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AGRICULTURAL BIODIVERSITY IN FAO

FAO's goal is to alleviate poverty and hunger by promoting sustainable agricultural development, improved nutrition and food security, and the access of all people at all times to the food they need for an active and healthy life. The importance of biological diversity for food security was reconfirmed in commitment No.3 of the Rome Declaration on Food Security made at the World Food Summit held in Rome in 1996. FAO is actively promoting the conservation and sustainable use of biodiversity for food and agriculture.

FAO provides intergovernmental fora where biodiversity-related policy is discussed and relevant agreements negotiated and adopted by member countries. The International Plant Protection Convention, the Code of Conduct for Responsible Fisheries and the International Treaty on Plant Genetic Resources adopted in 2001, are examples of such agreements.

FAO assists in the implementation of the Global Plan of Action on Plant Genetic Resources and the Global Plan of Action for Animal Genetic Resources, adopted under the aegis of FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA) in 1996 and 2007, respectively.

The Organization manages a broad range of programmes and activities to enhance sustainable agricultural systems and management practices, for example the promotion of mixed agricultural systems such as rice-fish farming and agroforestry; participatory training for integrated pest management; pollination management; advice on soil and water conservation; and promotion of technologies and management options of grasslands and forage resources in arid, semi-arid and humid tropical ecosystems.

FAO also addresses legal and economic aspects of agricultural biodiversity, and seeks to capitalize on its multidisciplinary expertise through an integrated approach to biodiversity conservation and sustainable use.

Through its work as a specialized UN organization, FAO assists countries in the implementation of biodiversity-related agreements of relevance to food and agriculture. These include the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the Convention on Biological Diversity (CBD), and the Convention to Combat Desertification (CCD).

The leading role of FAO is recognized in these international fora and FAO contributes actively to the development of international plans and programmes in this area. The Conference of the Parties (COP) to the CBD has recognized the "specific nature of agricultural biodiversity and its distinctive features and problems requiring distinctive solutions", and the leading role of FAO in agricultural biodiversity, including leading support to the programme of work on agricultural biodiversity (Decision V/5 Nairobi 2000).

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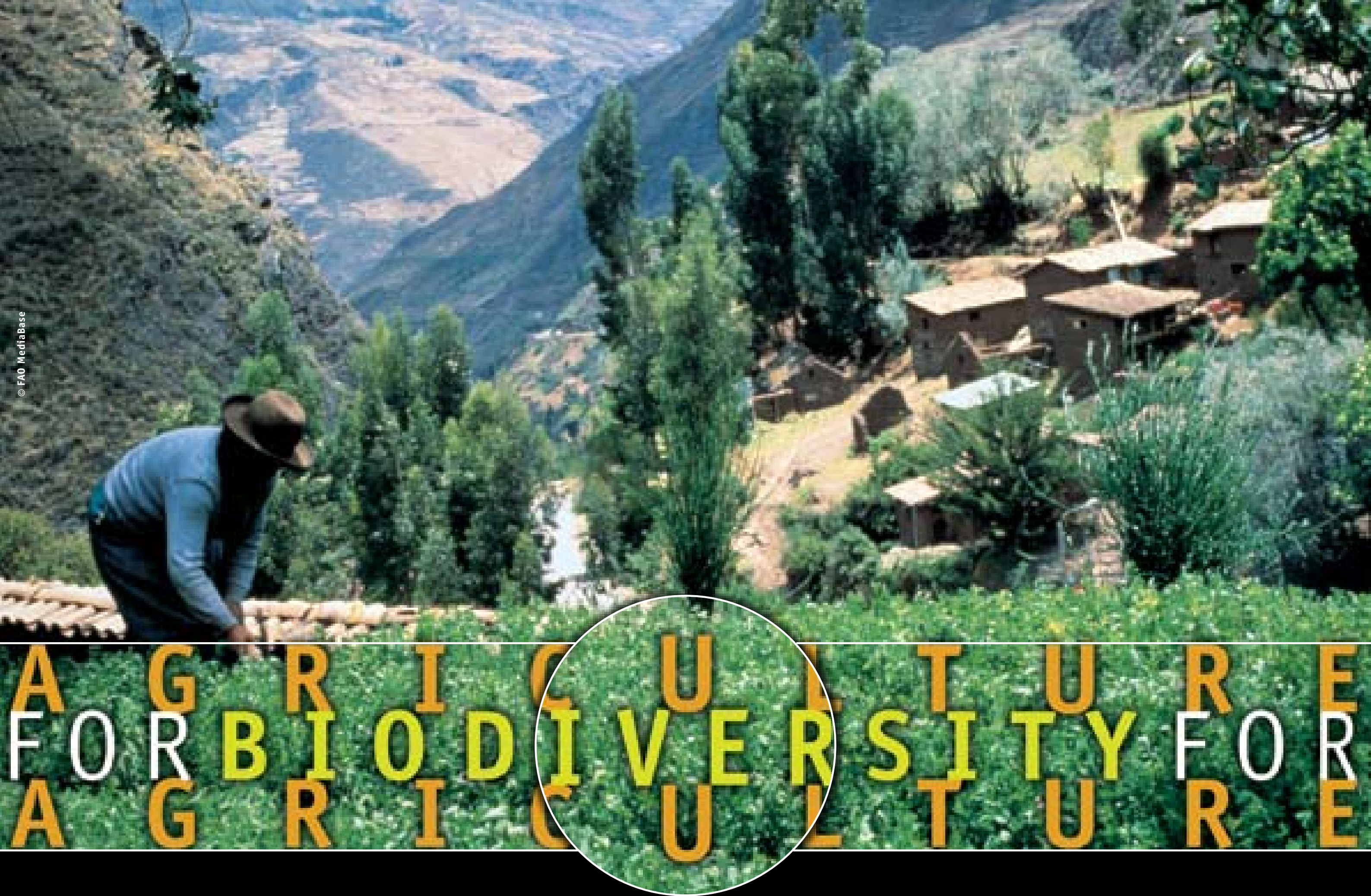
Further information about the work of FAO on biodiversity is available at:
www.fao.org/biodiversity

AGRICULTURE FOR BIODIVERSITY FOR AGRICULTURE



AGRICULTURE FOR BIODIVERSITY FOR AGRICULTURE

HOW DOES BIODIVERSITY BENEFIT AGRICULTURE?

PRODUCTIVITY: Conservation and management of broad-based genetic diversity within domesticated species has been improving agricultural production for 10 000 years. A wide range of species provide many thousands of products through agriculture. High production levels are sustained through maximizing the beneficial impact of ecosystem services for agriculture.

ADAPTATION: A diverse range of organisms contributes to the resilience of agricultural ecosystems and their capacity to recover from environmental stress and to evolve. Informed adaptive management of planned agricultural and unplanned associated biodiversity above and below ground secures agricultural production and provides valuable options in the face of climate change.

MAINTENANCE OF ECOSYSTEM FUNCTIONS: Essential functions such as nutrient cycling, decomposition of organic matter, crusted or degraded soil rehabilitation, pest and disease regulation, and pollination are maintained by a wide range of populations in and near agricultural ecosystems. Building on and enhancing these functions reduces external input requirements by increased nutrient availability, improved water use and soil structure, and natural control of pests.

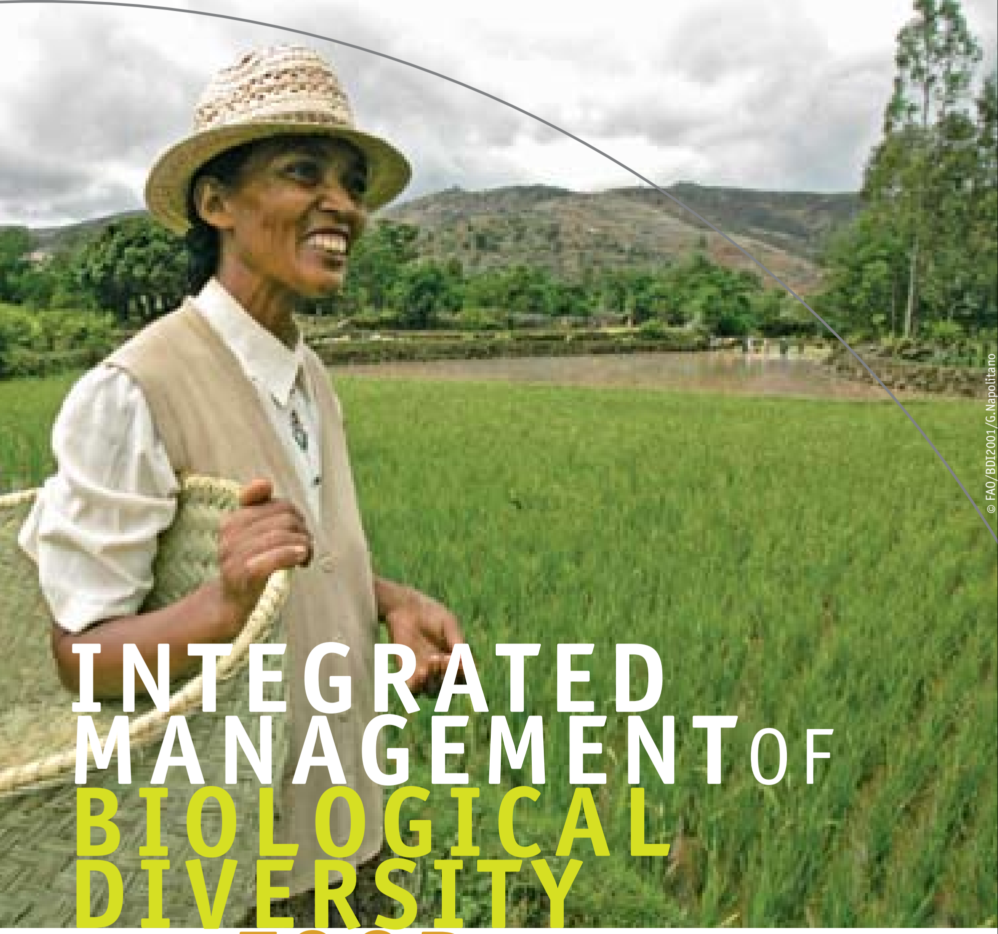
HOW DOES AGRICULTURE BENEFIT BIODIVERSITY?

DELIVERY OF ECOSYSTEM SERVICES: Agriculture occupies more than one-third of the land in most countries of the world. Agricultural lands and coasts managed sustainably as ecosystems contribute to wider ecosystem functions such as maintenance of water quality, soil moisture retention with reduction of runoff, water infiltration, erosion control, carbon sequestration, pollination, dispersal of seeds of wild and endangered plants, and refugia for species during droughts.

INCENTIVES: A range of populations needed by agriculture, such as pollinators and beneficial predators, need habitat diversity to survive. Agriculture therefore provides incentives to preserve areas such as hedgerows and field borders. The need for adaptation and potential for improvement in productivity provides an incentive for the conservation of a diverse range of genetic resources both *in situ* and *ex situ*.

ECOLOGICAL KNOWLEDGE: A large part of the human legacy of knowledge of biodiversity, its importance and functions has been gained and will continue to be gained across cultures through agriculture practice and reflection. This is a resource that should be more actively used, as in schools' programmes, to strengthen the ecological literacy of all citizens.

FIAT PANIS



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INTEGRATED MANAGEMENT OF BIOLOGICAL DIVERSITY FOR FOOD AND AGRICULTURE AT FAO

The FAO Priority Area for Interdisciplinary Action (PAIA) on the "Integrated Management of Biological Diversity for Food and Agriculture" brings together multidisciplinary expertise to address biodiversity issues globally and at the ecosystems levels. Through this, a holistic approach is pursued and a coordinated position on biological diversity for food and agriculture is established. The PAIA is a mechanism to assist countries including in the implementation of several biological diversity related instruments of relevance to food and agriculture, and cross-cutting issues covering the range of FAO's departments and their related activities.

The culture through which the inter-departmental working group was developed welcomes sharing, is open to outside alliances, and promotes ties to allies within FAO to move new ideas forward[1] and better respond to emerging issues. The work of the PAIA includes not only areas related to crops, livestock, forestry, fisheries and natural resource management, but also cross-cutting issues such as gender and biodiversity, using the ecosystem approach, and invasive alien species, to name a few. Legal and other technical aspects such as communications and media are also involved. At the local level, the application of the farmer field school approach is an example of how the PAIA brings together different disciplines.

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[1] Report of the Independent External Evaluation of FAO, September 2007

The FAO PAIA on the "Integrated Management of Biological Diversity for Food and Agriculture" is responsible for providing, among other things:

- Support to relevant international instruments and policy fora, such as the FAO Commission on Genetic Resources for Food and Agriculture, the International Plant Protection Convention, and the International Treaty on Plant Genetic Resources for Food and Agriculture hosted at FAO, as well as the Convention on Biological Diversity, in order to ensure an enhanced profile of agriculture and positive relationship with biodiversity and the ecosystem;
- Methodologies and guidelines on participatory technology development and adaptive management of agricultural biodiversity for sustainable food production and rural livelihoods;
- Support to national programmes of community-based learning, including in situ conservation of biodiversity, access and exchange of genetic resources and strengthened indigenous knowledge systems;
- Case studies on management of biodiversity for food and agriculture (including plants, forests, domestic animals, inland and marine fisheries, pollinators and soil biodiversity) using ecosystem approaches and with special reference to pastures, watersheds, natural forests and woodlands, buffer zones in protected areas, and organic agriculture systems; and
- Multi-media products and training materials for both field practitioners and policy-makers on the sustainable management of biodiversity for food and agriculture.

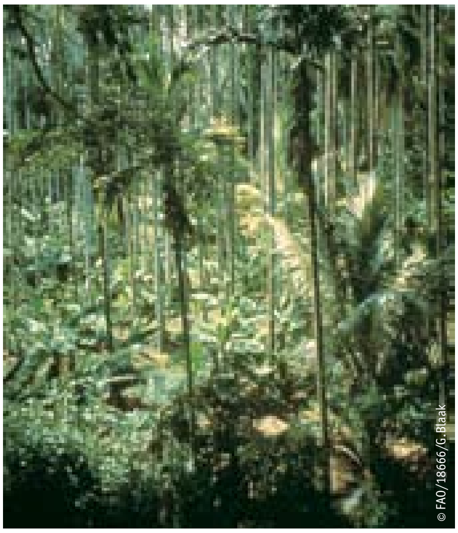
The FAO PAIA on the Integrated Management of Biological Diversity for Food and Agriculture is responsible for bringing together all FAO Departments to work on cross-cutting issues related to biodiversity for food and agriculture. It also acts as a coordination mechanism. For example, the PAIA prepared for the Convention on Biological Diversity's Thirteenth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), which was hosted at FAO from 18-22 February 2008.
SBSTTA-13 addressed issues of key importance to FAO, and for which FAO plays a lead role in implementing – including the Programmes of Work on Forest and Agricultural Biodiversity but also other cross-cutting issues such as Invasive Alien Species.

Further information about the work of FAO on biodiversity is available at:
www.fao.org/biodiversity

AGRICULTURE
FOR BIODIVERSITY FOR
AGRICULTURE

BIODIVERSITY FOR MAINTENANCE OF AGRO-ECOSYSTEM FUNCTIONS

Biodiversity, the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels, is necessary to sustain key functions of the ecosystem, its structure and processes.



