BIODIVERSITY AND AGRICULTURE

Safeguarding Biodiversity and Securing Food for the World

Convention on
Biological Diversity

UNEP

INTERNATIONAL DAY FOR BIOLOGICAL DIVERSITY

22 May 2008

BIODIVERSITY AND AGRICULTURE

Safeguarding Biodiversity and Securing Food for the World

Convention on
Biological Diversity

Published by the Secretariat of the Convention on Biological Diversity.
ISBN: 92-9225-111-2

Citation: Secretariat of the Convention on Biological Diversity (2008). *Biodiversity and Agriculture: Safeguarding Biodiversity and Securing Food for the World.* Montreal, 56 pages.

For further information, please contact:
Secretariat of the Convention on Biological Diversity
World Trade Centre
413 St. Jacques Street, Suite 800
Montreal, Quebec, Canada H2Y 1N9
Phone: 1 (514) 288 2220
Fax: 1 (514) 288 6588
E-mail: secretariat@bodiv.int
Website: www.cbd.int

Design & typesetting: Em Dash Design

The cover of this booklet has been designed using extracts from a traditional embroidered tapestry from Pakistan that was donated to the *CBD Museum of Nature and Culture* in 2006 by the Government of Pakistan.

Measuring some two metres across and two metres high, the intricately stitched and brightly coloured Gabba tapestry depicts scenes of everyday life and the rich heritage of biodiversity and agriculture in a farming landscape of Pakistan.

The tapestry has been reproduced in full on a poster for the International Day for Biological Diversity, and extracts from the tapestry have also been reproduced in a set of five logos that depict different aspects of a traditional mixed farming system.

TABLE OF CONTENTS

Preface 4

Introduction 7

one Biodiversity is the Foundation of Agriculture 10

two The Growing Challenge 18

three Responding to the Challenge: Stabilizing Biodiversity in Agriculture for the 21st Century and Beyond 24

four International Partnership: Promoting Good Practice and Exchange of Experience 40

five Producing While Preserving: Conclusion and Recommendations 48

References 52

Glossary 53

PREFACE BY THE EXECUTIVE SECRETARY

The ecosystems of our planet produce a wealth of nourishing food. Vast quantities of grain are harvested from its plains and steppes, valleys and terraces; while its orchards brim with fruit. Biodiversity is the root of this plenty: the variety of crops and food on which human civilizations have grown and depend is possible because of the tremendous variety of life on Earth. If the Earth's population is to feed itself in the 21st century and beyond, humankind needs to preserve the biodiversity that grants us our own complex and diverse lives.

But biodiversity is diminishing at unprecedented rates. Over the past few hundred years humans have increased the rate of species extinction. Human drivers of change, including habitat loss, climate change and overexploitation of resources, have increased the rate at which species are going extinct by as much as 1,000 times background rates typical of Earth's history.

In April 2002, the Parties to the Convention on Biological Diversity (CBD), seeking to make an historic contribution to poverty alleviation and to benefit all life on Earth, committed themselves to achieve a significant reduction of the current rate of biodiversity loss at the global, regional and national levels by 2010.

Every year on the 22 May, to raise awareness of the importance of biodiversity, the world celebrates the International Day for Biological Diversity. This year's theme on "Biodiversity and Agriculture" highlights the importance of sustainable agriculture not only to preserve biodiversity, but also to feed the world,

maintain sustainable agricultural livelihoods, and enhance human well-being, now and in the future. This booklet sets out the links and offers possible solutions to preserve biodiversity and the benefits it provides.

The 190 Parties to the CBD have agreed to implement the Convention's three over-arching objectives—the conservation of biodiversity, its sustainable use, and the fair and equitable sharing of benefits arising from the utilization of genetic resources—through thematic programmes of work, including that on agricultural biodiversity, and through cross-cutting initiatives, including the ecosystem approach.

As a leading partner in the CBD, FAO has made a major contribution to the development and implementation of the Convention as a whole and in particular to its programme of work on agricultural biodiversity. This partnership has aided the Convention's evolution and implementation, as well as assisted in the drafting of this booklet and the compilation of the related toolkit of materials.

The theme for the International Day for Biological Diversity coincides with the Convention's in-depth review of the programme of work on agricultural biodiversity at the ninth meeting of the Conference of the Parties (COP-9) in May 2008 that will amplify the importance of safeguarding biodiversity for agriculture at the international, national and local levels.

Ahmed Djoghlaf

Executive Secretary
Convention on Biological Diversity

Key Messages

BIODIVERSITY is the basis of **AGRICULTURE**. Its maintenance is essential for the production of food and other agricultural goods and the benefits these provide to humanity, including food security, nutrition and livelihoods.

BIODIVERSITY is the origin of all crops and domesticated livestock and the variety within them. Biodiversity in agricultural and associated landscapes provides and maintains ecosystem services essential to **AGRICULTURE**.

AGRICULTURE contributes to conservation and sustainable use of **BIODIVERSITY** but is also a major driver of biodiversity loss. Farmers and agricultural producers are custodians of agricultural biodiversity and possess the knowledge needed to manage and sustain it.

Sustainable **AGRICULTURE** both promotes and is enhanced by **BIODIVERSITY**. Sustainable agriculture uses water, land and nutrients efficiently, while producing lasting economic and social benefits. Barriers inhibiting its widespread adoption need to be reduced.

AGRICULTURAL producers respond to consumer demands and government policies. To ensure food security, adequate nutrition and stable livelihoods for all, now and in the future, we must increase food production while adopting sustainable and efficient agriculture, sustainable consumption, and landscape-level planning that ensure the preservation of **BIODIVERSITY**.

INTRODUCTION

From the products we buy to the food we consume, agricultural production is an integral part of everyone's life. Agriculture provides humans with food and raw materials for goods—such as cotton for clothing, wood for shelter and fuel, roots for medicines, and materials for biofuels—and with incomes and livelihoods, including those derived from subsistence farming.

Biodiversity has enabled farming systems to evolve ever since agriculture was first developed some 10,000 years ago in regions across the world including Mesopotamia, New Guinea, China, Mesoamerica, and the Andes. Worldwide there is now a huge diversity of agricultural systems ranging, for example, from rice paddies of Asia, to dryland pastoral systems of Africa, and hill farms in the mountains of South America.

Biodiversity is the source of the plants and animals that form the basis of agriculture and the immense variety within each crop and livestock species. Countless other species contribute to the essential ecological functions upon which agriculture depends, including soil services and water cycling.

However, the Earth's biodiversity is being lost at an alarming rate, putting in jeopardy the sustainability of ecosystem services and agriculture, and their ability to adapt to changing conditions. The conservation and sustainable use of biodiversity is essential for the future of agriculture and humanity. At the same time, since agricultural lands extend across such a considerable proportion of the Earth's surface and harbour significant biodiversity, the conservation of biodiversity within agricultural landscapes must play an important part in global conservation strategies.

As custodians of land and natural resources, including biodiversity, farmers and agricultural producers manage agricultural biodiversity and their associated landscapes. Generally, managers of biodiversity aim to achieve sustainability to preserve resources for future generations. Where this does not occur, the root causes often lie outside their control. Farmers and producers are allies in global efforts to manage biodiversity better.

Agricultural livelihoods are based on the use of agricultural produce directly for subsistence and, or, on income derived from work and produce. Agricultural livelihoods are the oldest mode of humans' subsistence and remain the principal form of livelihood in many regions today.

A major challenge will be to increase agricultural production over the coming decades to adequately feed the growing world population and meet the rising expectations of economically improving societies.

It is essential for every human being to have adequate access, availability, and stability of food. The Food and Agricultural Organization of the United Nations (FAO) defines food security as "a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1999).

The global agricultural labor force includes approximately 1.3 billion people, about a fourth (22%) of the world's population and half (46%) of the total labor force.

(Millennium Ecosystem Assessment)

It is also essential for everyone that the foods they eat meet their nutritional needs. While these needs differ according to age, stage of growth, gender, health status and activity, everyone must have sufficient protein, carbohydrates, fats, and micronutrients.

As we all use biodiversity and have ecological impacts on its use, we are all responsible for its conservation and sustainable use; policymakers and citizens globally, need to do their part to ensure the sustainable use and equitable distribution of resources now and in the future.

The Convention on Biological Diversity (CBD), with near universal membership of countries around the world, provides a comprehensive framework for collective action among the countries and citizens of the world to halt the destruction of biodiversity and decline in ecosystem functions that are of such basic need to human survival

Over 826 million people are chronically hungry; they need 100–400 calories more per day.

(FAO, "Building on Gender, Agrobiodiversity and Local Knowledge")

one

BIODIVERSITY IS THE FOUNDATION OF AGRICULTURE

Biodiversity in agriculture

Biodiversity is the variability among living organisms and the ecological complexes of which they are part, including diversity within species (genetic diversity), between species, and of ecosystems. A description of each of these three levels of biodiversity is provided in the first column of Table I. Biodiversity provides both the basis of agriculture—the species and genetic variation of crops and livestock—and, through its role in ecosystem functions and services, the underpinning of production.

