved knowledge on aquatic genetic resources. Following the 11th Regular Session of The Commission on Genetic Resources for Food and Agriculture (CGRFA), and according to the outline for the major outputs and milestones in the Commission's Multi-Year

[15] In May 2006, an International Workshop was held in BC, Canada, on "*The Status and Trends in Aquatic Genetic Resources: a Basis for International Policy".* A summary of the proceedings and outcomes of the workshop were prepared as Background Paper No. 37 for the 11th Regular Session of the Commission on Genetic Resources for Food and Agriculture (can be found at ftp://ftp.fao.org/ag/cgrfa/bsp/bsp37e.pdf). Of note is an extract of the paper by Roger S. V. Pullin "*Genetic Resources for Aquaculture: Status and Trends*".
[16] FAO (2006) *The State of World Fisheries and Aquaculture*; and FAO (2007) *State of World Aquaculture 2006*.
[17] From 7-11 May 2007, FAO and the University of Illes Balears held a workshop on "Building an Ecosystem Approach to Aquaculture (EAA): Initial Steps for Guidelines".

Programme of Work, if appropriate funding can be secured a review of information sources for aquatic genetic resources and key issues for *The State of the World's Aquatic Genetic Resources* will be ready for the 13th Regular Session of the CGRFA (tentatively scheduled for 2011), and will be presented at the 14th Regular Session of the CGRFA. The 27th Session of the FAO Committee on Fisheries welcomed the increased attention given aquatic genetic resources by the CGRFA. The Committee on Fisheries and its sub-committees on aquaculture and trade will be continuously consulted and appraised of this work.

1.4 Forest Genetic Resources

Over the past 10 years, FAO and international partners have supported interested countries and regions to convene action-oriented, country-driven forest genetic workshops to review status, trends, needs and gaps, with a view to harmonizing and intensifying forest genetic resources activities at regional, sub-regional and eco-regional levels. The aim of the workshops, held in seven sub-regions, has been to elaborate a flexible framework for national action which is valid at the regional level, and which is as consistent among regions as possible. This was facilitated by agreed-upon national and regional reporting formats, concepts and terms, and common mechanisms for species priority setting for action. The regional, subregional and eco-regional action plans on forest genetic resources which were developed in the workshops continue to serve as dynamic tools underpinning action by countries concerned.

FAO's information system REFORGEN is the result of gathering, through the workshops, this country-driven information on forest genetic resources status, trends, priorities and threats. Throughout this period, the FAO Panel of Experts on Forest Gene Resources has overseen the process. In the short and medium term, priority should be given to continuing and intensifying support to these country-driven, action-oriented workshops. This process should gradually expand their coverage, ensuring regular verification and up-dating of available information and, most importantly, implementation of recommended action at country and regional levels, ensuring inter-sectoral links and broad stakeholder involvement.

There is still however lack of a consolidated global picture on the status and trends of forest genetic resources, and the lack of estimators of the rate of genetic diversity loss, which are limiting factors in decision-making at international and institutional levels.

The FAO Panel of Experts on Forest Gene Resources has been already discussing the possibility of developing a global assessment for forest genetic resources at its last two sessions. At its Fourteenth Session, the Forest Gene Panel recommended that top priority should be given to the preparation of the first country-driven *State of the World's Forest Genetic Resources*, in connection with Global Forest Resource Assessment and the strengthening of REFORGEN and other relevant FAO information systems. As stressed by the Panel, the preparation of *The State of the World's Forest Genetic Resources* could provide unique opportunities to:

- Further clarify the contribution of forest genetic resources to the achievement of Millennium Development Goals 1 and 7.
- Strengthen and promote collaboration and cooperation among Member Countries and international organizations involved in the management of forest genetic resources.
- Strengthen cooperation mechanisms between the Forest Gene Panel and the Commission on Genetic Resources for Food and Agriculture (CGRFA) in a practical way.

At the 11th Regular Session of the CGRFA (and as part of discussions on the Multi-Year Programme of the CGRFA), it was decided that an analysis of key issues in forest genetic resources, for the *State of the World's Forest Genetic resources*, would be discussed at the 12th Regular Session of the CGRFA. It was further decided that the *State of the World's Forest Genetic Resources* will be presented to the 14th Regular Session of the CGRFA[18].

[18] The Working Document CGRFA-11/07/15.2 "The world's forest genetic resources: status and needs" can be found at: ftp://ftp.fao.org/ag/cgrfa/cgrfa11/r11w152e.pdf

"Forest biological diversity" denotes the variability among forest living organisms and the ecological processes of which they are part. It includes variation at landscape, ecosystem, species, population, individual, and molecular levels of biotic organization. As these levels are inter-related, a comprehensive approach to conservation is necessary. At the same time, it is essential to specify clearly the level or levels targeted by specific management action (including non-intervention), as it is possible to conserve an ecosystem and still lose specific species, or to conserve a species and lose genetically distinct populations, genes or valuable gene complexes. "Ecosystem conservation cannot be reduced to conserving genes, nor can gene conservation be reduced to conserving ecosystems" (Namkoong 1990).

1.5 Overview of Microorganisms and Invertebrates for Food and Agriculture

Micro-organisms and invertebrates together are the most numerous group of species on Earth. Micro-organisms include the diversity of yeasts, bacteria and fungi; invertebrates comprise insects, arachnids, springtails, earthworms and others. Agricultural production and food processing depend heavily on this "hidden" biodiversity: plants and animals cannot grow optimally without them - for example, crops are pollinated by insects; fungi and other micro-organisms establish mutually beneficial symbiosis with the roots of certain plants and the guts of ruminant livestock that increases efficiency of certain functional processes; both micro-organisms and invertebrates play major roles as bio-control agents, and in the degradation and recycling of organic matter in soils; and micro-organisms also provide beneficial services in food processing. For millennia, humans have used the fermentation by micro-organisms for food production. A variety of yeasts, bacteria and fungi are used in food processing: examples include for bread, cheese and yogurt, beer, wine, and fermented meats. In addition to beneficial organisms, certain micro-organisms and invertebrates also act as plant and animal pests and diseases. In this case, increasing the understanding of these potentially pathogenic species, including their genetic variability and conditions under which they become harmful, is critical, in order to find remedies to prevent and/or control pest and disease outbreaks.

Despite considerable interest in specific areas regarding micro-organisms and invertebrates, and the existence of substantial and diverse culture collections, the breadth of the subject has meant that the sector has so far received little systematic attention. This is likely to change in the near future, as the importance of the management of micro-organisms and invertebrates is increasingly recognized as an important emerging area in international policy discussions.

At its 11th Regular Session, the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) noted that this component of biodiversity for food and agriculture had not received adequate attention, especially given the many types of micro-organisms and invertebrates that play critical roles in the provision of essential services within the food chain. It further recognized the important role of micro-organisms and invertebrates in relation to food security and sustainable agriculture, and the need to strengthen capacity and knowledge in order to further understand the many roles and functions of these essential resources in relation to sustainable agriculture.

The CGRFA adopted a new programme of work on microorganisms and on invertebrates to deal with these issues in a comprehensive manner. As part of its Multi-year Programme of Work, the CGRFA will review a scoping study on micro-organisms and invertebrates at its 12th Regular Session and then review of key issues on micro-organisms and invertebrates at its 14th Regular Session. Progress on this area will be regularly reviewed.

1.5.1 Soil Biodiversity

The complexity of the web of soil life can also be appreciated by the diversity of natural enemies of pests that live in the soil and their importance as biological control agents – such is the case for invertebrate predators, parasitic nematodes (which feed and develop in invertebrate pests, often killing them in the process), micro-organisms as control agents of invertebrate pests, weedy plants and other micro-organisms. This extremely rich biodiversity present in soils is threatened by a number of factors including the use of pesticides, particularly insecticides, which leads to the resurgence of insect pests through the selective reduction of their untargeted natural enemy communities. There is a substantial proportion of protoctista, fungi, nematodes, insects and chelicerate (a type of Arthropod) species that are natural enemies of pests. Many other natural enemy species still need to be described – indeed, one of the current limitations to enhance natural biological control is a lack of information on the biology and ecology of these species.

Many thousands of species (or genotypes) contribute to the vast amount of below-ground biodiversity (see Table 1) - as an example, agricultural soil usually contains living biomass in the order of 3,000 kg (fresh weight) per hectare.

The ecological functions of soil depend on a healthy and dynamic community of soil biota. Ants, beetles, earthworms, termites, nematodes, enchytraeids, mites, springtails, protozoa, bacteria and fungi are some of the main groups in the diversely rich soil food web. Soil organisms can also be classified according to functional groups, for example, nitrifying bacteria, bacterivorous nematodes, litter feeders, ecosystem engineers and others. However, soil biology and function is little recognised, understood or considered in most efforts to reverse land degradation and enhance land productivity and sustainability. Due to its three-dimensional below ground structure, soil cannot be characterized by easily observable organisms; even the larger groups are included in the category of cryptobiota (small and thus "hidden" organisms), not to mention micro-organisms which are invisible to the human eye. Efforts to characterise soils, instead of assessing species richness and abundance as with domesticated plants and livestock, are resorting to assessing functional groups using microbial techniques. In some cases, indicator species are identified to reflect the maintenance of specific soil functions for example, earthworms in regard to soil bio-tillage (mixing) and aeration and rhizobium nodules in regard to soil nitrogen fixation.

Soil micro-organisms[19]
These are usually divided into the following five categories: archaea, bacteria, actinomycetes, fungi, and algae. Many studies show that the abundance of soil organisms responds to changes in soil health. In fact, changes in microbial populations, and most importantly, in specific functional groups (*e.g.,* nitrifying bacteria, root nodule nitrogen-fixing bacteria, and mycorrhizal fungi) can be used to determine impacts of certain management practices, for instance the impact of chemical pollution in soil or of tillage practices on soil biological function

A frequently unaddressed consideration in many of the attempts to evaluate soil biodiversity is the scale at which the evaluation is to be undertaken, but since soils exhibit complex patterns of variability, any interpretations based on the results of analyses carried out from soil samples must take into account the number and nature of the samples. The assessment of microbial diversity has the potential to provide useful insight into the health and functioning of soil. The inability to culture most micro-organisms present in soils has, until recently, impaired studies of the relationships between the structure and function of soil microbial communities. This shortcoming has been partly overcome by the use of a number of molecular techniques that allow detection, enumeration, and characterization of soil micro-organisms, but that do not depend on species cultivation.

[19] Some sections adapted from CGRFA-11/07/Circ.1

Table 1. Total number of described species of major groups of soil organisms (Brown et al., 2007 from several sources)

Soil organism	Number of species described
Microorganisms (bacteria and Fungi)	
Bacteria and archaea	3,200
Fungi	60,000
Microfauna	
Protozoa (Protista)	36,000
Nematodes	15,000
Rotifers	2,000
Tardigrads	750
Mesofauna	
Mites (Acari)	ca. 45,000
Springtails (Collembola)	7,500
Pseudo-scorpions	3,235
Diplura	659
Symphyla	200
Pauropoda	700
Enchytraeids	800
Macrofauna	
Root herbivorous insects	> 40,000
Beetles (Coleoptera)	350,000
Millipedes (Diplopoda)	10,000
Centipedes (Chilopoda)	2,500
Scorpions	1,259
Spiders	38,884
Harvestmen (Opiliones)	30,000
Snails (Gastropoda)	4,250
Woodlice (Isopoda)	2,800
Termites (Isoptera)	11,826
Ants (Formicidae)	5,500
Earthworms (Oligochaeta)	3,800
Velvet worms (Onchophora)	90

Sources: Harwksworth and Mound (1991); Brussaard et al., 1997; Wall and Moore (1999); Moreira et al. (2006); Lewinsohn and Prado (2005, 2006).

Assessment of soil microbial diversity

In research, soil micro-organism diversity is one of the most used indicators of soil quality. Soil micro-organisms studies to assess soil quality were classified in 1992[20] as follows:

- Population level studies: the study of the dynamic of important individual species (e.g. species sensitive to specific perturbation of bio-indicator species, for their role in soil functioning)
- Community level studies: the estimation of species diversity and the frequency of occurrence of species (bacteria and fungi in particular).
- Ecosystem level studies: the study of the processes involved in cycling organic matter, and nitrogen and nutrient retention efficiencies.

[20] Visser and Parkinson

Researchers working on soil micro-organisms are capable of handling a wide range of microorganisms belonging to several taxa (for example: Bacteria, Chromista, Cyanobacteria, Fungi, *etc*), but in most cases, research groups focus on few genera of the same taxa (population level studies), because of the high specialization level required by these studies. Therefore, such studies ignore a great amount of data of potential use for conservation and sustainable use of soil biodiversity and lose understanding of impacts of the management practices on ecosystem stability and resilience which require holistic ecosystem approaches. In community level studies of soil biodiversity, most activities begin with soil DNA characterization, made possible by the technological advances in molecular tools. Such studies that provide information on the status of soil microbial diversity can be used as an indicator of soil quality.

Assessment of soil microbial diversity

A typical gram of soil contains a billion individual bacteria, and possibly several thousands different microbial genomes present[21]. The absolute diversity of micro-organisms is widely held to be unknown and unknowable at any scale in any environment, particularly soil, where the diversity is extremely high. New concepts and approaches are required to establish quantitative and causal links between microbial communities and ecosystem functioning. The broader concept of microbial community composition is recognised as potentially more useful than microbial genetic or taxonomic diversity. New concepts and approaches are being evaluated to establish quantitative and causal links between microbial communities and ecosystem functioning. As being used by the Global below ground biodiversity project funded by the Global Environment Facility for characterising soil biodiversity.

Molecular methods, starting from direct extraction of nucleic acid from soil, permit the effective monitoring of this diversity. In the last fifteen years molecular methods have been used to improve the knowledge of soil inter-specific and intra-specific diversity of culturable micro-organisms. Furthermore, the study of the populations with functional genes allows the identification of bacteria that belong to diverse physiological groups, as an alternative to classical methods.

With regards to classification and nomenclature systems, these are historically based on observable, morphological or physiological characteristics. However, traditional methods of micro-organism enumeration and characterization are often insufficient for reliably identifying many food associated microbial species, and for monitoring the presence of specific strains in complex microbial communities. In addition, taxonomists are aware that the phenotype may not accurately reflect true ecological relationships. Traditional detection techniques are unable to study micro-organisms that do not grow in culture (the so-called “non-cultivable cells”), or to help address the question of whether micro-organisms are cosmopolitan – found in more than one location – or instead tend to be endemic to only specific location. Development of molecular biology techniques has helped improve knowledge of the taxonomy and ecology of micro-organisms, and has opened a new interdisciplinary field, molecular microbial ecology, for studying microbial communities. In conclusion, molecular methods are complementary to traditional methods, in order to obtain more data concerning soil microbiota.

[21] Torsvik et al. 1990

Assessment of Soil Invertebrates

Estimating the diversity of soil invertebrates requires a clear definition of what a soil animal is. For the purpose of this document, the *sensu lato* definition[22] is used, including both soil full- and part-time inhabitants, as well as those species found in the soil annexes[23]. The paradox of soil invertebrates is that despite their huge contribution to global diversity, they have received little comparative taxonomic attention when compared to plants and vertebrates, for example. This is particularly evident for small-sized animals, as the ratio of described species by number of existent species within a given group steadily decreases according to its body size. However, biological and ecological information for larger soil invertebrates are also lacking. The lack of taxonomic expertise for such a vast number of groups, the different standard sampling protocols used and the threats imposed on global diversity are some reasons for limited knowledge on soil invertebrate diversity.

The identification of soil invertebrates are constrained by four main limitations:[24]

(1) both phenotypic plasticity and genetic variability in the characters employed for species recognition can lead to incorrect identifications;
(2) variability in characters employed for identification overlooks morphologically cryptic taxa, which are common in many groups;
(3) many individuals cannot be identified as morphological keys are often effective only for a particular life stage, gender or caste;
(4) the use of keys often demands a high level of expertise and thus misdiagnoses are common.

All these limitations highlight the need for the use of new and more relevant approaches to taxon recognition within soil animals. DNA bar-coding employs sequence diversity in short, standardized gene regions to help species identification. The mitochondrial gene cytochrome *c* oxidase I (COI) has been identified as a potential universal species barcode for animals[39] after being successfully used in different groups of animals. An integrated bioinformatics platform that supports all phases of the analytical pathway from specimen collection to validated barcode library is now available[25]. Stable isotopes are also useful in precisely classifying invertebrate feeding-groups.

Soil Biological Functions and Services

Soil organisms are an integral part of agricultural ecosystems, and are key actors in maintaining soil health, ecosystem functions and production. The important role that soil organisms play in ecosystem functioning and processes and the economic benefits of the environmental services they provide needs to be acknowledged. The overlooking and depletion of the beneficial soil biological functions performed by soil organisms (bacteria, fungi, invertebrates) in agricultural ecosystems is contributing, amongst other factors, to increased rates of land degradation, nutrient depletion, fertility decline, water scarcity, crop productivity and yield reductions. All these factors negatively affect the livelihoods of people who directly depend on agriculture for their subsistence.

It is increasingly recognized that the understanding and management of this biodiversity is crucial in overall sustainable development, with important economic contributions. Although some examples exist, to date the information related to the ecosystem services and derived benefits of the biological functions performed by soil organisms is still scarce in the literature. There are various reasons, including the difficulty of analysing these processes and their economic contributions, and limited available tools to the understanding and promotion of holistic or integrated solutions for specific farming systems. Efforts are

[22] Decaëns et al. 2006
[23] Gobat 1998
[24] Hebert et al. 2003
[25] Ratnasingham and Hebert 2007

thus rather urgent to include this subject in the global analysis of environmental services and benefits provided by both natural ecosystems and agroecosystems. Some examples include:

- In Uruguay, the value of nitrogen-fixing bacteria in forages and soy-bean, is estimated to save the country around US$ 150 millions annually, based on of the cost of replacing fixed nitrogen with manufactured fertilizer[26].
- Recent developments in genomics and applied biotechnologies are rapidly increasing the appropriable value of micro-organism genetic resources. In the mid-1990s, the economic value of micro-organisms worldwide was "at least many tens of billions of US dollars"[27].

The term "soil health" conveys the idea of soil as a living system, which contains vast assemblages of organisms responsible for a variety of functions, such as decomposition and recycling of nutrients from dead plant and animal tissues, fixation of nitrogen, maintenance of soil structure, regulation of the quality of air and water, and detoxification of pollutants (the soil acts as a sink for pollutants, including global gases). Both soil micro-organisms and invertebrates can be utilized as indicators of soil health in agricultural systems.

In fertile soils some of the organisms that play an important role in nutrient cycling are microfauna (nematodes and protozoa) and earthworms, whereas infertile soils tend to support a food web dominated by fungi and arthropods, mainly mites, springtails and millipedes[28]. Bacteria-feeding nematodes and protists (micro-organism) are important in N-mineralization through grazing on microbial biomass, thus affecting flux of N in the soil. In arable agricultural fields soil microbes are most important for N mineralization but in N-limiting environments like a forest the contribution of soil invertebrates to the mineralization of N through grazing becomes more important. Only enchytraeids, also known as "pot worms", seem to contribute to carbon mineralization.