What is an Agro-ecosystem?

Agro-ecosystems are ecosystems in which humans have exercised a deliberate selectivity on the composition of living organisms. Agro-ecosystems are distinct from unmanaged ecosystems as they are intentionally altered, and often intensively managed, for the purposes of providing food, fibre and other products; hence they inherently have human community, economic and environmental-ecological dimensions.

Why is Biodiversity Important for the Maintenance of Agro-ecosystem Functions?

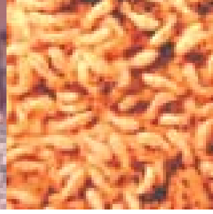
Maintenance of biodiversity within an agro-ecosystem is necessary to ensure the continued supply of goods and services such as:

(i) evolution and crop and livestock improvement through breeding – the interaction between the environment, genetic resources and management practices that occurs *in situ* within agro-ecosystems ensures that a dynamic portfolio of agricultural biodiversity is maintained and adapts to changing conditions;

(ii) biological support to production – support is provided by the organisms that make up the biological diversity of the agro-ecosystem. For example, soil fauna and micro-organisms, together with the roots of plants and trees, ensure nutrient cycling; pests and diseases are kept in check by predators and disease control organisms, as well as genetic resistances in crop plants themselves; and insect pollinators contribute to the cross-fertilization of outcrossing crop plants; and

(iii) wider ecological functions – valuable ecological processes that result from the interactions between species and between species and the environment include the maintenance of soil fertility, water quality and climate regulation.

EXAMPLES OF AGRICULTURAL BIODIVERSITY'S ROLE IN THE AGRO-ECOSYSTEM



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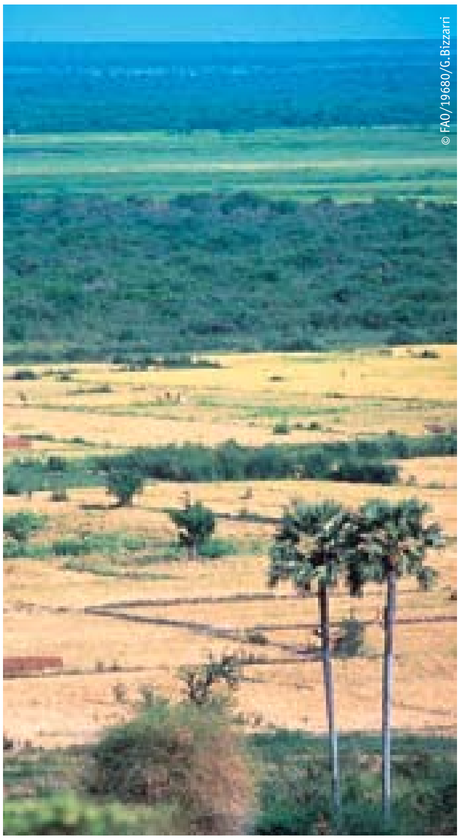
Pest control. Predators, parasitic wasps and micro-organisms play a key role in controlling agricultural pests and diseases. For example, more than 90% of potential crop insect pests are controlled by natural enemies living in natural and semi-natural areas adjacent to farmlands. Many methods of pest control, both traditional and modern, rely on biodiversity.



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Pollination. There are more than 100 000 known pollinator species (bees, butterflies, beetles, birds, flies and bats). Pollination mediated by components of agricultural biodiversity is an important function in agro-ecosystems. The global financial value contributed to agriculture each year by pollinators, representing 9.4% of the world agricultural production used for human food in 2005, is approximately € 153 billion.

Biomass production and yield efficiency. Diverse agro-ecosystems (fish polycultures, mixed herds, intercrops, integrated agro-sylvo-pastoral) are generally highly productive in terms of their use of energy and unit land area (or unit water volume). This efficiency is largely a product of the systems' biological and structural complexity, increasing the variety of functional linkages and synergies between different components.

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THE NEED TO BETTER UNDERSTAND BIODIVERSITY IN AGRICULTURE

Biodiversity is indeed an important regulator of agro-ecosystem functions, not only in the strictly biological sense of impact on production, but also in satisfying a variety of needs of the farmer and society at large.

Understanding the lifecycles, ecological responses and interactions within and between the organisms that provide ecological services enables agro-ecosystem managers to build on and enhance the essential services provided by biodiversity. Managers can reduce external input requirements, increase productivity and improve the sustainability of the ecosystem.

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www.fao.org/biodiversity

CLIMATE CHANGE AND FOOD PRODUCTION

AGRICULTURE AND CLIMATE CHANGE – THE CHALLENGES

Projected changes in the frequency and severity of extreme climate events can have consequences on food production, potentially provoking crop failure, forest-disturbance, diseases and mortality of livestock, losses of genetic resources available for food and agricultural production, and regional changes in the distribution and productivity of particular fish species. It is predicted that a 1-3º C increase in temperature will destabilize food production particularly in low-latitude regions, while increased recurrent droughts and floods will affect local production especially in dry and tropical ecosystems. This will affect food security, and smallholder and subsistence farmers, pastoralists and fisherfolk will suffer the brunt of the complex and localised impacts of climate change[1]. In the majority of world regions improved agricultural management technologies will be needed to deal with complex issues such as a potential increase demand for irrigation water.

But adaptation options imply different costs and technologies and climate change raises new demands on policy support for sustainable agricultural practices and technologies[2]. Sustainable agricultural production can play a role in adapting to and mitigating the impacts of climate change, because agriculture is:

- an important emitter of greenhouse gases;
- the sector with the highest potential for the reduction of emissions (Table 1);
- the sector most affected by climate change, with the largest need for adaptation.

Table 1: Global C stocks in vegetation and top 1 m of soils

Biome	Area	Carbon Stocks (Gt C)		
	(10^6 km^2)	Vegetation	Soils	Total
Tropical forests	17,6	212	216	428
Temperate forests	10,4	59	100	159
Boreal forests	13,7	88	471	559
Tropical savannas	22,5	66	264	330
Temperate grasslands	12,5	9	295	304
Deserts and semi-deserts	45,5	8	191	199
Tundra	9,5	6	121	127
Wetlands	3,5	15	225	240
Croplands	16,0	3	128	131

Source: Watson, R. T., Noble I. R., Bolin, B., Ravindranath,N.H., Verardo, D. and Dokken, D. (2000). Land Use, Land Use Change and Forestry. 375pp. Cambridge University Press, Cambridge, UK.

1. Apapted from: Easterling, W.E., P.K. Aggarwal, P. Batima, K.M. Brander, L. Erda, S.M. Howden, A. Kirilenko, J. Morton, J.-F. Soussana, J. Schmidhuber and F.N. Tubiello, 2007: Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 273-313.

2. ibid

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ADAPTATION, ECOSYSTEM SERVICES AND CLIMATE CHANGE

Ecosystem services build important measures of resilience and risk mitigation into agriculture – elements that are increasingly important under changing climates. The greater number and kinds of facilitative interactions in an ecosystem mean that as conditions change, different groups of organisms (e.g. pollinators) are favoured to continue providing ecosystem services.

THE ESSENTIAL ROLE OF AGRICULTURAL BIODIVERSITY

Biodiversity for food and agriculture will be affected by climate change, but will also be an important element in the development of production strategies to meet the challenges of climate change. It is also very likely that climate change will affect the ecosystem services provided by agricultural biodiversity. Global warming will create new climates, changing where, how, and what crops farmers will be able to cultivate. To face these challenges farmers will have to rely on adapted genetic resources, and need technological, political and information support to reinforce and improve their ability to select, maintain, and exchange genetic resources that will be adapted and adaptable to new climatic conditions and guarantee sustainability of the world's food, fibre and energy production.

THE ESSENTIAL ROLE OF INDIGENOUS KNOWLEDGE

The traditional knowledge held by indigenous and other peoples in agriculture can be considered as a "storage" of knowledge, including on best practices for sustainable agriculture. This knowledge has always been essential in adapting to environmental conditions. Knowledge of the details of local crop production patterns is the necessary foundation of site specific adaptation of cropping systems to increased climate variability.

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INDIGENOUS POTATOES AND WILD RELATIVES

With drastic climate change, areas where indigenous potatoes and wild relatives grow naturally could be reduced and many of these could become extinct. By conserving and utilizing the potato genetic diversity raised by their ancestors, Andean women farmers help to ensure world food security and adaptation to climate change.

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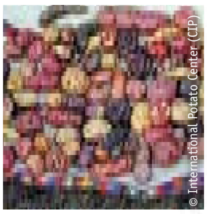

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Prepared 2008

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PEOPLE AND BIODIVERSITY

Agricultural biodiversity is fundamental to human populations who rely on the environment and on ecosystem services for their livelihoods. Men and women farmers not only use biodiversity to meet daily needs; they also hold a special role as *custodians* of biodiversity information and practices. This specialized knowledge needs to be recognized as a tool for achieving food security and sustainable rural development. FAO is committed to help conserve both the variety of the biosphere's resources *and* the local knowledge for dealing with them.

BIODIVERSITY AT THE HUMAN LEVEL

Biodiversity exists in all land and water-related dimensions of agricultural activity, and also supplies ecosystem services such as oxygen production, erosion control and pollination. Together, biodiversity and the ecosystem services it provides sustain the environmental functions on which the well-being of all humans depends. *Rural* men and women, however, are often *entirely* dependent on the environment for daily living and food security - the more natural resources available to people, the easier it is for them to find products which meet livelihood necessities. In this respect, any change in biodiversity patterns will first and foremost affect the viability of rural survival. Since rural dwellers are often among the world's most poor and vulnerable groups, preserving agricultural biodiversity is a necessary component of sustainable rural development, food security, and poverty alleviation.

LOCAL KNOWLEDGE AND BIODIVERSITY

Rural populations have relied on the environment for thousands of years, and local knowledge about that environment has persisted throughout. This unique relationship means that rural men and women have accumulated specialized information about biological variation and management, allowing to protect themselves against crop failure, animal loss, soil infertility, climate shifts, and other threatening factors. Indeed, men and women farmers are both **users** and **custodians** of biodiversity. In Mozambique, for example, knowledge about wild plants such as the Mungomu Tree protected rural communities against food shortages during the war; only because of their local expertise in alternative foodstuffs were these communities able to avert starvation. The collection of "famine foods", such as the fruit of the Mungomu tree, and other strategies of survival depend on **biodiversity awareness** and **availability**.

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THE GENDER DIMENSION OF AGRICULTURAL BIODIVERSITY

Local knowledge about biodiversity differs between the genders, reflecting variations in men's and women's social positions. This gendered differentiation in local knowledge has important implications for biodiversity management and conservation. For example, men tend to have better knowledge about deep-sea fishing practices and organisms, as they are generally involved in commercial fishing activities with better access to big boats. Women, on the other hand, know more about inland aquatic environments and utility, since they tend to concentrate their efforts in shallow marine zones closer to home. In the end, men and women's knowledge systems act as complements in rural agricultural systems, and both are equally important.

THREATS TO BIODIVERSITY AND REPERCUSSIONS OF BIODIVERSITY LOSS

Local knowledge about biodiversity and natural resources management has allowed people to subsist in often challenging environmental conditions. However, the magnitude and intensification of more recent developments is threatening both this adaptive capacity *and* nature's biodiversity itself. Issues such as climate change, over-harvesting, environmental degradation, globalization, and commercialization have serious impacts on biological and human systems. Many genetic varieties have disappeared and hence people will loose their understanding of biological resource use. The result is an erosion in the foundations which uphold our agricultural systems and food security. Agricultural systems are underpinned by the interdependence between biodiversity and local knowledge of both men and women. Development processes and practices must take this into consideration if rural development and food security are to become viable prospects.

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www.fao.org/sd/LINKS/GEBIO.HTM

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A G R I C U L T U R E FOR BIODIVERSITY FOR A G R I C U L T U R E

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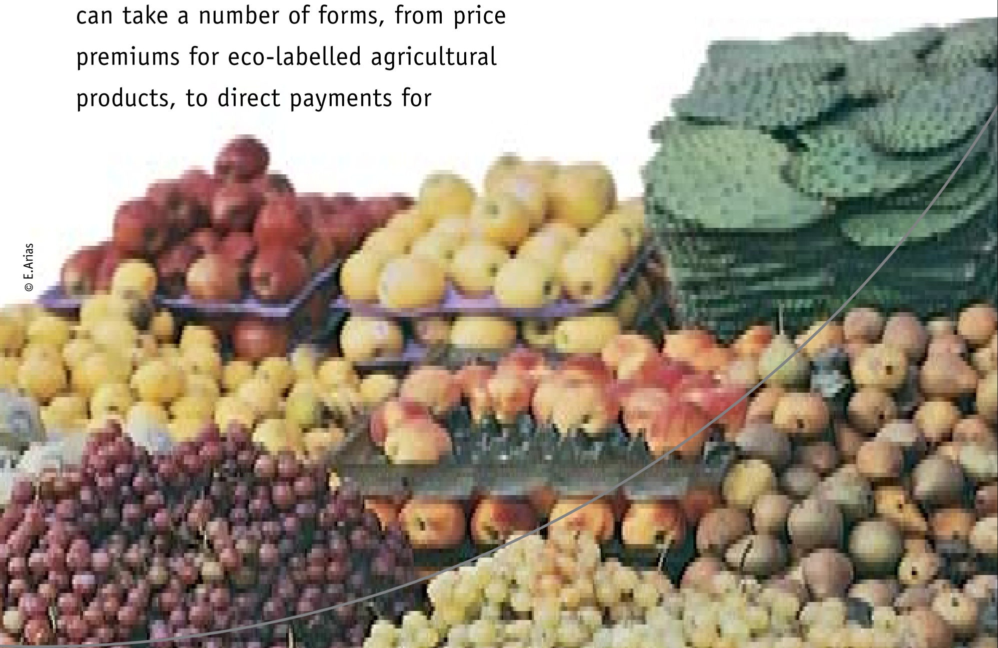
PAYING FARMERS FOR BIODIVERSITY CONSERVATION SERVICES

Ecosystems can be managed to provide a wide range of goods and services that are beneficial to people. Farmers are the largest group of ecosystem managers on earth. They manage agricultural ecosystems to provide marketed products such as food, fibre and fuel. Services such as biodiversity conservation and climate change mitigation can also be provided from agricultural ecosystems, however farmers lack incentives to do so.

Paying farmers for environmental services (PES) is one way of compensating agricultural producers, including farmers, herders, fisherfolk and forest dwellers, for the provision of biodiversity conservation services, including agricultural biodiversity. Payments for biodiversity conservation can take a number of forms, from price premiums for eco-labelled agricultural products, to direct payments for improving land use. Governments or NGOs are often involved in making payments on behalf of beneficiaries. Global conservation NGOs such as Conservation International, the Nature Conservancy and WWF have been supporting the development of PES, to encourage farmers living in or near protected areas, buffer zones and biological corridors to adopt improved land management techniques that can reduce negative impacts on biodiversity. The Global Environment Facility is another major supporter. Since 2002, GEF has contributed $188 million over 22 projects that have some elements of PES. Paying farmers for environmental services is just one of several ways of improving incentives to farmers to provide a wide range of ecosystem services, but it is an important option to consider. PES can be a relatively cheap, effective and equitable means of improving environmental management and conserving biodiversity. It can also be a quick means of responding to some environmental problems, including threats to biodiversity conservation. Farmers can take three types of actions to provide biodiversity conservation services.