Agricultural biodiversity is a term that includes all components of biodiversity—at genetic, species and ecosystem levels—that are relevant to food and agriculture and that support the ecosystems in which agriculture occurs (agro-ecosystems). This includes the crop and livestock species, and the varieties and breeds within these, and also includes those components that support agricultural production. Components at the species level that support ecosystem services include earthworms and fungi that contribute to availability and cycling of plant nutrients through the breakdown and decomposition of organic material. Examples of agricultural biodiversity, at each level of biodiversity, are provided in Table I.

Of the 27,000 species of higher plants, about 7,000 are used in agriculture.

(FAO)

Table 1. BIODIVERSITY AND AGRICULTURAL BIODIVERSITY

Level of Diversity	Biodiversity	Agricultural Biodiversity
Ecosystem	An ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Different types of ecosystems include forests, grasslands, wetlands, mountains, costal areas, lakes, and deserts.	The diversity of agro-ecosystems partly results from both agricultural and non-agricultural land and water uses. Examples of agro-ecosystems include rice paddies, pastoral systems, aquaculture systems, and cropping systems and the broader ecosystems within which these are based. Elements of these systems may be combined to form mixed systems.
Species	A species is a group of morphologically similar organisms that are able to interbreed and produce fertile offspring. A diverse number of species exists for plants, animals and micro-organisms.	The diversity of plants and animals used in agriculture resulted from human management of biodiversity for food, nutrition and medicinal purposes. For example, domesticated livestock include cattle, sheep, chickens, and goats. Examples of crop species include wheat, banana, cabbage, sweet potato, and ground nuts.
Genetic	Genetic diversity is the variation of genes for all individuals within a species; it determines the uniqueness of each individual, or population, within the species. The expression of DNA into traits, such as the ability to tolerate drought or frost, facilitates adaptation to changing conditions.	The diversity within species partly results from the selection by farmers based on specific traits to meet environmental and other conditions. For example, many varieties of corn, or maize, have been developed based on traits such as taste, height, colour and productivity. Many of these are now maintained as distinct populations entirely within agriculture.

Species and genetic diversity

ADAPTING TO CHANGE AND MAINTAINING PRODUCTIVITY

According to the FAO, about 7,000 species of plants have been cultivated since humans first began farming. However, today, only 30 crops provide an estimated 90% of the world population's dietary energy requirements, with wheat, rice and maize alone providing about half the dietary energy consumed globally.

Of the estimated 15,000 species of mammals and birds, only some 30 to 40 have been domesticated for food production and less than 14 species—including cattle, goats, sheep, buffalo and chickens—account for 90% of global livestock production. In recent decades there has been alarming genetic erosion within these species. FAO data indicate that during the past six years, a breed has been lost each month.

The great diversity of plants that over millennia have been selected and cultivated, and animals that have been domesticated and reared, forms the basis of the genetic resources that farmers, livestock keepers, and other agriculturalists now and may in the future draw upon.

Agricultural biodiversity is the result of both human and natural selection. Its conservation depends on proper management and sustainable use. The diversity of crop species and varieties, and of livestock, has both enabled and been borne from human settlement and agricultural production in almost all eco-climatic zones on Earth, bar extreme environments too cold or too dry. This diversity among crops and livestock is also important to enabling balanced and nutritious diet.

A characteristic of the major crop and livestock species upon which human society depends, has been their ability, with human selection, to adapt and thrive in a wide range of environmental conditions. Genetic traits such as tolerance to frost, high temperature, drought and water-logging, resistance to particular diseases, pests and parasites will be invaluable resources for enabling future breeding and adaptation.

DIVERSE DIETS LEAD TO BETTER NUTRITION AND FOOD SECURITY

As well as enabling production across a wide spectrum of natural conditions, crop diversity also contributes towards quality of nutrition which improves with the consumption of greater food diversity, particularly in fruits and vegetables. Diverse diets can contribute to the fight against malnutrition, obesity and other health problems in both developing and developed countries.

One in three people worldwide, mostly women and children, suffer from diseases associated with malnutrition and inadequate access to food. At the same time diseases previously associated with affluence, such as obesity, type 2 diabetes and heart disease, are on the rise among the poor in developing and developed countries.

The causes of malnutrition are complex, but high among them is a general simplification of diets. In cities, people are increasingly deriving most of their energy from refined carbohydrates (chiefly wheat, rice and sugar) and processed fats and oils, which are currently cheaper than ever in many developing countries. In many countries of the developing world, traditional and indigenous foods, which are often more nutritious than modern foods traded on the global market, are being neglected and forgotten.

Farmers' knowledge of nutrition

Farmers and local consumers are often very aware of the nutritional properties of plants and crops. For example, Bioversity International found that Ethiopian farmers have identified at least three varieties of sorghum that contain about 30 percent more protein than other varieties. More important, they contained 50 to 60 percent more lysine (a limiting amino acid in sorghum) than average. These varieties are recognized as having value for sick children and nursing mothers. (www.bioversityinternational.org)

Worldwide, 32% of pre-school children are underweight.

(Millennium Ecosystem Assessment)

Agricultural ecosystems that are rich in biodiversity provide a diversity of foods that can be used to increase food security and improve nutrition by broadening the food base and diversifying diets. Even within a particular crop, nutrient contents vary significantly between varieties. Different varieties of rice vary in their protein content from 5 to 14%; beta-carotene content of different sweet potato varieties can vary by a factor of 60; and in different banana varieties, the provitamin A content ranges from less than 1 to more than 8,500 µg/100 g (Toledo and Burlingame 2006).

Ecosystem Services

Enabling and sustaining agricultural production

A recent major global study, the Millennium Ecosystem Assessment (MA) (2005), has served to emphasize that the health and well-being of humans and other species across the planet depends on a variety of ecosystem goods and services. Services and benefits provided by ecosystems include:

- *Provisioning services:* food, fiber, fuel, biochemical, genetic resources, and fresh water;
- *Regulating services:* flood, pest control, pollination, seed dispersal, erosion regulation, water purification, and climate and disease control;
- *Cultural services:* spiritual and religious values, knowledge systems, education and inspiration, and recreational and aesthetic values; and
- *Supporting services:* primary production, nutrient cycling, provision of habitat, production of atmospheric oxygen, and water cycling.

Biodiversity underpins the provision of these ecosystem services that maintain the conditions necessary for life on Earth.

One of the most important ecosystem services for humans is the provisioning service that provides food and other agricultural goods. Other ecosystem services such as water cycling (providing rain and irrigation waters) are essential to agricultural production. Such services are provided from both within the immediate agricultural landscape and from adjoining landscapes.

Collectively, ecosystem services to agriculture include:

- Regulation of pests and diseases;
- Nutrient cycling, such as decomposition of organic matter;
- Nutrient sequestration and conversion, as in Nitrogen-fixing bacteria;
- Regulating soil organic matter and soil water retention;
- Maintenance of soil fertility and biota; and
- Pollination by bees and other wildlife.

One fundamental component of the agricultural system is the soil, whose structure, composition and chemistry—and hence fertility and suitability for particular crops—are determined by both mineral and living components.

At landscape scale, biodiversity-rich natural or managed areas (including forest, wetlands, hedgerows and woodland) adjoining or within agricultural landscapes also provide ecological services necessary for agricultural production.

Below-ground biodiversity: Why "dirt" matters

Soil is one of the most diverse habitats on earth and contains one of the most diverse assemblages of living organisms, including microorganisms such as bacteria and fungi, and macro-organisms such as worms, mites, ants, and spiders. The soil of just a square metre of forest may contain more than 1000 species of invertebrates and the number and diversity of microorganisms in just one gram of soil may be even greater. Soil organisms provide essential services toward the sustainable functioning of all ecosystems, and are therefore important resources for the sustainable management of agricultural ecosystems. For example, earthworms, termites and other burrowing organisms mix the upper layers, redistributing nutrients and increasing water infiltration. (www.fao.org/landandwater)

Between 1960 and 2000, the demand for ecosystem services grew significantly as the world's population doubled to 6 billion people and the global economy increased more than sixfold.

(Millennium Ecosystem Assessment)

Animals and insects pollinate approximately 80% of angiosperms, which amounts to about 300,000 flower-visiting species.

(Millennium Ecosystem Assessment)

Pollination is one of the most valuable services provided by ecosystems. Pollinators help maintain the diversity of ecosystems by facilitating the reproduction of many plant species. Examples of pollinators include flies, moths, butterflies, wasps, beetles, bats, and hummingbirds, but bees are the principal agents of crop pollination. Not only do crop pollinators contribute to food security, their service contributes to the economy. For example, estimates of the value of bee pollination services in the USA alone range up to $16 billion annually (Losey and Vaughan, 2006).

However, mounting evidence from around the world points to a potentially serious decline in populations of pollinators due to many stresses, such as habitat fragmentation, decline in non-crop food sources, diseases and parasites, and exposure to chemicals or agricultural pollution.

