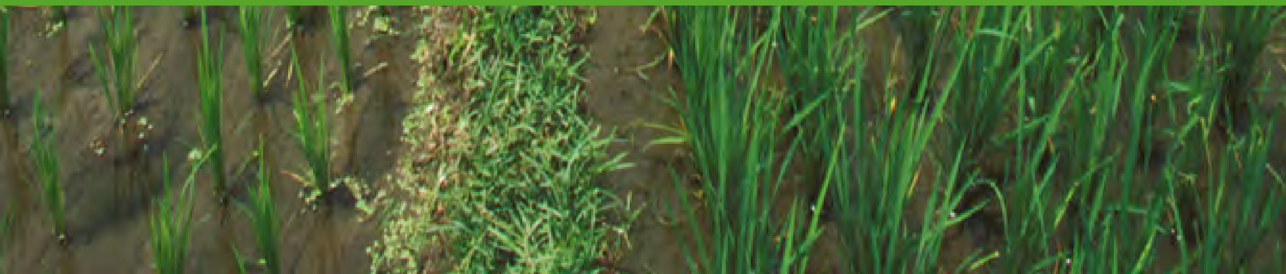
SECURING SUSTAINABILITY THROUGH THE CONSERVATION AND USE OF AGRICULTURAL BIODIVERSITY

THE UNEP-GEF CONTRIBUTION



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SECURING SUSTAINABILITY THROUGH THE CONSERVATION AND USE OF AGRICULTURAL BIODIVERSITY

THE UNEP-GEF CONTRIBUTION

FOREWORD

The link between agriculture, food security and ecosystems is a vital one. The world is in danger of not achieving the Millennium Development Goals and with less than 5 years to run, evidence shows that agricultural biodiversity can make a critical contribution.

By harnessing agricultural biodiversity, we can transform agriculture from a key driver of biodiversity loss, into a motor for securing ecosystem stability, preserving genetic resources in crops and livestock and driving investment towards the sustainable management of natural capital on which the sector depends.

In light of the twin crises of increasing food insecurity and worsening environmental degradation, United Nations Environment Programme (UNEP) through the Global Environment Facility (GEF), has partnered with national and international organizations on a set of national and multi-country projects, focusing on different components of agricultural biodiversity over the last decade.

These projects contribute towards the seven-point plan for reducing the risk of hunger and rising food insecurity as proposed in a recent UNEP report, "The Environmental Food Crises". These include opportunities for boosting agriculture without intensifying damage to the environment, alongside opportunities for minimizing and utilizing food waste right across the food supply chain.

The projects outlined in this booklet assist farmers in developing diversified and resilient agricultural systems and ensure communities and consumers have more predictable supplies of nutritious food. Projects are focused on developing and testing, within a wide range of biodiversity-rich ecosystems, a set of tools and methodologies that can be used and adapted by any country or organization, concerned with the conservation and sustainable management of agricultural biodiversity.

The results achieved so far, summarized in the "Key results" section of this booklet highlight the strengthened capacity of farmers and rural communities to conserve and manage local agricultural biodiversity which benefits both local farmers and the global community.

As the GEF Agency for these projects, UNEP has provided a platform for collaborative partnerships bringing together leading scientists and agricultural experts, affiliated with international organizations, with their national counterparts.

Through these partnerships, the projects have sought to mainstream biodiversity conservation into agricultural production systems as well as improve health, nutrition and rural development.

It is imperative we find ways to manage the ecosystems that underpin sustainable agriculture and appreciate that agricultural biodiversity is an innovative and critical driver towards sustainability.

We hope this booklet, which describes UNEP-GEF agricultural biodiversity projects; their results and lessons learnt, will illustrate the importance of making continued investment in environmental sustainability through the conservation and use of agricultural biodiversity.