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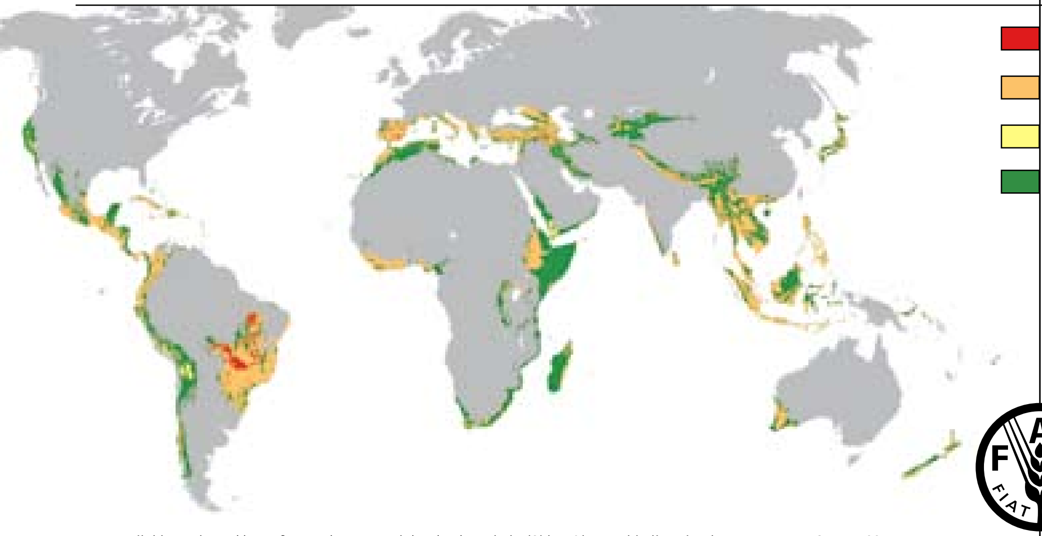
They can change the way they farm, altering the way they till the land, apply fertilizers and pesticides, or changing the mix of crops, varieties and animal breeds used. They can also change land use systems, shifting land from cropping to forests or wetlands to provide habitat and conservation. They may avoid making a land use change, as in choosing not to convert forested uplands to annual crop production.

Much of the focus of payments for biodiversity conservation has been on land use change. Recent interest in reducing deforestation and degradation for climate change mitigation is likely to increase payments for avoided land use change. Payments for biodiversity conservation within agricultural systems are relatively rare. One example is being implemented in Masaai Mara and Kitengela in Kenya, where the private sector and concerned individuals are paying pastoralists to maintain wildlife corridors on their traditional grazing lands.

Barriers to the development of payments for biodiversity conservation in developing countries include limited demand and willingness to pay for the service and high transactions costs. The establishment of long term sources of funding for payments, improving information and streamlining institutions is needed to realize the full potential of payments for biodiversity conservation.

PES programs can have either positive or negative impacts on the poor. If poor people are small landholders located in areas that have the potential to provide valuable biodiversity conservation services, they could benefit. PES could also hurt the poor, if they result in loss of access to lands or increased food prices. These are important concerns to take into consideration in designing PES programs. The best opportunities for achieving biodiversity conservation through PES depend on local agricultural, environmental and socio-economic conditions. For example, some biodiversity-rich areas under threat of conversion to agriculture may actually be poorly suited for crop production. Compensating farmers to avoid farming these areas may be relatively low cost. The map below showing the suitability of biodiversity-rich lands for rainfed cropping gives a rough idea of where some of these areas may lie, although more detailed analyses are required to make any firm conclusions.

Biodiversity hotspots in croplands poorly suited to rainfed agriculture



Note: available at: http://www.fao.org/geonetwork/srv/en/google.kml?id= 5&layers=biodiversity_hotspots - *Source:* SOFA 2007

Learn more:
http://www.fao.org/es/esa/en/pubs_sofa.htm

(Paying farmers to conserve biodiversity, and other environmental services is explored in greater depth in **The FAO State of Food and Agriculture Report 2007**)

Further information about the work of FAO on biodiversity is available at:
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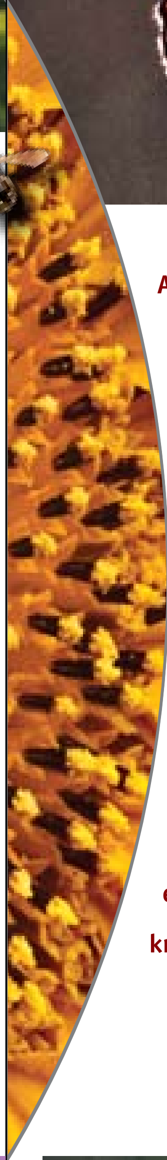
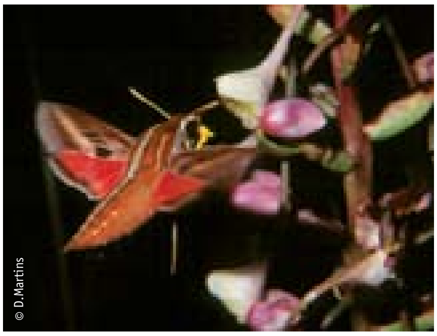
POLLINATION

AN ECOSYSTEM SERVICE



WHY CONSIDER POLLINATION?

Pollination is critical for food production and human livelihoods, and directly links wild ecosystems with agricultural production systems. The vast majority of flowering plant species only produce seeds if animal pollinators move pollen from the anthers to the stigmas of their flowers. Without this service, many interconnected species and processes functioning within an ecosystem would collapse.



The losses of pollination services have been well documented in many specific instances.

As managed pollinators such as honeybees face a suite of debilitating threats, the services provided by wild pollinators become even more essential. On a global level, the international community has identified the importance of pollinators with the establishment of the International Initiative for the Conservation and Sustainable Use of Pollinators (also known as the International Pollinators Initiative-IPI) in 2000 by the Convention on Biological Diversity, facilitated and coordinated by FAO.

A Plan of Action for the IPI was adopted at COP 6 (decision VI/5), providing an overall structure to the initiative, with four elements of assessment, adaptive management, capacity building and mainstreaming. The plan of action recognises the need to take action, while still collecting evidence and expanding the knowledge base.

MORE IS BETTER

The diversity of pollinators and pollination systems is striking. Most of the 25 000 to 30 000 species of bees are effective pollinators, and together with moths, flies, wasps, beetles and butterflies, make up the majority of pollinating species. Vertebrate pollinators include bats, non-flying mammals (several species of monkey, rodents, lemur, tree squirrels, olingo and kinkajou) and birds (hummingbirds, sunbirds, honeycreepers and some parrot species). Healthy pollination services are best ensured by an abundance and diversity of pollinators.

TROPICS AND MOUNTAIN ECOSYSTEMS HIGHLY DEPENDENT ON POLLINATORS

Tropical crops such as cocoa have some of the greatest dependence on pollinators; 90% of the yield of cocoa trees depends on good pollination. Arid and mountain ecosystems often have highly diverse pollinator communities as well, with finely tuned adaptations to ensure that pollination is effective even when climatic conditions are erratic.

POLLINATION IS ESSENTIAL FOR HUMAN LIVELIHOODS

In agro-ecosystems, pollinators are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fiber crops. About two-thirds of the crop plants that feed the world, plus many plant-derived medicines in our pharmacies, rely on pollination by insects or other animals to produce healthy fruits and seeds. For human nutrition the benefits of pollination include not just abundance of fruits, nuts and seeds, but also their variety and quality; the contribution of animal-pollinated foodstuffs to human nutritional diversity, vitamin sufficiency and food quality is substantial.

Learn more:
www.fao.org/ag/AGP/default.htm
e-mail: GlobalAction-Pollination@fao.org

Further information about the work of FAO on biodiversity is available at:
www.fao.org/biodiversity

AGRICULTURE FOR BIODIVERSITY FOR AGRICULTURE

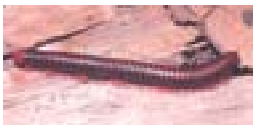
SOIL BIOTA AND BIODIVERSITY

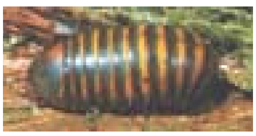
THE "ROOT" OF SUSTAINABLE DEVELOPMENT

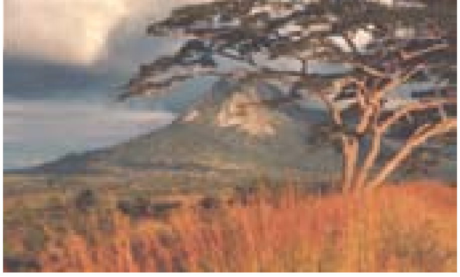
Soil organisms contribute a wide range of essential services to the sustainable functioning of all ecosystems by acting as the primary driving agents of nutrient cycling; regulating the dynamics of soil organic matter, soil carbon sequestration and greenhouse gas emission; modifying soil physical structure and water regime; enhancing the amount and efficiency of nutrient acquisition by vegetation; and enhancing plant health. These services are not only essential to the functioning of natural ecosystems but also constitute an important resource for the sustainable management of agricultural systems.

SOIL IS ALIVE

Soils are one of the most poorly researched habitats on earth. Although not generally visible to the naked eye, soils are among the most diverse habitats and contain some of the most diverse assemblages of living organisms. The soil is one of nature's most complex ecosystems: it contains thousands of different organisms, which interact and contribute to the global cycles that make all life possible - the life support systems. Nowhere in nature are species so densely packed as in soil communities. For example, a single gram of soil may contain many millions of individuals and several thousand species of bacteria. Soil biota also includes the roots that grow in the soil and interact with other species above and below ground.







The species numbers, composition and diversity of a given soil depend on many factors, including aeration, temperature, acidity, moisture, nutrient content and organic substrate. However, the number and types of organisms vary from one system and environment to another and this is strongly influenced by land management practices.

Agricultural practices, including forestry, have significant positive and negative impacts on soil biota. An integrated management approach to agriculture should, *inter alia*, enhance the biological efficiency of soil processes with a view to optimizing soil productivity and crop production and protection.

There are many cases in the literature demonstrating beneficial and negative effects of management practices on soil biological activity and its impacts on agricultural productivity and agro-ecosystem sustainability.

For example:

- Earthworms, termites and other burrow-building soil organisms enhance soil productivity by mixing the upper soil layers, which redistributes nutrients, aerates the soil and increases surface water infiltration.
- Worldwide, soil is being lost at a rate 13 to 80 times faster than it is being formed. It takes about 500 years to form 25 mm of soil under agricultural conditions, and about 1000 years to form the same amount in forest habitats. The value of soil biota to soil formation on agricultural land worldwide has been estimated at US$ 50 000 million per annum.
- Biological nitrogen fixation, the process by which some micro-organisms fix atmospheric nitrogen and make it available to the ecosystem, offers an economically attractive and ecologically sound means of reducing external nitrogen inputs and improving the quality and quantity of internal resources.

Recent estimates indicate that global terrestrial biological N_2 fixation ranges between 100 and 290 million tonnes of N per year, of which 40-48 million tonnes per year is estimated to be biologically fixed in agricultural crops and fields.

Improvement in agricultural sustainability will require conservation and management of soil biodiversity.

KEY FACTS

- Soil organisms maintain critical processes such as carbon storage, nutrient cycling and plant species diversity.
- Soil biodiversity plays a role in soil fertility, soil rehabilitation and nutrient uptake by plants, biodegradation processes, reducing hazardous waste and control of pests through natural biocontrol.
- Soil organisms enhance crop productivity through:
  - recycling the basic nutrients required for all ecosystems, including nitrogen, phosphorus, potassium and calcium;
  - breaking down organic matter into humus, hence enhancing soil moisture retention and reducing leaching of nutrients; and
  - increasing soil porosity and hence water infiltration and thereby reducing surface water runoff and decreasing erosion.
- Ecologically, the soil biota is responsible for regulating several critical functions in soil. Excessive reduction in soil biodiversity, especially the loss of keystone species and/or species with unique functions may have cascading ecological effects leading to the long-term deterioration of soil fertility and the loss of agricultural productive capacity.

Learn more:
www.fao.org/ag/AGL/agll/soilbiod/default.htm

Further information about the work of FAO on biodiversity is available at:
www.fao.org/biodiversity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NUTRITION AND BIODIVERSITY

Nutrition and biodiversity converge to a common path leading to food security and sustainable development. They feature directly the Millennium Development Goals (MDGs): halve the proportion of people who suffer from hunger; and ensure environmental sustainability. In combination, a nutrition and biodiversity initiative provides the very foundation for achieving these MDGs.

In order to be successful, strategies to address nutrition problems have to be systematic and multi-sectoral, and should be integrated into a general framework. Sustainable improvement in nutritional well-being is achieved through a combination of evidence- and community-based actions to address local causes of malnutrition; improvements in national and sectoral policies and programmes; support to civil society institutions to enable poor households to access or acquire sufficient food and utilize it most effectively; and enhancement of education and public information for dietary improvement. These approaches go beyond simple improvements in dietary energy availability, to overall improvements in nutrition security, particularly related to micronutrients.

Gathering wild foods, growing locally adapted varieties and eating from the local ecosystem continue to be part of civilizations and cultures and their potential value for food security and rural development is recognized. There is also growing acknowledgment of the need to adapt nutrition and health interventions to the diversity of needs of individuals and communities. If nutrient analysis and data dissemination of the various food species and intra-species diversity are systematically undertaken, national information systems for food and agriculture will be strengthened and can be used to form the basis for priority setting and national policy making.

BIODIVERSITY AND NUTRITION RATIONALE

- Wild species and infraspecies biodiversity have key roles in global nutrition security.
- Different varieties of the same species have statistically different nutrient contents.
- Acquiring nutrient data on existing biodiversity needs to be a prerequisite for decision-making in GMO work.
- Nutrient content needs to be among criteria in cultivar promotion.
- Nutrient data for wild foods and cultivars need to be systematically generated, centrally compiled and widely disseminated.
- Biodiversity questions and/or prompts need to be included in food consumption surveys.
- Acquiring nutrient data and intake data for varieties is essential in order to understand the impact of biodiversity on food and nutrition security.


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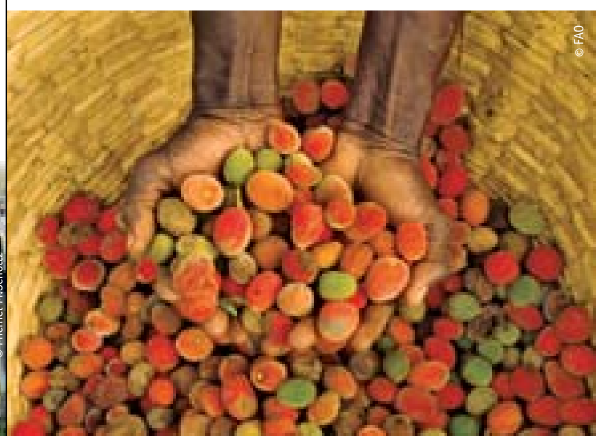
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For nutrition, this will mean introducing more compositional data on biodiversity in national food composition databases and tables; developing and using dietary assessment instruments that capture food intake at the species and variety/breed level; and allowing marketing and food labelling that encourage awareness of food plant varieties and food animal subspecies.