The mechanisms by which above- and below-ground processes interact are difficult to identify precisely. Above-ground biota (plants) have important effects on soil organisms, and below-ground interactions can also impact primary productivity. For example, parasites, soil-borne pathogens and root herbivores (beetle larvae) can directly remove carbon and nitrogen from root tissues, reducing plant uptake capacity. Plant above-ground phenotypes can be affected by the activities of soil invertebrates (earthworms) in plant tolerance to parasites. For example, when earthworms were present root biomass was not affected by nematode attack and the expected inhibition of photosynthesis was suppressed[29]. Another example shows how arbuscular mycorrizal fungi increase a number of plant traits to which pollinators (mainly insects) are known to respond[30]. Indirectly, the activities of soil invertebrates can also affect plants by changing the physical and chemical characteristics of the soil through their engineering capacities (production of biogenic structures). The effects of soil biodiversity in above-ground processes and attributes range from positive to negative, depending on context[31].

Finally, the complexity of the web of soil life can also be appreciated by the diversity of natural enemies of pests that live in the soil and their importance as biological control agents – such is the case for invertebrate predators, parasitic nematodes (which feed and develop in invertebrate pests, often killing them in the process), plant weeds, micro-organisms as control agents of invertebrate pests, weedy plants and other micro-organisms. This extremely rich biodiversity present in soils is threatened by a number of factors including the use of pesticides, particularly insecticides, which leads to the resurgence of insect pests through the selective reduction of their untargeted natural enemy communities. There is a substantial proportion of protoctista, fungi, nematodes, insects and chelicerate (a type of arthropod)

[26] See CGRFA-11/07/Circ.2.
[27] Holmes, Bob. 1996. *Life Unlimited.* New Scientist
[28] Wardle et al. 2004
[29] Blouin et al. 2005
[30] Gange and Smith 2005
[31] Wardle 2002

species that are natural enemies of pests - there are thought to be millions of other natural enemy species, many of which are yet to be described. One of the current limitations to enhance natural biological control is that biology and life history of natural enemies are not known. Besides, the problem of not distinguishing between insect natural enemies of insect pests or weeds and insect pests themselves is reducing populations of natural enemies in agricultural systems with insecticide applications. The likely trends in biological control for the near future rely on both conservation and increase of natural enemies.

1.5.2 Pollinators[32]

Pollination is critical for food production and human livelihoods, and directly links wild ecosystems with agricultural production systems. The vast majority of flowering plant species only produce seeds if animal pollinators move pollen from the anthers to the stigmas of their flowers. Without this service, many interconnected species and processes functioning within an ecosystem would collapse. With well over 200,000 flowering plant species dependent on pollination from over 100,000 other species, pollination is critical to the overall maintenance of biodiversity in many senses.

The diversity of pollinators and pollination systems is striking. Most of the 25,000 to 30,000 species of bees (Hymenoptera: Apidae) are effective pollinators, and together with moths, flies, wasps, beetles and butterflies, make up the majority of pollinating species. Vertebrate pollinators include bats, non-flying mammals (several species of monkey, rodents, lemur, tree squirrels, olingo and kinkajou) and birds (hummingbirds, sunbirds, honeycreepers and some parrot species). Current understanding of the pollination process shows that, while interesting specialized relationships exist between plants and their pollinators, healthy pollination services are best ensured by an abundance and diversity of pollinators.

In agro-ecosystems, pollinators are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fibre crops. About two-thirds of the crop plants that feed the world, plus many plant-derived medicines in our pharmacies, rely on pollination by insects or other animals to produce healthy fruits and seeds[33]. For human nutrition the benefits of pollination include not just abundance of fruits, nuts and seeds, but also their variety and quality; the contribution of animal-pollinated foodstuffs to human nutritional diversity, vitamin sufficiency and food quality is substantial. Estimations of the global value of pollinator services vary widely, from US$ 112 to 200 thousand million annually. In the United States alone, the annual contribution of wild pollination services has recently been estimated at over US$ 3 thousand million annually[34].

Pollinator declines have been noted in many regions of the world. Every continent, except for Antarctica, has reports of pollinator declines in at least one region/country. Evidence is generally in the form of case studies and fragmented in nature, making it difficult to identify general trends across taxa and across regions. However a recent large-scale assessment and analysis of long-term data in the Netherlands and the United Kingdom has shown parallel declines in pollinating species and the plants they pollinate[35].

Honeybees (*Apis mellifera*) colonies, both managed and wild, have undergone marked declines in the US and some European countries. The number of managed honeybee colonies in the US has dropped from 5.9 million in the 1940's to 1.9 million in 1996, and most feral colonies have also been lost.[36] In the EU, honeybee colonies are reported to have declined by 16% between 1985 and 1991 and losses thereon were expected to be great.[37] Two major causes of honeybee declines are parasitic mites (*Varroa jacobsoni* and

[32] Elements have been extracted from CGRFA-11/07/Inf.15 "Pollinators: Neglected Biodiversity of Importance to Food and Agricuture". ftp://ftp.fao.org/ag/cgrfa/cgrfa11/r11i15e.pdf
[33] Klein et al. 2006.
[34] Losey, J. and M. Vaughn. 2006. The economic value of ecological services provided by insects. BioScience 56(4):311-323.
[35] Biesmeijer et al. 2006
[36] Ingram et al. 1996; USDA National Agricultural Statistics Service 1997; Kearns et al. 1998.
[37] Williams et al. 1991.

Acarapsis woodi) and the expansion of the range of Africanized honeybees in the US[38]. Honeybee colonies in the North America, and possibly beyond have been heavily impacted in 2007 by the poorly understood phenomenon of Colony Collapse Disorder involving the massive die-off of bee colonies. The related Himalayan cliff bee (*Apis laboriosa*) has experienced significant declines. In a regional study, all but one censused cliff showed declines in number of colonies or total loss across a 15 year period.[39]

Studies have described marked declines of *bumblebees* (*Bombus* spp.) in Britain, Belgium and eastern Germany and *native solitary bee* species in Germany and in Britain[40]. Changes have been attributed to habitat loss resulting from agricultural intensification.

Beekeepers of the *stingless bee Melipona beecheii*, traditionally kept in log hives in the Maya zone in Quintana Roo state, southeastern Mexico, testify to a sharp drop during the last twelve years in the already declining managed bee populations. Important reasons for that decline include deforestation, competition from introduced feral African *Apis mellifera*, hurricane damage, a lack of economic incentives for traditional stingless beekeeping, and the failure to properly instruct new stingless beekeepers. Since 1980, the numbers of bee hives have decreased by over 90%. For the tropics, this scenario, sampled from 20% of the largest traditional beekeeping group in the Americas, shows how pollinators are threatened both by environmental events and inappropriate conservation efforts[41].

Population characteristics of bees may show changes before actual declines may be detected: bees that appear common may be in jeopardy. For genetic reasons alone, bees are more extinction prone than other taxa as single locus sex determination makes them particularly sensitive to the effects of small population size through the production of sterile diploid males[42]. An example of this is the most abundant orchid bee in lowland forest in Panama, *Euglossa imperialis*, which frequently has high levels of sterile males resulting in low effective population sizes subject to extinction[43.]

Additional pollinator taxa besides bees are the focus of monitoring concerns: There are several local and national-level *butterfly* (Lepidoptera) recording schemes in Europe, notably those in Great Britain, the Netherlands and Germany. Comparison with historical records (1970-1982) showed that half of British resident butterflies have disappeared from over 20% of their range, and a quarter has declined by more than 50%. Many European butterflies are under serious threat because of changing land-use and agriculture intensification[44]. The concentration of data in Europe, it should be noted is more a reflection of the location of specialists to gather it, than a reflection of zones of greatest concern; similar trends are likely to be found in many other locations.

Strong evidence is available for declines in mammalian and bird pollinators. At least 45 species of *bats*, 36 species on *non-flying mammals*, 26 species of *hummingbirds*, 7 species of *sunbirds* and 70 species of *passerine birds* are of global conservation concern[45].

One of the most potent indicators of the health of pollinator interactions may be the incidence of plants suffering pollen limitation: receiving insufficient quantities of pollen to produce seed or fruit at what would be considered optimal levels. Recent research has shown pollen-limited fecundity is widespread amongst natural populations; in natural communities up to 62% of plants may be experiencing pollen

[38] Allen-Wardell et al. 1998.
[39] Ahmad et al. 2003.
[40] Williams 1986; Rasmont 1988; Peters 1972; Westrich 1989; Falk 1991.
[41] Villanueva et al. 2005
[42] Zayed, A. & Packer, L. 2005
[43] Zayed et al. 2003; Zayed 2004a; Zayed 2004b.
[44] Asher et al. 2001; Swaay and Warren 1999;
[45] Nabhan 1996.

deficits[46]. Pollen limitations are more severe in areas of high diversity, and may be due to a shortage of pollinators[47].

PART II. REVIEW OF THE IMPLEMENTATION OF THE PROGRAMME OF WORK ON AGRICULTURAL BIODIVERSITY (POW AGBD)

The following chapters review the work carried out by international organization on agricultural biodiversity since the adoption of the PoW AgBD. This includes the progress made by countries through a number of intergovernmental organizations or with support of international research and technical organizations, or the efforts made by many international civil society organizations and their networks. Chapter 2 presents developments in a number of intergovernmental fora since the adoption of the PoW AgBD.

Through a world-wide survey, inputs from international organizations were received on their contribution to the implementation of the PoW AgBD. International organizations were asked to provide information on work they undertook/were undertaking on the four elements of the Programme of Work, as well as the international initiatives on pollinators, soil biodiversity and biodiversity and nutrition. The responses were put together and analyzed to understand to what extent programme elements are being implemented, but also to have a global picture of how this is proceeding.

Chapters 3 and 4 provide a ***synthesis of the main issues****, with* ***examples,*** of each programme element and international initiative, resulting from the review of the inputs received from international organizations, as well as through internet research.

CHAPTER 2: INTERNATIONAL COOPERATION AS A GUIDING PRINCIPLE OF THE PROGRAMME OF WORK ON AGRICULTURAL BIODIVERSITY

The programme of work on agricultural biodiversity, as adopted by Decision V/5, was developed bearing in mind a number of guiding principles. These included the need to build upon existing international plans of action, programmes and strategies that have been agreed by countries and to promote synergy and coordination, and to avoid duplication, between relevant programmes of various international organizations, while respecting the mandates and existing programmes of work of each organization and the intergovernmental authority of the respective governing bodies, commissions and other forums. Since the adoption of the programme of work on agricultural biodiversity, new internationally agreed instruments and intergovernmental programmes have emerged in the international arena, and these need to be taken into account in this review.

Progress made in two intergovernmental forums at FAO is of particular relevance. The Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture which has recently held is Second Regular Session and has advanced work in two key areas of the Treaty: its Multilateral System for Access and Benefit-Sharing, and its Funding Strategy. As of 20 November 2007, the International Treaty has 116 Contracting Parties.

With 170 Member Countries and the European Community, FAO's intergovernmental Commission on Genetic Resources for Food and Agriculture (CGRFA) has also made significant progress since the adoption of the programme of work, in particular in the field of animal genetic resources, which has culminated with the adoption of the Global Plan of Action for Animal Genetic Resources in the Interlaken Conference. This Global Plan of Action for Animal Genetic Resources provides a comprehensive and coherent framework for enhancing management activities in relation to animal genetic resources for food

[46] Burd 1994; Ashman et al. 2004.
47 Vamosi et al. 2006

and agriculture, including through strengthening policies, institutions and building capacity. This new international framework contains 4 strategic priority areas:

- Characterization, Inventory and Monitoring of Trends and associated Risks: to provide a consistent, efficient and effective approach to the classification of animal genetic resources, and to assess trends in and risks to animal genetic resources.
- Sustainable Use and Development: to ensure sustainability in animal production systems, with a focus on food security and rural development.
- Conservation: to preserve genetic diversity and integrity, for the benefit of current and future generations.
- Policies, Institutions and Capacity-Building: to address the key questions of practical implementation, through coherent and synergistic development of the necessary institutions and capacities.

The implementation of the strategic priorities for action under the Global Plan of Action for Animal Genetic Resources will therefore provide a cooperation framework to regularly assess the status and trend of agricultural biodiversity in the animal sector; build capacity and develop adaptive management strategies for the sustainable use of animal genetic resources and mainstream the conservation and sustainable use of animal genetic diversity into appropriate national, regional and international policies and programmes.

Overall progress in the implementation of the Global Plan of Action for Animal Genetic Resources will be assessed by national governments and Members of FAO, through the CGRFA. Implementation of the Global Plan of Action for Animal Genetic Resources will require substantial and additional financial resources and long-term support for national, regional and international animal genetic resources programmes and priority activities, provided such incentives are consistent with relevant international agreements. The CGRFA has been requested to develop a Funding Strategy for the implementation of the Global Plan of Action for Animal Genetic Resources.

Moreover, at its 11th Regular Session, the CGRFA adopted a ten-year Multi-Year Programme of Work (Annex 1), which covers all components of biodiversity of relevance to food and agriculture, including:

- Plant Genetic Resources;
- Animal Genetic Resources;
- Aquatic Genetic Resources;
- Forest Genetic Resources; and
- Micro-organisms and invertebrates.

The Multi-Year Programme of Work also addresses cross-sectoral matters, including:

- Policies and arrangements for Access and Benefit-Sharing for genetic resources for food and agriculture;
- The application of biotechnologies in the conservation and utilization of genetic resources;
- International targets and indicators for biodiversity for food and agriculture;
- The ecosystem approach to biodiversity management in agriculture, forestry and fisheries;
- The contribution of biodiversity for food and agriculture to the achievement of the Millennium Development Goals; and,
- The development of a *State of the World's Biodiversity for Food and Agriculture*.

Future work of the CGRFA will develop the necessary global assessments to understand the status and trends of the biodiversity most relevant to food and agriculture. In the past, the finalization of these global

assessments has lead to the negotiation and adoption by FAO of new international agreements, undertakings, codes of conduct or other instruments relating to genetic resources of relevance to food and agriculture. The CGRFA Multi-Year Programme of Work contains a set of intergovernmentally agreed goals and milestones for the next decade, to strengthen the overall policy regime for the conservation and sustainable use of biodiversity for food and agriculture, and for the sharing of benefits arising out of its use. The CGRFA emphasized the importance of the Multi-year Programme of Work as a vehicle to strengthen cooperation in relation to biodiversity for food and agriculture, both within FAO and between FAO and other relevant international bodies. FAO will therefore seek synergies and build partnerships with relevant international organizations, to facilitate the implementation of the Multi-year Programme of Work. This new agenda is likely to have a very positive impact in halting the loss of agricultural biodiversity by:

- Improving the information base on the status and trends of biodiversity for food and agriculture; including on the capacities and institutional needs of countries to conserve and use agricultural biodiversity.
- Strengthening the international framework for food and agriculture in the field of biodiversity; defining priorities for cooperation and investment, and building consensus for the development of fair equitable policies on biodiversity for food security and sustainable agriculture.
- Building new synergies and partnerships, bringing new international actors from the food and agriculture, and also from the environment or the development circles, to work together in the sustainable management of biodiversity for food and agriculture.

Much is therefore to be gained in enhancing cooperation between the CBD and FAO, and its CGRFA, in the next phase of implementation of the programme of work on agricultural biodiversity.

CHAPTER 3: PROGRAMME ELEMENTS

The first Programme Element is to be carried out by Parties, Governments and networks, making use of existing networks and programmes of international organizations. Two key expected outputs were identified in the original programme of work:

- A key set of standard questions and a menu of potential indicators of agricultural biodiversity that may be used by Parties at their national level, and agreed terminology of production environments by 2002; and
- Reports on the state of the world's genetic resources, as programmed, leading progressively towards a comprehensive assessment and understanding of agricultural biodiversity, with a focus on the goods and services it provides, by 2010.

Further steps for the implementation of the Programme of Work outlined in Annex 1 of decision VI/5 include: the comprehensive assessment of the status and trends of agricultural biodiversity; the state of the world reports on plant and animal genetic resources; status and trends of pollinator diversity; state of the world's traditional knowledge on biodiversity (CBD- Article 8 (j) process); assessment of interactions between agriculture and biodiversity as a component of the Millennium Assessment; indicators including agri-environmental indicators (OECD), and work on indicators of genetic diversity/erosion and agricultural biodiversity; as well as an agreed terminology and classification for production environments (compilation of existing classification for MA). Most of these activities have now been completed or have made significant progress.

3.1 Element 1: Assessment

Activity 1.1. Support the ongoing or planned assessments of different components of agricultural biodiversity, for example, the reports on the state of the world's plant genetic resources for food and agriculture, and the state of the world's animal genetic resources for food and agriculture, as well as other relevant reports and assessments by FAO and other organizations, elaborated in a country-driven manner through consultative processes.

The assessment of agricultural biodiversity has made significant progress: global assessments overseen by the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) are completed, on-going or planned, and will be a valuable contribution to the preparation the *State of the World's Biodiversity for Food and Agriculture*, to be presented at the 16th Regular Session of the Commission[48]. Assessments of the status and trends of the world's plant and animal genetic resources have been produced, and the preparation of the second SoW-PGRFA is underway (to be presented to the 12th Regular Session of the CGRFA in 2009). The *State of the World's Aquatic Genetic Resources* and the *State of the World's Forest Genetic Resources* will be presented at the 13th and 14th Regular Sessions of the CGRFA, respectively. The *State of World Fisheries and Aquaculture* and *State of World Aquaculture* are regularly produced by FAO.

Several ongoing and completed major international assessments that contribute indirectly to the Programme of Work on Agricultural Biodiversity have been undertaken by the International Assessment on Agricultural Science and Technology for Development (IIASTD), GLOBIO and the Millennium Ecosystem Assessment (MEA).

Activity 1.2. Promote and develop specific assessments of additional components of agricultural biodiversity that provide ecological services, drawing upon the outputs of programme element 2. This might include targeted assessments on priority areas (for example, loss of pollinators, pest management and nutrient cycling).

In addition to the assessments mentioned above (Activity 1.1), a number of projects are underway that examine ecological interactions and their potential benefits for agriculture (particularly for pest management and pollination). The assessment of invertebrates and micro-organisms poses a number of significant challenges. In general, the assessment of invertebrate groups is approached from the perspectives of their functionality, particularly for pollination, pest control and for the maintenance of soil fertility. There are also ongoing efforts to assess the interactions between agricultural practices and the conservation and sustainable use of components of agricultural biodiversity, particularly at the landscape scale (e.g. activities under the UNDP/GEF/FAO "Globally Important Agricultural Heritage Systems" (GIAHS)).