Maryam Niamir-Fuller
GEF Executive Coordinator and Director
Division of Global Environment Facility (GEF) Coordination
United Nations Environment Programme

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INTRODUCTION

Current agricultural practices are regarded as one of the most significant drivers of biodiversity loss. At the same time, the goal achieving global food security remains a long way off; indeed, the number of malnourished has recently risen to over 1 billion people.

The world desperately needs an agricultural production system that is both sustainable and contributes to achieving food security. Agricultural biodiversity will play a central role in achieving these twin objectives. By conserving and harnessing agricultural biodiversity, food and agriculture production can contribute to sustaining healthy biodiverse ecosystems. By recognizing and value of agricultural biodiversity, agriculture can deliver more benefits to the communities that manage this biodiversity. In addition, as the world copes with the challenge of adapting to climate change, agricultural biodiversity becomes an especially critical resource. For these reasons UNEP and GEF consider agricultural biodiversity to be a transformative force.

This booklet describes the different agricultural biodiversity projects UNEP has undertaken as the GEF implementing agency, summarizes their achievements, considers some of the most important lessons that have been learned and offers insights into possible avenues for future activities.

◄ Wild potato (Centro Internacional de la Papa)

Investing in line with the Convention on Biological Diversity (CBD)

Over the past ten years, UNEP and GEF have worked together on eleven innovative agricultural biodiversity projects. Together these projects have demonstrated agricultural biodiversity's potential to contribute to overall biodiversity maintenance and ecosystem function, as well as to better nutrition, increased food security and improved well-being in rural communities.

GEF is the financing mechanism for the Convention of Biological Diversity (CBD) and activities carried out in the eleven projects reflect the four elements of the CBD's work programme on agricultural biodiversity:

- global assessments, which provide an overview of the status and trends of the world's agricultural biodiversity, their underlying causes, and knowledge of management practices;
- the identification of adaptive management practices, technologies and policies that promote biodiversity-friendly agriculture, improve productivity and build the capacity of farming communities to sustain livelihoods;
- strengthening the capacities of farmers, indigenous and local communities, and their organizations and other stakeholders to benefit from the sustainable management of agricultural biodiversity; and
- mainstreaming the conservation and sustainable use of agricultural biodiversity into national development plans, programmes and strategies in a range of different sectors, including agriculture, the environment, rural development and health and nutrition.

The UNEP implemented GEF projects have contributed to three global cross-cutting initiatives included within the CBD's work programme on agricultural biodiversity:

- The International Initiative for the Conservation and Sustainable Use of Pollinators,
- The International Initiative for the Conservation and Sustainable Use of Soil Biodiversity and
- The International Initiative on Biodiversity for Food and Nutrition.

The total budget invested in partner countries through these projects is USD 122 million. GEF contributions have accounted for USD 50 million of this amount, with the other USD 72 million coming from co-financing arrangements.

Working with global leaders

In implementing these projects, UNEP has provided support to 34 countries in Africa, Asia and Latin America and made a direct contribution to national planning strategies in these countries. Nine of the agricultural biodiversity projects are multi-country projects; of these five are global, and four are regional. Two national projects are set to begin.

As the GEF implementing agency for these projects, UNEP has worked in partnership with international organizations with specialized experience in agricultural biodiversity, particularly the Consultative Group for International Agricultural Research (CGIAR) Centres and the Food and Agriculture Organization (FAO) of the United Nations.