Agricultural landscapes also provide habitat and food for wild animals, including birds, mammals and insects that have important non-agricultural significance for ecosystems and human cultures, spirituality, and recreation. Agricultural landscapes form an integral part of human cultural diversity.

Agriculture for Biodiversity

HOW AGRICULTURE CAN PROMOTE BIODIVERSITY

Delivery of ecosystem services

Managed sustainably as ecosystems, agricultural systems contribute to wider ecosystem functions such as maintenance of water quality, waste removal, reducing runoff, and promoting water infiltration, soil moisture retention, erosion control, carbon sequestration, and pollination.

Incentives

Species needed by agriculture such as pollinators need habitat diversity to survive. Agriculture therefore provides incentives to preserve areas such as hedgerows and field borders. Farming of aquatic species often occurs in natural water bodies, providing incentives to protect the aquatic environment from

adverse impacts, for example from pollution and water diversion. The need for adaptation and potential for improvement in productivity provides an incentive for the conservation of a diverse range of genetic resources.

Ecological knowledge
Much of our knowledge of ecology and biodiversity, its importance, and functions have been gained and will continue to be gained through agricultural practice. (www.fao.org/biodiversity)

HOW AGRICULTURE CAN REDUCE BIODIVERSITY

Crop production
Many modern practices and approaches to intensification aimed at achieving high yields have led to a simplification of the components of agricultural systems and biodiversity and to ecologically unstable production systems. These include use of monocultures with reduction in cropping diversity and elimination of crop succession or rotation; use of high-yielding varieties and hybrids with the loss of traditional varieties and diversity together with a need for high inputs of inorganic fertilizer; control of weeds, pests and diseases based on chemical (herbicides, insecticides, and fungicides) treatments rather than mechanical or biological methods.

Land and habitat conversion to large-scale agricultural production, including drainage of land and conversion of wetlands has also caused significant loss of biodiversity. The homogenization of farming landscape with elimination of natural areas, including hedgerows, woodlots and wetlands, to achieve larger scale production units for large-scale mechanized production has also led to decline in biodiversity and ecological services.

Livestock production
Intensive, or so-called landless, large-scale production systems are on the rise leading to an increase in both demand for animal feeds and of site-concentrated livestock wastes. The increased demands for feed puts increased pressures on cultivated systems, with consequently an increased demand for water and nitrogen, other fertilizers and other chemical inputs. Emphasis in modern systems on quantity of yield, has led to selection and breeding for high production and the loss of traditional breeds that held other traits, qualities and adaptations, now lost.

two

THE GROWING CHALLENGE

Loss of biodiversity and ecosystem services

Despite the fundamental importance of biodiversity and ecosystem services to the Earth's functioning and to human society, human activities are driving the loss of biodiversity at an unprecedented rate, up to 1000 times the natural rate of species loss. And despite the specific importance of crop and livestock diversity, and of associated agricultural biodiversity, advances in agricultural production over recent decades have been achieved largely without major regard to the erosion of biodiversity.

The biggest driver of terrestrial biodiversity loss in the past 50 years has been habitat conversion, in large part due to conversion of natural and semi-natural landscapes to agriculture. Nutrient loading, particularly of nitrogen and phosphorus, much of which derived from fertilizers and farm effluent, is one of the biggest drivers of ecosystem change in terrestrial, freshwater and coastal ecosystems. Climate change is projected to become a major driver of biodiversity loss as well as a serious challenge to agriculture, whose response, to adapt, will draw upon the genetic diversity of crops and livestock and the services provided by other components of agricultural biodiversity.

Against the backdrop of a declining natural resource base and environmental change, food production in the coming decades will need to increase considerably to feed a growing population and rising expectations.

During the second half of the 20th century the global food system was able to respond to the doubling of world population by more than doubling food production.

(Comprehensive Assessment of Water Management in Agriculture)

Population and economic growth

Global demand for food is increasing considerably, driven by growth in world population, by dietary change arising from urbanization and increasing real incomes of households worldwide, and by the need and international commitment to lift people from poverty and malnutrition. The global population has doubled over the past 50 years and is expected to reach 9 billion by 2050. Furthermore, FAO estimates that 854 million people were undernourished in 2000-2003, including 820 million in developing countries, 25 million in countries in transition and 9 million in industrialized countries (FAO 2006).

Demand for food and feed crops will nearly double in the coming 50 years. The increase in population is above the rate of increase in the yields of the three major cereals (wheat, maize and rice) that supply most nutritional needs. To date, the response to the increase in demand has been a combination of land conversion and the intensification of agricultural systems.

The significant increase needed in global agricultural production will require major contribution from large-scale intensive farming. Learning from experience —both positive and negative—associated with the advances in production over recent decades, to ensure sustainability the value of the environment will need to be included in the cost of production; improvements in efficiency sought; and post-harvest losses reduced.

Biodiversity will provide an essential resource to meet the challenge—through genetic diversity within crop and livestock species that will enable breeding and adaptation to changing conditions and enable production in diverse conditions; and through the maintenance of healthy service-providing ecosystems.

Climate change, agriculture and biodiversity

Climate is the most important environmental factor affecting agricultural production and is also now significantly influenced by agriculture. About 24% of the Earth's land surface is covered by cultivated systems (defined by the MA to be areas in which at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture in any particular year) and the cumulative impact of worldwide agricultural practices on the global climate is significant. Global agriculture is estimated to account for about 20% of the total anthropogenic emissions of greenhouse gases (GHG) (UNEP 2001). The most important categories of agricultural emissions are:

- Increasing land under cultivation by decreasing carbon sinks, including deforestation and the conversion of wetlands, especially peatlands;
- Carbon dioxide (CO_2) emissions from burning forests, crop residues, and land;
- Methane (CH_4) emissions from rice cultivation;
- Methane emissions from ruminant livestock such as cattle;
- Use of nitrogen fertilizers that release nitrous oxide (N_2O); and
- CO_2 emissions from farm machinery, facilities, processing and transport.

Agriculture accounts for 44% of anthropogenic methane emissions and about 70% of nitrous oxide gases, mainly from the conversion of new land to agriculture and nitrogen fertilizer use.

(Millennium Ecosystem Assessment)

Biofuels: Opportunities and potential pitfalls

Models indicate that the production and use of liquid biofuels can contribute to a net reduction of GHG emissions and so, in helping to mitigate climate change, contribute indirectly to the conservation of biodiversity. In addition, crop production for biofuels, as for other purposes, using good, sustainable agricultural practices can also have directly beneficial impacts on biodiversity. However, use of unsustainable agricultural methods and planning may have adverse impacts, for example through the loss of habitat, pollution of water, and increased net GHG emissions from wetland conversion and deforestation (CBD 2007B). Furthermore, the large volume of water consumed in industrial processing, in addition to that used in irrigated systems may also have negative environmental and socio-economic impacts. In some cases, with the energy consumption and emissions from mechanical farm operations and industrial plant, there may be limited or no net carbon benefit; and the redeployment of land from food production—particularly of grain—into fuel production could contribute to commodity shortages, higher food prices and increased pressure on land elsewhere.

Agriculture can also play an important role in reducing greenhouse gas emissions through sequestration and storage of carbon in soils and in crops, including trees. The physical potential to sequester carbon varies considerably by land use type and region. Reductions of greenhouse gas emissions can be generated by changes in agricultural production systems or changes in land use. One particularly important source of mitigating carbon emissions is decreasing the amount of land use changes from natural lands into cultivated systems, especially deforestation (FAO 2007).

20% of CO_2 emissions in the 1990s originated from land use changes, mostly deforestation.

(Millennium Ecosystem Assessment)

Climate change poses a serious challenge to agriculture and is expected to affect agricultural activities through a number of factors, including:

- Changes in water availability;
- Increases in exposure to heat stress;
- Changes in distribution of agricultural pests and diseases;
- Greater leaching of nutrients from the soil during intense rains;
- Greater soil erosion due to stronger wind and rainfall; and
- More frequent wildfires in drier regions and increased flooding in others.

Many developing countries could lose over a fifth of crop production, with serious food security consequences, while developed countries could see significant agricultural production gains. Global warming will lead to higher temperatures and changes in rainfall, and this in turn will modify the extent and productivity of land suitable for agriculture. It will lead to shifts in the boundaries between agro-climatic zones, requiring geographic changes in crops and varieties grown. It will lead to an increase in extreme weather events—and potential crop damage and loss—and increased spatio-temporal variance of rainfall events and weather extremes, retarding production.

Genetic diversity within crop and livestock species will be an invaluable resource to enabling adaptation to changing conditions through breeding.

Agricultural expansion

Over the past 50 years, patterns of agricultural expansion especially into tropical and sub-tropical forests, grasslands and savannas have substantially reduced levels of biodiversity and ecosystem services over significant areas undermining the long-term sustainability of agricultural production itself (CBD 2006). The Millennium Ecosystem Assessment has reported that much of the land converted was in areas of high biodiversity. Furthermore, some countries with persistently low levels of productivity continue to rely mainly on the expansion of cultivated areas. Globally, since nearly all well-suited land is currently cultivated, continued opportunities for expansion are marginal.