From the perspective of functional components of agricultural biodiversity, the establishment of international initiatives under the Programme of Work on Agricultural Biodiversity has helped in focusing assessments and providing a clearer picture of their respective issues. For example, the rapid assessment of pollinator's status undertaken by FAO provides an overview of their status and trends, and on another number of issues such as economic value – furthermore, the preparation of the rapid assessment of pollinators is also an exercise in identifying gaps in understanding and knowledge.

There are no specific global assessments of other invertebrate (taxonomic or funcionsal groups) but work is being undertaken to document insect diversity in particualr settings (e.g. UNEP), databases are being developed (e.g. Ecoport, Ecocrop, ICIPE, OIE, SADC ICOSAPM project).

[48] In decision VII/3, COP notes "the postponement of the preparation of the final report of the comprehensive assessment of agricultural biological diversity and related milestones by two years". At the 11th Regular Session of the CGRFA, the development of an authoritative report on *The State of the World's Biodiversity for Food and Agriculture* was approved as a long-term goal for FAO's Commission on Genetic Resources for Food and Agriculture within its MYPoW.

Information on worldwide collections of micro-organisms (e.g. CABI, CGIAR) is coordinated by the World Federation of Culture Collections. CABI and the CGIAR are examples of international organizations that hold collections, but also look at other related issues such as release of micro-organisms, or their utilization, preservation and distribution. Regional and inter-regional intitatives are also relevant for micro-organisms, such as OECD's work on Biological Resource Centers, including the possibility of establishing a global Biological Resources Centre (BRC) network.

As part of its Multi-year Programme of Work, the CGRFA included, as part of its major outputs and milestones, a review of a scoping study on micro-organisms and invertebrates (to be presented at its 12th Regular Session), a review of key issues on micro-organisms and invertebrates (to be presented at its 14th Regular Session), and a review of work on micro-organisms and invertebrates (to be presented at its 15th Regular Session).

Activity 1.3. Carry out an assessment of the knowledge, innovations and practices of farmers and indigenous and local communities in sustaining agricultural biodiversity and agro-ecosystem services for and in support of food production and food security.

The ecosystem approach to agricultural biodiversity implies the need for an in-depth understanding of the interactions between social, economic and environmental factors. Traditional and local knowledge is one important aspect in the assessment of such interactions: here, there is also a need for greater synthesis of the information available and this will also form an important part of the comprehensive global assessment of agricultural biodiversity – for example, the important nexus between agricultural biodiversity management, local knowledge systems and gender roles[49]. An increasing number of international organizations are utilizing approaches such as Farmer Field Schools (FFS) developed and promoted by FAO to build on the knowledge of farmers to address agrobiodiversity issues, such as IPM.

Efforts have been focussed on a number of issues by different international origanizations (e.g. CGIAR centers, AVRDC, SEARICE, CINE, IIED, CONDESAN, LPP) including: farmer seed systems; management of PGR; documenting local knowledge on wild relatives, medicinal and herbal species; tradtional agriucultural practices; and potential of ethnoveterninary knowledge to contribute to animal health and empower local peoples.

There are also ongoing efforts to coordinate and manage the information gathered in a useful way and some organizations are using the Internet to share available traditional and local knowledge. In general, an increase in the use of participatory approaches implies that indigenous and local knowledge is more often being taken into account in defining the needs of communities and in project formulation. A number of international initiatives are supporting efforts to better value and protect traditional and local knowledge associated with agricultural biodiversity (e.g. UNDP/GEF/FAO "Globally Important Agricultural Heritage Systems"). A number of other studies have also been reported on other socio-economic factors influencing agricultural biodiversity (such as CIMMYT's socio-economic research has allowed understanding the relationship between modern varieties and landraces and how farmers manage this diversity).

Activity 1.4. Promote and develop assessments of the interactions between agricultural practices and the conservation and sustainable use of the components of biodiversity referred to in Annex I to the Convention.

A number of projects are underway that examine ecological interactions and their potential benefits for agriculture, particularly for pest management (e.g. work undertaken by FAO, CGIAR Centers, CABI,

[49] This has been highlighted under the LinKS project

UNEP/GEF, IUCN), while a number of ongoing efforts assess the interactions between agricultural practices and the conservation and sustainable use of components of biodiversity (e.g. the work of GLOBIO as part of the IIASTD assessment, DIVERSITAS agroBIODIVERSITY, ICIPE). Assessments have been undertaken in more specific contexts (e.g. assessment of the interaction between cattle keeping and the conservation of wildlife in Kenya and Tanzania (ILRI), and at the landscape level (e.g. international review and assessment of "Scientific Foundations of Ecoagriculture", conducted by Cornell University, in collaboration with Ecoagriculture Partners). In 2002, a workshop was held by FAO and ICRISAT on crop-associated biodiversity in semi-arid tropical ecosystems, looking at interactions between components of crop-associated biodiversity[50].

Activity 1.5 Develop methods and techniques for assessing and monitoring the status and trends of agricultural biodiversity and other components of biodiversity in agricultural ecosystems; including (a) criteria and guidelines for developing indicators to facilitate monitoring and assessment of the status and trends of biodiversity in different production systems and environments, and the impacts of various practices, building wherever possible on existing work, in accordance with decision V/7, on the development of indicators on biological diversity, in accordance to the particular characteristics and needs of Parties; (b) An agreed terminology and classification for agro-ecosystems and production systems to facilitate the comparison and synthesis of various assessments and monitoring of different components of biodiversity in agricultural ecosystems, at all levels and scales, between countries, and regional and international partner organizations; (c) Data and information exchange on agricultural biodiversity (including available information on ex situ collections) in particular through the clearing-house mechanism under the Convention on Biological Diversity, building on existing networks, databases, and information systems; (d) Methodology for analysis of the trends of agricultural biodiversity and its underlying causes, including socio-economic causes.

Considerable relevant work has been carried out by international organizations, particularly in relation to indicators. These range from highly specific indicators of components of agricultural biodiversity (e.g. indicators developed under the monitoring approach for implementation of the GPA) to more general indicators such as the third, revised set of indicators of sustainable development[51] recently announced by DSD, in which biodiversity is considered a major theme. Other work on indicators is undertaken by OECD, the UNEP/GEF 2010 Biodiversity Indicators Partnership.

Regarding indicators of agricultural biodiversity, considerable progress has been made and highly relevant work is ongoing by a number of international organisations. The main challenge in this area of work is to draw together, coordinate and refine the information generated from these sources in order for it to be useful and coherent on a global scale.

Having considered the document "*The ecosystem approach applied to food and agriculture: status and needs*"[52] at its 11th Regular Session (June 2007), the CGRFA stressed the importance of the ecosystem approach in assisting the Commission to address biodiversity for food and agriculture, particularly in regard to the planned *State of the World's Biodiversity for Food and Agriculture*. Another important consideration in the development of this global assessment is the synthesis of the many indicators developed that are relevant to agricultural biodiversity, and the development of a monitoring framework based on the tools and information available. In many cases, appropriate indicators and monitoring frameworks are already being developed as part of other international efforts related to agriculture and the environment, and efforts should be made to promote synergies and avoid overlaps.

[50] Beyond the Gene Horizon: Sustaining Agricultural Productivity and Enhancing Livelihoods Through Optimization of Crop and Crop-Associated Biodiversity with Emphasis on Semi-arid Tropical Agroecosystems *F. Waliyar , L. Collette and P. E. Kenmore*

[51] http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm
[52] CGRFA-11/07/15.4/Rev.1

Databases and other information relevant to agricultural biodiversity, including case studies and information on best practices, are increasingly being made available on the Internet. Every international organisation considered in the survey of international organisations has a website, most of which include information on their activities, publications and often databases. There are also some significant and relevant information "clearing houses". As such, information becomes increasingly available; a major challenge is to ensure its accessibility and usefulness, globally.

Different classifications of production environments exist, and it is noted that the classification system used in the FAO/World Bank work[53] on farming systems, and FAO/IIASA work on agro-ecological zones[54] are commonly used. A classification system for the world's livestock production systems was published by FAO[55] in 1996, and was used in slightly modified form to structure the discussion of livestock sector trends in *The State of the World's Animal Genetic Resources for Food and Agriculture.* Efforts have also been made to develop a comprehensive set of production environment descriptors[56] for animal genetic resources.

Biodiversity is being integrated to some extent in other land resources assessments for example efforts are being made to see how agricultural biodiversity can be included in the integrated natural resources assessment being piloted by FAO with the Government of Kenya, in the Global Land Degradation Assessment of drylands methodology which is led by FAO and being piloted in six countries and in FAO's work with partners in assessing the area under sustainable agro-ecosystems.

3.2 Element 2: Adaptive Management

This programme element is divided into three activities. The first is to carry out case studies (activity 2.1). These should be conducted and documented by national institutions, civil-society organizations, and research institutes, with support from international organizations, and should be representative of regional issues and prioritize. On the basis of these, the following would be identified: cost-effective practices and technologies, related policy and incentive measures that enhance the positive and mitigate the negative impacts of agriculture on biological diversity, productivity and capacity to sustain livelihoods (activity 2.2); and information on them would be disseminated (activity 2.3) (decision V/5). The complementary and often overlapping nature of these three activities means that many organizations are addressing all activities under this element through the same projects or programmes. In addition, the definition of a case study can vary from organization to organization.

The aim of this programme element was to improve understanding of the multiple goods and services provided by agricultural biodiversity and the complex interactions that contribute to its enhancement or loss. While this has been partially achieved in the context of the work of individual organizations, there have been limited efforts to synthesize and disseminate the findings of these studies. It should also be noted that very little of this work is reflected on the website of the CBD on case studies of relevance to agricultural biodiversity, indicating that most of these case studies have not been officially submitted to the CBD under the PoW. The few cases that have been submitted since the adoption of the Programme of Work, while relevant to agricultural biodiversity, are in general focused primarily on other areas such as trade, biotechnology, environmental impact assessment and technology transfer.

Activity 2.1 Carry out a series of case studies, in a range of environments and production systems, and in each region: a) to identify key goods and services provided by agricultural biodiversity, needs for the

[53] FAO/WB. "Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World". 2001. ftp://ftp.fao.org/docrep/fao/003/y1860e/y1860e00.pdf
[54] http://www.fao.org/ag/AGL/agll/gaez/index.htm
[55] FAO. 1996. *World livestock production systems. Current status issues and trends*, by C. Seré & H. Steinfeld with J. Groenewold. Animal Production and Health Paper, No. 127. Rome.
[56] FAO. 1998. *Report: Working group on production environment descriptors for farm animal genetic resources*. Report of a Working Group, held in Armidale, Australia, 19 – 21 January 1998. Rome.

conservation and sustainable use of components of this biological diversity in agricultural ecosystems, and threats to such diversity; b) to identify best management practices; and c) to monitor and assess the actual and potential impacts of existing and new agricultural technologies..."

Calls for case studies in the context of a particular initiative or issue, such as the International Initiative for the Conservation and Sustainable Use of Pollinators[57], Initiative on Biodiversity for Food and Nutrition[58] and the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity[59], have drawn significant response and have also been more effectively synthesised and disseminated to interested parties, in comparison with the general call for case studies on a range of topics under the Programme of Work. This highlights the importance of information gathering efforts under the Programme of Work to be issues-driven.

A wide range of case studies has been undertaken by different organizations and in different contexts (component-specific to the landscape level). There is also a considerable range of ongoing work to identify and promote the dissemination of information on cost-effective practices and technologies. Nearly every organisation included in the survey has made some contribution to this activity within the context of their own mandate and focus, particularly regarding the analysis and dissemination of ways to mitigate negative and promote positive impacts. In particular, FAO and others, including many CGIAR centres, have carried out a great deal of work in this area in specific regions, environments and contexts. There is also a considerable range of work ongoing to identify and promote the dissemination of information on cost-effective practices and technologies.

Examples of some of the issues for which case studies have been prepared include, among others, plant and animal genetic resources, farmer field schools[60], goods and services, pollinators[61], soil biodiversity[62], nutrition[63], potential of wild species for local people's livelihoods, plant breeding, organic farming, access and benefit sharing, protecting community rights over their traditional knowledge.

Studies showing the financial value of biodiversity-friendly practices have been reported by a number of organisations (e.g. IFPRI, CIMMYT) including efforts to develop mechanisms for benefiting poor farmers through payments for ecosystem services[64].

It should be noted that many case studies provided under other thematic and cross-sectoral programmes of work under the Convention, particularly the programme of work on dry and sub humid lands and work carried out in the context of the Ecosystem Approach, are also relevant to agricultural biodiversity.

[57] The first *Rapid Assessment of Pollinators' Status Report* considered a number of sources for its preparation, including over fifty case studies submitted to FAO (http://www.fao.org/ag/AGP/AGPS/Default.htm), documenting activities and findings from thirty-three countries; case studies on the International Pollinator Initiative (IPI) submitted to the Ecoport portal; and from ICIMOD, which is also conducting case studies in the context of a comprehensive analysis of mountain horticulture and cash crop farming, with and without the use of managed pollination.

[58] Notably documentation on nutrient composition and consumption of species and subspecies, as well as case studies with CINE on traditional food systems, and the original research and review papers published in the Special Issue of the Journal of Food Composition and Analysis on Biodiversity and Nutrition in 2006 (http://www.elsevier.com/wps/find/journaldescription.cws_home/622878/description#description)

[59] http://www.fao.org/landandwater/agll/soilbiod/default.stm

[60] Some sources: http://www.communityipm.org/ or www.farmerfieldschool.net

[61] http://www.fao.org/ag/AGP/AGPS/Default.htm

[62] http://www.fao.org/landandwater/agll/soilbiod/default.stm

[63] Special Issue of the Journal of Food Composition and Analysis on Biodiversity and Nutrition (2006)

[64] An example is the FAO PESAL (Payments for Ecosystem Services from Agricultural Landscapes: Making Sure the Rural Poor Benefit) project, funded by the FAO Netherlands Partnership Programme (FNPP) aimed at developing tools and information for policy-makers and technical staff on designing PES schemes that can reach the poor and contribute to poverty alleviation and at improving collaboration and coordination between strategic institutions involved in PES.

Activity 2.2. Identify and promote the dissemination of information on cost-effective practices and technologies, and related policy and incentive measures that enhance the positive and mitigate the negative impacts of agriculture on biological diversity, productivity and capacity to sustain livelihoods.

Most work being carried out in the areas of trade and marketing relate to the promotion of underutilised crops, seed and output market chain analysis and trade issues relating to plant genetic resources. In the area of policy as it contributes to adaptive management, there is considerable ongoing work on intellectual property rights, particularly on protecting the rights of local communities to landraces.

Several organisations (e.g. Greenpeace and Friends of the Earth) are working to restrict or ban the use of GMOs. Other organisations such as IFOAM continue to focus on the promotion of organic agriculture.

In order to make the available information useful in the context of agricultural biodiversity, greater activity is required not only to synthesize and analyze the wide range of information and experiences available, but also to ensure that it reaches those who can make use of the information. A successful example of such work is the LEISA Magazines, which focus on a field-level readership and support adaptive management in the same way as experiential learning approaches such as Farmer Field Schools (FFS) – by promoting creative thinking and innovation.

Activity 2.3. Promote methods of sustainable agriculture that employ management practices, technologies and policies that promote the positive and mitigate the negative impacts of agriculture on biodiversity, with particular focus on the needs of farmers and indigenous and local communities.

FAO and many organisations are working to develop methods of sustainable agriculture that employ management practices, technologies and policies that promote the positive and mitigate the negative impacts of agriculture on biodiversity. Integrated pest management is one major focus of these activities and a number of organisations have noted the promotion and use of integrated and/or participatory approaches such as farmer field schools and community based biodiversity management. For years, FAO has promoted integrated pest management (IPM) through conservation of natural enemies as a way of reducing chemical pesticide use. Asia rice yields have increased as pesticide use has declined: in Indonesia alone, an annual pesticide subsidy that reached more than US$ 140 million in 1987 was eliminated by 1989[65].

There are also strong contributions from ongoing international efforts in the context of the CBD, on both the *Ecosystem Approach* and *Sustainable Use*. Regarding Sustainable Use, there have been recent efforts to recognize these synergies: CBD COP decision VII/12 recognized that agricultural biodiversity was not fully addressed in the process leading up to the development of the Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity and noted the need for their further elaboration, specifically with respect to domesticated species, breeds and varieties in the context of the programme of work on agricultural biodiversity. The third regional workshop on sustainable use in Nairobi (December 2006) focused in particular on the applicability of the Addis Ababa Principles and Guidelines for the sustainable use of agricultural biodiversity in Africa. This third regional workshop focusing on the sustainable use of agricultural biodiversity is a first step in a larger process, in developing guidance for the application of the Addis Ababa Principles to agricultural biodiversity[66].

3.3 Element 3: Capacity Building

Element 3 on capacity building focuses on empowering local communities to improve the management of agricultural biodiversity at the agro-ecosystem level. As such, it is to be implemented primarily through

[65] Kenmore, Peter. 1996. *Integrated Pest Management in Rice*. In *Biotechnology and Integrated Pest Management*. CAB International.
[66] The information document on Sustainable Use is available at: UNEP/CBD/SBSTTA/13/Inf

initiatives within countries, including through extension services, local government, educational and civil-society organizations, including farmer/producer and consumer organizations and mechanisms emphasizing farmer-farmer exchange. According to decision V/5, this programme element would engage the widest possible range of civil-society organizations, including those not normally linked to biodiversity initiatives.

It is also noted in decision V/5 that "catalytic support may need to be provided through national, regional and global programmes, organizations, facilities and funding mechanisms, In particular to support capacity building, exchange and feedback of policy and market information, and of lessons learned from this and programme element 2, between local organizations and policy makers, nationally, regionally and globally".

According to planned outputs in the Programme of Work, examples at country level of operational mechanisms for participation by a wide range of stakeholder groups including civil society organizations were to be available by 2002. Local-level forums and regional networks covering at least 1,000 communities should be established by 2010, by which time farmers and local communities should be involved in the majority of national programmes.

Activity 3.1. Promote enhanced capabilities to manage agricultural biodiversity by promoting partnerships among researchers, extension workers and farmers in research and development programmes for biological diversity conservation and sustainable use of biological diversity in agriculture. To achieve this, countries should be encouraged to set up and maintain, inter alia, local-level forums for farmers, including indigenous farmers using traditional knowledge, researchers, extension workers and other stakeholders to evolve genuine partnerships, including training and education programmes.

A major worldwide movement that continues to contribute to capacity building for agricultural biodiversity at local level is the Farmer Field School (FFS)[67] movement. The first FFS were initiated by FAO in 1989 as part of the Indonesian National IPM programme. In Asia alone, FFS have now involved over two million farmers in more than a dozen countries, supported by a wide range of government departments, NGOs, and international agencies (Bartlett 2005). A global survey, covering the period 1989-2005, shows that over 4 million farmers had been trained in Asia, many parts of Africa, Latin America and more recently also introduced in the Middle East, North Africa and Eastern/Central Europe[68]. The empowering approach taken by the first FFS did not emerge suddenly, but was the result of several years of experience and development - IPM training using an experiential learning approach was taking place as early as 1978 in parts of the Philippines[69]. Today, capacity building through FFS continues to grow, using participatory training, workshops, and study tours. In six countries in the Near East for example, during the period 2006-2007 FAO provided training to over 3800 farmers through FFS on IPM for various fruits and vegetables including tomatoes, cucumbers, grape, strawberry, citrus, mango, apple, olives and watermelon.