Creating opportunities for transformation

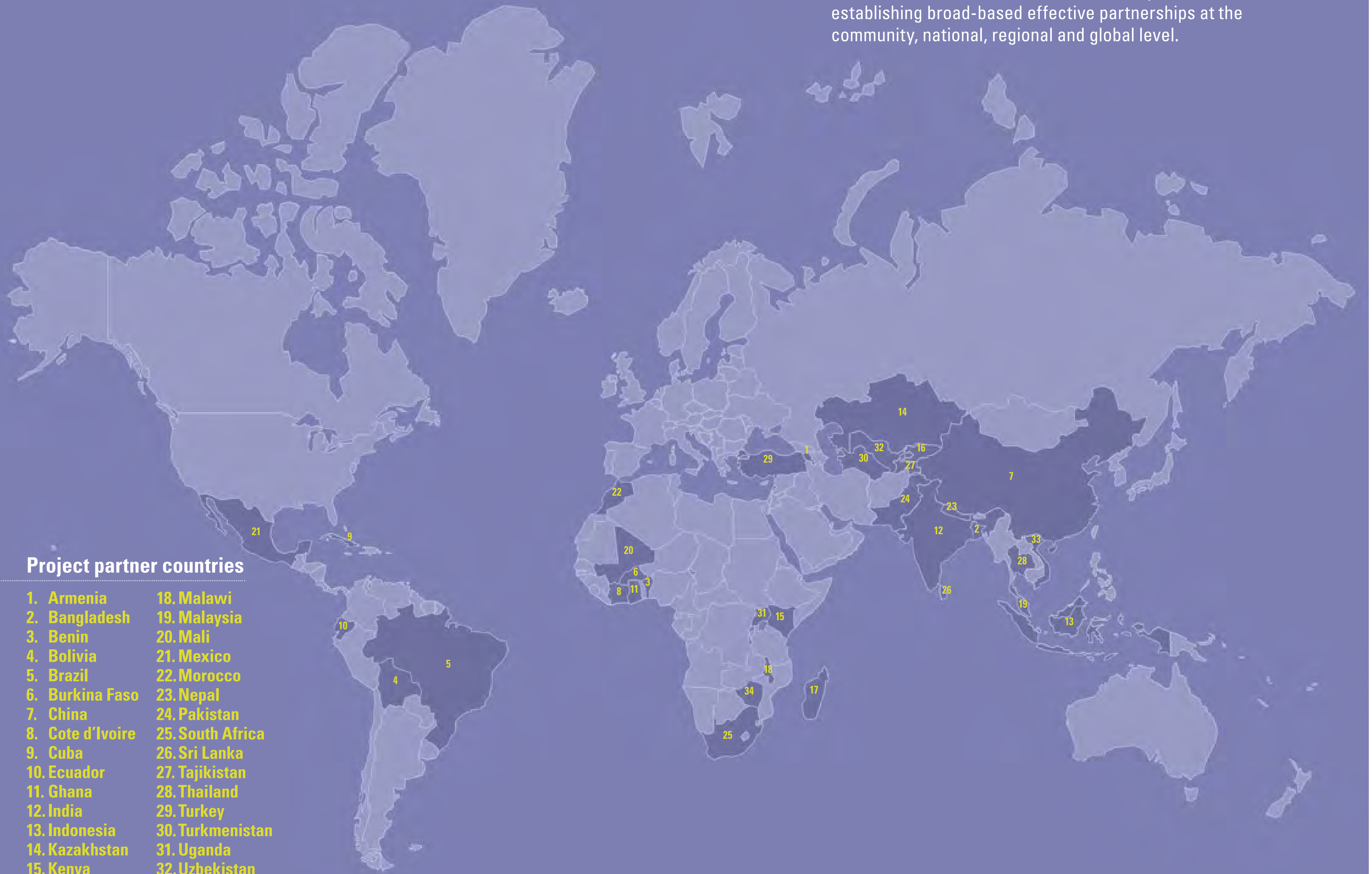
All the partners involved in the different projects adopted cross- and multi-sectoral participatory approaches that involved working with a wide range of institutions, civil society organizations, rural community groups and farmers. The projects provided innovative opportunities for the global scientific community and rural communities to engage with each other and learn from each other. Project teams have worked together to expand the agricultural biodiversity knowledge base and demonstrate that biodiversity conservation and adaptive management interventions can bring lasting benefits to rural communities.

The creativity and energy generated through these partnerships have helped to release some of the transformative force of agricultural biodiversity.