We need to increase the evidence base by filling our knowledge gaps with better inventories and more data, and accessible data, on composition and consumption. As we progress in this effort, information will be mainstreamed in all nutrition activities, and used effectively in community-based programmes and interventions.

Rice varietal differences in nutrient composition

Nutrient	Range	Average	Variety with highest nutrient content	Variety with lowest nutrient content
Protein (n=1339)	5.55 – 14.58 g/100g	8.55	Indica CR1707	Indica Rd 19 (Thailand)
Iron (n=57)	0.70 – 6.35 mg/100g	2.28	Long grained[a] red (China)	Undermilled Red[a] (Philippines)
Zinc (n=57)	0.79 – 5.89 mg/100g	3.34	Ganjay Roozy (IRRI)	Long grain[a] Fragrant (China)
Calcium (n=57)	1.0 – 6.5 mg/100g	26	ADT-21, red (India)	Brown Japonica[a] (Korea)
Thiamin (n=79)	0.117 – 1.74 mg/100g	0.475	Juchitan A-74 (Mexico)	Glutinous rice[a] special grade (China)
Riboflavin (n=80)	0.011 – 0.448 mg/100g	0.091	Tapol Dark Purple (Philippines)	Mun-pu red (Thailand)
Niacin (n=30)	1.97 – 9.22 mg/100g	5.32	Long grained[a] purple (China)	Glutinous round[a] grained (China)
Amylose (n=1182)	1.0 – 76.0 g/100g	22.4	Ingra 410 (Brazil)	Bpi-Ri-3 (Philippines)

[a] These data come from Food Composition Tables, and do not strictly represent rice varieties.

Sweet potato varieties: α- and β-carotene, mg/100g fresh wt

Variety	% moisture	β-carotene	α-carotene
Orange Flesh			
Excel	77.8 (0.8)	12.8 (0.1)	< 0.1
Kona B #	77.8 (0.6)	6.7 (0.2)	1.5 (0.2)
Regal	77.2 (2.1)	13.1 (0.7)	< 0.1
UH 71-5 #	70.3 (1.1)	8.0 (0.1)	< 0.1
Yellow White Flesh			
Hoolehua Red #	70.4 (2.7)	0.2 (0.1)	< 0.1
Satsuma #	68.3 (0.2)	0.6 (0.1)	< 0.1

n=6, values in parentheses are standard errors.
# Varieties are recommended by Extension Service for good yield and disease resistance.

Source: A.S. Huang, L. Tanudjaja, D. Lum. *Journal of Food Composition and Analysis, Vol. 12, No. 2*, Jun 1999, pp. 147-151.

THE INTERNATIONAL RICE COMMISSION

The commission noted the following:

- Diversity is a fundamental principle of good nutrition and the basis of dietary guidelines for individuals and populations.
- Diversification for enhancing human nutrition takes several important forms when dealing with rice-based systems: dietary diversification among rice-eating urban populations; diversity of foods for rural populations within a rice-based ecosystem; biodiversity of rice genetic resources; and diversification in processing and preparation of raw materials.
- The rice ecosystem also provides many options for improved nutrition for rural populations and the ecosystem approach to improved nutrition has been gaining more attention recently.

The Commission *recommended* that:

- Existing biodiversity of rice varieties and their nutritional composition need to be explored *before* engaging in transgenics.
- Nutrient content needs to be among the criteria in cultivar promotion.
- Cultivar-specific nutrient analysis and data dissemination should be systematically undertaken.
- The evaluation of the composition and consumption of rice cultivars should continue for the development of food biodiversity indicators to guide agro-biodiversity conservation and human nutrition. Increasing the availability and promoting the use of whole grain and moderately milled rice and rice products will provide human nutrition benefits, particularly related to micronutrient intakes.

Learn more:
www.fao.org/infoods/biodiversity/index_en.stm

Further information about the work of FAO on biodiversity is available at:
www.fao.org/biodiversity

BIODIVERSITY AND ORGANIC AGRICULTURE

AN EXAMPLE OF SUSTAINABLE USE OF BIODIVERSITY

Organic agriculture is a holistic production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems.

(Codex Alimentarius Commission, 1999)

BIODIVERSITY **FROM** ORGANIC AGRICULTURE

Organic farmers are both custodians and users of biodiversity at all levels:

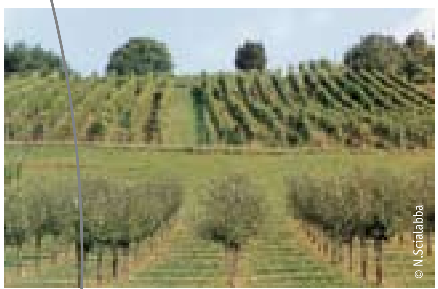
GENE level: endemic and locally adapted seeds and breeds are preferred for their greater resistance to diseases and resilience to climatic stress;

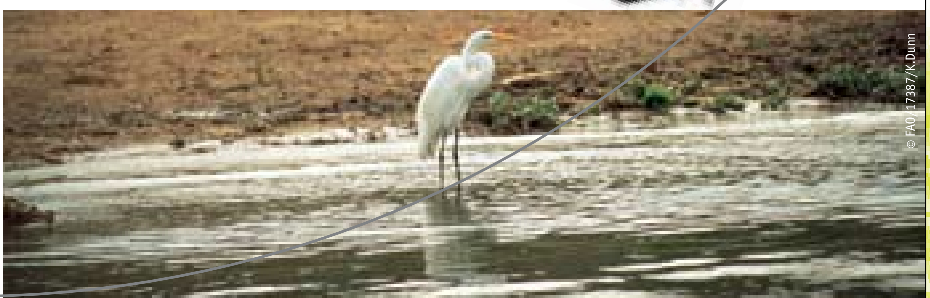
SPECIES level: diverse combinations of plants and animals optimize nutrient and energy cycling for agricultural production;

ECOSYSTEM level: the maintenance of natural areas within and around organic fields and the absence of chemical inputs create habitats suitable for wildlife. Reliance on natural pest control methods maintains species diversity and avoids the emergence of pests resistant to chemical controls.

BIODIVERSITY **FOR** ORGANIC AGRICULTURE

Organic agriculture manages locally available resources to optimize competition for food and space between different plant and animal species. The manipulation of the temporal and spatial distribution of biodiversity is the main productive "input" of organic farmers. By refraining from using mineral fertilizers, synthetic pesticides, pharmaceuticals and genetically-modified seeds and breeds, biodiversity is relied upon to maintain soil fertility and to prevent pests and diseases.





ORGANIC AGRICULTURE AND SOIL ECOSYSTEMS

Organic practices such as crop rotations and associations, cover crops, organic fertilizers and minimum tillage increase the density and richness of indigenous invertebrates, specialized endangered soil species, beneficial arthropods, earthworms, symbionts and microbes.[1] Such soil biodiversity enhances soil forming and conditioning, recycles nutrients, stabilizes soils against erosion and floods, detoxifies ecosystems and contributes to the carbon sequestration potential of soils.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ORGANIC AGRICULTURE AND AGRO-ECOSYSTEMS

Rotation of crops in organic systems functions as a tool for pest management and soil fertility. This, together with inter-cropping, integrated crop-tree-animal systems, the use of traditional and underutilized food and fodder species and the creation of habitats attracts pest enemies and pollinators and decreases the risk of crop failure across the agro-ecosystem. Agricultural biodiversity is conserved and developed through the regeneration of locally adapted landraces and the improvement of genotypes of many plant varieties and animal races near extinction.[2]

ORGANIC AGRICULTURE AND NATURE CONSERVATION

The maintenance of vegetation adjacent to crops and plant corridors are common in organic systems, providing alternative food and refuge for many insect predators, wild flora, birds and other wildlife. The absence of pesticide drifts and herbicides and on-farm integration of natural habitats (e.g. productive perennial plants, hedgerows) and other structures (e.g. stepping stones and corridors for migrating species) attract new or re-colonizing species to the area. Ultimately, the diversity of landscape and wildlife attracts people in the form of ecotourism, providing an important source of off-farm income.[3]

FOOD PRODUCTION, INCOME GENERATION AND BIODIVERSITY IN HARMONY

IUCN recognizes the potential of organic agriculture in several protected areas categories. In several national and regional protected areas and their buffer zones (e.g. Meso-American Biological Corridor), organic agriculture is encouraged in support of the objectives of the Convention on Biological Diversity. Organic standards and certification schemes of some European countries incorporate plans for the management of biodiversity on organic farms (e.g. Sweden, UK) or reward biodiversity growth on farms (e.g. Germany, Italy).

1. FiBL. 2000. Organic farming enhances soil fertility and biodiversity. Results from a 21-year-old field trial. Research Institute of Organic Farming (FiBL), Frick, Switzerland, Dossier no. 1, August 2000.

2. IFOAM. 2000. The Relationship between Nature Conservation, Biodiversity and Organic Agriculture. Proceedings of an international workshop held in Vignola, Italy, by IUCN, IFOAM, WWF and AIAB. S. Stolton, B. Geier and J.A. McNeely (eds).

3. McNeely, J.A., & Scherr, S.J. 2001. Common Ground, Common Future. How Eco-agriculture can help feed the world and save wild biodiversity. IUCN and Future Harvest, May 2001.


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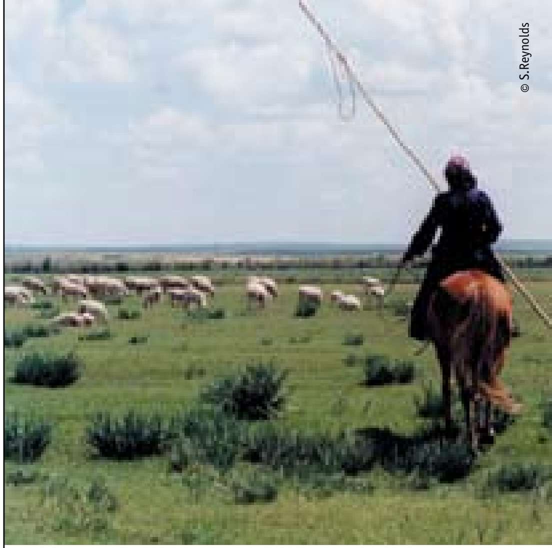
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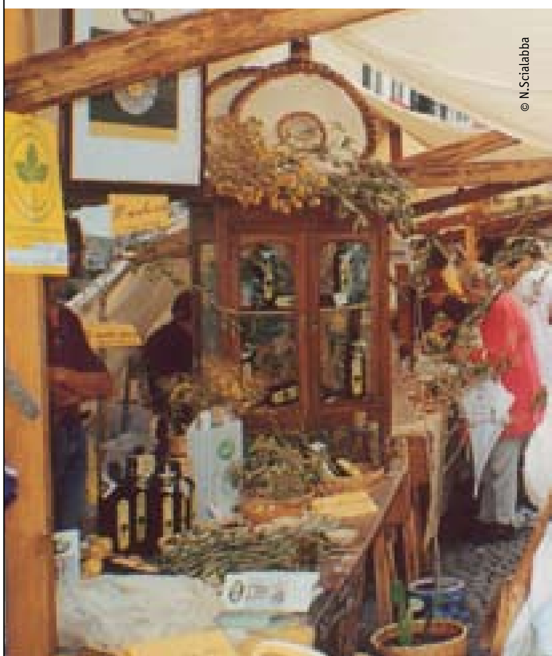
WORK IN PROGRESS

Organic farmers are pioneering practical solutions for the sustainable use of biodiversity. However, extensive research is needed to understand better – and acknowledge – the complex relationships between biodiversity and agriculture. Public policies and investments can unlock this potential.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Learn more:
www.fao.org/organicag

Further information about the work of FAO on biodiversity is available at:
www.fao.org/biodiversity

AGRICULTURE FOR BIODIVERSITY FOR AGRICULTURE

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THE INTERNATIONAL TREATY ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

The International Treaty on Plant Genetic Resources for Food and Agriculture, an international binding agreement with the overall goal of supporting global food security, was adopted by the FAO Conference in 2001 and entered into force in 2004.

The Treaty allows governments, farmers, research institutes and agro-industries to work together by pooling their genetic resources and sharing the benefits from their use – thus protecting and enhancing our food crops while giving fair recognition and benefits to local farmers who have nurtured these crops through the millennia.

In today's world, the pressure is on to improve agricultural production by developing food crops that can adapt to environmental changes and meet the growing food demands of a constantly increasing population. Under the Treaty, crops that produce our food – our breads, our curries, our tortillas, and our couscous – are put into a common pool. As nations ratify the Treaty, they begin the process of setting up national commissions and committees to oversee implementation. This means ensuring conformity of the country's laws, regulations and procedures with its obligations under the Treaty and providing guidance for including the relevant genetic resources in the Treaty's Multilateral System (MLS).

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THE DISAPPEARANCE OF OPTIONS

Over the millennia, humans have relied on more than 10 000 different plant species for food. Yet, today, we have barely 150 species under cultivation. Of those, only 12 species provide 80 percent of all of our food needs and just four of those – rice, wheat, maize and potatoes – provide more than half of our energy requirements. What has happened to the other 9850? The answer is startling. If they have not been lost already, they are vulnerable.

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THE TREATY PROVIDES INNOVATIVE APPROACHES TO PROTECT HUMANITY'S LONGEST TRADITION – AGRICULTURE

MultilateralSystem

The Treaty's truly innovative solution to access and benefit sharing, the Multilateral System, puts 64 of our most important crops – crops that together account for 80 percent of the food we derive from plants – into an easily accessible global pool of genetic resources that is freely available to potential users in the Treaty's ratifying nations for some uses.

Access and Benefit-sharing

The Treaty facilitates access to the genetic materials of the 64 crops in the Multilateral System for research, breeding and training for food and agriculture. Those who access the materials must be from the Treaty's ratifying nations and they must agree to use the materials only for research, breeding and training for food and agriculture. The Treaty prevents the recipients of genetic resources from claiming intellectual property rights over those resources in the form in which they received them, and ensures that access to genetic resources already protected by intellectual property rights is consistent with international and national laws. Those who access genetic materials through the Multilateral System agree to share any benefits from their use through four benefit-sharing mechanisms established by the Treaty.

BENEFIT-SHARING MECHANISMS (ART 13)

- exchange of information
- access to and transfer of technology
- capacity-building
- sharing of any commercial benefits


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Farmers' Rights

The Treaty recognizes the enormous contribution farmers have made to the ongoing development of the world's wealth of plant genetic resources. It calls for protecting the traditional knowledge of these farmers, increasing their participation in national decision-making processes and ensuring that they share in the benefits from the use of these resources.

Sustainable use

Most of the world's food comes from four main crops – rice, wheat, maize and potatoes. However, local crops, not among the main four, are a major food source for hundreds of millions of people and have potential to provide nutrition to countless others. The Treaty helps maximize the use and breeding of all crops and promotes development and maintenance of diverse farming systems.