Building capacity is important for improving the conservation and sustainable utilization of agricultural biodiversity - in doing so, countries will be able to better support local efforts to sustainably manage this

[67] Farmer Field Schools were built on the assumption that farmers can only implement IPM effectively once they have the ability to carry out their own analysis, make their own decisions and organize their own activities. These efforts are continuing in many areas: FAO is presently promoting FFS for the management of soil productivity in Africa. By 2006, forty-five FFS groups had been set up in Tanzania by District Agricultural Offices, with the technical support of relevant Lake Zone Agricultural Research Institutes. FAO is also using the FFS approach in Africa for IPM activities, as well as in Eastern and Central Europe, where activities include the training of trainers (ToT), students field schools and risk management activities in IPM.

[68] "A Global Survey and Review of Farmer Field School Experiences" . A. Braun, J. Jiggins, N. Röling, H. van den Berg and P.Snijders.
http://www.farmerfieldschool.info

[69] Bartlett, Aug 05 Case Study: IPM Farmer Field Schools
http://www.communityipm.org/docs/Bartlett-FFS_Case_for_IRRI_workshop_2005.pdf

vital resource, while improving achievement of internationally agreed goals and targets for biodiversity conservation and use. Success stories have shown that bottom-up approaches (such as FFS) from the community to national policy makers, are particularly effective. Networks and partnership building can assist in this process - many ongoing projects and programmes make efforts to involve multiple stakeholders and build networks. Key challenges highlighted in building sustainable, multi-stakeholder partnerships can include low levels of trust between farmers, agricultural policy and biodiversity conservation communities.

Activity 3.2. Enhance the capacity of indigenous and local communities for the development of strategies and methodologies for in situ conservation, sustainable use and management of agricultural biological diversity, building on indigenous knowledge systems.

Participatory and adaptive approaches are key to enhancing local capacity in the management of agricultural ecosystems. An increasing number of international organizations are utilizing approaches such as Farmer Field Schools (FFS), farmer participatory research and participatory plant breeding, which contribute not only to improving productivity in the short term, but also enhance local people's understanding of the ecosystems on which they depend and hence increase their capacity to manage them in the longer term. In addition, some organizations (e.g. ICARDA, BUCAP, Pedigree, Bioversity International) are actively building farmer's networks.

One major focus is in the area of genetic resources, for example through participatory breeding programmes[70] and work to empower farmers and local communities to secure their facilitated access to and sustainable use of genetic resources – and in particular, focusing on locally adapted biodiversity.

Activity 3.3. Provide opportunities for farmers and local communities, and other stakeholder groups, to participate in the development and implementation of national strategies, plans and programmes for agricultural biodiversity, through decentralized policies and plans, and local government structures.

Activities are ongoing to give local communities a voice in policy issues, for example the promotion of 'citizen's juries' to enable small farmers and indigenous peoples to participate in assessing different food, farming and rural development futures, and voice their priorities with regard to policy futures. Another example is the Bioversity International-lead project "Genetic Resources Policy Initiative", through which national level multistakeholder, multidisciplinary and multisectoral committees/platforms have been created to develop genetic resources policies in several countries**.**

There is a need to build capacity for bringing together the different components of agricultural biodiversity and at the decision-making level, capacity on bringing together the environment and the agriculture sectors will need to be strengthened. The adoption by governments of National Agricultural Biodiversity Programme (NABP)[71] as policy instrument like in the case of Lao PDR is an example of where the linkages between building capacity of decision makers and mainstreaming agricultural biodiversity into national thinking, are important.

[70] The Global Partnership Initiative for Plant Breeding Capacity Building (GIPB)[70] was launched in 2006 by FAO and partners with the mission of strengthening the capacity of developing countries to improve crops for food security and sustainable development through better plant breeding and delivery systems. One of its objectives is to provide training relevant to utilization of plant genetic resources. Participatory approaches are among the main elements of this training process.

[71] In December 2004, a National Agricultural Biodiversity Programme (NABP) was endorsed by the Government of Lao. Under this NABP, selected activities are being implemented, with technical and financial assistance from FAO through the FAO/Netherlands Partnership Programme, that specifically focus on building the capacity of farmers, technical staff, and government officials – and integrating the outcomes of selected activities into national policy. One example of this is the activity "Integrating agricultural biodiversity considerations into Environmental Impact Assessment in Lao PDR", whereby technical guidelines were developed with participation of staff from different line ministries to be submitted to the Ministry of Agriculture and Forestry for their consideration, to be then submitted to the Lao PDR Science, Technology and Environment Agency as part of their process for revising the national EA decree.

Activity 3.4. Identify and promote possible improvements in the policy environment, including benefit-sharing arrangements and incentive measures.

This element is primarily focused at national level, however many international organizations are carrying out capacity building activities within the framework of their own mandates. This includes providing technical assistance to requesting countries, to strengthen capacities at different levels – from the field level, to the policy-makers level. Indeed, linking local and policy levels is one area where international organizations can, and do, have an added value. An example of capacity building at the policy level is the training provided, by FAO and Bioversity International at national level, on the International Treaty. IUCN also contributed to training through its "Explanatory Guide to the International Treaty on PGRFA"[72]. Another example is FAO's work on policy-level workshops that are held at national, sub-regional and regional levels on a range of issues related to agricultural biodiversity (e.g. IPM).

Activity 3.5. Promote awareness about the value of agricultural biodiversity and the multiple goods and services provided by its different levels and functions, for sustainable productivity amongst producer organizations, agricultural cooperatives and enterprises, and consumers, with a view to promoting responsible practices

Many organizations carry out awareness-raising activities, from different angles. Some examples of the different organizations and the diversity of their "target audience" include ICUC, who carries out awareness-raising promoting underutilized crops, for example through its website[73], a newsletter and other publications. WBCSD, Earthwatch, WRI and IUCN contribute to awareness raising within the business community[74], but also CABI. The UNCTAD BioTrade Initiative, launched in 1996, promotes sustainable biotrade in support of the objectives of the CBD. Publications in the context of campaigns by organizations such as GRAIN, Greenpeace, Practical Action, ETC Group and PAN also contribute to raising awareness of relevant issues. Many activities of the Slow Food movement are focused on promoting awareness. The Ark of Taste, for example, is a growing catalogue of foods that have been forgotten or marginalized and are at risk of disappearing completely.

Lastly, many of the activities that contribute to programme element 2 (adaptive management) also contribute to awareness raising, in particular the landscape-scale activities of Ecoagriculture Partners and DIVERSITAS, and work on payments for ecosystem services (e.g. FAO).

Activity 3.6. Promote networks of farmers and farmers' organizations at regional level for exchange of information and experiences.

Many ongoing projects and programmes make efforts to involve multiple stakeholders and build networks (e.g. CIAT-supported bean network (ECABREN), or the LPP LIFE Network, which is a group of organizations and individuals who promote community-based conservation and development of indigenous livestock breeds and species). Key challenges highlighted in building sustainable, multi-stakeholder partnerships can include low levels of trust between farmers, agricultural policy and biodiversity conservation communities. It has been suggested that further investment is required in processes that enable stakeholders from agricultural and conservation sectors to build shared visions as the foundation for partnership development.

3.4 Element 4: Mainstreaming

According to the Programme of Work (decision V/5), programme element 4 was to be implemented primarily at the national level, drawing on the experiences of ongoing programmes. It was expected that as a result of these activities, over 100 countries would have participated in various assessments under

[72] IUCN Environmental Policy and Law Paper No. 57
[73] www.icuc-iwmi.org
[74] see Ecosystem Challenges and Business Implications published by the WBCSD, Earthwatch, WRI and IUCN in November 2006

programme element 1 by 2005. There was also expected to be coordination between sectoral assessments and plans of action at national level in the majority of countries by 2005, and a range of guidelines published at international level.

Activity 4.1. Support the institutional framework and policy and planning mechanisms for the mainstreaming of agricultural biodiversity in agricultural strategies and action plans, and its integration into wider strategies and plans for biological diversity, through: (a) Support for relevant institutions in the conduct of assessments on the status and trends of agricultural biodiversity within the context of ongoing biodiversity and sectoral assessments; (b) Development of policy and planning guidelines, and training materials, and support for capacity-building initiatives at policy, technical and local levels in agricultural and environmental forums for the development, implementation, monitoring and evaluation of policies, programmes and actions for the conservation and sustainable use of agricultural biodiversity; and (c) Improved consultation, coordination, and information-sharing within countries among respective focal points and lead institutions, relevant technical committees and coordinating bodies, to promote synergy in the implementation of agreed plans of action and between ongoing assessments and intergovernmental processes.

International organizations, and in particular FAO and the CGIAR Centres, have been providing support to countries to participate in the major ongoing assessments of components of agricultural biodiversity, and this target has been more than met through the assessments on plant and animal genetic resources.

Regarding this activity, the adoption by governments of national agricultural biodiversity programme or strategy, when implemented, constitute an excellent mean to ensure mainstreaming of agricultural biodiversity in sectoral policies and increase awareness of the role that agricultural biodiversity can play in the developmental agenda of a country. The National Agricultural Biodiversity Programme (NABP) developed with the technical and financial assistance from FAO through the FAO/Netherlands Partnership Programme (FNPP), in Lao PDR took into account sectoral and developmental policies such as agriculture and poverty reduction strategies and has been endorsed in 2004 by the Government of Lao. The FNPP is also supporting agricultural biodiversity mainstreaming in Kenya which is being supported through a range of initiatives at various levels: with pilot districts and farmers field schools to identify threats and needs for supporting conservation and sustainable use and develop training materials; with training institutions (universities and agricultural colleges) to develop agricultural biodiversity curricula and case studies as part of agricultural training; with the seed and market sectors to identify threats and opportunities for enhancing seed and crop diversity and reduce vulnerability of farming systems and livelihoods; with policy makers to assess status and trends of natural resources and biodiversity and promote the conservation and sustainable use of agricultural biodiversity as part of the mainstream national programmes and investments.

Of particular note in the area of policy development is the adoption of the International Treaty on Plant Genetic Resources for Food and Agriculture by the FAO Conference in November 2001. Regarding plant genetic resources policy issues, a wide range of support is being provided to countries, for example on the implementation of international agreements such as the International Treaty, as well as to harmonize related policies and laws. In addition, the monitoring of the Global Plan of Action for the Conservation and Sustainable Utilization of PGRFA and the process of preparation of the Second *State of the World's PGRFA* report (e.g. the National Information Sharing Mechanism) present another opportunity to mainstream components of agricultural biodiversity.

Another major success in this regard was the completion of *The State of the World's Animal Genetic Resources for Food and Agriculture*, endorsed at the First International Technical Conference on Animal Genetic Resources (AnGR) in Interlaken, Switzerland, in September 2007. The results of the Conference should further strengthen intergovernmental cooperation and action for the conservation and use of AnGR, which will then be integrated back into the future planning of the CGRFA.

The implementation of the recent decisions of the 11th session of the CGRFA should contribute to facilitate the dialogue between environment and agriculture, also at national level.

Activity 4.2. Support the development or adaptation of relevant systems of information, early warning and communication to enable effective assessment of the state of agricultural biodiversity and threats to it, in support of national strategies and action plans, and of appropriate response mechanisms.

Information systems are becoming well established. Early warning systems are in place or under development for PGRFA and AnGR as well as for animal diseases or invasive species under the auspices of FAO. For instance, through the Emergency Prevention System (EMPRES) for transboundary programme, FAO assists in early warning, early reaction and research on animal and plant pests and diseases of a transboundary nature in order to minimize the risk of such emergencies developing. Initial emphasis is on migratory pests, in particular the strengthening and support of the Desert Locust Management System. A cooperative programme has been developed in the Central Region and is being extended to West Africa. Regarding major transboundary livestock diseases, including Rinderpest and other epidemic animal diseases (contagious bovine pleuropneumonia, foot-and-mouth disease, contagious caprine pleuropneumonia, peste de petit ruminants, rift valley fever, and lumpy skin disease), they are among the most contagious and place a serious burden on the economies of the countries in which they occur.

Activity 4.3. Promote public awareness of the goods and services provided by agricultural biological diversity, and the value and importance of such diversity for agriculture and for society in general.

According to the Programme of Work on Agricultural Biodiversity, coordination between sectoral assessments and plans of action at national level in the majority of countries by 2005 was expected, and a range of guidelines published at international level. In this area, a wide range of activities are ongoing for the conservation of genetic resources, in particular PGR. Most of the guidelines reported to date have been produced on issues relating to PGRFA, for example on conservation and management, seeds, or policy issues such as access and benefit sharing. Other guidelines have been produced on issues such as invasive species management (e.g. IPPC, CABI), or more general guidelines on integrating agriculture and biodiversity conservation policies and the development of policies that enable better conservation and sustainable use of biodiversity (e.g. IICA, FAO, CGIAR Centers). *The State of the World's Animal Genetic Resources for Food and Agriculture* would also further stimulate ongoing activities in this area.

At the technical level, the on going international initiatives on agricultural biodiversity, namely those on pollinators, soil biodiversity and nutrition, have been successful. Preliminary findings show that the creation of these initiatives has garnered momentum for key international players to implement activities to achieve the objectives of these initiatives. In some cases, such as for pollinators, this momentum has leveraged the creation of partnerships to conduct technical work. Examples of this include the creation of the African Pollinator Initiative (API), the Brazilian Pollinator Initiative, and the partnerships created through the approved global-sized FAO/UNEP/GEF-funded project on the "Conservation and Management of Pollinators for Sustainable Agriculture, Through an Ecosystem Approach".

Activity 4.4. Promote ongoing and planned activities for the conservation, on farm, in situ, and ex situ, in particular, in the countries of origin, of the variability of genetic resources for food and agriculture, including their wild relatives.

Particularly outstanding in the review of activities is the entrenchment of two areas of work (throughout all the programme elements) in which there has been a strong focus for many years: the conservation and sustainable use of PGRFA and Integrated Pest Management (IPM). While activities in these fields have

been on-going, and continuously being developed since the 1950s and '60s – before the adoption of the Programme of Work on Agricultural Biodiversity - a large proportion of these ongoing activities nonetheless contribute substantially to the implementation of the PoW on Agricultural Biodiversity The development over time of these areas of work and the increased involvement of a wide range of organisations provides a positive message to more recent areas of activity where significant effort is being invested, such as animal genetic resources and pollinators, as well as many other focal areas. The success of these areas of work in filtering gradually into more "mainstream" thinking also highlights the importance of these issues in the overall Programme of Work. Cross-cutting initiatives within the Programme of Work have also shown to have a great potential to highlight particular issues and to focus work in these areas.

As the work in plant genetic resources for food and agriculture has now been consolidated in a number of international organizations (e.g. FAO, Bioversity International), and in particular the entry into force of the International Treaty, future focus of the CBD Programme of Work on Agricultural Biodiversity should emphasize all components of agricultural biodiversity, through an ecosystem and farming system approach.

At the global mainstreaming level, the 11th Regular Session of the CGRFA, with its broadened mandate to include all components of biodiversity for food and agriculture, adopted the major outputs and milestones to be addressed in its Multi-year Programme of Work over its next five sessions. The CGRFA also recognized the many ongoing areas of collaboration between FAO and the Convention on Biological Diversity, in the area of biodiversity for food and agriculture, and recommended further strengthening of cooperation between FAO and its Commission, and the CBD, acknowledging the need for complementarity and mutual support. The Commission also recommended a joint work plan on biodiversity for food and agriculture between FAO and its Commission and the Secretariat of CBD.

More recently, the intergovernmental forum of the CGRFA also stressed the need for enhanced cooperation among national programmes in agriculture and environment, and requested FAO to support synergies at the national level between these sectors.

CHAPTER 4: INTERNATIONAL INITIATIVES

4.1 Pollinators

Overview

In recognition of a looming pollination crisis, there has been a mobilization of effort on several levels to address pollination management and conservation[75].

The aim of the International Initiative for the Conservation and Sustainable Use of Pollinators is to promote coordinated action worldwide to:

- Monitor pollinator decline, its causes and its impact on pollination services;
- Address the lack of taxonomic information on pollinators;
- Assess the economic value of pollination and the economic impact of the decline of pollination

[75] On a global level, the international community has identified the importance of pollinators. Decision III/11 of the United Nations Convention on Biological Diversity (CBD) established the Programme of Work on Agricultural Biodiversity and called for priority attention to be given to components of biological diversity responsible for the maintenance of ecosystem services important for the sustainability of agriculture, including pollinators. The Fifth Conference of the Parties to the Convention Biological Diversity established an International Initiative for the Conservation and Sustainable Use of Pollinators (also known as the International Pollinators Initiative-IPI) in 2000 (COP decision V/5, section II) and requested the CBD Executive Secretary to "invite the Food and Agriculture Organization of the United Nations to facilitate and co-ordinate the Initiative in close co-operation with other relevant organizations." The Plan of Action of the IPI was prepared by FAO and the CBD secretariat was adopted at COP 6 (decision VI/5).

services; and

- Promote the conservation and the restoration and sustainable use of pollinator diversity in agriculture and related ecosystems.

The Initiative is structured around four elements: Assessment, Adaptive Management, Capacity Building and Mainstreaming. A wealth of activities has taken place globally with respect to pollinators, since the adoption of the International Initiative for the Conservation and Sustainable Use of Pollinators. These are summarized by element, below, and an assessment of overall progress is presented.