WORKING WITH PARTNERS
AROUND THE WORLD

34 COUNTRIES PARTICIPATE IN UNEP-GEF AGRICULTURAL BIODIVERSITY PROJECTS

UNEP works in GEF through partnerships. UNEP's Division of GEF Coordination has been very successful in establishing broad-based effective partnerships at the community, national, regional and global level.



Project partner countries

1. Armenia
2. Bangladesh
3. Benin
4. Bolivia
5. Brazil
6. Burkina Faso
7. China
8. Cote d'Ivoire
9. Cuba
10. Ecuador
11. Ghana
12. India
13. Indonesia
14. Kazakhstan
15. Kenya
16. Kyrgyzstan
17. Madagascar
18. Malawi
19. Malaysia
20. Mali
21. Mexico
22. Morocco
23. Nepal
24. Pakistan
25. South Africa
26. Sri Lanka
27. Tajikistan
28. Thailand
29. Turkey
30. Turkmenistan
31. Uganda
32. Uzbekistan
33. Vietnam
34. Zimbabwe

INTERNATIONAL PARTNERS

Federal Agency for Agriculture and Food

BGCI Plants for the Planet

Bioversity International

FAO FIAT PANIS

ILRI International Livestock Research Institute

IUCN

UNESCO United Nations Educational, Scientific and Cultural Organization | MAB Man and the Biosphere Programme

DEZA DDC DSC SDC COSUDE

CIAT

TSBF

UNEP WCMC

KEY RESULTS TO DATE

This section presents a partial overview of the major results achieved by UNEP-GEF's agricultural biodiversity projects. It is important to understand that many of these projects are still ongoing. Others are only at the design phase and have not yet started implementation. Consequently, it is too early to provide a complete summary of project results and measure their impact.

Area of coverage

The extent of the area where projects have already demonstrated sustainable agricultural management practices that strengthen on-farm conservation and use of agricultural biodiversity: 311, 000 hectares.

The extent of the area where projects have directly contributed to the conservation and sustainable use of agricultural biodiversity: 1,254,564 hectares.

Capacity building, training and public awareness

Project partners worked together to build national capacities to collect and analyze data, manage information systems, engage in participatory decision-making and carry out conservation actions.
Some examples of the tools for strengthening capacities developed by the projects include the publication:

› ***Crop Wild Relatives: A manual of in situ conservation***
edited by Danny Hunter and Vernon Heywood; Earthscan (in press)
- A first of its kind, the manual provides clear, practical guidance and examples of good practices for practitioners undertaking *in situ* conservation of crop wild relatives and guidance for the scaling-up of actions around the world.

◂ Visitors to Sri Lanka's Department of Agriculture Information Park (Anura Wijesekara)

Other projects have also established training centers and programmes to support the conservation and sustainable management of agricultural biodiversity.
These include:
- regional training centers on sustainable management of walnut, apricot and pomegranate genetic resources, socio-economic studies and molecular markers established at five national research institutes in Central Asia that deliver training programmes on a wide range of agricultural biodiversity conservation topics for researchers and educators, farmers, managers of protected areas, and policy makers;
- an agricultural biodiversity training centre in China established through national partner co-financing; and
- two sandwich programmes on crop genetic diversity to control pests and diseases: one with the Yunnan Agricultural University, China and Washington State University; and a second one between IAV Hassan II University, Morocco, and McGill University, Canada.

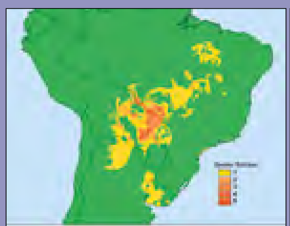
Innovative communication tools were used to raise public awareness about conserving and using agricultural biodiversity.
Some of the best examples include:
- two booklets for children, farmers and the general public on the importance of soil biodiversity:
  › ***Curumim and CUNHANTA helping soil biodiversity***
  edited by Fatima Maria de Souza Moreira, Julio N. C. Louzada, Ronald Zanetti; authors, Agno Acioli [et al.]. Lavras: UFLA, 2009. (published in English, Portuguese and Spanish)
  › ***Tierra Somos!***
  Leonel Torres and Isabelle Barois
  Instituto de Ecologia, 2010
- two agriculture information parks established by the Sri Lankan Department of Agriculture where visitors can learn about conventional crops and their wild relatives.