Environmental constraints exclude three-quarters of global land from crop agriculture, being too cold or dry or too steep or of poor soils. Potential agricultural land is ample to meet future world food needs, but profound concern exists for many countries with land and water scarcity. Major land expansion is possible in Africa and South America, but with substantial environmental and development costs. Although forestland in some regions has significant potential for crop cultivation, environmental consequences of forest clearance would be serious, including loss of biodiversity and disruption of carbon sinks, hydrological cycles, and fragile ecosystems.

Deforestation in the tropics and sub-tropics leads to a reduction in regional rainfall.

(Millennium Ecosystem Assessment)

Intensification of agriculture will be the main means to increase food production and there remains considerable scope for increasing crop yields in developing countries (Fischer et al, 2001).

Water

The productivity of irrigated land is more than double that of rain-fed land. Without irrigation, the increases in yields and output that have fed the world's growing population over recent decades would not have been possible. To meet growing needs, and with climate change leading to rising uncertainties in rain-fed agriculture, irrigation will be increasingly important to increase production. Currently, about 70 percent of all fresh water withdrawals—and 85 percent in developing countries—are used for agriculture and demand for water, for both agricultural and non-agricultural uses, is rising.

However, water scarcity is becoming acute in much of the developing world. According to the Comprehensive Assessment of Water Management in Agriculture, approximately 1.2 billion people now live in river basins with absolute water scarcity. With that scarcity, and with the competition from rapidly growing industrial sectors and urban populations, the water available for irrigated agriculture in developing countries is not expected to increase and future expansion of irrigation will be limited.

To achieve the increase in production needed, it will therefore be necessary to invest in water storage, improve productivity of existing irrigation schemes and the efficiency of their use of water, and to supplement rain-fed systems through water harvesting.

Water withdrawals from lakes and rivers doubled since 1960, with 70% worldwide used for agriculture.

(Millennium Ecosystem Assessment)

three

RESPONDING TO THE CHALLENGE

Stabilizing Biodiversity in Agriculture for the 21st Century and Beyond

Today, there is an increased pressure on biodiversity from direct and indirect drivers of change including population growth, agricultural expansion and the use of agricultural technologies and practices without full consideration of their overall environmental impacts. The resulting loss of biodiversity and associated decline in ecosystem services has significant consequences for the health and well being of all species on Earth, and mankind. The challenge will be to increase agricultural production to meet rising demands for food and other agricultural goods in ways that are increasingly sustainable.

Intensification and improving efficiency

Intensification of agricultural systems in an ecologically sound way is a good investment to building sustainable agriculture. The Millennium Ecosystem Assessment highlighted that for all developing countries over the period of 1961–1999, expansion of cultivated systems increased crop production only 29%, whereas increases in yields on existing land amounted to 71% (Bruinsma, 2003).

Agro-ecological forms of intensification, based on local and traditional knowledge and scientific research, can blend improved knowledge about agricultural ecosystems and develop sustainable practices. Beneficial mixes of land use, including environmental corridors in landscapes that have been transformed by crop and livestock production, also raise the overall level of biodiversity

in agricultural landscapes. These approaches represent a growing portion of cultivated land intensification efforts.

Sustainable intensification measures include:

- More rational and efficient use of nutrients, water, space and energy in all land-use systems;
- More effective measures for soil and water conservation;
- Greater recycling of nutrients;
- Better use of biological resources to raise and maintain yields of crops and livestock;
- Greater appreciation for and use of indigenous knowledge especially of neglected crops that could help improve livelihoods and the environment.

Natural biocides in West Africa

Desert locusts and grasshoppers cause millions of dollars in crop damage across Africa and widespread hunger and suffering. Broad-spectrum insecticides that have been used to combat these pests are often dangerous to people and also kill beneficial insects, birds and small mammals. Scientists identified a strain of fungus that grows naturally, is deadly to both pests, and now forms the basis of a new commercial biocide with several advantages over traditional insecticides. Its cost is similar, but it requires only one application compared to at least three for others. The fungus, a living organism, can be stored for up to a year without refrigeration—a distinct advantage in tropical countries. Finally, the new biocide is environmentally benign: It does not damage other insects, plants, animals, or people. (www.ecoagriculturepartners.org)

The ecosystem approach to natural resource management

The "ecosystem approach" is the primary framework for action under the Convention on Biological Diversity. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

USE OF WATER

In order to increase agricultural production in a sustainable manner, improvements in agricultural water management will be required. Inappropriate and excessive use of water often decreases water quality and increases land salinization. When agricultural activities change the quality, quantity, and timing of water flows, this can change the ecosystem services provided by the connected system, including supporting services, jeopardizing the sustainability of agriculture. In rain-fed cropping systems, various soil management practices, inter-cropping, cover cropping and mulching can increase infiltration and moisture retention in the soil. In irrigated systems, greater precision over the timing and frequency of applications, the delivery and distribution of water, and total volume used can significantly help to improve efficiency of water use—and help to minimize both economic and ecological costs.

In England and Wales the damage costs of freshwater eutrophication was estimated to be $105–160 million per year in the 1990s.

(Millennium Ecosystem Assessment)

USE OF ENERGY

As part of concerted action to combat climate change, efficiencies can also be gained in the consumption of energy in farm operations and the processing and delivery of food. Important in this will be working within environmental constraints, rather than in spite of them by creating artificial environments —for example the production of summer horticultural crops, in winter, under glass. Where feasible and appropriate, the use of renewable forms of energy, including solar, wind and geothermal, and energy derived from farm wastes will also be important in these and other farming systems.

Managing agricultural systems sustainably

Sustainable agriculture seeks to make use of nature's goods and services while producing good yields in an economically, environmentally, and socially rewarding way, preserving resources for future years and future generations.

Examples of sustainable agricultural practices and methods

- Mixed farming systems
- Organic agriculture
- Integrated pest management
- Organic fertilizers such as legumes
- Crop rotation
- Recycling crop and animal wastes
- No-till or minimum tillage agriculture
- Inter or multi-cropping
- Cover crops

Sustainable agricultural management aims to:

- Use water, land, nutrients, and other natural resources efficiently or at the rate they are replenished so that resources are conserved. For example, using water efficiently means taking into consideration other ecosystem services that water provides (flood mitigation, nutrient cycling, drinking water supply, and sanitation);
- Manage biodiversity in such a manner that biological resources are sustained; and
- Minimize the impact of agriculture on the wider environment in order to sustain the other ecosystem services, such as, minimizing chemical inputs, especially non-renewable sources, so there is minimal damage to the surrounding environment.

Since 1960, flows of nitrogen in ecosystems have doubled and flows of phosphorus have tripled.

(Millennium Ecosystem Assessment)

Within the context of unique site specific conditions and levels of biodiversity, agricultural producers should manage their production system within the associated landscapes keeping the broader impact of all three levels of biodiversity in mind.

There are several ways in which sustainable agricultural practices maintain biodiversity and thus help to sustain ecosystem services, including water quality maintenance, water infiltration, soil moisture retention, reduced runoff, carbon sequestration, and refuge for species, especially during droughts. For example, in the Bharatpur bird sanctuary in northern India, buffaloes were evicted. The result of this loss of herbivory was the growth of tall grass and the disappearance of nesting habitats for some of the migratory birds for which the sanctuary was famous. As a result, buffaloes were re-admitted to the sanctuary (CIP-UPWARD 2003).

Legumes in agricultural systems: The importance of N-fixers

As nitrogen (N) is the most limiting nutrient for increasing crop productivity in many soils, N fertilization is crucial. Legumes, such as alfalfa and soybeans, are very important species in sustainable agricultural practices, because they have a symbiotic relationship with N-fixing bacteria called *Rhizobium*. The symbiotic relationship ensures that nitrogen from the atmosphere is converted by the bacteria to a form the plant can use. Furthermore, once N is fixed in the plant tissues, legumes can be used as green fertilizer for other plants.

Soil management practices influence soil volume, structure, biodiversity, and chemistry. Tillage practices vary according to the type of soil (mixture of sand, silt and clay) and the crop or crops grown and thus differ from system to system. For example, very clayey soil will require much more aeration then a sandy soil, which may not need any tillage. No-till or minimum tillage agriculture helps to maintain soil structure, reduce compaction and erosion and maintain the organic and living components of soil.

Sustainable agricultural practices seek to preserve species diversity for many reasons, including providing better nutrition and increasing food security.

For example, mixed farming systems combine cropping with another type of agricultural practice, such as livestock, fish farming or agro-forestry activities. In a sustainable closed system, the "waste" products of each activity provide inputs to the others while a diverse range of nutritious food is produced. Organic agriculture uses a holistic approach to managing the cultivation system. It takes into consideration agroecosystem health, such as soil biodiversity, while emphasizing the use of on-farm inputs, and regional biodiversity and conditions to create a locally adapted system.