Element 1. Assessment[76]

1.1 Monitoring status and trends of pollinators: A diverse range of monitoring programmes and projects have been instituted carried out on different levels and often with different objectives. The *Project Ape Miele Ambiente* (Bee-Honey-Environment), in Italy for example, undertook a country-wide, four-year monitoring program of its wild bees in agricultural and semi-natural landscapes. *ALARM*: Assessment of Large Scale Environmental Risks with Tested Methods, a project that will run through 2009, has been supported by the EU 6th framework programme, to assess and forecast the risks of changes in biodiversity (with a particular focus on pollinator loss, climate change, environmental chemicals and biological invasions) on the structure, function, and dynamics of ecosystems, in the context of current and future European land use patterns. These comprehensive censuses of whole countries or assessments across an entire continent have yielded useful results, as benchmarks or as inputs into tools for decision makers, but as intensive research projects they are unlikely to be sustained over the long-term. Yet many groups have pointed to the necessity for long-term monitoring for mobile and highly variable taxa such as pollinators. For such an effort to be sustained, it must be cost effective and widespread, and targeted in scope to particular indicators to reduce variability. Initiatives to enlist volunteers with simple methods and to focus on key crop pollination systems have these characteristics. The *Squash Pollinators of the Americas Survey (SPAS)*- consisting of a network of volunteer collaborators drawn from universities and federal agencies from Guelph, Ontario, Canada to Buenos Aires, Argentina and three states in southern Brazil- has developed a methodology to focus on specific cropping system, as an indicator of overall trends. The *Bee Bowl Network* has develop a standardized sampling protocol to generate information on geographic patterns and trends of bee diversity and seek to encourage many investigators worldwide to contribute to a single set of data. A volunteer society in the UK, *Bees, Wasps and Ants Recording Society (BWARS)* contributed substantially to a large-scale assessment and analysis of long-term data in the Netherlands and the United Kingdom showing parallel declines in pollinating species and the plants they pollinate, published in Science magazine in 2006. A workshop on Survey Methods for bees: assessing status and suggesting best practices- the *Sao Paulo+5 Forum Workshop*- was held in October 2003 in Sao Paulo, Brazil, with a follow-up session at the *2004 Solitary Bees Workshop* in Ceara, Brazil. At this follow-up workshop, it has been proposed that from the different regional pollinator initiative undertake a pilot programme of comparing the results from different methodologies, deployed simultaneously at sites around the world, to be better able to agree on common standardized approaches. In the project development phase of a FAO/UNEP/GEF funded project that is coordinated by FAO- *Conservation and Management of Pollinators for Sustainable Agriculture, through an Ecosystem Approach*- monitoring methods were piloted in five countries, and a monitoring protocol was identified, based on protocols developed through ALARM, Bee Bowls and the Squash Bee Survey.

The *status of pollinators in North America* was assessed by the US National Research Council's Committee on this topic, who published their findings in 2006. The regionally-composed committee found evidence for the decline of some pollinator species in North America, including the most important managed pollinator, the honeybee, as well as some butterflies, bats, and hummingbirds. For most managed and wild pollinator species, however, population trends have not been assessed because populations have not been monitored over time. An international assessment of the state of knowledge on status and trends of pollinators globally has been carried out in the context of the International

[76] The Plan of Action of the IPI presented the following "Timing of expected outputs" for the first element, Assessment: The first stage of the global programme for monitoring of pollinator diversity should be completed by 2005. The second stage would be conducted for an initial period of five years (2006 - 2010) and then, depending on the progress made, renewed for a further five years at a time thereafter. Important and significant trends are likely to emerge only after several years (5-10) of monitoring. A preliminary report on the state of the world's pollinators would be prepared by 2004 based on existing data, and early results from elements 1 and 2. A first comprehensive report would be prepared by 2010, drawing upon, inter alia, the results of the monitoring programme, and the economic analyses.

Initiative for the Conservation and Sustainable Use of Pollinators, and the results, the first *Rapid Assessment of Pollinators' Status Report* will be presented to the CBD in 2008.

The final activity in monitoring the status and trends of pollinators is to develop and implement a g*lobal programme for monitoring pollinator diversity*. Lessons learned from the diverse initiatives are that there needs to be agreement on standardized methods; training is needed in the field; a few indicative systems should be selected and observations from around the world need to be pooled to identify global trends. It is assisting partner countries to implement standardized monitoring methods in a diverse set of developing countries that will significantly extend the reach of existing monitoring programs.

1.2 *Assess the economic value of pollinators.*

Efforts have begun to develop methods for economic valuation of pollination. A review of *methods of economic valuation of crop pollination* was carried out and the results published by FAO as a PDF document. A global study[77] was completed and published, of how much the production of crops that nourish humanity is dependent on animal pollination, based on FAO crop production data, providing a much more precise estimate of the contribution of pollinators to the world's crop production. Thus, methods and a more systematic framework for analysis are in place, to facilitate a credible assessment of the economic value of pollinators.

1.3 Assess the state of scientific and indigenous knowledge on pollinator conservation.

In addition to the *US National Research Council's Committee on Status of Pollinators in North America,* as mentioned in 1.1 (which focused extensively on gaps in scientific knowledge), the state of scientific and indigenous knowledge has also been assessed through:

- The proceedings of the Workshop on the Conservation and Sustainable Use of Pollinators in Agriculture, with Emphasis on Bees, Pollinating Bees: "*The Conservation Link between Agriculture and Nature*", and of a Workshop on "*Solitary Bees, Conservation, Rearing and Management for Pollination*" were published in 2002 and 2003, respectively.
- Case studies and a synthesis report on the state of indigenous knowledge of pollination, to be published as part of the *Rapid Assessment of Pollinators' Status Report* that will be presented to the CBD in 2008;
- The International Bee Research Association publishes the *Journal of Apicultural Research*, which regularly reports on research on management of pollination services.
- A forthcoming book, *Farming with Nature*, contains a "state of the art" assessment of Pollination, written by the African Pollinators Initiative steering committee and other collaborators.

In general, assessments of the state of knowledge have concluded that effective conservation or restoration of pollinator populations requires comprehensive knowledge of their biology, which is currently insufficient to inform the design of sustainable management and maintenance programs.

1.4 Promote the development of identification keys for bee genera.

Initiatives are underway to develop user-friendly tools for bee identification in:

- *Eastern North America* (http://stri.discoverlife.org),
- *South Africa* (http://www.arc.agric.za/home.asp?PID=1&ToolID=63&ItemID=1786)
- *Europe* http://www.nhm.ac.uk/hosted_sites/iczn/ALARM/Lucid_key.html.

[77] Klein et al, 2006

Methods to identify species on the basis of DNA are rapidly evolving and becoming more cost-effective. Through an initiative in Canada, about 40% of the Canadian bee fauna has had relevant segments of their DNA characterized and databased, so that these species can quickly be identified through a simple laboratory procedure carried out on a small piece of a specimen, such as a leg.

Element 2. Adaptive Management[78]

2.1 Carry out a series of case-studies, to identify key goods and services provided by pollinator diversity; to identify best management practices and to assess the actual and potential impacts of existing and new agricultural technologies.

Over fifty case studies of experiences with pollination in agroecosystems were contributed to the *Rapid Assessment of Pollinators Status* report, from Nepal, Pakistan, India, China, the United Kingdom, Ghana, Kenya, Egypt, Columbia, Brazil, Panama, Costa Rica, Mexico and the United States. They have been summarized in the report that will be presented to the CBD in 2008. The FAO UNEP/GEF-funded project coordinated by FAO- *Conservation and Management of Pollinators for Sustainable Agriculture, through an Ecosystem Approach*- is designed around specific sites and pollinator-dependent cropping system where these elements can be documented, and best practices identified. Methods to document current pollination services in key farming systems, the threats to these and best practices to promote pollinators are presently being piloted in Ghana, Nepal and India. A *Global Survey of Best Practices to Promote Pollination Services* is being undertaken by ICIPE, the International Centre of Insect Physiology and Ecology, in collaboration with FAO. An international working group, supported by the National Center for Ecological Analysis and Synthesis in the United States, is analyzing the available data and experience on *Restoration of Crop Pollination Services in Degraded Landscapes*, from cropping systems around the world. Conclusions will be published in late 2007.

2.2 Identify and promote the dissemination of information on cost-effective practices and technologies, and related policy and incentive measures that enhance the positive and mitigate the negative impacts of agriculture on pollinator diversity, productivity and capacity to sustain livelihoods.

Methods of carrying out site and farmer-based evaluation of the costs and benefits of pollinator-friendly practices are under development and testing in Ghana, Nepal and India, in part through the pilot phase of the FAO UNEP/GEF-funded project coordinated by FAO - *Conservation and Management of Pollinators for Sustainable Agriculture, through an Ecosystem Approach. The international working group on Restoration of Crop Pollination Services in Degraded Landscapes* will address an analysis of practices and technologies impacting pollination services. *CABI* is undertaking functional biodiversity field studies to study how manipulation of field margins can maximize benefits from biological control agents, pollinators, and other beneficial organisms. The *North American Pollinator Protection Campaign*, along with the Co-evolution Institute, has developed pollinator-friendly fact sheets.

Activity 2.3: Promote methods of sustainable agriculture that employ management practices, technologies and policies that promote the positive and mitigate the negative impacts of agriculture on pollinator diversity.

Integrated crop management techniques and/or organic vegetable production techniques, with positive anticipated impacts, are under development and promotion by a number of agencies, including AVRDC, the World Vegetable Center. ICIPE carries out research to stabilize agricultural productivity in Africa

[78] The Plan of Action of the IPI presented the following "Timing of expected outputs" for the second element, Adaptive Management: A first set of case-studies is already under preparation. Further case-studies would be studies published, analysed and disseminated by 2005. The case-studies should be representative of regional issues and prioritize best practices and lessons learned that can be broadly applied.

through utilization of biodiversity in wild systems, and seeks to raise awareness of the role of wild habitats in sustainable agriculture.

Element 3. Capacity Building[79]

Activity 3.1 Promote awareness about the value of pollinator diversity and the multiple goods and services it provides for sustainable productivity, amongst producer organizations, agricultural cooperatives and enterprises, and consumers, with a view to promoting responsible practices.

ICIMOD, International Centre for Integrated Mountain Development, has raised awareness in the Hindu-Kush region and globally on the *declines and threats to indigenous honeybees*. Awareness raising activities are the feature of annual *"Pollinator Days*" coordinated by the North American Pollinator Protection Campaign, with activities in Canada, US and Mexico. The Forgotten Pollinator Campaign, and the Migratory Pollinators Project of the Arizona-Sonoran Desert have worked to raise awareness of pollinators globally, and *the role of bats, hummingbirds, doves and monarch butterflies in migratory corridors between Mexico and the southwestern United States.* Xerces Society has developed *"Guidelines for Providing Native Bee Habitat on Farms"* and disseminated the publication, "*Farming for Bees".*

Activity 3.2: Identify and promote possible improvements in the policy environment, including benefit-sharing arrangements and incentive measures, to support local-level management of pollinators and related dimensions of biodiversity in agricultural ecosystems.

Brazil has explicitly promulgated *policies and intergovernmental directives to support pollination conservation and sustainable use on a national level.* An *initial survey of policy instruments* was developed as part of the FAO UNEP/GEF-funded project on *Conservation and Management of Pollinators for Sustainable Agriculture, through an Ecosystem Approach.* The North American Pollinator Protection Campaign held two strategic planning conferences to develop a *blueprint for pollinator protection.*

Activity 3.3: Promote enhanced capabilities to manage pollinator diversity at local level by promoting partnerships among and between farmers, researchers, extension workers and food processors.

Pilot *training /farmer community meetings for building capacity to manage pollinator diversity* are being organized in demonstration sites in Ghana, Nepal and India, coordinated by FAO. The African Pollinator Initiative, in its inaugural meeting, encouraged presentations by students and pollination practitioners, and published a *special issue of the International Journal of Tropical Insect Science, dedicated to building capacity to understand pollination in Africa. An international field course in Biology and Ecology of Pollination* has been held several times in Bahia, Brazil, with international participation.

Activity 3.4: Build taxonomic capacity to carry out inventories of the pollinator diversity and distribution in order to optimize their management, through, inter alia, the training of taxonomists and parataxonomists of bees and other pollinators.

The *"Bee Course*", sponsored by the American Museum of Natural History, has been held annually since 1999, training people from over 20 countries in bee taxonomic skills. An *African Bee Course*, modeled on the original, has been held in Kenya and Ghana, in 2004 and 2006, sponsored by FAO and BIOTA. The development of a *World Bee Catalogue*, and *Database of Bee Specimens*, which will provide

[79] The Plan of Action of the IPI presented the following "Timing of expected outputs" for the third element, Capacity Building: Ten on-the-ground cases of enhanced partnerships resulting in greater conservation of pollinator diversity at the local level, by 2006. Introduction of mechanisms promoting pollinator diversity by 2010; Progressively increased capacity at national level for taxonomy, information management, assessment and communication.

information to develop user-friendly identification materials, is underway, through a collaboration between FAO and GBIF, the Global Biodiversity Information Facility.

Activity 3.5: Develop tools and mechanisms for the international and regional exchange of information for the conservation, restoration and sustainable use of pollinators.

A website is currently under development for the *International Initiative for the Conservation and Sustainable Use of Pollinators.* In addition, websites have been developed for the African Pollinator Initiative, Brazilian Pollinator Initiative, European Pollinator Initiative and North American Pollinator Protection Campaign website, with facility for information posting and exchange. A major objective of *Apimondia* is to facilitate the exchange of information and discussion, through organising congresses, conferences and seminars where beekeepers, scientists, agriculturalists and legislators meet to discuss and learn from each other. Apimondia includes special sessions on pollinators in its congresses. *INESP* proposes to establish a network of scientific expertise for the development of sustainable pollination systems.

In terms of maintenance and exchange of information on threatened and endangered pollinators, two species of native bees are officially *listed as endangered in Brazil*. Xerces Society maintains a *red* list of endangered pollinators of North America (57 species of bees and 60 species of butterflies) The ALARM project is developing an extensive *database of pollinators in Europe, including red list status.*

Element 4. Mainstreaming[80]

Activity 4.1: Integrate considerations of pollinator diversity, and related dimensions of agricultural biodiversity, including host-plant diversity, at species, ecosystem and landscape levels, consistent with the ecosystem approach, into biodiversity strategies and action plans, and into planning processes in the agricultural sector.

A number of countries have included consideration of pollination in their national biodiversity strategy and action plan (NBSAP).

For example, in Pakistan's NBSAP, pollinators also are specifically mentioned:

> "Biodiversity provides free of charge services worth hundreds of billions of rupees every year that are crucial to the well-being of Pakistan's society. These services include clean water, pure air, pollination, soil formation and protection, crop pest control, and the provision of foods, fuel, fibres and drugs. As elsewhere, these services are not widely recognized, nor are they properly valued in economic or even social terms. Reduction in biodiversity (including local extinction of species) affects these ecosystem services. The sustainability of ecosystems depends to a large extent on the buffering capacity provided by having a rich and healthy diversity of genes, species and habitats. In that respect, biological diversity is like economic diversity in a city; it is essential for long term survival and a sound investment in the future."

[80] The Plan of Action of the IPI presented the following "Timing of expected outputs" for the fourth element, Mainstreaming: Progressively increased capacity at national level for taxonomy, information management, assessment and communication. Consideration of pollinators and related dimensions of agricultural biodiversity incorporated into national biodiversity and/or agricultural sector plans in 50 countries by 2010.

South Africa's draft National Biodiversity Strategy and Action Plan recognizes of the dependence of production sectors such as cultivation and plantation forestry needing ecosystem services, including pollination. In the UK, the National Biodiversity Action Plan[81] includes three types of specific action plans, for species, habitats and local planning. Of the 391 species plans, over a hundred of these focus on pollinators; many of the habitat plans address important pollinator habitats.

In the agricultural sector, pollination has often been overlooked in rural development strategies and is not included as a technological input in most agricultural development packages. High value agriculture is promoted by many governments, and agricultural development institutions offer packages of practices for different type of crops, but mostly overlook the importance of managing pollination to achieve a sustainable yield. Introducing substantive changes in agricultural development will first require changes in agricultural research and development investment policies, such that the research agenda recognizes pollination as an important aspect of crop productivity and seeks to identify optimal ways to use and conserve pollinators. Changing grower behaviour based on research findings is also another challenge that the policy environment can impact.

Activity 4.2: Support the development or adaptation of relevant systems of information, early warning and communication to enable effective assessment of the state of pollinator diversity and threats to it, in support of national strategies and action plans, and of appropriate response mechanisms.

The ALARM project is developing a *Rapid Assessment Toolkit*, for use by policymakers, general public, scientist and educators to assess risks of biodiversity loss, with a particular focus on pollinators, from different scenarios of climate change, alien invasive species and chemicals in the environment.

Activity 4.3: Strengthen national institutions to support taxonomy of bees and other pollinators.

The development of a *World Bee Catalogue*, and *Database of Bee Specimens*, through a collaboration of FAO and GBIF will assist national institutions to make use of taxonomic information, and will permit repatriation of specimen and locational information of use to pollinator conservation.

Summary

In numerous respects, the establishment of the International Initiative for the Conservation and Sustainable Use of Pollinators (IPI) has facilitated timely and coordinated efforts globally to attain the objectives of the initiative's Plan of Action.

Experience in piloting multiple approaches to the issue of monitoring the status and trends of pollinators has provided a solid basis for a global monitoring programme. The resulting programme will find commonalities between different approaches, rather than imposing one single methodology, and will benefit from a better understanding of the need to focus on indicator systems.

An initial focus, within the initiative, on the development of tools and methods (for example, with respect to economic valuation of pollination services) in a number of countries will bear fruit as these methods are applied over the next few years.

The large number of case studies that have been submitted to the IPI- the majority of which have focused on specific crop pollination systems- indicates the keen interest in developing adaptive management of pollinators. At the same time, much of the work that has been carried out has been of a research focus, and actual implementation and adoption of pollinator-friendly practices needs to be field-tested by

[81] www.ukbap.org.uk

farmers and land managers. It will be important that field implementation carefully tracks the costs and benefits of new practices. In many instances, proposed practices have synergies with the conservation and sustainable use of other aspects of agricultural biodiversity; for example, reducing pesticides benefits both natural enemies of pests, but also pollinators. It is quite likely that there may be multiple benefits from interventions, but this needs thorough documentation.

Two interlinked blocks in addressing conservation and management of pollinators is the taxonomic impediment and gaps in scientific knowledge. Proper identification of pollinators is needed to access information on their biology, and even then, information on the key resources needed by pollinators is often lacking. While nothing can substitute for solid life-history information on pollinating species, emerging technologies that permit pooling and sharing of information are helping to make the available information more accessible. Databases have been assembled by regional pollinator initiatives in Brazil and in Europe that link pollinators to their floral preferences, nesting sites and other resource needs. These can be expected to grow in content, coverage and utility over time.

Greater public appreciation of the role of wild pollination services to contribute an insurance policy that sustains pollination even when managed pollinators are suffering setbacks, would seem an ideal opportunity to make the link between biodiversity conservation and human livelihoods. This is particularly true with the Colony Collapse Disorder plaguing honeybees.

4.2 Soil Biodiversity

Overview

In 2002, the Conference of the Parties of the Convention on Biological diversity established an International Initiative for the Conservation and Sustainable Use of Soil Biodiversity as a cross-cutting initiative within the programme of work on agricultural biodiversity, and invited FAO and other relevant organizations, to facilitate and coordinate this initiative (paragraph 13 of decision VI/5)[82].

In the annex to the decision VIII/23 of the COP a set of goals were established for the implementation of the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity:

(a) Promote awareness-raising, knowledge and understanding of key roles, environmental services, functional groups and impacts of diverse soil management practices, including those performed by indigenous and local communities, in different farming systems and agro-ecological and socio-economic contexts.
(b) Increase understanding of the role of soil biodiversity in agricultural production, traditionally applied land management practices and ecosystem and environmental health.
(c) Promote the understanding of the impacts, ownership, and adaptation of all land use and soil-management practices as an integral part of agricultural and sustainable livelihood strategies.
(d) Promote the mainstreaming of soil biodiversity conservation into land and soil-management practices.