Tools to cope with climate change

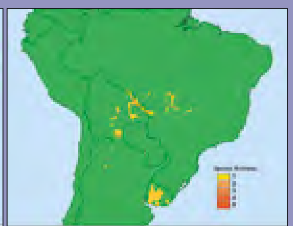
The Crop Wild Relatives project adapted existing geographic information system (GIS) analytical tools to investigate how different climate change scenarios might affect the future distribution of crop wild relatives. Evidence based on bioclimatic modelling using these tool suggests that climate change can cause a marked contraction in distribution ranges of crop wild relatives. In the case of wild populations of peanut, potato and cowpea, studies suggest that 16 to 22 percent of these species will go extinct by 2055, with most species losing half of their range size[1]. Results also suggests that many protected areas will suffer moderate to substantial species loss[2]. These results call into question the ability of protected areas in their present form to secure species under different climate change scenarios. The tools and methodologies developed through this project could be applied to support the management of Protected Areas so that they are more flexible in size and scale and better able to respond to climate change.

[1] Jarvis, A., Lane, A. and Hijmans, R. (2008) The effect of climate change on crop wild relatives. Agriculture, Ecosystems and Environment 126, 13-23

[2] Lira, R., Tellez, O. and Davila, P. (2009) The effects of climate change on geographic distribution of Mexican wild relatives of domesticated Cucurbitaceae. Genetic Resources and Crop Evolution 56, 691-703



Present distribution of species richness in section *Arachis*



Predicted 2055 distribution of species richness in section *Arachis*

Methodologies and tools for assessments and analysis

UNEP-GEF projects focus on developing and testing, in a wide range of biodiversity-rich ecosystems, tools and methodologies that can be used and adapted by any country or organization concerned with the conservation and sustainable management of agricultural biodiversity. These tools and methodologies, which constitute global public goods, are field tested in demonstration plots that help local farmers improve their livelihoods.
Examples include:

› ***Crop genetic diversity to reduce pests and diseases on-farm: Participatory diagnosis guidelines. Version I***
Devra Jarvis and D.M. Campilan; Bioversity International Technical Bulletin No. 12. 2006 (published in Chinese, English, French and Spanish)

- methodological guidelines in planning and implementing participatory diagnosis to understand farmers' knowledge, practices, problems and needs for using diversity to control pests and diseases on farm;
- presents a six-step decision-making process that enables farmers and agronomists to determine when the use of on-farm crop genetic diversity would be an appropriate option to minimize crop loss due to pests and diseases.

› ***Evaluation of Best Practices for Landrace Conservation: Farmer Evaluation***
Mikkel Grum, Edwin A. Gyasi, Cecil Osei, Gordana Kranjac-Berisavljevic; Bioversity International, 2008

- a framework for analyzing and comparing different decision-making practices used to maintain traditional varieties on farm.

› ***Framework for Transforming Best Practices for Landrace Conservation to Policies***
Peter Munyi, Mikkel Grum and Julia Ndungu-Skilton; Bioversity International, 2008

- a framework linking best practices to decision-making, including a process guide for identifying policy instrument required to sustain or scale-up best practices and developing mechanisms for their implementation.

› ***Handbook of Tropical Soil Biology: Sampling & Characterization of Below-ground Biodiversity***
Edited by Fatima M. S. Moreira, E. Jeroen Huising and E. Bignell; Earthscan, 2008

- provides tools and methods for carrying out systematic inventories of below-ground biodiversity, establishing baselines assessments and monitoring losses.