The International Treaty
ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE


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Contact Information:

International Treaty on Plant Genetic Resources for Food and Agriculture
FAO Headquarters
Viale delle Terme di Caracalla, 1
00153 Rome, Italy

Phone: (+39) 06 570 53554
Fax: (+39) 06 570 56347
E-mail: pgrfa-treaty@fao.org
Web: www.planttreaty.org

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PLANT GENETIC RESOURCES IN ACTION

Plant genetic resources for food and agriculture are an integral component of agricultural biodiversity.
The genetic diversity contained in traditional varieties and modern cultivars, crop wild relatives and landraces provide a basis for food production, and also act as buffer for adaptation and resilience in face of climate change. All countries in the world are interdependent on plant genetic resources and there is a continuous need to conserve, exchange and transfer healthy germplasm for sustainable agriculture and maintenance of a dynamic agro-ecosystem.

Effective conservation for a wider use of plant genetic resources.
Women and men farmers and breeders need access to plant genetic resources, including alternative crops and new cultivars, and related information and technologies, including through seed provision, to achieve sustainable increases in production and income generation. FAO, with partners, is actively strengthening plant breeding capacities and seed supply systems in developing countries, especially for those crops that are not addressed by the private sector. These activities are underpinned by the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture and the International Treaty on Plant Genetic Resources for Food and Agriculture.

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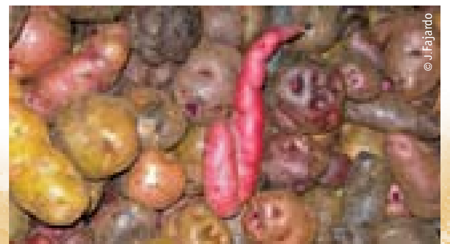

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Whether to face climate change or for providing ecosystem services, the continued availability of a diverse range of plant genetic resources is necessary to contribute to food production. Plant diversity is necessary for the delivery of ecosystem services such as pollination, pest-predator balances, carbon sequestration and water conservation, among others. Genetically diverse plant populations and species-rich ecosystems have greater potential to adapt to climate change and for increasing local adaptation and building ecosystem resilience.

Given the vast contribution of plant genetic resources to humanity, the main challenge is to mainstream the conservation and sustainable use of plant genetic resources, its associated biodiversity and seed related issues into policies at the national, sub-regional and international levels through capacity development and knowledge management. FAO provides policy advice and technical assistance to members in all related areas and offers a neutral forum for intergovernmental discussions on new and emerging issues. It is committed to promoting and supporting international instruments and partnerships for sustained conservation and use of plant genetic resources to alleviate hunger and make a positive impact on the livelihoods that depend on them.

KEY INTERNATIONAL EVENTS IN PLANT GENETIC RESOURCES: A TIME LINE

2004

- Entry into force of the **International Treaty on Plant Genetic Resources for Food and Agriculture** (ITPGRFA) with the signature of 40 Contracting Parties.
- Establishment of the **Global Crop Diversity Trust** to ensure ex situ crop conservation in perpetuity.

2001

- After seven years of negotiations in the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA), the FAO Conference adopts the ITPGRFA as a legally binding outcome of the revision of the International Undertaking on Plant Genetic Resources.

1996

- The rolling **Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food Agriculture** (GPA) adopted by 150 members through the Leipzig Declaration.
- Publication of the first **State of the World's Plant Genetic Resources for Food and Agriculture** to provide an assessment of the current situation of plant genetic resources and lay the foundation for the GPA. Periodic updating of this Report is undertaken by FAO to facilitate revision of the GPA in light of emerging issues and trends.

1983

- FAO Conference adopts the **International Undertaking on Plant Genetic Resources** as the first international agreement on plant genetic resources for food and agriculture and establishes the CGRFA.

Learn more:
www.fao.org/ag
www.globalplanofaction.org
http://km.fao.org/gipb
http://apps3.fao.org/wiews/wiews.jsp

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www.fao.org/biodiversity

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ANIMAL GENETIC RESOURCES

THE FIRST GLOBAL ASSESSMENT

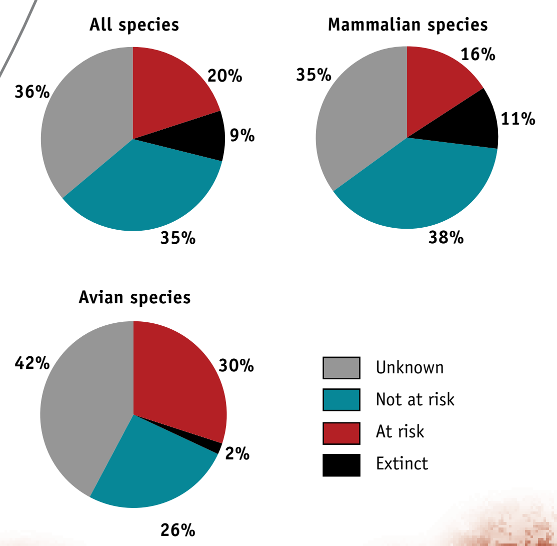
Sustainable management of agricultural biodiversity is vital to rural development, food security and the environment. *The State of the World's Animal Genetic Resources for Food and Agriculture is the first comprehensive global assessment of biodiversity in mammalian and avian livestock species: origins, utilization, distribution and exchange, risk status and threats; and its management: institutions, policy and legal frameworks, and breeding and conservation programmes. Needs and challenges are assessed in the context of forces driving change in livestock production systems. A section on "the state of the art" covers methods for characterization, genetic improvement, economic valuation and conservation.**

*available at: www.fao.org/docrep/010/a1250e/a1250e00.htm

KEY FINDINGS

- Risk-status data indicate a serious ongoing threat to livestock biodiversity. Almost one breed extinction per month was reported between 2000 and 2006.

Proportion of the world's breeds by risk-status category



THE STATE OF THE WORLD REPORTING PROCESS

In 1999, the Commission on Genetic Resources for Food and Agriculture requested the Food and Agriculture Organization of the United Nations to coordinate a country-driven report on *The State of the World's Animal Genetic Resources for Food and Agriculture*. In 2001, FAO invited 188 countries to submit Country Reports on animal genetic resources. By the end of 2005, 169 Country Reports had been received. These key resources for the preparation of the SoW-AnGR were complemented by nine reports from international organizations, 12 specially commissioned studies, and by the knowledge and expertise of more than 90 authors and reviewers. FAO's Global Databank for Animal Genetic Resources was the basis for assessment of risk status and trends in AnGR diversity.

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

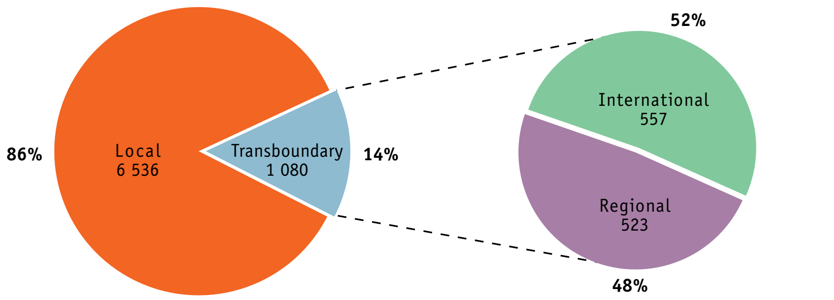


FIG. 2: Distribution of Holstein-Friesian cattle

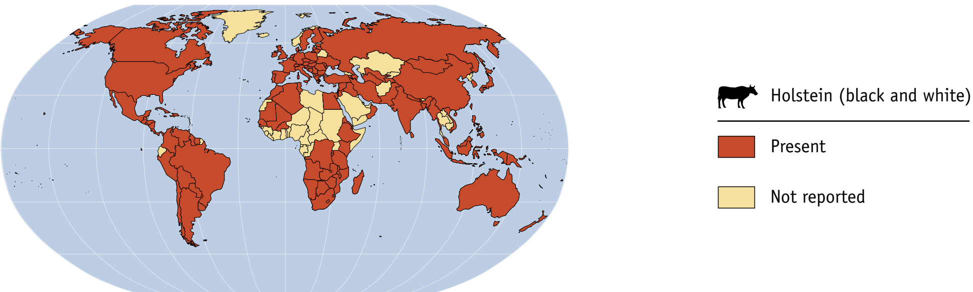


FIG. 3: Distribution of transboundary sheep breeds

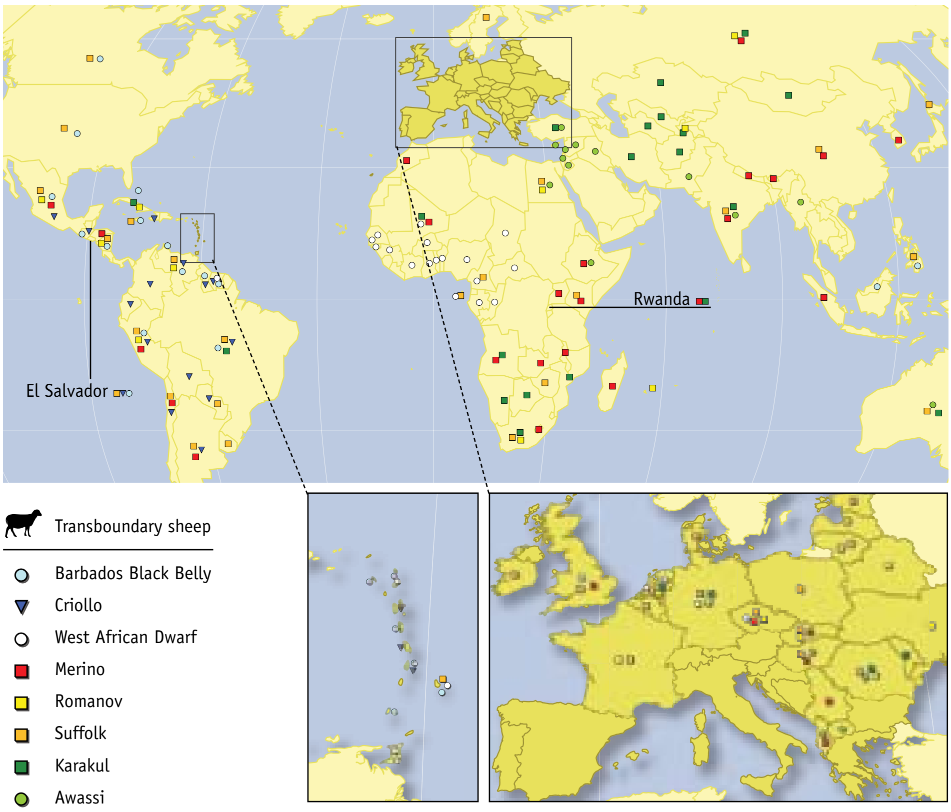
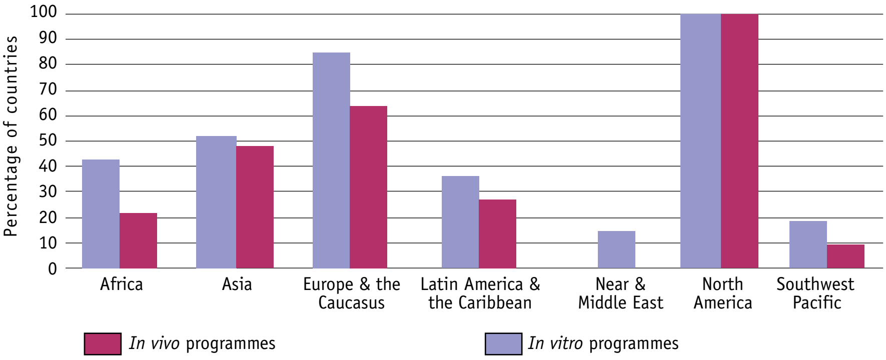


FIG. 4: Regional distribution of conservation programmes



- Local breeds are defined as those occurring in only one country, while transboundary breeds occur in more than one country. The latter group are further divided into international transboundary breeds (occurring in more than one region of the world) and regional transboundary breeds (occurring in only one region).
(see fig. 1)
- The most widely distributed transboundary breeds are largely from the industrialized countries of temperate zones – for example, the Holstein-Friesian is the breed found in the largest number of countries worldwide.
(see fig. 2)
- There is significant movement and exchange of animal genetic resources among the countries and regions of the developing world.
(see fig. 3)
- Breed conservation programmes are lacking in many countries. The same is true for structured breeding programmes, and for the policy and legal frameworks needed to support sustainable management of animal genetic resources.
(see fig. 4)

Sustainable use, development and conservation of AnGR can make an important contribution to meeting the Millennium Development Goals, in particular Goals One (to eradicate extreme poverty and hunger) and Seven (to ensure environmental sustainability), and to feeding a human population set to rise to 9 billion during the next 40 years. Securing the policies and resources needed to ensure that livestock biodiversity is well managed and remains available for future generations is a global responsibility.

Learn more:
www.fao.org/dad-is
e-mail: DAD-IS@fao.org

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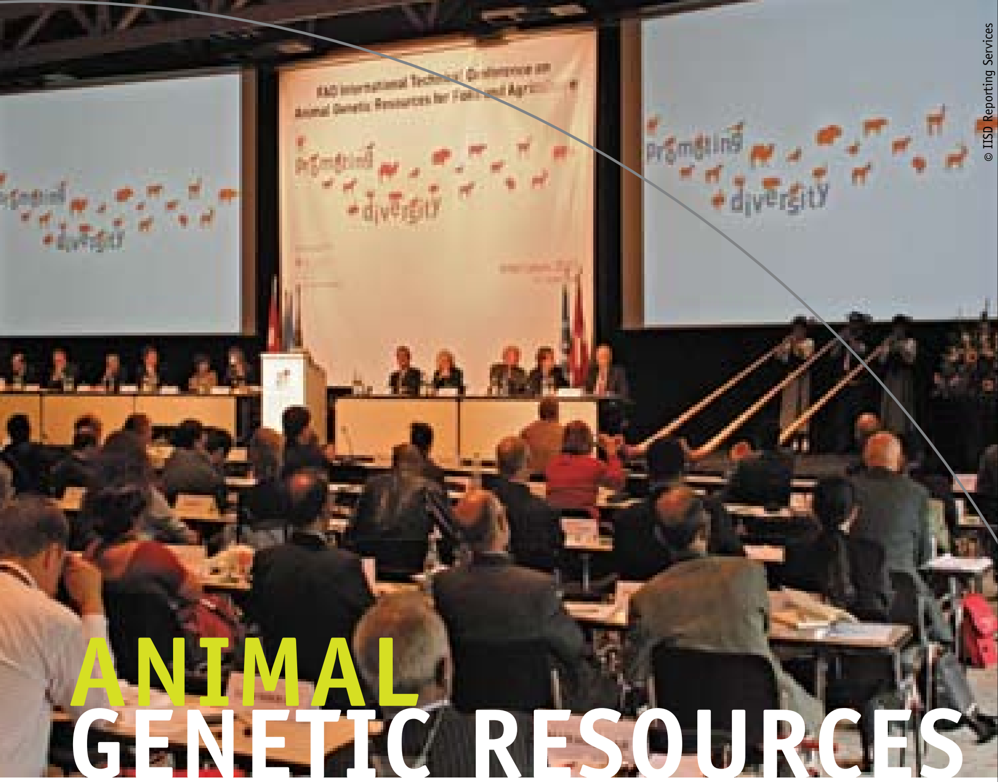

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ANIMAL GENETIC RESOURCES

THE GLOBAL PLAN OF ACTION

FAO has worked on genetic resources for food and agriculture since the 1960s. The Commission on Genetic Resources for Food and Agriculture (CGRFA) is a permanent intergovernmental forum. It has developed several international agreements, voluntary undertakings and codes of conduct, to promote and facilitate wise management, and access and benefit-sharing, of genetic resources. To these achievements can now be added the results of the International Technical Conference on Animal Genetic Resources for Food and Agriculture, held 3–7 September 2007 in Interlaken Switzerland.