Work on soil biodiversity has been conducted in the areas of assessment, monitoring and mainstreaming under programmes and projects conducted by institutions, e.g. TSBF-CIAT, IRD, CAB International,

[82] The annex of the Conference of the Parties (COP) decision VIII/23 states that the Initiative is to be implemented as a cross-cutting initiative within the programme of work on agricultural biodiversity, through the coordination, and with the technical and policy support of the Food and Agriculture Organization of the United Nations (FAO), with appropriate links to other thematic programmes of work of the Convention, particularly those on the biodiversity of dry and sub-humid lands, mountain and forest biological diversity, and with relevant cross-cutting issues, particularly the Global Taxonomy Initiative and work on technology transfer and cooperation. The Initiative provides an opportunity to apply the ecosystem approach and the Addis Ababa Principles and Guidelines for Sustainable Use. The Initiative will liaise closely with the United Nations Convention to Combat Desertification and its advisory bodies and processes in order to enhance cooperation between the conventions and avoid effort duplication.

among others. In general, some groups of soil biota studied more than others, especially earthworms, termites, ants and nitrogen-fixing bacteria.

Summary

Regarding Objective 1, *sharing of knowledge and information and awareness-raising,* while some case studies exist[83], new case studies would allow for the needed updated information. To date, there has been limited work undertaken to compile, synthesize, and evaluate case studies for practical advice and active dissemination.

There is still limited coordinated effort to gather data and information specific to soil biodiversity. Databases and information systems exist that contain relevant information but these are intrinsic to project work being carried out. In general there is considerable potential for development of information systems and augmentation of networking regarding sharing of knowledge and information. Moreover, there is much more work required in this area and efforts are needed to enhance public awareness and make relevant information widely available.

Regarding Objective 2, *capacity-building for the development and transfer of knowledge of soil biodiversity and ecosystem management into land use and soil management practices,* the promotion of adaptive management approaches, as well as capacity building efforts and some targeted participatory research is ongoing, e.g. in Brazil, the AMAZ-BD (IRD) is conducting participatory farmer-oriented learning-by-doing processes on soil life and function. Some very relevant work has been undertaken on indicators, which has the potential to contribute to broader efforts to develop tools, build information and identify and develop datasets on soil biodiversity at national level that are important for agriculture. FAO has provided support for the development of extension field guides on soil macro-fauna and soil health in collaboration with IRD. Taxonomic expertise lacks in many countries for most of the soil biota groups, therefore collaboration with the Global Taxonomy Initiative could be strengthened, to fill specific gaps. Technical expertise and capacity building is provided at the technical level and only for some groups of soil organisms. Nonetheless, there is a need for training on soil biodiversity and function at the farmer level with advocacy material and training manuals.

Regarding Objective 3, *strengthening collaboration among actors and institutions and mainstreaming soil biodiversity and biological management into agricultural and land management and rehabilitation programmes,* activities have so far been limited. There is also a need to strengthen collaborative mechanisms between sectors in order to ensure mainstreaming of soil biodiversity and biological management

In conclusion, the work carried out to date has highlighted the very real need and considerable potential for work under this Initiative to develop further partnerships and in particular to make available relevant research findings for application for promoting sustainable and efficient agricultural development. As requested by the Executive Secretary of the CBD, FAO continues to facilitate interaction and collaboration between partners and institutions on the different program elements of the Soil Biodiversity Initiative, and on know-how technologies about the sustainable use of soil biodiversity so that farmers can profit from their beneficial functions in agroecosystems. There is also the need for projects and programmes conducted by international institutions in contributing to increase knowledge of soil biodiversity and function from other less studied ecosystems and land uses, for example, from semi-arid and arid regions.

4.3 Biodiversity for Food and Nutrition

[83] Some case studies are available on the FAO soil biodiversity portal: http://www.fao.org/landandwater/agll/soilbiod/default.stm

Overview

The Cross-cutting Initiative on Biodiversity for Food and Nutrition[84], led by FAO and Bioversity International, has already made significant progress in some areas despite its recent establishment, and a number of activities have also been planned for 2007 and early 2008. The Initiative is presented in four elements:

- *Element 1: Developing and documenting knowledge,* with the objective to improve the evidence base, i.e., data on composition and consumption of food genetic resources, to substantiate the links and relationships between biodiversity and nutrition, and the relevant links between human health and ecosystem health.
- *Element 2: Integration of biodiversity, food and nutrition issues into research and policy instruments,* with the objective to mainstream the conservation and sustainable use of biodiversity into agendas, programmes and policies related to nutrition, health, agriculture and hunger and poverty reduction.
- *Element 3: Conserving and promoting wider use of biodiversity for food and nutrition,* with the objective to counter the loss of diversity in human diets, and in ecosystems.
- *Element 4: Public awareness, t*o raise awareness of the links between biodiversity, food and nutrition, and the importance of biodiversity conservation to meeting health and development objectives, including the elimination of hunger and other forms of malnutrition.

Element 1

There have been a number of efforts to develop and document relevant knowledge. This element focuses on research and case studies, as well as the development of relevant indicators. Particular needs have been identified in terms of biodiversity indicators in food composition and nutritional analysis, and an International Expert Consultation on *Nutrition Indicators for Biodiversity is planned* in São Paulo, Brazil on October 21, 2007 as an official satellite meeting to the 7th International Food Data Conference (IFDC7). The IFDC7 has adopted the theme of Nutrition and Biodiversity for its 3 day meeting (22-24 Oct 2007). The need for cross-training between nutritionists and those involved in biodiversity science has also been highlighted, and Bioversity and FAO have planned courses in 2007 in Brazil, Malaysia and Nigeria as well as the first West African Graduate Course on Food Composition and Biodiversity in Accra, Ghana (FAO and Bioversity International).

A Special Issue of the Journal of Food Composition and Analysis on Biodiversity and Nutrition was jointly published by FAO and Elsevier in 2006[85], containing original research and review papers on biodiversity in local and traditional food systems; new nutrient data to underpin the sustainable use of plant genetic resources for food and agriculture; diversity of fruits, nuts and their products for improving nutrient intakes; farm animals and fisheries diversity for human nutrition; ecosystems and nutrition: rice-based aquatic ecosystems and dietary diversity. Further Special Issues of this journal are being planned on relevant topics including animal genetic resources.

A significant point of focus in information gathering activities has been on the role of traditional foods. To this effect, Bioversity International has conducted a study on "Dietary diversity: linking traditional foods and plant genetic resources to rural and urban health in Sub-Saharan Africa" (Kenya, Uganda,

[84] A proposed framework for the Initiative is provided in an annex to decision VIII/23, drawing on the work of the first expert consultation on biodiversity for food and nutrition (Brasilia, March 2005), as well as a Nutrition Stakeholders Meeting (Rome, February 2006).

The overall aim of the initiative is to promote and improve the sustainable use of biodiversity in programmes contributing to food security and human nutrition, as a contribution to the achievement of Millennium Development Goal 1, Goal 7 and related goals and targets and, thereby, to raise awareness of the importance of biodiversity, its conservation and sustainable use. The proposed framework also notes that activities should be implemented taking into account the Voluntary Guidelines to Support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security (the "Right-to-Food Guidelines") adopted by the FAO in November 2004.

[85] see CGRFA-11/07/20

Tanzania and Senegal); and contributed a paper and presentation at the 10th Annual Nutrition Forum of the Economic Community of West African States (ECOWAS), Cape Verde, on "Managing Biodiversity for Food and Nutrition Security: building on indigenous knowledge for more sustainable livelihoods" (September 2006). The Asian Vegetable Research and Development Center (AVRDC) also has a number of projects promoting indigenous vegetables and studying the effect of dietary diversification on nutrition.

FAO and the Centre for Indigenous People's Nutrition and Environment (CINE) will soon publish Indigenous Peoples' Food Systems for Nutrition and Health, as 12 case studies from different parts of the world. This represents the first of two phases of research to understand the importance of local food systems for Indigenous Peoples' health and well-being. It describes the vast diversity of food species known within these cultures and ecosystems and describes several parameters of them, including nutrient composition, the influx of globalized food and the extent of the nutrition transition. Each of the twelve chapters has been researched and prepared by a team of Indigenous community leaders and their academic research partners. Both qualitative and quantitative research methods were used in different ways within the chapters to present a comprehensive view on the diversity of circumstances Indigenous Peoples face in protecting their cultures, ways of life, and intrinsic views on health and healthy diets. These chapters set the stage for the second research phase, which is the implementation of health promotion interventions using local resources.

CINE has also published a number of highly relevant peer reviewed publications on the linkages between agricultural biodiversity, nutrition and health, and ongoing research is focused on these linkages. CINE also maintains a traditional food database including nutrient values (minerals, vitamin A, macronutrients and fatty acids) for many of the mammals, birds and fish regularly consumed by Arctic Indigenous Peoples.

Bioversity International has carried out case studies in Uganda, Kenya and South Africa on the role of leafy vegetables, traditional medicines, and the role of wild-gathered foods in nutrition, as well as a study on the significance of rural traditional food diversity in urban markets: the case of Nairobi City in Kenya. More generally, case studies in LEISA Magazines such as issue 20.1 "Valuing Crop Diversity", and 20.3 "From field to market", as well as some of the case studies being developed by Ecoagriculture Partners and the DIVERSITAS agroBIODIVERSITY network may be relevant to this initiative.

Element 2

The integration of biodiversity concerns into nutrition instruments has been initiated in FAO in the context of FAO's program of work in nutrition. FAO's Regional and Subregional offices have worked towards specific major outputs in food composition analysis and dietary assessments in projects for the promotion of traditional food crops, such as the work by the FAO Sub-Regional Office for the Pacific Islands (SAPA) in supporting the identification and promotion of specific cultivars of Pandanus (*Pandanus tectorius)* as a source of beta-carotene to address the vitamin A deficiency problems in some atolls, in close collaboration with the Ministry of Agriculture and Forestry. Technical assistance in this context included development of promotional material (posters, leaflets) and seminars. Biodiversity elements are also included within other outputs such as food based dietary guidelines, household food security, National Plans of Action for Nutrition, Dietary Guidelines and Goals, National Poverty Reduction Strategy Papers, Food Production Systems (Including a project by the FAO Regional Office for Asia and the Pacific (RAP) on *Nutrition Orientation to Food Production* (October, 2006)), The Right to Food, and emergency response and preparedness. The Right to Food is also part of Bioversity Nutrition strategy in connection with food and biocultural diversity and communities facing periodic chronic hunger.

Work is also ongoing in the area of food composition analysis and dietary guidelines. Inter-sectoral planning is underway between Bioversity, FAO and NGOs on food-based dietary guidelines, and a

workshop is being organized in Brazil for September 2007 on food composition analysis. The INFOODS network, with its secretariat at FAO, is working with national and regional centres to sample, analyze and compile food composition data for underutilized species and subspecies, and incorporate these data into national food composition databases and tables for wide-scale promotion and use. AVRDC is very active in analysis of the composition of vegetables for nutritional value as well as health-related factors such as antioxidant and anti-microbial activity. Composition analysis is also being carried out by ICRISAT on small millets to test the levels of iron, zinc and calcium and compare with major cereals. CIAT is also examining the use of landraces and wild relatives to improve nutritional value (iron and zinc in beans, provitamin A in cassava). CINE research also contributes to this area.

Integration of biodiversity for food and nutrition concerns into food security and poverty reduction strategies has also started: Bioversity is providing support to the Brazilian government to develop and adopt a Biodiversity for Nutrition action plan, including poverty reduction aspects. The African Union has included biodiversity and nutrition as a priority for development.

A number of food security projects and programmes have started to integrate diversity and nutrition aspects. Bioversity has completed a project to strengthen food security at household level through home gardens in Nepal, and is working to link up local municipalities with local producers in order to provide school meals using nutritionally rich crops. Food security underlies all major proposals prepared and submitted to donors by Bioversity, including a proposal to strengthening the teaching of the role of Biodiversity in schools and nutritional education in Peru and Kenya, and a proposal on the role of European home gardens in food security.

AVRDC has developed and distributed Indigenous Vegetable Seed Kits and Nutrition Seed Kits, including the distribution of around10000 home garden nutrition kits to poor farmers of Southern Sudan, Zambia, Tanzania, Rwanda, Kenya, Mozambique, Uganda, and Malawi through the Regional Center for Africa. Vegetable Seed Kits for Gardening were also distributed to Tsunami victims for nutrition relief. Some relevant AVRDC projects include "Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa" phase I and II (2003-2009) (funded by GTZ); "Promoting Utilization of Indigenous Vegetables for Improved Nutrition of Resource-Poor Households in Asia" Phase I and II (2000 − 2006) funded by the Asian Development Bank (ADB); "Linking Agrobiodiversity and Nutrition Security: The Importance of Traditional Vegetables for Nutritional Health of Women in Rural Tanzania" and "Promotion of Indigenous Vegetables for Poverty Alleviation and Nutrition Improvement of Rural Households in the Philippines". AVRDC is also studying the effect of promoting indigenous vegetables through pilot school gardens studied in selected sites of Thailand, Philippines, and Lao PDR.

Ecoagriculture Partners has also reported attention to the linkages between biodiversity conservation, food security, health and nutrition in the context of relevant activities, for example through the Community Knowledge Service, and CABI has noted the significant impact of their 'Living Positively' programme on quality of life of HIV-infected people. This programme, which establishes a participatory learning programme about nutrition needs among HIV-infected people and production of nutritious, vitamin-rich vegetables and fruits, has now been taken up by a number of civil society organizations.

Element 3

The ways and means described for element 3 on conserving and promoting wider use of biodiversity for food and nutrition, contained in the proposed framework described under the annex to decision VIII/23, notes that most of the activities outlined under this element will be pursued under the Convention's existing programme of work on agricultural biodiversity.

FAO is assisting the government in Afghanistan, and more specifically the Ministry of Agriculture through a three year project "Managing Biodiversity for Sustainable Food Security and Nutrition in

Afghanistan". The project aims to improve household food security and nutrition by promoting the consumption of local food species (including wild foods) with high nutritional value and developing income generating activities based on the commercialization of local natural resources. It aims to do so by promoting sustainable management of natural resources and preservation of local biodiversity.

Activities under the FAO Global Plan of Action (GPA) for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture and the Global Strategy for Plant Conservation contribute strongly to the conservation and diversification of plant genetic resources, and in considering the role of animal products in relation to nutrition, the Global Strategy for the Management of Farm Animal Genetic Resources "provides an important technical and operational framework for guiding activities on conserving animal genetic diversity"(decision VIII/23). In terms of market-related activities, activity 14 of the GPA is highlighted, as well as opportunities for cooperation with the BioTrade Initiative of the United Nations Conference on Trade and Development (UNCTAD). In general, most of the activities described under the main programme of work contribute to the objectives of element 3.

Element 4

A range of public awareness materials are available or under development, including:

- Bioversity International is producing recipe books using traditional food in four African countries
- AVRDC has also designed indigenous vegetable recipes based on iron bioavailability studies and African and Asian traditional preparations, and has published and promoted recipe books to Northern and Southern India. recipe book development for Sub Saharan Africa is in progress
- FAO and CINE have published four posters on the *2nd International Decade of the Worlds Indigenous Peoples: Celebrate Diversity in Indigenous Food* for Africa, Asia, Pacific Islands and global; and expect to publish posters for Latin America and the Middle East.
- Traditional Food, Is It Safe? (1997) CINE developed this half-hour video as an educational tool for Indigenous Peoples describing the dilemma of contaminants in traditional food. It illustrates the value of combining scientific inquiry and traditional knowledge in addressing these problems.

Other publications under preparation by FAO include the *Food Composition Manual: Sampling protocols for determining compositional differences at the sub-species level*, to be published in September 2007 (FAO, with United States Department of Agriculture and the International Network of Food Data Systems), and the Proceedings of the 7th International Food Data Conference: Biodiversity and Food Composition.

FAO in collaboration with the National Association of Ecological Producers (ANPE) of Peru and support from FIVIMS, has developed a Field Guide on Andean Foods. The fundamental goal is to alleviate and prevent micronutrient deficiencies and to enhance food and nutrition security by promoting the production and consumption of these foods. The guide includes scientific and local names, nutrient content, methods of preparation, uses and agronomic information. This guide currently *in press*, will serve as a tool for easy and quick retrieval of reliable information related to indigenous foods of nutritional value and for training at various levels.

FAO supports school gardening and nutrition education for primary and secondary school children, including the promotion of indigenous and underutilized vegetables and fruits that are rich in micronutrients. FAO has published a manual on "Setting up and Running a School Garden" (English; Spanish; French in press) and has prepared 30 classroom lesson plans to enable teachers and pupils, with support from parents and the community, to learn how to grow, tend, harvest and prepare nutritious seasonal produce in the educational setting of the classroom, the garden, the kitchen, the school cafeteria and the home. The experience promotes the environmental, social and physical wellbeing of the school community and fosters a better understanding of how the natural world sustains itself. FAO currently implements school garden projects in collaboration with ministries of education and agriculture in: South

Africa, Lesotho, Zimbabwe, Mozambique, Rwanda, El Salvador, Honduras, Nicaragua, the Dominican Republic and Brazil; projects are in the pipeline for: Bolivia, Belize and Bermuda. www.fao.org/schoolgardens

Other activities that contribute to awareness raising at different levels include the transectoral initiative between the UNESCO Cultural Sector and the Science Sector to redefine the selection criteria of the UNESCO Cities of gastronomy, with a specific focus on the conservation and use of agricultural biodiversity. This activity, which aims to use the already existing framework and classification of UNESCO's Cities of Gastronomy to promote a more integrated vision of gastronomy and food systems, is still on a design phase and will hopefully be implemented by mid 2007.

AVRDC has also noted linking the issues of biodiversity and nutrition in public awareness materials as integral to the organization's mission, as well as relevant activities including holding a series of field days for local farmers in Taiwan to explain the nutritional and economic value of some indigenous vegetables. AVRDC has noted the potential to expand this work in East Africa, however sufficient research understanding is required in order to be able to present comprehensive recommendations for policy makers or farmers.

The Slow Food movement also contributes significantly to raising public awareness of dietary diversification, particularly through taste education activities such as "taste workshops" and school programs, a learning "convivium" supporting a range of awareness activities and the "ark of taste", a growing catalogue of foods that have been forgotten or marginalized and are at risk of disappearing completely. The slow food "Presidia" also help support the production of traditional foods.