› ***Libro Rojo de Parientes Silvestres de Cultivos de Bolivia***
PLURAL Editores.
La Paz, 2009

- the first IUCN Red List specifically dedicated to crop wild relatives.

Information and knowledge management tools

Baseline studies have indicated that information management is a major constraint for effective decision-making regarding agricultural biodiversity conservation. For this reason, all projects have included a major component on information management. One of the most significant results in this area is:

- ***The Crop Wild Relatives Global Portal***
  www.cropwildrelatives.org
  - The Portal brings together pre-existing and new global data on crop wild relatives and provides access to national crop wild information systems established by project partners in Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan.

Other knowledge management tools developed though UNEP-GEF's agricultural biodiversity projects include:

- ***Below-ground Biodiversity web site***
  www.bgbd.net
  - provides access to project documents, publications and the below-ground biodiversity database as well as links to national partner web sites.
- ***Farm Animal Genetic Resources – Asia web site***
  www.fangrasia.org
  - provides access to technical reports prepared by project partners and links to partner web sites.
- ***Pollination Information Management System***
  www.internationalpollinatorsinitiative.org/pims.do
  - delivers accurate information on managing pollination services of key crops to farmers, farm advisors and land managers.

Conservation actions

The methodologies and tool developed for conservation and sustainable management of agricultural biodiversity, participatory decision-making and capacity building were used for implementing conservation actions. The most important achievements in this area are *in-situ* conservation strategies and action plans developed thought the crop wild relative project. The strategies and action plans cover:

- five species of wild yam in Ankarafantsika National Park, Madagascar;
- a wild relative of cinnamon in Kanneliya Forest Reserve, Sri Lanka;
- a wild almond variety in Chatkal Biosphere Reserve, Uzbekistan;
- four wild relatives of wheat in Erebuni State Reserve, Armenia; and
- wild cacao species in Isiboro Sécure National Park and Indigenous Territory, Bolivia.

Along with these actions, new assessments were carried out on the distribution and uses of native crop wild relatives species from 36 priority genera. More than 310 crop wild relative species were Red List assessed according to IUCN guidelines.

CONSERVATION OF CROP LANDRACES IN AFRICA

Community-based Management of On-farm Plant Genetic Resources in Arid and Semi-Arid Areas of Sub-Saharan Africa

Countries
Benin | Burkina Faso | Ghana | Kenya | Mali | Malawi | Uganda | Zimbabwe

Executing agencies
Benin: Institut National de Recherche Agricole du Benin (INRAB)
Burkina Faso: Institut d'Etudes et de Recherche Agricoles (INERA)
Ghana: University of Ghana
Kenya: National Genebank of Kenya (NGBK)
Malawi: National Plant Genetic Resources Centre in Chitedze (NPGRC)
Mali: Insitut d'Economie Rurale (IER)
Uganda: National Agricultural Research Organization (NARO)
Zimbabwe: Department of Agricultural Research and Extension
Regional: Bioversity International

Project cost
GEF financing: USD 0.75 million
Co-financing: USD 1.7 million
Total cost: USD 2.45 million
Project start: 2002
Completion: 2006

Conserving farmers' varieties

In many countries, traditional local crop varieties, also known as 'landraces' or 'farmers' varieties, contribute significantly to sustainable food production, household nutrition and farmers' incomes. This is especially true for resource-poor farmers in marginal agricultural areas, such as arid and semi-arid zones. However, increased population, poverty, land degradation, environmental change, the introduction of modern crop varieties and other factors have often led farmers to abandon many of their traditional cultivars.

The project aimed to get a better understanding of why farmers across Africa continue to maintain and use some landraces and not others. It also assembled a set of practices that could improve the contribution traditional farming systems make to biodiversity conservation and help maintain the rich diversity of local varieties specific to these systems. Crop species that have their primary centre of origin in the semi-arid regions of sub-Saharan Africa or those that have developed distinctive traits in the region over time were selected for study in this project.