The Interlaken Conference's main achievement was the adoption of the *Global Plan of Action for Animal Genetic Resources,* the first ever international framework to promote the wise management of animal genetic resources (AnGR). Additionally, at its 11th Regular Session, in June 2007, the CGRFA adopted a Multi-year Programme of Work to facilitate the coordination and coherence of efforts in the various areas of genetic resources management, as well as to address cross-sectoral linkages. FAO and its CGRFA play a crucial role in supporting the Convention on Biological Diversity's programme of work on agricultural biodiversity.

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ADOPTION OF THE GLOBAL PLAN OF ACTION FOR ANIMAL GENETIC RESOURCES

The overall objective of *the Global Plan of Action* is to support and increase the overall effectiveness of national, regional and global efforts in AnGR management. The *Global Plan of Action* consists of three parts:

- the Rationale;
- the Strategic Priorities for Action; and
- Implementation and financing.

The Rationale describes the objectives of the *Global Plan of Action* and provides an overview of its underlying assumptions.

The Strategic Priorities for Action comprise a set of concrete actions needed to achieve the desired outcomes or improvements in current conditions. The main responsibility for implementation of the *Global Plan of Action* rests with national governments, but the *Global Plan of Action* calls upon governments of developed countries to "attach due attention, including funding, to the implementation of activities within the Strategic Priority Areas of the *Global Plan of Action* through bilateral, regional and multilateral cooperation." The CGRFA was requested to oversee and follow up on the implementation of the *Global Plan of Action*.


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THE INTERLAKEN DECLARATION ON ANIMAL GENETIC RESOURCES

The *Global Plan of Action* was adopted through the *Interlaken Declaration on Animal Genetic Resources* in which governments reaffirmed their common and individual responsibilities for the management of AnGR. The *Declaration* notes the significant ongoing loss of livestock breeds and calls for prompt action through the implementation of the *Global Plan of Action* to conserve breeds at risk. It acknowledges that maintaining AnGR diversity is essential to enable farmers, pastoralists and animal breeders to meet current and future production challenges, and recognizes the enormous contribution that indigenous communities and farmers, pastoralists and animal breeders have made and continue to make to the AnGR management. By adopting the *Declaration*, governments have committed themselves to implementing the *Global Plan of Action*, to facilitating access to AnGR and to ensuring the fair and equitable sharing of the benefits arising from their use.

Promoting diversity

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DOMESTIC ANIMAL DIVERSITY INFORMATION SYSTEM

The Domestic Animal Diversity Information System (DAD-IS) developed by the Food and Agriculture Organization of the United Nations (FAO) is a multilingual, dynamic database driven Web-based communication and information tool based at http://www.fao.org/dad-is. Since the mid 1990s, DAD-IS has been recognized as a clearing house mechanism and early warning tool for animal genetic resources for food and agriculture (AnGR) by the Convention on Biological Diversity (CBD). The recently adopted *Global Plan of Action for Animal Genetic Resources*, the first agreed international framework for the management of AnGR, calls on FAO to continue to develop DAD-IS to strengthen these roles.

WHY DAD-IS?

DAD-IS provides countries' National Coordinators with a means to manage and disseminate data on their animal genetic resources. It is the centre of an expandable global network of national and regional information systems (FABISNet), which facilitates the coordination of national, regional and global efforts in AnGR management, while allowing scope for national or regional specificities in the management and dissemination of information. One regional (EFABIS at http://efabis.tzv.fal.de) and thirteen national systems (Austria, Cyprus, Georgia, Estonia, Iceland, Ireland, Italy, Netherlands, Poland, Slovakia, Slovenia, Switzerland and the United Kingdom) had been established and linked to DAD-IS. Thus, Europe serves as a pilot for other regions of the world.

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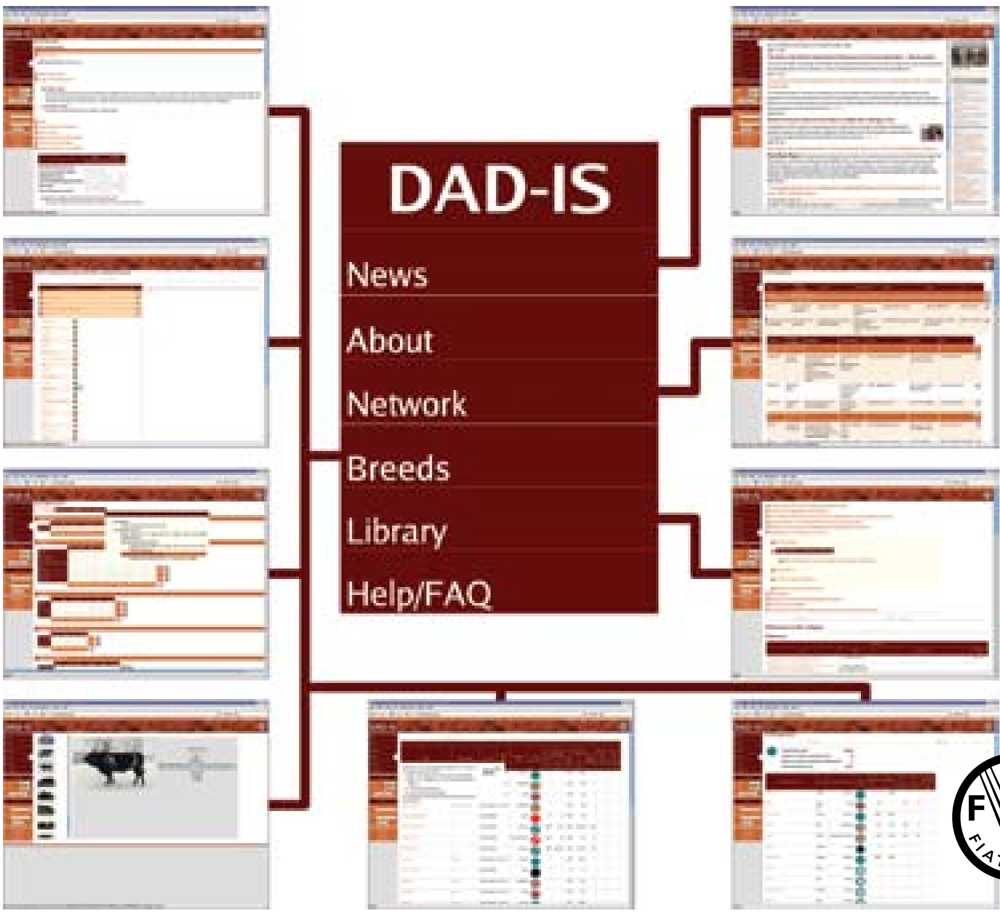
WHO CAN BENEFIT

DAD-IS contains a wide range of information on AnGR. It not only provides countries' National Coordinators for the Management of Animal Genetic Resources (NCs) with a means to manage and disseminate data, but also offers governments, international agencies, NGOs, universities and research organizations access to information that can strengthen their activities in AnGR management. The information contained in DAD-IS is available to the general public via the Internet.

WHAT DOES DAD-IS OFFER USERS?

DAD-IS provides access to information on 14 000 national breed populations, representing 37 species and 181 countries. It features data on breed characteristics, performance-related statistics, and population size, structure and trends. It also includes more than 4 000 high-quality images. NCs take full responsibility for maintaining data quality and quantity. DAD-IS also provides users with up-to-date news on AnGR management and an extensive library of full text publications and links to other Web resources.

The new version of DAD-IS is characterized by more user-friendly interfaces. It has a multilingual interface and content; it is currently available in Arabic, English, Spanish and French (Chinese and Russian are in preparation). Users can switch languages according their needs. Search functions allow users easily to locate breed information and publications within the system. Another important features are new reporting and analytical tools. These include a set of tools designed especially for NCs, with which they can identify gaps in their national data sets. Reporting tools such as a cross-table generator allow users to get quick customized data overviews.



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LINKAGES BETWEEN ANIMAL AND PLANT GENETIC RESOURCES

COMMON FEATURES OF ANIMAL AND PLANT GENETIC RESOURCES

Animal and plant genetic resources for food and agriculture share not only common features, they are the results of human intervention and continue to co-evolve with economies, cultures, knowledge systems and societies, but also many of the same threats and risks of erosion.

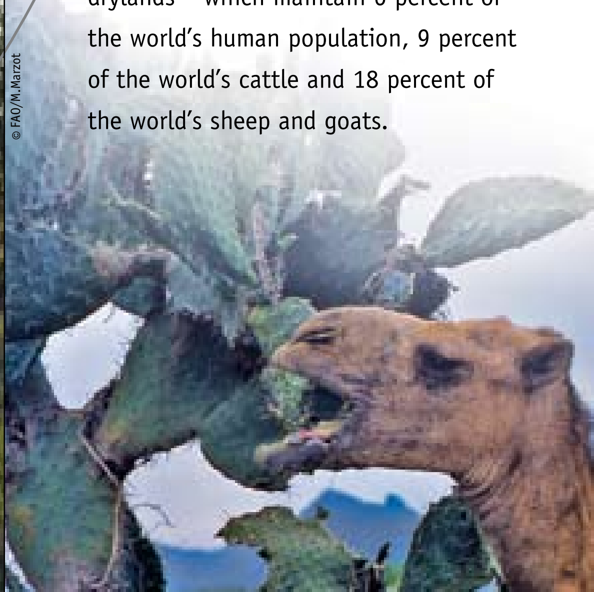
This erosion has many causes, including:

- changes in production systems;
- mechanization;
- the loss of rangeland grazing resources;
- natural calamities;
- disease and pests outbreaks;
- inappropriate breeding policies and practices;
- inappropriate introduction of exotic breeds or species/varieties;
- loss of farmers' and livestock keepers' security of tenure on land and access to other natural resources;
- changing cultural practices, the erosion of customary institutions and social relations;
- the influence of population growth and urbanization; and
- the failure to assess the impact of practices in terms of sustainability, and to develop adequate policies and economic measures.

Climate change has recently been recognized as an additional factor driving the erosion of genetic resources.

LIVESTOCK, RANGELANDS AND GRASSLAND A SPECIFIC INTERACTION

Although plant and animal genetic resources interact in many ways, their most direct interaction is in grasslands and rangelands, ecosystems which can only be productively used by ruminants. Rangelands often co-evolved with animal grazing and depend on it. Grasslands cover more than 25 percent of emerged lands and are utilized at a wide range of production intensities. They are home to important wildlife populations, as well as animal and plant genetic resources whose products contribute to rural income and development. Pastoralism, the use of extensive grazing on rangelands for livestock production, is an important – and often the only – ecological and economic adaptation that exploits the diverse, constantly changing, yet inherently resilient arid and semi-arid rangeland ecosystems. Thirty percent of the world's grazing lands are classified as drylands – which maintain 6 percent of the world's human population, 9 percent of the world's cattle and 18 percent of the world's sheep and goats.



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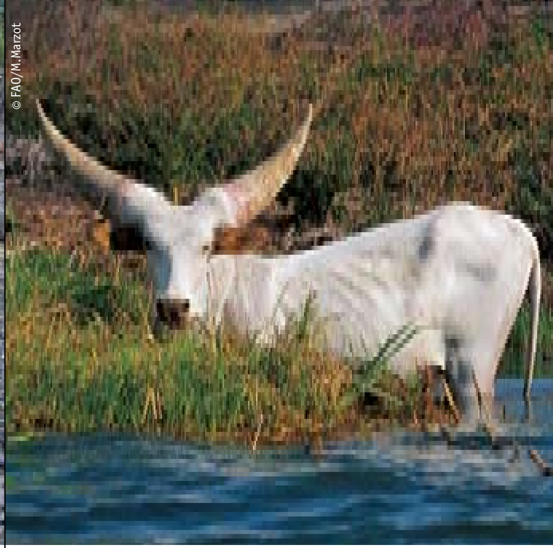

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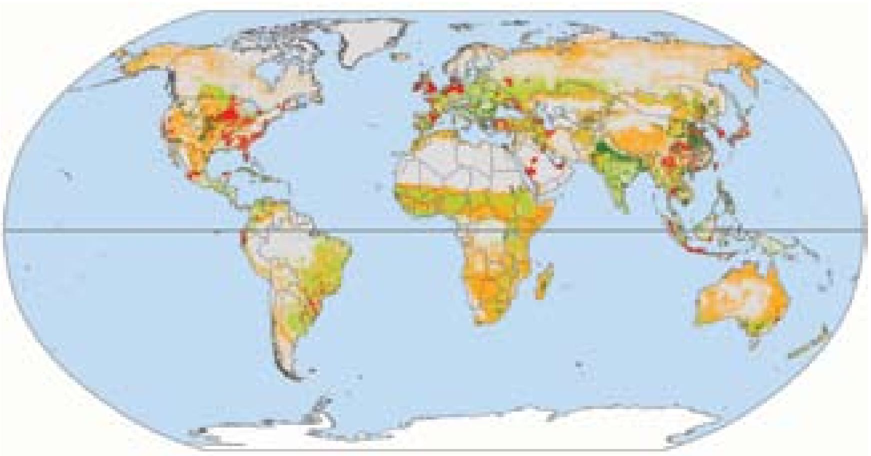
Livestock production systems



Source: Steinfeld, H., Wassenaar, T. & Jutzi, S. 2006. *Livestock production systems in developing countries: status, drivers, trends*. Rev. Sci. Rech. Off. Int. Epiz., 25(2): 505–516

NEEDS AND CHALLENGES

Driven by poverty, population growth and other factors, humans are increasingly expanding into the marginal land frontier. Currently, at least 20 percent of rangeland is estimated to be degraded through overgrazing, over-collection of timber, fuelwood, food, medicinal plants, or abandon and overgrowth. This leads to a decline of rangeland productivity, and subsequently also a decline of livestock productivity, with major economic and livelihood implications. In addition, many rangeland livestock breeds and plant species have not been characterized, because of the marginal nature and location. Better understanding of the diversity of plants and livestock and their values, and improved insight into the relationship between both types of genetic resources, particularly in rangeland environments need to be achieved. Only then will governments and other stakeholders be able to fully appreciate this biodiversity and make strategic decision for its conservation and use. Because of the complex linkages among the different components of agricultural biodiversity, the ecosystems approach should be applied and cross-sectoral linkages addressed. In particular, the role of local and indigenous communities, farmers, pastoralists and breeders as custodians of much of the world's agricultural biodiversity should be strengthened.