Worldwide, soil is being lost at a rate of 13 to 18 times faster than it is being formed.

(FAO. "Agriculture for Biodiversity, Biodiversity for Agriculture.")

Agroforestry: Farmers learning from farmers

Trees constitute an important part of agricultural landscapes. Agroforestry is a land-use system in which woody perennials are used in production, such as integrating fruit trees into coffee plantations or fodder trees among food crops. The World Agroforestry Centre spreads innovations through networks of farmers in cost effective ways. Their strategy is that farmers learn best through other farmers. ICRAF staff and national partners demonstrate new technologies and sustainable agroforestry practices for farmers to try, and then provide feedback and encouragement. These activities have improved soil fertility, diversified incomes, and increased food security. (www.worldagroforestry.org)

Natural areas within farming landscapes are conserved for many reasons including the services they provide, such as habitat for pollinators. Policy objectives should serve to protect and restore critical ecosystems that provide such service and ensure that they are sustainably used. Creating a mixture of land use systems at ecosystem level, employing an ecosystem approach, is a key objective of ensuring the conservation and sustainable use of biodiversity.

A study in Costa Rica found that forest-based pollinators increased coffee yields by 20% within 1 kilometer of the forest.

(Millennium Ecosystem Assessment)

The challenge is considerable. Farmers need to help mitigate adverse environmental changes and adapt to changing conditions while both preserving biodiversity and contributing to meeting the nutritional needs of a growing population. Farmers do not control all factors involved and need support from government policy, including that related to agricultural development, and the influence of markets and consumers to maximize their contributions.

The Millennium Development Goals (MDGs) and Agricultural Biodiversity

Under the burden of chronic poverty and hunger, livestock herders, subsistence farmers, forest dwellers and fisherfolk may use their natural environment in unsustainable ways, leading to further deterioration of land and resources and their livelihood conditions. Empowering the poor and hungry as guardians and managers of land, waters, forests, and biodiversity can advance food security and poverty reduction (MDG 1), environmental sustainability (MDG 7) and improved health (MDGs 4, 5 and 6).

Conserving Genetic Diversity

The conservation and sustainable use of distinct animal breeds and the varieties and wild relatives of crops, provides genetic insurance for adapting to changing conditions, including climate change, and to consumer needs and demands, present and future. Maintenance of varietal and farm animal diversity is crucial to the food security of present and future generations. Crop and livestock genetic resources can be conserved *ex situ* and *in situ*.

Ex situ conservation involves taking representative samples from their natural habitats for preservation, off-site. Seed banks are an important part of this: seeds, genetic samples, of different varieties and ecotypes of crop species are collected and stored in controlled conditions at sub-zero temperatures for future reproduction use. There are some 1,500 facilities around the world. Plant accessions growing in botanical gardens and field genebanks also contribute to ex situ conservation.

Seed Banks: Preserving Diversity

Genebanks conserve varieties of our most important crops, providing an insurance policy for the world's future food supply. Launched in February 2008, the Svalbard Global Seed Vault in Norway, or the "Doomsday Vault" as the media have nicknamed it, aims to be the ultimate safety net for the world's most important natural resource. Constructed deep in a mountainside, permafrost and thick rock will ensure that even without electricity, the vault will preserve frozen samples. With capacity to hold up to 4.5 million seed samples, the vault will eventually house virtually every variety of almost every important food crop in the world. (www.croptrust.org)

In situ, on-farm, conservation of crop and livestock genetic diversity involves maintaining viable populations of crops and livestock breeds in the farming landscapes within which they have developed their distinctive properties. Sustainable agricultural practices within many traditional farming systems seek to preserve genetic diversity within the agricultural landscape, as it helps farmers adapt their crops to changing conditions through selection. Growing different races of the same crop allows farmers to crossbreed and develop new varieties suitable for different conditions. Farmers, as custodians and managers of biodiversity, use traditional selection to maintain local crop and animal diversity.

Local and traditional knowledge and practices are key aspects for on-farm and *in situ* conservation. The daily activities of growing, collecting, preparing and consuming food are considered an integral part of many cultures. The resulting cultivation systems vary greatly, but at the core of most of them is the knowledge required to sustain them. This local and traditional knowledge has provided communities with the ability to sustainably manage their cultivation systems, thus ensuring food security, reducing hunger, providing nutrition, and creating livelihoods.

Dryland systems cover about 41% of the Earth's land and more than 2 billion people inhabit them

(Millennium Ecosystem Assessment)

Promoting *in situ* conservation of dryland agrobiodiversity

The centres of origin, diversity and domestication of many globally important crops are located in drylands and mountainous areas. The "hot spots" of remaining diversity are now confined to traditional farming systems and harsh environments.

West Asia encompasses one of three mega-centres of crop diversity where wheat, barley, lentil, faba bean, and many forage legumes and fruit trees have evolved over the last 10,000 years. Crop landraces and their wild relatives are still found within the traditional farming systems that form the basis of livelihoods for local communities. But this remaining biodiversity is seriously threatened by over-exploitation, destruction of natural habitats and the spread of new cultivars and introduced species.

A holistic approach for effective in situ conservation was developed by ICARDA and national partners, that improves the livelihoods of the main custodians of the agrobiodiversity by enhancing productivity and sustainability of farming systems using low-cost technological packages and through add-value technologies and alternative activities to increase incomes. Complementing these efforts, the ICARDA genebank holds around 130,000 accessions of cereals and legumes, 60% of which are from the dry areas of Central and West Asia and North Africa. (www.icarda.org)

Seed supply has a major impact on a farmer's use of crop genetic diversity. Individual farmers and farming communities, through their seed management strategies of formal and informal trading networks, play an important role in conserving on-farm genetic resources.

Farmer's rights and benefit-sharing

The International Treaty on Plant Genetic Resources for Food and Agriculture recognizes in its Article 9, "the enormous contribution that the local and indigenous communities and farmers of all regions of the world (...), have made and will continue to make for the conservation and development of plant genetic resources (...)". Farmers' Rights include the protection of traditional knowledge and the right to participate equitably in benefit-sharing and in national decision-making about plant genetic resources. (www.fao.org)

Diversification on farm, by maintaining and growing different crops and different lines of specific crops, also provides farmers with insurance to survive climate-induced stresses.

BREEDING

Classical plant breeding uses controlled cross breeding of individuals to produce offspring and eventually races or varieties that possess specific desirable inheritable traits. Cross breeding is carried out between lines with different qualities to create another that combines both. Traits that have been developed through breeding programmes include increased quality and yield; tolerance of environmental pressures such as soil salinity, extreme temperatures and drought; resistance to viral, fungal and bacterial diseases; and resistance or tolerance to insect pests.

Globally, there are 6,500 breeds of domesticated animals, but 20% of these are under threat of extinction.

(FAO State of the World's Animal Genetic Resources Report)

Characteristic breeds of livestock have been developed through selection and breeding over centuries to enable enhanced produce for example milk, meat and wool, and to enable production in diverse conditions. In recent decades yield improvements in tropical countries have been gained by crossbreeding local breeds, with hardiness to local conditions and challenges, with high yielding breeds of temperate climates resulting in progeny that share the qualities of each.

Roughly 80% of wheat area in developing countries and three quarters of rice area in Asia is planted with modern varieties.

(Millennium Ecosystem Assessment)

African Genetic Treasures Key to Reducing Disease and Poverty

Sheep producers the world over face a billion-dollar problem in fighting intestinal worms that infect their flocks. A little known sheep breed kept by Maasai pastoralists in East Africa is genetically resistant to intestinal worm parasites. This resistance makes the distinctive Red Maasai breed well adapted to a region where the worm challenge is high. Although livestock in Africa often appear to be small and low-producing, they are supremely adapted through natural selection to survive in harsh environments. Another example is the resistance of West African N'Dama cattle to trypanosomiasis, a disease that prevents cattle production throughout vast areas of Africa. Combining the resistance genes of livestock from developing countries with the production genes of developed-country livestock could in future provide optimal animals for both tropical and temperate environments. (www.ilri.org)

Modern biotechnology

Modern biotechnology uses *in vitro* and direct injection of nucleic acids, such as recombinant DNA (fusion of genetic material from different species), into cells or organelles that overcome natural reproduction and that are not techniques used in traditional breeding and selection. Modern biotechnology can be used to create living or genetically modified organisms (GMOs), which thus possess a novel combination of genetic material. GMOs used in agriculture, such as some corn, soybeans, canola, tomatoes, potatoes, and rice are modified for a variety of reasons, such as to become more resistant to pests, richer in nutrients, to produce higher yields, to create a more attractive product, and to last longer for transportation to the market (CBD 2006). However, if GMOs are not properly tested before use, potential risks include the modified gene, through cross breeding, spreading to wild relatives and disrupting ecosystem functions.