A number of relevant workshops and conferences have also been convened, including:

- Nutrition Stakeholder Workshop: Cross Cutting Initiative on Biodiversity for Food and Nutrition. Bioversity Headquarters, Maccarese, Rome (Italy), February 16 – 17, 2006
- International Union of Nutritional Sciences. Task Force: Indigenous Peoples' Food Systems and Nutrition
- CINE Global Health Meeting 2006: Indigenous people's food systems for health: 2006 meeting of case study partners, August 10 – 13, 2006, McGill University, Ste-Anne-De-Bellevue, Canada
- Developing African leafy vegetables for improved nutrition: A Regional Workshop held at the African Institute for Capacity Development, Juja, Nairobi, December 6 - 9, 2005
- 10th Annual Nutrition Forum of the Economic Community of West African States (ECOWAS), Cape Verde. Theme of forum: "Nutrition and Chronic Diseases in the framework of the Double Burden of Malnutrition" Sep 2006
- The Tenth International Congress of Ethnobiology on "Ethnobiology : Food Health and Cultural Landscape", Thailand Nov 2006
- Expert Consultative Meeting On The African Regional Nutrition Strategy; 4-8 December 2006, Brazzaville, Congo, organized by the African Union in collaboration with the WHO.
- A regional workshop in West Africa on the HIV/AIDS–nutrition-farming linkage, led by CABI
- Terra Madre, a biennial world meeting organized by Slow Food that brings together food communities working for the sustainability and quality of their food products. In Turin, October 2004, Slow Food held the first edition of Terra Madre. Nearly 5,000 delegates representing 1,200 food communities from 130 countries attended, including farmers, breeders, fishermen, processors, distributors, cooks and agricultural experts, providing considerable networking opportunities. Participants at Terra Madre attend workshops and panel discussions devoted to problems they encounter every day as well as on broader themes, such as biodynamics and genetic engineering. Other International and local events organized by Slow Food such as Slow Fish (Sustainable Fish Event), Cheese, Aux Origines du Goût, Salone Del Gusto, are open to the public.

In addition, Bioversity is presently involved in planning an Advocacy Strategy workshop for Africa on Biodiversity for Nutrition and Health, and ICUC is planning an international Symposium 3-7 March 2008 in Arusha, Tanzania, on the role of "Underutilized plants for food, nutrition, income and sustainable development". The COHAB Initiative Second International Conference on Health and Biodiversity is also planned to be held in Galway, Ireland from the 25th to 28th February 2008; FAO and Bioversity will co-chair the Workshop on Food Resources, Diet and Nutrition – Meeting Food Security Challenges with Biodiversity.

Summary

The Initiative, led by FAO and Bioversity International, has made considerable progress relative to the short time since its inception, highlighting the importance of this issue as well as the importance of the impetus gained since the establishment of the Initiative. For example, a number of activities have been planned for 2007 and early 2008. A number of efforts have been made to develop and document relevant knowledge. Important examples include emphasis of the Journal of Food Composition and Analysis on nutrition and biodiversity, with publication of a special double issue in 2006[86] and plans for further special issues. Other examples include the work of FAO and Bioversity International have been documenting use of biodiversity for consumption, food security and health in different ecosystems in Latin America and Asia, including leafy vegetables, underutilized grains, traditional medicines, and wild-gathered foods in nutrition, as well as the importance of rural traditional food diversity in urban markets. Other examples can be found in the work of CINE and the Asian Vegetable Research and Development Center (AVRDC), among others. Particular needs have also been identified in terms of biodiversity indicators in food composition and nutritional analysis. The integration of biodiversity concerns into nutrition instruments has been initiated in FAO in the context of its program of work in nutrition. Work is also ongoing in the area of food composition analysis and dietary guidelines, as well as integration of biodiversity for food and nutrition concerns into food security and poverty reduction. Experience is being generated at national and local level through the implementation of technical cooperation projects on managing local biodiversity for food and nutrition. Biodiversity International, in technical cooperation with FAO, has pursued its advocacy work in West Africa with senior managers from the agriculture and health sectors. Finally, a number of public awareness materials have been made available, or are under development. As this is a relatively new area of activity, considerable attention is needed to increase the evidence base in order to improve and increase in-depth understanding of the linkages between biodiversity and nutrition.

Chapter 5: Constraints in implementation of the Programme of Work on Agricultural Biodiversity

Through the review of the input of international organizations on the implementation of the Programme of Work on Agricultural Biodiversity, it emerged that Programme Elements addressed (i.e. assessment, adaptive management, capacity building and mainstreaming) still prove a relevant framework for addressing the conservation and sustainable use of biodiversity, and should continue to be applied.

Most constraints to implementing the objectives of the CBD are mainly found at the national level. One aspect of national-level considerations that has an impact at the international level involves misunderstanding/miscommunication of issues between sectors – especially between the agriculture and the environmental sectors. The Programme of Work on Agricultural Biodiversity, in reality, provides a framework through which much can be done to positively and complementarily address both environmental and agricultural issues. Often instead, what is seen is a lack of representation of ministries of agriculture at international environmental fora, and a lack of representation of ministries of environment at international agricultural fora.

[86] Journal of Food Composition and Analysis. Volume 19, Numbers 6-7. September-November 2006. *Special Issue – Biodiversity and Nutrition: a common path*

PART III. GLOBAL EVENTS AND ISSUES

Chapter 6: Global events

There are a number of global events which set the stage for global priorities, and which are linked to the scope and implementation of the Programme of Work on Agricultural Biodiversity. These events are characterized by their constant response to changing global priorities, and request of governments. Examples include the Millennium Development Goals (MDGs), the World Summit on Sustainable Development (WSSD), the Millennium Ecosystem Assessment (MEA), and the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA).

The MDG's (developed as an outcome of the 2000 United Nations Millennium Summit) range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world's countries and all the world's leading development institutions. The implementation of the Programme of Work on Agricultural Biodiversity, and specifically the role that international organizations play in ensuring its implementation, contribute to achieving the MDG's - in particular 1, 7 and less directly, to MDG 8[87]. The programme of work contributes directly to Goal 1 (to eradicate extreme poverty and hunger) though its contribution to improving agricultural productivity and also, for instance, through the Cross-Cutting Initiative on Biodiversity for Food and Nutrition. By enhancing the resilience of agricultural ecosystems to environmental stress, the Programme of Work on Agricultural Biodiversity further contributes to food security and hence the eradication of hunger. It also contributes directly to Goal 7 (to ensure environmental sustainability), particularly to target 9 (to integrate principles of sustainable development into country policies and programmes and to reverse the loss of environmental resources).

The Programme of Work may also contribute indirectly to several other MDGs. In particular, increasing the diversity and nutritional quality of food production can contribute to reducing child mortality (Goal 4); to improving maternal health (MDG 5) and also to combating HIV/AIDS, malaria, and other diseases (MDG 6)[88].

The WSSD (Johannesburg, 2002) recognized that agriculture plays a crucial role in addressing the needs of a growing global population, and is inextricably linked to poverty eradication, especially in developing countries. The Summit emphasized that biodiversity plays a critical role in overall sustainable development and poverty eradication. Since biodiversity is currently being lost at unprecedented rates due to human activities, the WSSD called for actions to promote the wide implementation and further development of the ecosystem approach to reverse this trend. In order to increase food production and enhance food security and food safety in an environmentally sustainable way, an integrated approach, such as the ecosystem approach provides, is essential. Specifically, in paragraph 44 (e) of the Report of the WSSD, when addressing the conservation and sustainable use of biodiversity, it states to include actions to "Promote the wide implementation and further development of the ecosystem approach, as being elaborated in the ongoing work of the Convention".

In many cases, the relationship of agriculture with the surrounding environment is still considered from a primarily negative perspective. The Millennium Ecosystem Assessment highlighted the role of cultivated systems in the fact that 60% of the ecosystem services examined were found to be degrading or used unsustainably, including fresh water, capture fisheries, air and water purification, and the regulation of regional and local climate, natural hazards, and pests. On the other hand, the Programme of Work on Agricultural Biodiversity targets sustainable agriculture. It brings together the *conservation* and the

[87] MDG 1: Eradicate extreme hunger and poverty; MDG 7: Ensure environmental sustainability; MDG 8: Develop a global partnership for development
[88] See Rosengrant 2006. Agriculture and Achieving The Millennium Development Goals" World Bank/IFPRI.

sustainable use of biodiversity in agriculture – through its four programme elements and three International Initiatives, the PoW advocates the management of biodiversity, through an ecosystem approach. Implementation of the PoW at the national, regional and international levels will contribute to reversing the degradation of ecosystem services.

From an institutional angle, at its 11the Regular Session, the CGRFA adopted the major outputs and milestones to be addressed in its Multi-year Programme of Work. The Commission underscored the importance of the Multi-Year Programme of Work as an excellent vehicle to strengthen cooperation in relation to biodiversity for food and agriculture, between FAO and other relevant international bodies. It further stressed the need to ensure synergy and complementarity, and to avoid duplication.

Chapter 7: Links to climate change

Reconciling agriculture, biodiversity, and climate change adaptation is a global challenge. The importance of biodiversity, and the ecosystem services derived from biodiversity, are possibly some of the most important elements contributing to climate change mitigation and adaptation - especially in the context of agricultural production and food security. A new challenge will be responding to the increasing pressure on agriculture to adapt to climate change, such as by providing ecosystem services (e.g. carbon sequestration) to mitigate the effects of climate change.

Climate change will also directly affect future food availability, access, stability and utilization. In recognition of the inextricable link between agriculture and climate change, in 2001, FAO's integrated climate change programme was approved. FAO's programme on climate change includes the promotion of practices for climate change mitigation, the adaptation of agricultural systems to climate change, the reduction of emissions from the agricultural sector as far as it is carefully considered within the major objective of ensuring food security, the development of practices aimed at increasing the resilience of agricultural production systems to the vagaries of weather and climate change, national and regional observing systems, as well as data and information collection and dissemination. It also recognized that the most effective contribution in the area of climate change adaptation lies in providing countries with tools and information for adapting their agricultural policies and practices to changing climate regimes and to improve farmers' capacities to reduce risk or make optimal use of climate variability. FAO is organizing a high-level meeting, to be held in June 2008, on "World Food Security and the Challenges of Climate Change and Bioenergy".

The Synthesis Report of the IPCC[89] Fourth Assessment Report "Climate Change 2007" made a list of possible impacts of climate change on ecosystems:

- The resilience of many ecosystems is *likely* to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g. land-use change, pollution, fragmentation of natural systems, over-exploitation of resources)
- Over the course of this century, net carbon uptake by terrestrial ecosystems is likely to peak before mid-century and then weaken or even reverse, thus amplifying climate change;
- For increases in global average temperature exceeding 1.5-2.5°C and in concomitant atmospheric CO2 concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions, and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem goods and services, e.g. water and food supply;
- The progressive acidification of oceans due to increasing atmospheric CO2 is expected to have negative impacts on marine shell-forming organisms (e.g. corals) and their dependent species (*medium confidence*).

[89] IPCC: Intergovernmental Panel on Climate Change (http://www.ipcc.ch/index.htm)

With climate change, the value of genetic resources for food and agriculture will increase in the near future, and many of these resources will become more threatened, as global climate change will erode biodiversity and destabilize ecosystems significantly, particularly in dryland environments such as the African Sahel. At the same time, the genetic resources used by the forestry, fisheries and agricultural sectors will become ever more crucial in developing adaptation strategies to confront climate change, so as to ensure the sustained increase that will be necessary to feed the world in 2050. In the case of plant genetic resources for example, in the last decades, some countries have lost up to 75% of the genetic diversity of particular crops. It is urgent to conserve the remaining plant genetic resources, as breeders and farmers will need them to adapt to new abiotic and biotic stresses brought by climate change, in particular to drought and to pest and disease outbreaks. Many crop wild relatives, which are an important source of valuable traits for the future, are at risk of erosion with the loss or fragmentation of the habitats in which they live. Another example is fish genetic resources - freshwater aquaculture has high potential for growth as a source of protein and income, especially where integrated sustainably with other sectors, but freshwater fish are the world's most threatened species used by humans. Some of the world's aquatic ecosystems most threatened by climate change are home to the most important wild populations critical for the future of aquaculture (i.e. Tilapia).

In response to the expected severe and quick climate change events, farming communities will have to respond rapidly by adapting their agricultural systems. Building resilience into food and livelihood systems is seen as the best adaptation strategy, especially in rural farming communities of the developing world that are still dependent on rainfed agriculture for local food supplies, and that are already vulnerable to food insecurity. Responses by the global community must take into consideration changes at the ecosystem level, empowerment at the local community level, and decisions at the national and regional levels in order to ensure food security and production, livelihood and equity. Examples of key options for integrating mitigation and adaptation objectives into the conservation and sustainable use of agricultural biodiversity objectives include enhanced insurance systems, including capitalization of diversity of genetic resources and improved management of ecosystem services, improved ecosystem resilience, and using the ecosystem approach.

In its decision VIII/30, the Conference of Parties to the CBD requested SBSTTA to present guidance on the further integration of climate change impact and response activities into the programmes of work of the Convention. The document UNEP/CBD/SBSTTA/12/7 presents guidance on the integration of relevant climate change impact and response activities into the programmes of work of the Convention, including the programme of work on agricultural biodiversity. General guidance provided suggests the identification of vulnerable regions, sub-regions and ecosystem types, including vulnerable biodiversity within these areas; assessment of the threats and likely impacts of climate change on biodiversity in identified vulnerable areas; identification and evaluation of climate change adaptation and mitigation options and evaluation of their impacts on biodiversity; and implementation and monitoring the selected adaptation and mitigation plans.

Document UNEP/CBD/SBSTTA/12/7 presents specific guidance to the programme of work on agricultural biodiversity, suggesting that the programme of work "enhance climate change impact and response activities and address identified gaps during the in-depth review of implementation of the programme of work". Two main gaps were identified in the Programme of Work in relation to climate change: 1) lack of consideration of the vulnerability of agricultural biodiversity to the impacts of climate change and the associated predicted increase in extreme climatic events; and 2) significant information gaps on agricultural biodiversity and climate change links with regards to livestock, food and nutrition, soil biodiversity and pollinators. It highlighted the need to identify agricultural biodiversity that can contribute to climate change adaptation in agricultural areas, especially within vulnerable regions, and to assist Parties to integrate such biodiversity into climate change planning; to document observed impacts, consider the projected impacts of climate change on agricultural biodiversity and use the information in

cross-sectoral planning in agricultural areas; and to compile information on the impacts of climate change on livestock, food and nutrition, pollinators, soil biodiversity, IPM and to develop proposals on options for adaptation, taking into account ongoing initiatives.

Moving forward work on agricultural biodiversity and climate change can be enhanced through linkages with other relevant existing Programmes of Work under the CBD. And example is the potentially strong linkage between the Programme of Work on Agricultural Biodiversity and the Programme of Work on Dry and Sub-humid Lands. These two Programmes of Work can be mutually reinforcing, and should emphasize synergies between each other.

Chapter 8: Biofuels

As the issue of climate change becomes a globally increasing reality, the issue of alternative forms of energy to fossil fuels has become a major issue. Today, the issue of climate change is looking to agriculture for the production of biofuels as this alternative source.

The production of liquid biofuels has been increasing worldwide in recent years, and interlinkages between biodiversity and liquid biofuel production has been identified as a new and emerging issue for consideration by SBSTTA. As liquid biofuel is presently being produced in agricultural production systems, there are a number of important linkages between this issue and agricultural biodiversity.

The conservation and sustainable use of agricultural biodiversity is the backbone for food security, bringing together food production and environmental considerations. Hence, the conservation and sustainable use of agricultural biodiversity resources are paramount in agricultural production systems. The linkages between agricultural biodiversity and agricultural production for biofuels thus needs to be carefully analyzed, since the first considers sustainable production systems for food production and hence food security, while the driving force behind the other production system is to use agriculture to mitigate the environmental problems linked to climate change.

At the UN level, the issue of energy is addressed through UN-Energy – the principal interagency mechanism in the field of energy to help ensure (a) coherence in the UN system's multi-disciplinary response to the WSSD; and (b) collective management of non-UN stakeholders. UN-Energy, sponsored by FAO, produced a document entitled "Sustainable Bioenergy: A Framework for Decision-Makers", which points to key social, economic and environmental sustainability issues raised by the rapid development of bioenergy in both small and large-scale applications.

FAO's International Bioenergy Platform as well as its support to the Global Bioenergy Partnership (for which it hosts the Secretariat) and FAO's involvement in the Bioenergy Wiki are some of the mechanisms put in place to ensure that food security, energy security, rural development and mitigation of climate change are not mutually exclusive targets. The core of the IBEP strategy combines a comprehensive framework with the identification of national, regional and global bioenergy task forces as implementation instruments. It aims at motivating key partners — governments, organizations, rural institutions and other public and private stakeholders — to actively participate. The Global Bioenergy Partnership brings together public, private and civil society stakeholders in a joint commitment to promote bioenergy for sustainable development, and builds its activities upon three strategic pillars – energy security, food security and sustainable development. FAO has also embarked on a multi-year effort to mainstream food security and environmental concerns into assessments of bioenergy potential through targeted analysis and field activities that support rural development. These efforts are supported in part by the Bioenergy and Food Security project (BEFS).

As noted in the document UNEP/CBD/SBSTTA/12/9, scientific data indicate that large scale production of liquid biofuel can have positive greenhouse gas balances and contribute to the reduction of greenhouse

gas emissions, an important indirect contribution to the conservation of biodiversity. However, large scale biofuel production can also have a number of adverse impacts on biodiversity. Most of the potential adverse effects identified are related to agricultural expansion for the purpose of biofuel production. These include the use of natural lands for biofuel production; competition for land with other agricultural uses, in particular for food production; and increased water use and water pollution.

Mitigation of these effects depends heavily on the crops used and the means of producing the required biomass. There is a danger that monocultures of energy efficient crops may be the preferred option for large-scale producers of liquid biofuels. This scenario suggests an increase in all the negative environmental effects generally associated with intensive monoculture cultivation. This is of particular concern in areas of developing countries where such production would be in direct competition with the cultivation of food.

Another important environmental issue in considering the potential effects of liquid biofuel production is the carbon balance of such production systems. As noted in the section on climate change (above), agriculture is a major contributor to greenhouse gasses and carbon emissions in particular are strongly affected by the way feedstocks for biofuels are produced. Soil conservation measures, for example, can reduce the production of greenhouse gasses by between 16 and 42 percent[90]. Practices that reduce the need for agricultural inputs, such as crop rotation and the selection of crops well adapted to the environment in which they are grown, also contribute to reducing carbon emissions.

Diversity in agricultural ecosystems is important to ensure that production is sustainable and that adverse effects are mitigated. Diversification of monoculture ecosystems, through the production of energy crops in rotation with food or other crops, may enhance the positive effects of biofuel production, and alternative options under development such as the use of cellulosic biofuels produced from perennial grasses and trees may have the potential to enhance the protection of vulnerable lands and the restoration of degraded lands. Crop-associated biodiversity may have a role to play in this context, and would need to be further explored. It is recommended[91] that a sound policy framework be developed for liquid biofuel production operations; that guidelines and standards be developed and applied; that research, especially on second-generation feedstocks, be promoted; and that international cooperation on this issue (particularly South-South cooperation) be promoted.