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LIVESTOCK DIVERSITY AND CLIMATE CHANGE

Maintaining the diversity of animal genetic resources is essential to enable farmers, pastoralists and animal breeders to meet current and future production challenges resulting from changes in the environment, including climate change; to enhance resistance to diseases and parasites; and to respond to changes in consumer demand for animal products. Livestock contribute, to and will be affected by, climate change. Livestock producers will have to cope with both slow climatic changes and more frequent extreme climatic events. It is expected that climate change will affect livestock production and productivity both directly and indirectly.

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DIRECT IMPACT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTION AND DIVERSITY

Loss of animals through droughts and floods, or disease epidemics related to climate change may increase. This is one reason why it is important to characterize animal genetic resources, and build inventories, including spatial information on breeds and valuable breeding stocks. Additionally, temperature is predicted to increase globally, with reduced precipitation in many regions. Heat stress reduces reproduction and production in livestock. The high-output breeds, originating from temperate regions, that provide the bulk of market production today, will be required to continue to express their genetic potential in the future. The question is how such production levels can be maintained in view of expected higher feed, energy and water prices, and how fast the breeds can genetically adapt to changing environments, including higher disease pressure? More study of adaptation differences between breeds is needed. If the available breeds cannot be selected fast enough to adapt to climate change, an increased need for movement of breeds carrying the desired traits will arise. This would require that livestock keepers continue to have access to a wide portfolio of genetics.

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INDIRECT IMPACT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTION AND DIVERSITY

Developments in the livestock sector are crucial for adaptation and mitigation of climate change – because the livestock sector is a large producer of greenhouse gases. Therefore, the various policies and technologies introduced to mitigate climate change are expected to influence the livestock sector. In addition, the non-food sector's demand for feed inputs, especially for biofuel and other industrial use, is expected to increase, thereby potentially exacerbating the impact of climate change for the livestock sector.

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If the present increase in feed prices continues, the comparative advantage of monogastrics, with their better feed-conversion ratio as compared to ruminants, will increase, and commercial breeds may out-compete local breeds. Optimization of feed rations, and feed additives or other technologies, may be used to reduce greenhouse gas emissions from the livestock sector. Further research on mitigation technologies is needed. The predicted temperature increase will further the expansion of vector-borne infectious diseases (e.g. Rift Valley fever, bluetongue and West Nile virus) to high elevations and higher latitudes. Such disease pressure will favour genotypes that are resistant or tolerant to the diseases and may change breeding goals.

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FAO AND AQUATIC BIODIVERSITY

The FAO Fisheries and Aquaculture Department is carrying out a variety of activities in relation to aquatic biodiversity that are considered essential for sustainable fisheries and aquaculture. The 1982 United Nations Convention on the Law of the Sea (UNCLOS 1982) and the FAO Code of Conduct for Responsible Fisheries (CCRF 1995) provide the umbrella for FAO's work in fisheries.

FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES

The CCRF, in harmony with major international agreements such as UNCLOS and the UN Fish Stocks Agreement, the United Nations Conference on Environment and Development (UNCED), and the Convention on Biological Diversity (CBD), sets out principles for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the environment and the people who depend on aquatic biodiversity. The Articles of the Code are addressed through FAO's normative programme and field programme, in part coordinated by a global FishCode Programme.

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ECOSYSTEM APPROACH

Aquatic biodiversity plays a vital role in rural livelihoods. However, it is being threatened by factors within the fisheries sector, such as overfishing, destructive fishing practices and introduction of alien species, as well as by external factors such as habitat loss and degradation mainly caused by land-based activities.

Thus, the FAO Aquaculture Management and Conservation Service embarked on a programme aimed at constructing an inventory and valuation of inland aquatic biodiversity that is used by rural communities in natural and modified ecosystems with special emphasis on traditional knowledge, sustainable use, enhancement and gender issues.

The conservation and sustainable use of fish stocks need to be promoted urgently by linking ecosystem considerations into capture fisheries management practices and procedures. A set of guidelines on ecosystem approaches to fisheries management has been developed by FAO.

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INFORMATION RESOURCES

FAO accords high priority to providing and enhancing information resources including facts and data, status and trends, strategic advice and facilitated networking for sustainable world fisheries. Major information resources include:

FAO FISHSTAT PLUS Database
www.fao.org/fi/statist/fisoft/fishplus.asp

UN Atlas of the Oceans
www.oceansatlas.org

FAO Fisheries Global Information System (FIGIS)
www.fao.org/fishery/figis

FAO Species Identification and Data Programme
www.fao.org/fishery/sidp

FAO Database on Introductions of Aquatic Species (DIAS)
www.fao.org/fishery/dias

GLOBEFISH Markets and Trade
www.globefish.org

ONEFISH
Internet Portal for Fisheries Research
www.onefish.org/global/index.jsp

FISHBASE
www.fishbase.org/search.cfm

The State of World Fisheries and Aquaculture (SOFIA)
www.fao.org/sof/sofia/index_en.htm

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SPECIES IDENTIFICATION AND DATA PROGRAMME

The FAO Fisheries Management and Conservation Service through its Species Identification and Data Programme contributes to improved knowledge on biodiversity and provides tools for proper species identification. Leading taxonomists in the world collaborate with FAO in the elaboration of regional and national Species Identification Guides, Catalogues and Synopses, which also include species-specific information on conservation status, socio-economic and traditional importance.

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EXPERT ADVICE AND SUPPORT

The FAO Fisheries and Aquaculture Department supports CBD activities as related to aquatic biodiversity and aquatic genetic resources. Further, FAO collaborates actively with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) providing recommendations and advice on costs and implications of listing commercially exploited aquatic species. FAO promotes and facilitates international treaties and negotiations relevant to the use of aquatic biodiversity and the conservation of endangered aquatic species including sharks, turtles, seabirds and marine mammals, and supports an expert group on the scientific aspects of marine environmental protection.

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MARINE AND COASTAL AQUATIC BIODIVERSITY

Marine and coastal areas support a rich assortment of aquatic biological diversity that contributes to the economic, cultural, nutritional, social, recreational and spiritual betterment of human populations. Indeed, life originated in the world's oceans and over the millennia has evolved into the diverse forms used today by a variety of stakeholders, including commercial and artisanal fishers, fish farmers, developers and tourists.

TREMENDOUS BIOLOGICAL DIVERSITY

Of the known phyla on Earth, nearly all are found in the marine environment; 20 phyla are found nowhere else.

FAO Fisheries and Aquaculture Department maintains information contributed by countries on the use of this biodiversity for food, economic returns and livelihoods. More than 28 000 species of fish have been described and the vast majority of the 52 000 crustaceans and 112 000 molluscs species live in marine environments. Despite a comparatively small number of species, the marine mammals are an important component of aquatic biodiversity.

VALUABLE RESOURCES

The marine waters in 2005 produced about 84 million tonnes of seafood with catch data reported for over 1 300 marine taxa; farming of over 260 taxa of fish, molluscs and crustaceans produced 18.8 million tonnes, whereas the production of kelp, seaweed and other aquatic plants contributed an additional 14.7 million tonnes.

Many marine and coastal species are extremely high valued, such as tuna, lobster, crab, shrimp, abalone and numerous specialty products such as Fugu (potentially deadly puffer fish considered a delicacy in parts of Asia), surimi (pure fish protein extracts) and fishmeals and oils. They are thus capable of generating foreign exchange and economic opportunities in many areas. The harvest of small, fast-growing pelagic species such as sardine and anchovy provides large quantities of inexpensive and high-quality animal protein that is widely used in agriculture and aquaculture feed formulation.

An important component of the biodiversity is comprised of marine mammals which, depending on areas or culture, have a high value as an economic resource to be harvested sustainably or as emblematic species to be preserved in their own rights or for non-consumptive uses (e.g. for tourism).

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THREATENED BIODIVERSITY

Marine and coastal biodiversity are threatened by the impacts of a growing human population that overharvests the diversity and affects the habitats that the diversity depends on. Approximately three-quarters of the world's population live within 60 km of marine coastal areas and marine and coastal biodiversity is a valued resource. FAO regularly assesses the state of world fisheries and aquaculture and has reported that of the major fish stocks, 23 percent are underexploited or moderately exploited, 52 percent are fully exploited, 17 percent overexploited, and 8 percent of stocks are depleted or recovering from depletion. Land-based activities threaten sensitive near shore areas such as coral reefs and mangrove forests with pollution, sedimentation and habitat clearing for other development. FAO is working with international conventions such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the World Conservation Union (IUCN) to help assess the threats to marine and coastal species and promote awareness of critical issues. International plans of action have been developed on threatened marine species such as sharks and seabirds. The FAO Code of Conduct for Responsible Fisheries aims at ensuring sustainable use of aquatic biodiversity, integrating the requirements of the 1982 Convention, the UN Fish Stocks Agreement and the Convention on Biodiversity.
The implementation of the Code is underpinned by the implementation of four International Plans of Action: to reduce fishing capacity (to eliminate overfishing); to combat illegal fishing; to protect seabirds from accidental capture in longline fisheries; and to improve shark fisheries management.

DIVERSITY OF HABITATS

Biological diversity of estuarine, marine and coastal areas is related to the diversity of aquatic habitats. Coastal waters and estuaries constitute the interface of inland and marine environments and are some of the most productive waters. Coral reefs are hot-spots of biodiversity. Other important habitats include soft-bottom continental shelves and upwelling continental shelves, which are also extremely productive; in contrast are the open oceans, including the deep sea, which are vast, but much less productive per unit area than other habitats, and polar oceans with important enrichment processes that sustain other fishery resources (e.g. krill).

TRANSBOUNDARY RESOURCES

In light of the connected nature of the world's marine and coastal areas, much of the biodiversity is distributed across or migrates through political boundaries. Migrations are often necessary for the survival of the stocks as spawning, feeding and nursery sites may be thousands of kilometres apart. Management of fisheries exploiting these stocks has been specifically addressed by the 1982 UN Convention on the Law of the Sea in the Articles dealing with transboundary stocks (those extending across more than one Exclusive Economic Zone (EEZ) and straddling stocks (those occurring not only in EEZs but also extending into the high seas). The UN Fish Stocks Agreement specifically addresses the responsible use of the latter.

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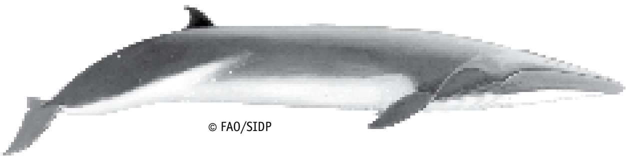

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INLAND AQUATIC BIODIVERSITY

Inland waters contain a vast array of biological diversity that provides livelihood, recreation and spiritual opportunities for people in developing and developed areas of the world. Inland waters are themselves extremely diverse, ranging from natural water bodies, such as swamps, rivers, flood plains and lakes, to modified habitats such as rice fields, reservoirs and aquaculture ponds.

BIOLOGICAL DIVERSITY MORE THAN FISH

The aquatic biodiversity of inland waters useful to humans includes plants, fish, amphibians, reptiles, molluscs, crustaceans and even insects. FAO Fisheries and Aquaculture Department information contributed by member countries in 2005 officially indicates that about 9.5 million tonnes were harvested from inland capture fisheries and 29.3 million tonnes from inland aquaculture. However, accurate information on small-scale inland capture fisheries and rural aquaculture is extremely difficult to obtain because of the informal and diffuse nature of these subsectors. Additionally, much of what is caught or produced by small-scale fishers/farmers is consumed by them or bartered locally, and therefore does not enter the formal economy and accounting of national governments. In-depth work has revealed that real production from inland waters is several times higher than that officially reported. It is clear that inland aquatic biodiversity is an important resource for rural communities and often provides a "safety net" to rely on in the face of other crop and food shortages.

MULTIPLE USE OF INLAND WATERS MULTIPLE THREATS TO BIODIVERSITY

Inland waters are used for a number of activities other than fisheries, including power generation, agriculture, navigation, tourism, urban and industrial water supply and waste disposal. These compete with fisheries by modifying the structure of the environment and the quality and quantity of water. Many of these alternative demands on water are judged by powerful sections of society to be of greater value than fisheries and therefore are assigned a higher priority in reaching decisions as to the allocation of water.

Inland waters are often the sink in which chemicals, agricultural runoff, sedimentation and other forms of pollution accumulate. Fish farming may also contribute pollution in the form of uneaten food, therapeutic drugs and pathogens to lakes and reservoirs where improper culture practices are used. As a result, aquatic ecosystems are being threatened, as are their fisheries and many of the people that depend on them. Freshwater vertebrates, e.g. amphibians and fish, are the most threatened group of organisms used by people.

Alien species have been used to generate economic opportunities through use in fisheries and aquaculture. However, they also pose threats to native biodiversity through competition, predation, genetic contamination and habitat modification. FAO maintains a registry of alien species that reveals that over 379 species have been moved across international borders and that there have been more positive socioeconomic benefits than adverse environmental impacts. Nonetheless, alien species pose a serious threat to inland biodiversity.

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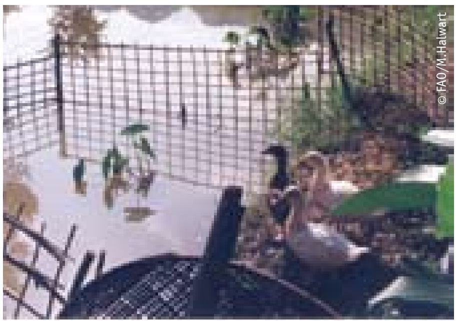
INTEGRATION

Because of the multiple use of inland waters, integration of such use becomes important and constitutes other hierarchies of biodiversity at the ecosystem and landscape levels. Thereby it is important to apply an integrated basin management approach where the requirements of fish and fisheries are duly taken into consideration in planning and management. Where watersheds have been modified by hydro-electric development, mitigation measures need to be implemented, e.g. habitat rehabilitation, specific water management programmes and fish-passage systems, to protect species that depend on longitudinal and lateral movements to complete their lifecycle successfully. Particular attention needs to be given to sensitive and specialized species, e.g. sturgeon or salmon. Although rural people in developing countries may refer to themselves as farmers or labourers the use of inland resources is often an integrated part of their livelihoods. The frequency and the ways in which they use living aquatic resources vary seasonally and with the cultural and geographic setting. Fishing or aquaculture may for example take place in rice paddies which typically contain several hundreds of species other than rice, many of which are directly useable by rural communities. Fish, insects, shellfish and other animals in the paddies not only provide needed nutrition that rice alone does not, but also provide motivation to reduce pesticides because the animals serve as natural predators and grazers. Animals in rice paddies can either be natural components of biodiversity that are "trapped" in the paddies, or they can be purposefully stocked, such as many tilapia, barb and carp species.



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AQUACULTURE

The farming of inland aquatic species has a much shorter history than farming of crops or livestock. Except for the common carp that was domesticated approximately 2000 years ago, breeding of aquatic species for food is relatively recent. However, the sector is increasing rapidly and represents the fastest growing food producing sector: in 1985 only 73 freshwater species were farmed, in 2000 there were over 150. Traditional animal breeding, chromosome-set manipulation and hybridization have used the genetic diversity of aquatic species such as tilapia, catfish, rainbow trout, and common carp to create characteristic breeds of fish to suit environmental and consumer demands. Agriculture and aquaculture can form integrated farming systems where nutrients are cycled between production components, where fish ponds can provide a source of water for irrigation, and where irrigation systems can be fished. Aquaculture is further used to support culture-based fisheries. There is also a trend for inland water biodiversity to be supplemented or even constructed to maximize benefits from the modified systems.