The Cartagena Protocol on Biosafety

In 2000, the Conference of the Parties to the CBD adopted a supplementary agreement to the Convention known as the Cartagena Protocol on Biosafety. The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. It establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory. The Protocol also establishes a Biosafety Clearing-House to facilitate the exchange of information on living modified organisms and to assist countries in the implementation of the Protocol. By January 2008, 142 countries and the European Community are Parties to the Protocol. (www.cbd.int/biosafety)

The influence of markets and trade in agricultural goods

Food production systems consist of growing, harvesting and getting the products to market. Many food production systems package and process the food before it reaches the end consumer. Because new links between agribusinesses and large retailers have reconfigured the traditional method of farmers selling directly to local markets, different components of the production system can influence each other—positively and negatively. In order to conserve resources for the future, agricultural producers at all levels of the food production chain will have to use land, water and nutrients efficiently in ways that conserve biodiversity.

Corporate Social Responsibility (CSR)

The development and adoption of sustainable practices and systems by companies is often done through the concept of Corporate Social Responsibility (CSR). CSR is when an organization takes responsibility for its impact on customers, employees, shareholders, communities and the environment in all their operations.

CONSUMPTION AND CONSUMER CHOICE

Markets are an essential component in food production systems. Consumers are the key drivers of markets. In recent years, increasing demands among consumers in richer economies for more attractive-looking and high value products and the desire to meet these demands has reorganized food production systems and increased their mechanization. For example, the increasing demand for meat is being met by intensive or landless livestock systems, which have many negative environmental consequences.

Taking into consideration nutrition and environmental impacts, including ecological footprints, there is an emerging trend for consumers to be more aware of both their food choices and the relationship to changes in food production systems, such as increases in packaging. As such, through consumer choices, changes are being made. Trends towards preferences for organic products, more diverse diets, and both environmentally and socially acceptable production systems, are examples of how markets can positively influence biodiversity.

Community-supported agriculture

Farmers' markets and community-supported agriculture (CSA) are growing in many developed economies. Farmers' markets allow farmers to sell their produce directly to the public who gain from better quality and freshness while the farmers gain from higher prices. CSA is a model of food production in which a group of people pledge to support local farmers, who then ensure that resources including land, plants and animals are used sustainably. For example, in Canada the Quebec-based organization, Équiterre, is promoting environmental social responsibility through ecological agriculture, fair trade, sustainable transportation, and energy efficiency. CSA is part of its ecological agriculture programme which, in turn, is part of creating an ecological food, agricultural and land continuum. (equiterre.org)

Increases in overall demand for food could be moderated by reducing excessive consumption, especially of meat, by more affluent sectors of society—that would provide both health benefits and environmental benefits.

TRADE LIBERALIZATION

Because of their essential importance for food production, agricultural markets are, in many countries, highly protected and subsidized. In countries of the OECD (Organisation for Economic Co-operation and Development), despite recent progress, well over one quarter of farmers' income, on average, is not actually earned in agricultural markets, but comes from a range of government subsidies and other support measures that not only dominantly restrict agricultural trade and distort markets, but also contribute to overproduction.

For example, the production of crops for biofuels in industrial countries has often developed behind high protective tariffs and large subsidies resulting in few current biofuel programs that are economically viable (World Bank 2008). These policies hurt developing countries that could become efficient producers in profitable new exports, and the poor, who pay higher food prices for staples.

Removing these subsidies, as mandated by the Doha Development Agenda of the World Trade Organization, can contribute to easing the pressure on biodiversity stemming from agricultural expansion and intensification. As such, the World Banks' *World Development Report 2008* calls for full trade liberalization and the elimination of protections in industrialized countries that create distortions, such as subsidization policies for international commodities.

Because of the shift in geographical patterns of agricultural production expected from global trade liberalization, and as a result of higher pressures on biodiversity in many production systems, a proactive approach of incorporating biodiversity and ecosystem services into national agricultural policies is a necessary condition to trade liberalization.

Government subsidies paid to the agricultural sectors of OECD countries between 2001 and 2003 averaged over $324 billion annually, or one third the global value of agricultural products in 2000.

(Millennium Ecosystem Assessment)

LINKING COMMODITIES TO MARKETS

Many local and indigenous communities in rural areas have difficulty accessing local, regional and international markets, leading their products to be marginalized. To promote *in situ* conservation of agricultural biodiversity including crops and livestock, it is important that marginalized agricultural products and small farmers are integrated into the marketplace and that, particularly for sustainable produce, they receive a fair price.

Stimulating markets, diversity and production

In many developing countries, local and traditional vegetables are becoming forgotten or neglected in favour of mass-produced 'world crops.' Many of these forgotten vegetables are high in vitamins and minerals essential for daily nutrition. By education and through awareness and marketing efforts, consumer demand and production can be stimulated. Bioversity International coordinates projects with local partners, such as the reintroduction of traditional leafy green vegetables into Kenyan marketplaces, including local markets, supermarkets, and restaurants. (www.bioversityinternational.org)

Neglected and underutilized species can become valuable commodities for the poor, who have used them to survive for centuries as subsistence crops in difficult and low-input production environments.

(Bioversity International, 2002)

four

INTERNATIONAL PARTNERSHIP

Promoting Good Practice and Exchange of Experience

The Convention on Biological Diversity

In 1996, at the third meeting of the Conference of the Parties (COP) to the CBD, the international community addressed the conservation and sustainable use of agricultural biodiversity for the first time in a comprehensive manner, resulting in the COP decision III/11 on agricultural biodiversity that included development of a programme of work on this issue.

The multi-year Programme of Work on Agricultural Biodiversity subsequently adopted in 2000 in the COP decision V/5, aims, first, to promote the positive effects and mitigate the negative impacts of agricultural practices on biodiversity in agro-ecosystems and their interface with other ecosystems; second, to promote the conservation and sustainable use of genetic resources of value for food and agriculture; and third, to promote the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

The programme is composed of four elements (assessment, adaptive management, capacity building and increasing awareness, and mainstreaming), and three International Initiatives on pollinators, soil biodiversity, and biodiversity for food and nutrition.

The programme of work recognizes the contributions of farmers and indigenous and local communities to the conservation and sustainable use of agricultural biodiversity as well as the importance of it to their livelihoods.

In related decisions, the COP has also encouraged Parties to the Convention to develop national strategies, programmes and plans regarding agricultural biodiversity that will, among other things, encourage farming practices that not only increase productivity but also arrest degradation and enhance biological diversity and monitor adverse effects on sustainable agricultural biodiversity.

Programme of Work on Agricultural Biodiversity

At the request of the Conference of the Parties, the CBD Secretariat, FAO and other partners have jointly conducted the review of the Programme of Work on Agricultural Biodiversity, which is being considered at COP 9, including assessing progress made, barriers to implementation and priorities for capacity building. Based on this assessment, at the international level, major progress has been achieved in consolidating intergovernmental agendas on agricultural biodiversity. At the technical level, a number of successful initiatives have been started, especially with regard to the three international initiatives (discussed in the next section), such as the African Pollinators Initiative. A major challenge is now to bring together and synthesize the available information (CBD 2007A).

THE CBD CROSS-CUTTING INITIATIVES ON BIODIVERSITY AND AGRICULTURE

The CBD cross-cutting initiatives on agriculture and biodiversity are a means of building upon and strengthening the programme of work as well as a means of linking other programmes of work—forests and mountain biodiversity—and initiatives, such as and the Global Taxonomic Initiative. These initiatives are opportunities to apply the ecosystem approach and the Addis Ababa Principles and Guidelines for Sustainable Use.

The International Initiative for the Conservation and Sustainable Use of Pollinators aims to facilitate timely and coordinated efforts globally to attain the objectives of the initiative's Plan of Action (monitor pollinator decline; increase taxonomic information; assess economic value and impact; and promote the conservation, restoration and sustainable use of pollinator diversity).

International Pollinator Initiative: Kenya

The Kenya Pollinators Initiative coordinated by the National Museums of Kenya is spearheading the implementation of activities prescribed by the plan of action. The private sector and civil society organizations are implementing various programmes on conservation of pollinators, such as Honeycare Africa Limited and Baraka Institute of Agriculture that are promoting community conservation of honeybees (CBD "Third National Reports").

The International Initiative for the Conservation and Sustainable Use of Soil Biodiversity aims to increase the recognition of the essential services provided by soil biodiversity across all production systems and its relation to land management, to share information, and to increase public awareness, education and capacity-building. This initiative focuses on building capacities of farmers to improve their livelihoods using holistic approaches.

Termites improve soil fertility in the Sahel

Termites are the predominant soil fauna in the Sahel and live mainly underground. Traditionally held to be pests, termites can also be human friends. They are a resource that can be used by farmers to manage and counteract land degradation through their soil burrowing and feeding activities. Farmers in Burkina Faso and in other areas of West Africa are making use of termite-mediated processes, together with mulch applications of organic matter, to enhance the restoration of denuded land with crusted soils and enhance agricultural production in their farming systems (Mando *et al.* 2007).

There are over 25,000 bee species.