The production of biofuels, or any other agricultural commodity, is not addressed specifically in the Programme of Work on Agricultural Biodiversity. However, the implementation of its elements can assist in maximizing the positive and mitigating the negative effects of increased liquid biofuel production. Of particular note in light of the above recommendations are the activities under programme element 2, including the promotion of sustainable and diverse agricultural practices, and under programme element 4, such as providing support to the institutional framework and policy and planning mechanisms for the mainstreaming of agricultural biodiversity, including the development of policy and planning guidelines, and training materials, and support for capacity-building initiatives.

Many different factors will play a part in the future positive and negative effects of liquid biofuel production. The fact that both the carbon balance and the environmental effects of are strongly influenced by the way such biofuels are produced implies that it is very important to take agricultural biodiversity considerations into account, particularly in developing recommendations and frameworks that deal with the manner in which liquid biofuels are to be produced.

[90] Kimbrell in Clay 2004
[91] UNEP/CBD/SBSTTA/12/9

PART IV: CONCLUSIONS AND MOVING FORWARD

Chapter 9: Conclusions

The broad nature of the scope of agricultural biodiversity[92] has allowed for tackling of issues not only related to "sectoral" biodiversity but the interactions among components of agricultural biodiversity, and at different levels (i.e. genetic, species and ecosystem), giving the Programme of Work on Agricultural Biodiversity the capacity to implement the objectives of the Convention. As importantly, the Programme of Work can also adapt and remain relevant as new issues emerge to challenge the conservation and sustainable use of agricultural biodiversity. Recognizing the special nature of agricultural biodiversity was an important step in elaborating the Programme of Work, and hence it is suggested to re-instate decision II/15, particularly in light of achieving MDG 1 and 7 and the need to address the climate change issue.

Since the adoption of the Programme of Work on Agricultural Biodiversity in 2000, the Strategic Plan and 2010 Biodiversity Target have been adopted. In order to make the Programme of Work on Agricultural Biodiversity consistent with the other Programmes of Work, and the Strategic Plan of the CBD, a vision and mission is proposed in Annex 2. The operational objectives are still very much relevant. In addition, since the adoption of the PoW AgBD, countries have adopted the International Treaty on Plant Genetic Resources for Food and Agriculture, the Global Plan of Action for Animal Genetic Resources, and the State of the World's Animal Genetic Resources.

The assessment of agricultural biodiversity has made significant progress: global assessments overseen by the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) are completed, on-going or planned, and will be a valuable contribution to the preparation the *State of the World's Biodiversity for Food and Agriculture*, to be presented at the 16th Regular Session of the Commission[93]. Assessments of the status and trends of the world's plant and animal genetic resources have been produced, and the preparation of the second SoW-PGRFA is underway (to be presented to the 12th Regular Session of the CGRFA in 2009). The *State of the World's Aquatic Genetic Resources* and the *State of the World's Forest Genetic Resources* will be presented at the 13th and 14th Regular Sessions of the CGRFA, respectively. The *State of World Fisheries and Aquaculture* and *State of World Aquaculture* are regularly produced by FAO.

The Programme of Work on Agricultural Biodiversity was developed using the framework of the Ecosystem Approach. Through the experiences gained on the conservation and sustainable use of agricultural biodiversity, it became increasingly clear that the use of the ecosystem approach should be strengthened – not only at the ground level, but also at the policy level. Further strengthening the use of the ecosystem approach should contribute to the sustainable production of food, the provision of ecosystem services for food, feed and fibre, and the role of agriculture in providing a source of alternative energy.

At the ground level, in the PoW, the Programme Element 2 (adaptive management) in particular, requires an understanding of linkages and complex issues that characterize the special nature of agricultural biodiversity. The ecosystem approach is particularly relevant to this programme element, as adaptive

[92] Prior to the development of the Programme of Work on Agricultural Biodiversity, at the second Conference of Parties, Parties recognized "...the special nature of agricultural biodiversity, its distinctive features, and problems needing distinctive solutions" (decision II/15 - retired). It was the recognition of this "special nature" that set the framework for the development of the PoW AgBD, it elements, and its international initiatives.

[93] In decision VII/3, COP notes "the postponement of the preparation of the final report of the comprehensive assessment of agricultural biological diversity and related milestones by two years". At the 11th Regular Session of the CGRFA, the development of an authoritative report on *The State of the World's Biodiversity for Food and Agriculture* was approved as a long-term goal for FAO's Commission on Genetic Resources for Food and Agriculture within its MYPoW.

management is a core concept in its implementation. Another example of the application of the ecosystem approach is with regards to climate change - over thousands of years of co-evolution in specific climatic and ecological conditions, most agricultural species (e.g. rice) have reached dynamic equilibrium with respect to their pest and pest predator populations. Climate change disrupts such co-evolution, making the key species of production systems more susceptible to pest and disease introductions. These factors mean that a sectoral approach to climate change and genetic resource conservation must be coupled with overall ecosystemic adaptation strategies.

At the international policy level, the continuing relevance of the ecosystem approach was reaffirmed by recent events, in particular by the CGRFA at its 11th Regular Session. Having considered the paper "The ecosystem approach applied to food and agriculture: status and needs"[94], the importance of the ecosystem approach in assisting the Commission to address biodiversity for food and agriculture was stressed, particularly in regard to *The State of the World's Biodiversity for Food and Agriculture.* The Commission also acknowledged that the ecosystem approach is relevant for integrating crosscutting issues, such as the impacts of climate change on agricultural biodiversity. Furthermore, it recommended that FAO continue to advance the application of the ecosystem approach across its diverse programmes and activities in relation to biodiversity for food and agriculture, and that it continue to provide support to countries, in particular developing countries, to assist them to apply the ecosystem approach.

The four Elements and the International Initiatives contribute to achieving the goals of the CBD, and MDG's (particularly those related to food security and environmental sustainability). With regards to the implementation of the four programme elements and the international initiatives, the analysis of inputs from international organizations show that the PoW AgBD is still a relevant framework to achieve the objectives of the CBD, addressing areas: (i) where gaps have been identified (e.g. knowledge of the status and trends of agricultural biodiversity, assessments); (ii) that need to be strengthened in order to contribute effectively to the conservation and sustainable use of agricultural biodiversity (e.g. capacity building, mainstreaming); (iii) that require targeted action (e.g. international initiatives); and (iv) flexibility for addressing new challenges arising from emerging global issues (e.g. climate change, biofuels).

The international initiatives and their plans of action have proven to be particularly effective in contributing towards the objectives of the PoW AgBD. The case of pollinators has made this very evident, illustrating the impetus that the endorsement of this imitative has had in mobilizing partners - for example through the development of national and regional initiatives and plans of action. It is proposed to maintain the International Initiatives as such, and capitalize on the momentum created by the initiatives. Consequently these initiatives should be maintained.

This analysis has shown that momentum and visibility has not only been achieved through international initiatives, but also through major events, such as the case of the recent adoption of the Global Plan of Action and Strategy for the Management of Farm Animal Genetic Resources.

The analysis of Programme Element 2 (adaptive management) revealed that the submission of case studies needs to be strengthened, specifically, with regards of the format in which case studies are submitted. Adhering to a case study format would allow for better analysis of the case studies.

Currently, the issue of climate change and the production of biofuels have a place at the top of the global agenda. With regards to the production of biofuels, it should be noted that the scope of the PoW AgBD allow this issue to be addressed. Hence, the principles of sustainable agriculture in biofuel production need to be applied.

[94] CGRFA-11/07/15.4 Rev.1

The PoW AgBD provides a useful framework for the agricultural community to contribute to the section to opportunities to address emerging issues including climate change and biofuels. The review also provides an opportunity to suggest improvements to the text of the PoW AgBD which could address emerging issues. Annex 3 suggests some proposals should it be necessary.

Hence, the PoW AgBD constitutes a framework that should ensure that the contribution of the agricultural sector - particularly through the farmers (the custodians of agricultural biodiversity) - is considered at its just value in the arena of environment. It is a valuable framework available to parties to maintain and enhance agricultural biodiversity, contributing to the win-win scenario which would be strengthened by linking the arenas of environment and agriculture. Measuring the direct impact of the PoW is challenging since it is linked to other processes, particularly the ones in the agricultural sector lead by FAO.

With the assistance of international organizations, the PoW AgBD is quite well implemented, particularly the programme elements 1 and 3. More work still to be done, particularly at national level and synergies between agricultural and environment sectors as promoted by the POW should be strengthened.

Changing conditions such as climate change and increase production of biofuels, can be integrated in the implementation at national level, given the "adaptive" aspect of the POW. This could be reinforced by recognizing the role of the private sector in efficient energy and cleaner production alternatives. The programme of work also provides a useful framework to address emerging biodiversity-related issues including climate change and biofuels.

A better understanding of the importance of agricultural biodiversity in different sectors including environment is required - to that effect, strengthening the capacity of stakeholders is needed not only from international organizations such as FAO and the CG Centers but also from local and indigenous communities and farmer associations.

Finally, the programme of work builds upon existing international plans of action, programmes strategies and instruments that have been agreed by countries under the auspices of FAO (e.g. CGRFA, IPPC, International Treaty on PGRFA, to name a few). When developing the Programme of Work, particular attention was given to the fact that synergy and coordination be promoted to avoid duplication. This should remain. Moreover, at the global level, the 11th Regular Session of the CGRFA held in June 2007, with its broadened mandate to include all components of biodiversity for food and agriculture, adopted the major outputs and milestones to be addressed in its Multi-year Programme of Work over its next five sessions (i.e. 10 years). The CGRFA also recognized the many ongoing areas of collaboration between FAO and the Convention on Biological Diversity, in the area of biodiversity for food and agriculture, and recommended further strengthening of cooperation between FAO and its Commission, and the CBD, acknowledging the need for complementarity and mutual support. The Commission also recommended a joint work plan on biodiversity for food and agriculture between FAO and its Commission and the Secretariat of CBD. The review of the programme of work represents a good opportunity to strengthen collaboration with FAO and to link with the important long standing programmes, instruments and networks on genetic resources and ecosystem approaches that FAO has been sustaining.

Chapter 10: Proposed Priorities for implementation

To date, the Programme of Work on Agricultural Biodiversity has benefited from country driven assessments and development of tools and instruments under the auspices of FAO and particularly its Commission on Genetic Resources for Food and Agriculture and from substantial support provided by international organizations such as FAO and the CGIAR Centers. However, there are a number of priority areas which need to be highlighted, to ensure successful implementation. Furthermore, these suggestions for priorities for implementation reflect either some, or all, of the following: (i) recent global

events; (ii) new and emerging global priorities; and/or (iii) the analysis of inputs from international organizations for the review of the PoW AgBD.

At the technical level:

- In light of the contribution of agricultural biodiversity to food security and livelihoods, put more effort into increasing appreciation of role of agricultural biodiversity in food security and poverty reduction strategies as well as in sectoral policies including agriculture and environment. For instance, further integrate agricultural biodiversity considerations in national biodiversity strategies and action plans with the aim of developing national agricultural biodiversity strategies, programmes or action plans under the leadership of the agriculture sector.

- As re-enforced by recent CBD and the CGRFA decisions, the implementation of the PoW should be approached by increasingly considering interactions between components of agricultural biodiversity (this is also linked to ecosystem resilience, ecosystem functions and ecosystem services – important for adaptation to climate change) using the Ecosystem Approach. This is particularly important when considering the implications of climate change.

- Further the mutually reinforcing effort to support the implementation of FAO's instruments in the area of agricultural biodiversity.

- A significant amount of work has come out of the implementation of the Programme Elements – this is evident for example for capacity building and awareness raising. For assessment, a lot has been done (for example the preparation of the 2nd Report of the State of the World's Plant Genetic Resources for Food and Agriculture is underway, and the first State of the World's Animal Genetic Resources for Food and Agriculture has been completed). Consideration needs to be given to how to move forward with regards to assessments – hence, approaching assessments by farming systems, rather than solely sectorally. Work on different land and production classification systems is available, and this work should be capitalized upon. This is linked to the ecosystem approach, and "holistic" consideration of the management of agricultural biodiversity.

- Strengthen efforts to implement activities focusing on the sustainable use of agricultural biodiversity, using the ecosystem approach.

- The interface between agriculture and environment should be given priority (this has been shown to be a positive focus, particular seen through work on pollinators and soil biodiversity).

- Establish partnership mechanism to regularly monitor the implementation of the PoW AgBD (e.g. liaison group).

- Increasingly use the Platform for Agricultural Biodiversity Research to further identify areas of future research in agricultural biodiversity.

- Currently, the issues of climate change and the production of biofuels have a place at the top of the global agenda. With regards to the production of biofuels, it should be noted that the PoW AgBD already addresses this. The production of biofuels means growing crops, and hence agriculture. The same concerns apply for biofuel crops as they do for all other agricultural crops. Hence, there is no need to "re-invent the wheel" – rather, the principles of sustainable agriculture in biofuel production need to be highlighted.

- Further strengthen cooperation between main actors such as FAO, the CGRFA Centers, the private sector, consumers and farmers' associations.

- Re-instate COP decision II/15 particularly in light of achieving MDG 1 and 7 and the need to address climate change.

At the policy level:

- Strengthen international partnerships
    - Particularly, through a joint work plan on biodiversity for food and agriculture with FAO and the Secretariat of CBD. An updated joint work plan that would assist countries in inter alia, in streamlining reporting requirements, facilitate the dialogue at country level between environment and agriculture.

- Capitalize on, and enhance, synergies between agricultural and environmental intergovernmental fora.

- Enhance partnerships at national level between agriculture and environment policy makers, through the development of national agricultural biodiversity policy instruments adopted and implemented by the country.

ANNEX 1: FAO's Commission on Genetic Resources for Food and Agriculture's Multi-Year Programme of Work:

Major Outputs and Milestones

	12th Session	13th Session	14th Session	15th Session	16th Session
Plant Genetic Resources (PGRFA)	Presentation of *The State of the World's Plant Genetic Resources*	Consideration of the updated *Global Plan of Action* for adoption, and review of cooperation with the International Treaty			Update of *The State of the World's Plant Genetic Resources*
Animal Genetic Resources (AnGR)	Follow-up to the Interlaken Conference		Review of implementation of Interlaken outcomes		Update of *The State of the World's Animal Genetic Resources*
Aquatic Genetic Resources (AqGR)		Review of information base for aquatic genetic resources, and key issues for *The State of the World's Aquatic Genetic Resources*	Presentation of *The State of the World's Aquatic Genetic Resources*	Development of elements related to the *Code of Conduct of Responsible Fisheries* aimed to maintain a broad genetic basis and to ensure sustainable use and conservation of aquatic genetic resources	
Forest Genetic Resources (FoGR)	Analysis of key issues in forest genetic resources, for *The State of the World's Forest Genetic Resources*		Presentation of *The State of the World's Forest Genetic Resources*		
Micro-organisms and invertebrates	Review of scoping study on Micro-organisms and invertebrates		Review of key issues on micro-organisms and invertebrates	Review of work on micro-organisms and invertebrates	
Cross-sectorial matters	Consideration of policies and arrangements for access and benefit-sharing for genetic resources for food and agriculture	Review ways and means [of promoting][considering] [for] the application and integration of biotechnologies in the conservation and utilization of genetic resources [as a basis for future work such as, the development of guidelines, consideration of Codes of Conduct or other work]	Review of all relevant international targets and indicators for biodiversity for food and food and agriculture	Consideration of the internalization of the ecosystem approach to biodiversity management in agriculture, forestry and fisheries Review of contribution of biodiversity for food and agriculture to the achievement of the Millennium Development Goals	Presentation of *The State of the World's Biodiversity for Food and Agriculture*
Management of the Multi-year Programme of Work		Progress Report/ Periodic assessment/ Review of the Multi-year Programme of Work		Progress Report/ Periodic assessment/ Review of the Multi-year Programme of Work	

ANNEX 2

Vision, mission and operational objectives for the Programme of Work

The Programme of Work on Agricultural Biodiversity was adopted in 2000, and since then, the Strategic Plan and 2010 Biodiversity Target have been adopted. In order to make the Programme of Work on Agricultural Biodiversity consistent with the other Programmes of Work, and the Strategic Plan of the CBD, a vision and mission are proposed (below). The operational objectives presented below are the same ones in the Programme of Work on Agricultural Biodiversity (decision V/5). Lastly, targets are also proposed, which will assist in measuring progress of the implementation of the Programme of Work on Agricultural Biodiversity.

Vision

Sustainable agriculture that can both provide food security and maintain the many other ecosystem services necessary to support life on earth, by sustaining and utilizing the biological diversity necessary for the productivity, ecological stability and resilience of each agricultural ecosystem.

Mission

To increase the capacity of agriculture to provide food security and support other ecosystem services both in the present and for future generations by promoting the conservation and use of biological diversity in agricultural ecosystems.

Operational Objectives

- *Programme Element 1: Assessments*: To provide a comprehensive analysis of status and trends of the world's agricultural biodiversity and of their underlying causes (including a focus on the goods and services agricultural biodiversity provides), as well of local knowledge of its management.
- *Programme Element 2: Adaptive Management:* To identify management practices, technologies and policies that promote the positive and mitigate the negative impacts of agriculture on biodiversity, and enhance productivity and the capacity to sustain livelihoods, by expanding knowledge, understanding and awareness of the multiple goods and services provided by the different levels and functions of agricultural biodiversity.
- *Programme Element 3: Capacity Building:* To strengthen the capacities of farmers, indigenous and local communities, and their organizations and other stakeholders, to manage sustainably agricultural biodiversity so as to increase their benefits, and to promote awareness and responsible action.
- *Programme Element 4: Mainstreaming:* To support the development of national plans or strategies for the conservation and sustainable use of agricultural biodiversity and to promote their mainstreaming and integration in sectoral and cross-sectoral plans and programmes.

ANNEX 3

Climate Change and Biofuels – proposals

The PoW AgBD provides opportunities to address emerging issues including climate change and biofuels. This review of the PoW AgBD provides an opportunity to suggest improvements to the text of the PoW AgBD, to address emerging issues. Should it be required, the suggested proposals are as follows:

- In the scope of agricultural biodiversity (Annex I, Decision V/5), highlight, and stress the importance of the ecosystem services that are provided by agricultural biodiversity and that are linked to climate change (e.g. carbon sequestration, climate regulation).

- When undertaking the assessment of agricultural biodiversity, consider activities to assess, identify and reduce the vulnerability of agricultural biodiversity to the impacts of climate change.

- Integrate monitoring of agricultural biodiversity and ecosystem services in addressing issues of impact of climate change and the production of biofuels.

- Stress the impact of climate change on *all* the different components of agricultural biodiversity (e.g. livestock, pollinators), in particular the focus on genetic resources for adaptation and adaptive management.

- Emphasize the role that agricultural biodiversity plays in adaptation - not only in climate change linked to mitigation and regulation- through provision of ecosystems services. This is linked to ecosystem resilience, a key concept in the "justification of" the conservation and sustainable use of AgBD, particularly at the genetic level.

- When discussing the ecosystem approach, make specific reference to the use of the ecosystem approach in addressing the impacts of climate change and biofuels.

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