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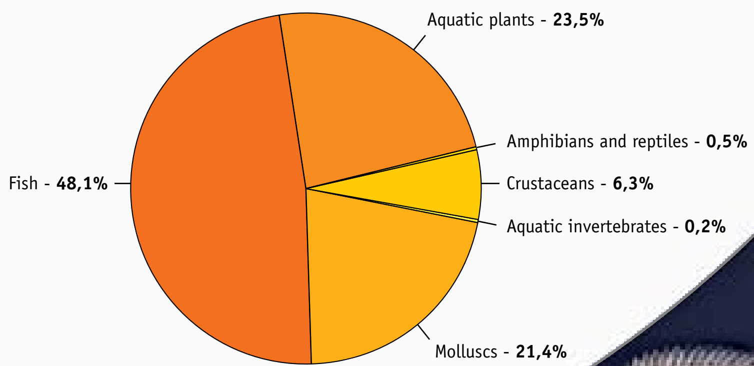
GENETIC BIODIVERSITY IN AQUACULTURE

Genetic biodiversity helps produce the variety of shapes, sizes, behaviour, and colours that make aquatic species valuable and interesting. It also allows species to adapt to new farming systems and new habitats. Without genetic biodiversity there would be no special varieties or breeds of aquatic species; eventually species would go extinct as they would be unable to cope with climate change and other changes to their environment. The FAO addresses these issues through its Committee of Fisheries and its Commission on Genetic Resources for Food and Agriculture.

BIODIVERSITY AT THE SPECIES LEVEL

Over 440 species of fish, invertebrates and plants are farmed around the world. This represents a wealth of genetic diversity both within and among species that helps make aquaculture one of the fastest growing food production sectors. However, most of these farmed species have not been genetically improved or domesticated to the extent that livestock and crops have been. Thus, there is tremendous potential to create improved breeds and better domesticated farmed aquatic species.

Biodiversity in aquaculture



Source: FAO FishStat

MANAGEMENT OF GENETIC BIODIVERSITY IN AQUACULTURE

The FAO Code of Conduct for Responsible Fisheries recognizes in Article 9.3 that genetic diversity of both farmed and natural populations must be managed responsibly. Genetic biodiversity provides the raw ingredients that allows breeders to improve the production, efficiency and marketability of animal and plant species in aquaculture. Genetically improved plants and animals can grow faster and use food more efficiently. Thus less inputs are required and less waste products are produced. Genetic improvement can help breeds grow in diverse salinities or temperatures or under low oxygen conditions. Disease resistant varieties require less pharmaceutical treatments. Broodstock management can help avoid inbreeding while allowing for genetic improvement of farmed species.

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GENETIC TECHNIQUES
USING GENETIC BIODIVERSITY

Selective breeding, a traditional animal breeding technique, has only been applied to a small percentage of the hundreds of farmed aquatic species. Thus, there is tremendous scope for increased production from those unimproved species. Gains from selective breeding programmes can be on the order of 8% per generation.

Many aquatic species are easily hybridized. This technique can be used to produce sterile organisms as in certain tilapia crosses, or to combine positive traits from two different species into one hybrid as is done in crosses between species of catfish. Hybridization depends on maintaining the genetic biodiversity of each of the original pure species; uncontrolled hybridization could endanger the pure species.

The chromosome-set number of many aquatic species can be increased. This is often done to produce sterile organisms. Sterility in farmed species is often desirable to reduce the chance of unwanted reproduction and to improve growth efficiency; sterile organisms do not spend as much energy on reproduction and therefore can use it for growth. Temperature, pressure, and chemical treatments, as well as hybridization have been used in carps, salmon, trout, and oysters to mass produce organisms with extra chromosomes.

NATURAL GENETIC BIODIVERSITY
A RESOURCE FOR SUSTAINABLE FISHERIES AND AQUACULTURE

Natural genetic biodiversity is a resource that aquaculturists can draw on periodically in genetic improvement programmes. However, aquaculture and the use of genetically altered breeds could pose a risk to wild relatives through interbreeding and other adverse ecological impacts. Better Management Practices and the use of sterile organisms will reduce this risk; other measures such as limiting the use of aquaculture to areas that do not contain valuable wild resources would reduce the risk even further.

Conservation hatcheries can be developed that will match genetically and behaviourally wild populations that have become threatened or endangered. By following strict breeding protocols and culture methods, conservation hatcheries in conjunction with an overall species recovery programme can help rebuild wild populations.

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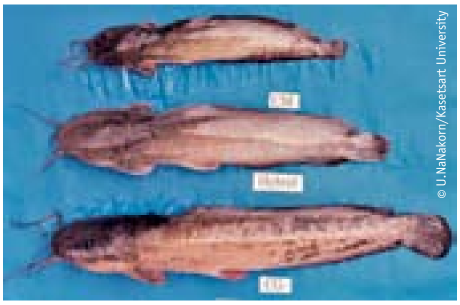

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FOREST BIODIVERSITY

Biodiversity is the variety of life at different levels of biological organization, such as the genetic, species and ecosystem levels.

In terms of biodiversity, tropical forests are the richest terrestrial ecosystems. Like all other types of forests, they have been used by humans since time immemorial, providing a range of goods, such as wood, foods and medicines, which have waxed and waned in perceived importance through the ages. From the earliest known times, wood has been used for construction, tools, implements and artifacts and as a vital source of energy. Thus timber from the cedars of the Lebanon was used in the construction of the Temple of Solomon and of Persepolis, one of the capitals of ancient Persia. The building of the church of Santa Maria della Salute in Venice began with the driving of more than 1 million trunks of alder, oak and larch into the muds of the lagoon.

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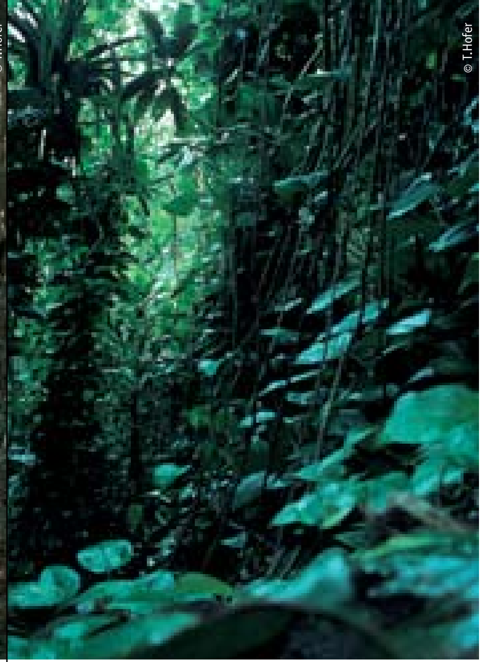
For centuries the forests of Europe provided the timber for the ships of the navies and merchant fleets of the powers that came to dominate the earth.

In the modern world, the role and the perception of forests is different and more complex. A plethora of institutions, groups and individuals have interests in forests and their biodiversity for reasons ranging from the maximization of corporate profits, to obtaining resources needed for survival, to maintaining cultural and spritual values, to conserving biodiversity for its own sake.

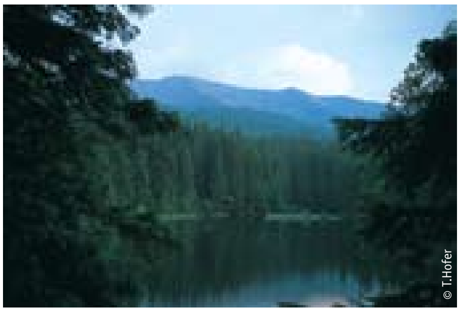
To accommodate and attempt to reconcile this great diversity of interests and to conserve and manage forests and their biodiversity, a great variety of activities are implemented by actors including governments, intergovernmental organizations, corporations, NGOs, communities and individuals.



Out of this complex situation, a richer understanding of forests is emerging, which includes recognition not only of the goods provided by forests but also of the ecosystem services that they provide, such as watershed protection, protection of soils and climate stabilization.

Especially in the biodiversity-rich tropical forests, processes are at work, such as the conversion of forest to other land uses, illegal logging and illegal harvesting and trading in forest plants and animals, which are reducing forest cover and threatening forest biodiversity.

To manage and conserve forests effectively and to address the causes of deforestation and biodiversity loss, forest management and conservation are continuously evolving. Sustainable forest management involves activities at levels ranging from genes to ecosystems. Forest conservation is becoming ever more complex as conservationists attempt to understand and accommodate the needs and rights of people who live in and around forests.



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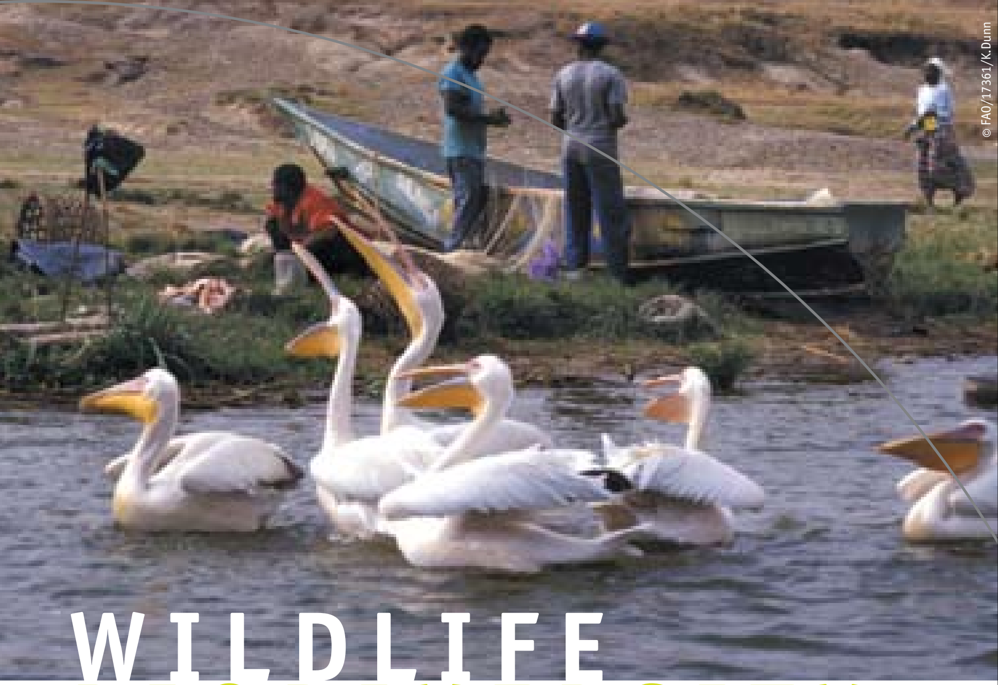

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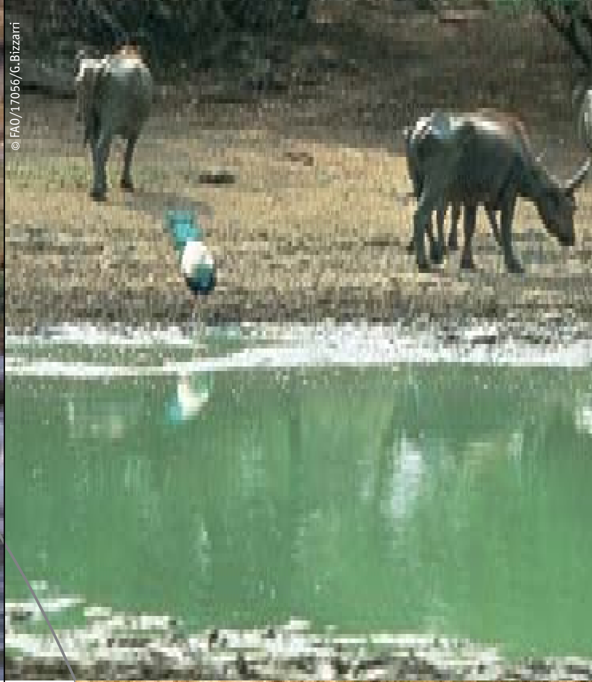

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WILDLIFE BIODIVERSITY

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The term "wildlife" refers to all non-domesticated animals. It thus singles out one component of biodiversity.

In historical terms it is understandable that wildlife is singled out in this way. The earliest humans were hunter gatherers, whose lives were intimately involved with what we now refer to as wildlife. An eloquent testimony to its importance, which included a strong spiritual component, is to be found in the rock art in which it is so magnificently portrayed. It also features strongly in traditional poetry and song.

In the sense that wildlife is currently one of the most threatened components of biodiversity, there is a reason for also singling it out in the contemporary world.

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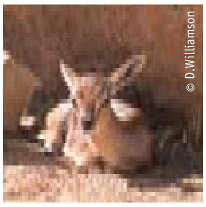

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Wildlife faces a number of dire threats. Perhaps the most ominous of these, because at present it is the least controllable, is the commercialization of trade in wild meat and animal parts for use in traditional medicine. Wild meat is particulary important in Africa. The medicinal aspect is especially important in Asia. Other severe threats to wildlife are habitat loss, due to conversion of forest to other land uses, and habitat fragmentation, due to road construction and other infrastructural developments. The challenges posed by these threats have generated a steep learning curve for conservationists and managers.

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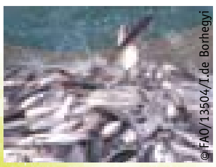

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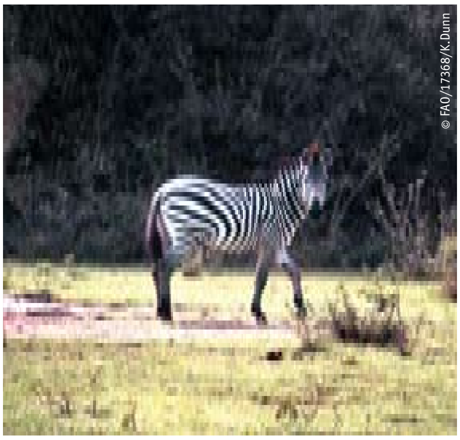
In historical terms, the scientifically based conservation and mangement of wildlife is a very new enterprise, which began in earnest only in the twentieth century. Until around 30 years ago it consisted mainly of singling out areas rich in wildlife for complete protection in national parks or other types of protected area.



A paramilitary approach to the enforcement of conservation laws was taken, which frequently resulted in confrontation and conflict with people living in and around protected areas.
This approach persists in some places, but is rapidly being replaced by a much more complex and demanding approach, which is based on the recognition of realities which were previously ignored.
In ecological terms, it is now understood that most forest biodiversity is found outside protected areas, which means that much greater investment of time and resources has to be made in conserving and managing biodiversity through sustainable forest management in production landsapes.
In socio-economic terms it is recognized that people living in and around protected areas have both rights and needs, and that unless these are accommodated, effective protected area management will be impossible. To accomplish this, accommodation approaches have been and are being developed, including co-management, community based natural resouce management and transboundary resource area management.

Conservationists and managers are also having to address the aspirations of growing human populations for improved living standards, rather than mere survival. Integrated Conservation and Development Projects are one of the approaches to this issue that are being tested. Alliances of conservation and development NGOs with local communities is another innovative approach that is increasingly being adopted.

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