(Millennium Ecosystem Assessment)

The International Initiative on Biodiversity for Food and Nutrition aims to promote the sustainable use of biodiversity in programmes contributing to food security and improved human nutrition. FAO and Bioversity International, two leading partner organizations of the CBD are tasked with leading the initiative. Efforts to link biodiversity, food and nutrition issues are expected to contribute to achieving the Millennium Development Goals 1, 4, 6 and 7, thereby raising awareness of the importance of biodiversity, its conservation and sustainable use.

The Food and Agriculture Organization

Linking food security and biodiversity

There can be no global food security without biodiversity. This is why the Food and Agriculture Organization of the United Nations (FAO), an intergovernmental organization, has been actively promoting the conservation and sustainable use of biodiversity for food and agriculture for more than three decades. FAO's goal is to alleviate poverty and hunger by promoting sustainable agricultural development, improved nutrition, enhanced food security, and access to all people at all time the food they need for an active and healthy life.

At the policy level, FAO's intergovernmental fora deal with complex biodiversity issues for the agriculture, forestry and fisheries sectors and have negotiated new international instruments and frameworks such as the:

- International Plant Protection Convention
- Code of Conduct for Responsible Fisheries
- Forest Resources Assessment
- International Treaty on Plant Genetic Resources
- Global Plan of Action for Animal Genetic Resources

Policy-making on genetic diversity at FAO

With more than 170 member countries, the Commission on Genetic Resources for Food and Agriculture (CGRFA) negotiates international policies for the conservation and sustainable use of the biodiversity. Recently it adopted a 10-year Multi-Year Programme of Work for crop, animal and other genetic resources, which includes access and benefit-sharing and the ecosystem approach. In another example, the International Treaty on Plant Genetic Resources for Food and Agriculture is a new binding agreement, with 110 contracting Parties. The Treaty is developing some innovative mechanisms and provisions, in harmony with the CBD, such as the Multilateral System on Access and Benefit Sharing, a Funding Strategy or Farmer's Rights. In particular, the Multilateral System covers a list of crops established according to criteria of food security and interdependence. These crops provide about 80% of the food we derive from plants. (www.fao.org/ag/cgrfa)

FAO technical support and field activities focus on building capacity, identifying best agricultural practices, disseminating information and mainstreaming agricultural biodiversity into national policy and decision-making processes.

Integrated pest management (IPM)

Successful IPM implementation at FAO has three components: applicable research results, a policy change, such as removing pesticide subsidies, and a farmer participatory training programme. Numerous IPM programmes have been implemented in developed countries. The IPM Programmes implemented in Asia stress the responsibility of farmers for diagnosing pest problems and for participating in the development of solutions. IPM programmes involve farmers and field staff from national and local government units and non-governmental institutions, enhancing ecological awareness, decision-making and other business skills, and farmer confidence. IPM thus has long-lasting socio-economic benefits far beyond the field of plant protection.

The Consultative Group on International Agricultural Research

The Consultative Group on International Agricultural Research (CGIAR) is a strategic partnership of countries, international and regional organizations and private foundations supporting the scientific research and related work of 15 international Centres in the fields of agriculture, forestry, fisheries, policy and environment. (www.cgiar.org)

CGIAR's main areas of focus are:

- Sustainable land management and production;
- Enhancing National Agricultural Research Systems;
- Germplasm improvement and collection; and
- Policy research.

In collaboration with national agricultural research systems, civil society and the private sector, the CGIAR fosters sustainable agricultural growth through science aimed at achieving sustainable food security and reducing poverty in developing countries. Today more than 8,500 CGIAR scientists and staff are working in over 100 countries, addressing every critical component of the agricultural sector.

Some examples of the work of the international research centres of the CGIAR have been presented in previous sections. Other examples of the work of the CGIAR are provided below.

CGIAR's System-wide Genetic Resources Programme (SGRP)

To build synergy and to ensure common policies and strategies around the collections, the 15 genetic resources programmes of the different centres have united. Through SGRP, the centres have made a commitment to support the development and implementation of a global system for the conservation and use of plant diversity. Eleven of the thirteen CGIAR centres hold ex situ collections of crop diversity. Together these collections contain some 650,000 accessions of the world's most important crops.

Food production increased by roughly two-and-a-half times (160%) between 1961 and 2003.

(Millennium Ecosystem Assessment)

BIOVERSITY INTERNATIONAL

One of GGIAR centres, Bioversity International, is the world's largest research organization dedicated to the use and conservation of agricultural biodiversity to improve the lives of poor people. It undertakes, encourages and supports research and other activities on the conservation and sustainable use of agricultural biodiversity, especially genetic resources, to create more productive, resilient and sustainable harvests. Bioversity International aims to promote the greater well-being of people, particularly poor people in developing countries, by helping them to achieve food security, to improve their health and nutrition, to boost their incomes, and to conserve the natural resources on which they depend.

Banana hybrids in Cuba

An important concern of farmers is to manage pests and diseases and to maintain soil fertility. Bioversity International's banana researchers work with diverse partners in both industrialized and developing countries to generate new environmentally-friendly technologies and test them on banana farms, communities and markets. The greatest adoption of FHIA hybrids (developed by Fundación Hondureña de Investigación Agrícola) has been in Cuba. Since 1992, more than 16,000 ha have been planted. Economic analysis suggests that the new varieties offer farmers benefits of more than $400/ha/yr, mainly in reduced fungicide applications. (www.bioversityinternational.org)

INTERNATIONAL POTATO CENTRE

Another CGIAR centre, the International Potato Centre (known by its Spanish acronym, CIP) seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato, sweet potato, other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas. This year's focus as the International Year of the Potato, 2008, highlights the importance of this species for food and income and agriculture in general.

Potato blight

Since 2003, CIP has been working in the Chacllabamba farming community in Cusco, Peru. CIP staff worked closely with the local farmers to screen varieties and identify two improved lines with resistance to late blight. The new varieties will add value to native potatoes and improve the income of farming communities. The new improved native varieties also give higher yields than those of their ancestors. They have been named Pallayponcho (multi-colored poncho) and Pukalliclla (red lliclla, a square shawl) by the farmers after their traditional clothes. (www.cipotato.org)

INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

The International Livestock Research Institute (ILRI) addresses the rapidly evolving challenges that the highly dynamic livestock sector is posing to poor people and their environments. The ILRI mission is to help people in developing countries to move out of poverty. The challenge is to do so while conserving the natural resources on which the poor directly depend. Among the natural resources important to the world's poor are the 'living assets' people accumulate in the form of their farm animals The accelerating speed of change within the intensifying livestock systems of developing countries—changes in production, feeding, markets and consumption—means that the diverse indigenous farm animal populations of the developing world have little time in which to adapt to meet the world's changing circumstances.

Wildlife livestock interaction

Across East Africa's Masailands, wildlife have co-existed with livestock and their Masai owners for millennia. Here, in the cradle of humankind, remains the richest diversity of large mammals on earth. Working closely with the communities, ILRI's research has revealed an increase of diversity and density of wild ungulates in the rangeland close by the Masai villages, which provide indirect protection towards predation. The future conservation of these "last lands of Eden" will depend critically on helping their traditional pastoral stewards find sustainable pathways out of poverty while preserving this unique ecosystem. (www.ilri.org)

Conclusion and Recommendations

From the earliest examples of the domestication of plants and animals, human civilizations have used a rich diversity of wild species and modified landscapes and environments to facilitate agriculture. The challenge has always been to manage agricultural systems and their associated landscapes in a sustainable manner ensuring that future generations have access to these resources.

In the face of new direct and indirect drivers of change, policymakers and consumers must do their part to ensure that farmers and agricultural producers have the right incentives to adopt sustainable agricultural practices. Individually, education about the consequences of food choices will be an important step in the right direction.

If humanity can create sustainable agricultural systems, preserving biodiversity and ecosystem services globally, we can feed the world and ensure resources for future generations. If we fail in this collective challenge, environmental security and human wellbeing will be in peril.

Globally, the potential of rainfed agriculture is large enough to meet present and future food demand through increased productivity.

(Comprehensive Assessment of Water Management in Agriculture)

What can you do?

POLICYMAKERS

Endorse policy changes that reduce the subsidies that lead to unsustainable agriculture and promote sustainable practices.

Promote markets for biodiversity-friendly agricultural goods, which allow these products to diversify and trade in unsubsidized agricultural goods.

Create a proactive approach of incorporating biodiversity and ecosystem services considerations into national agricultural policies.

Where appropriate, in partnership with farmers, promote incentives that pay farmers for their incremental costs for adopting environmentally friendly practices, including contributions to mitigating climate changes.

According to available resources, provide training, education programmes, consultation, and financial aid in managing and conserving biodiversity in agriculture.

Support local level management by empowering people with knowledge to develop sustainable agricultural systems and by ensuring that they obtain training, consultation, and financial aid.

Promote a mixture of land use systems at the ecosystem level that ensures the conservation and sustainable use of biodiversity. Employ the CBD Ecosystem Approach to guide landscape-level planning.

Protect and restore critical ecosystems that provide resources and ensure that they are sustainably used.

Create partnerships to achieve the above goals, where resources do not exist.

Integrate agricultural biodiversity in agricultural strategies and sustainable agriculture into other sectors.

FARMERS AND AGRICULTURAL PRODUCERS

Adopt sustainable agricultural practices, such as integrated pest management techniques and mixed farming, with a view to converting to sustainable agricultural systems over time.

Develop and employ a balance of modern and traditional varieties and "super" and local livestock breeds.

End over-exploitation of natural resources, including water and land, and wild resources and try to ensure the sustainable use and consumption of what is harvested.

Reduce fertilizer, pesticide, herbicide, and fungicide applications to minimum levels by increased efficiency.

Conserve, protect and plant tree, bush or grass "buffer strips" where relevant to decrease soil erosion and to reduce excess nutrients entering waterways.

Share traditional knowledge associated with sustainable agricultural practices and management.

CONSUMERS

Be aware of the environmental impact of your choices in everyday consumption for food and other agricultural goods.

Sustainable consumption: adopt good nutritional habits for you and your family and limit over-consumption in general, but particularly of meat.

Support local food growers as much as you can, such as buying their products or volunteering your time.

Stop consuming species in decline or endangered. Purchase sustainably-produced and harvested goods (be prepared to pay a little more) for the benefit to both yourself and the planet.

Demand more information on what you consume—its origin, conservation status and means of production, so you can make you own choices.

Grow native plants that support pollinators in your areas.

Recycle food wastes by composting.

Reduce water, fertilizer, pesticide, herbicide, and fungicide applications to your garden or lawn to minimum levels by increased efficiency and shift to species better adapted to local conditions.

If possible, according to your available resources, grow some of your own food using environmentally friendly methods.

REFERENCES

Bioversity International. "Geneflow." 2007. Bioversity International. 6 December 2007. <http://www.bioversityinternational.org/publications/pubfile.asp?ID_PUB=1259>

Bioversity International (IPGRI), 2002. Neglected and Underutilized Plant Species: Strategic Action Plan of the International Plant Genetic Resources Institute. Bioversity International, Rome, Italy

Bruinsma, J. (ed). *World Agriculture: Towards 2015/2030—An FAO Perspective*. 2003. FAO. 17 October 2007 <http://www.fao.org/DOCREP/005/Y4252E/y4252e00.htm#TopOfPage>

CBD. "In-Depth Review of the Implementation of the Programme of Work on Agricultural Biodiversity." 26 November 2007A. CBD. 14 December 2007. <http://www.cbd.int/doc/meetings/sbstta/sbstta-13/official/sbstta-13-02-en.pdf>

CBD. SBSTTA. "New and emerging issues relating to the conservation and sustainable use of biodiversity: biodiversity and liquid biofuel production." 12 April 2007. CBD. 1 November 2007. <http://www.cbd.int/doc/meetings/sbstta/sbstta-12/official/sbstta-12-09-en.pdf>

CBD. "Cartagena Protocol on Biosafety." 2 November 2006. CBD. 14 Nov 2007B. <http://www.cbd.int/decisions/default.shtml?dec=III/11>

CBD. Third National Report. No date. CBD. 11 October 2007. <http://www.cbd.int/reports/comments.aspx?lgm=0&qst=NR-03-241010100&opt=0&col=0&grp=G-CBDP>

Comprehensive Assessment of Water Management in Agriculture. 2007. *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*. London: Earthscan, and Colombo: International Water Management Institute

FAO. *State of Food and Agriculture Report 2007*. 2007. FAO. 16 November 2007. <http://www.fao.org/docrep/010/a1200e/a1200e00.htm>

FAO. *The State of Food Insecurity in the World 2006*. October 2006. FAO. 5 October 2007. <ftp://ftp.fao.org/docrep/fao/009/a0750e/a0750e00a.pdf>

FAO, 2005. *Building on Gender, Agrobiodiversity and Local Knowledge: A Training Manual*. FAO. < http://www.fao.org/sd/dim_pe1/pe1_060302_en.htm >

FAO. "Soil biodiversity and sustainable agriculture: paper submitted by the Food and Agricultural Organization of the United Nations." 5 November 2001B. CBD. 1 October 2007. <http://www.cbd.int/doc/meetings/sbstta/sbstta-07/information/sbstta-07-inf-11-en.pdf>

FAO. "Background Paper 1: Agricultural Biodiversity." 12 September 1999. FAO/Netherlands Conference on the Multifunctional Character of Agriculture and Land. 1 October 2007. <http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/EPdirect/EPdocs/MFCAL.pdf>

Fischer, G., van Velthuizen, H., Shah, M., Nachtergaele, F., 2001. Global Agro-ecological Assessment for Agriculture in the 21st Century. International Institute for Applied Systems Analysis, Laxenburg, Austria and FAO.

International Potato Center—Users' Perspectives With Agricultural Research and Development. *Conservation and Sustainable Use of Agricultural Biodiversity: A Sourcebook* (3 Volumes). Laguna: CIP-UPWARD, 2003.

Losey, J.E., and Vaughan, M. (2006). The Economic Value of Ecological Services Provided by Insects. BioScience: Vol. 56, No. 4 pp. 311–323

Mando, A., L. Brussaard, L. Stroonijder and G. G. Brown. 1997. "Case Study A2: Managing termites and organic resources to improve soil productivity in the Sahel." FAO. 1 November 2007. <http://www.fao.org/ag/AGL/agll/soilbiod/cases/caseA2.pdf>

Millennium Ecosystem Assessment. *Ecosystem and Human Well-Being Synthesis*. Washington: Island Press, 2005

SCBD. *Global Biodiversity Outlook 2*. Montreal: SCBD, 2006.

Toledo, A. and B. Burlingame. "Biodiversity and nutrition: A common path toward global food security and sustainable development." *Journal of Food Composition and Analysis*. 19.6-7 (2006): 477-483.

UNEP. UNCCC. *Climate Change Information Sheets*. 2001. UNEP. 5 October 2007 <http://www.unep.org/dec/docs/info/ccinfokit/infokit-2001.pdf>

World Bank. *World Development Report 2008: Agriculture for Development*. Washington: The International Bank for Reconstruction and Development, 2007.

GLOSSARY

ADAPTIVE MANAGEMENT
The mode of operation in which an intervention (action) is followed by monitoring (learning), with the information being used at the time in designing and implementing the next intervention (acting again) to steer the system towards a given objective or to modify the objective itself.

BIODIVERSITY
The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic systems and the ecological complexes of which they are part of; this includes diversity within species (genetic), between species and of ecosystems.

BIOTECHNOLOGY
Any technological application that uses biological systems, living organism, or derivatives thereof, to make or modify products or processes for specific use.

DRIVER
Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.

ECOSYSTEMS
A dynamic complexity of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit.

ECOLOGICAL FOOTPRINT
The area of productive land and aquatic ecosystems required to produce the resources used and to assimilate the wastes produced by a defined population at a specific material standard of living, wherever on Earth that land may be located.

ECOSYSTEM APPROACH
a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

ECOSYSTEM FUNCTION
An intrinsic ecosystem characteristic related to the set of conditions and processes whereby an ecosystem maintains its integrity (such as primary productivity, food chain, biogeochemical cycles). Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

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

ECOSYSTEM STABILITY
A description of the dynamic properties of an ecosystem. An ecosystem is considered stable if it returns to its original state shortly after a perturbation (resilience), exhibits low temporal variability (constancy), or does not change dramatically in the face of a perturbation (resistance).

ECOTYPE
distinct form or race of a plant or animal species occupying a particular habitat.

FOOD SECURITY
The Food and Agricultural Organization of the United Nations as a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

NUTRITIONAL NEEDS
Sufficient protein, carbohydrates, fats, and micronutrients provided by a diversity of food sources for an individual to lead a healthy and active life.

PRECAUTIONARY PRINCIPLE

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

SUSTAINABILITY

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

WELL-BEING

A context-and situation-dependent state, comprising basic material for a good life, freedom and choice, health good social relations and security.

Source: Millennium Ecosystem Assessment. *Ecosystem Health and Well-being: A Framework for Assessment*. Washington: Island Press, 2003.

For more information please visit:

The Convention on Biological Diversity
www.cbd.int

The Food and Agriculture
Organization of the United Nations
www.fao.org

The Consultative Group of
International Agriculture Research
www.cgiar.org

Bioversity International
www.bioversityinternational.org

International Center for
Agricultural Research in the Dry Areas
www.icarda.org

International Livestock Research Institute
www.ILRI.org

International Potato Center
www.cipotato.org

World Agroforestry Centre (ICRAF)
www.worldagroforestrycentre.org

www.cbd.int

The Secretariat of the Convention on Biological Diversity
413 Saint Jacques Street, Suite 800, Montreal, Quebec, Canada H2Y 1N9
Tel. +1 514-288-2220 Fax: +1 514-288-6588
secretariat@cbd.int