Analytical frameworks and farmer evaluations

The project's first task was to develop a framework for the analysis and comparison of the different practices used to maintain traditional varieties on farm. Project partners developed and tested a methodological framework for conducting farmer evaluations that links the empirical language of traditional knowledge with that used by agricultural scientists (referenced earlier in the Key Results to Date section). Between 2,000 - 3,000 farmers and 150-200 extension workers in the eight countries participated in testing the framework for farmer evaluations.

Using the framework, the eight partner countries carried out sixteen case studies and analyzed different decision-making practices. In each of the sixteen case studies, farmers evaluated between 20-25 traditional community-based plant genetic resources management practices. The case studies confirmed that in the arid and semi-arid zones of Sub-Saharan Africa effective traditional farming systems do conserve agricultural biodiversity on farm. The studies also identified the different ways in which communities and farmers achieve this.

Sorghum ear from a farm in Uganda (Patrick Maundu)

Top: A young woman selling finger millet in Limbe Market, Malawi (Patrick Maundu)

Preceding page: Fresh pigeon peas from the Meru region of Eastern Kenya (Patrick Maundu)

The Universities in Ghana and Benin have incorporated the analytical framework developed through the project in their teaching curricula. It has also been adopted directly for other projects in Mali, Benin, and Ghana.

The project further worked to develop a framework that links best practices for on-farm conservation of crop landraces to decision-making and policies (referenced earlier in the Key Results to Date section). The framework developed provides a process guide that can be applied in testing the process of transforming best practices to policies.

Establishing platforms for continued landrace conservation

Through regular updates and exchange of information, the project opened and strengthened communication channels linking project teams, farmers, decision-makers and formal and informal institutions. Project partners in all eight countries established a regular and ongoing exchange of information and ideas on landrace conservation with their findings relayed to decision-makers through reports and meetings. In all countries, project teams also organized public awareness events that brought together farmers, project staff and decision makers. These activities contributed to the development of different platforms for action, such as Diversity Field Fora in Mali and Burkina Faso, parliamentary committee meetings on agriculture in Benin and Innovation Platforms in Malawi.

Reports have been produced on the status of genetic erosion of crop landraces in selected areas in Benin, Ghana, Kenya, Mali, Malawi, Uganda and Zimbabwe. These reports sent an eye-opening message to policy makers and served as a convincing starting point for encouraging on-farm conservation of local landraces.

Main conclusions

The project reached two main conclusions. First, the maintenance of a diversity of landraces is the result of a diversity of community-based plant genetic resources management practices. Each of these practices often contributes to the conservation of only one or two varieties. Indeed, it is this diversity of practices by communities across Africa, often strongly rooted in tradition, that drives conservation of crop diversity and which must be maintained to ensure the on-farm conservation of these varieties.

Second, any attempt to promote any particular individual traditional community-based practices as being the 'best' might well lead to an overall erosion of traditional varieties. Creating an environment that recognizes, respects and learns to build on the positive aspects of these varieties and all the practices that lead to their conservation is probably the overarching best practice that needs to be recognized and supported through appropriate policies.

BELOW-GROUND BIODIVERSITY

Conservation and Sustainable Management of Below-ground Biodiversity, Phase I and II

Countries
Brazil | Cote d'Ivoire | India | Indonesia | Kenya | Mexico | Uganda

Executing Agencies
Brazil: Universidade Federal de Lavras
Côte d'Ivoire: Université de Cocody, Abidjan
India: Jawaharlal Nehru University
Indonesia: Universitas Lampung
Kenya: University of Nairobi
Mexico: Instituto de Ecologia, Xalapa
Uganda: Makerere University
Global: Tropical Soil Biology and Fertility Institute (TSBF) of the International Center for Tropical Agriculture (CIAT)

Project cost
GEF financing: USD 9.03 million
Co-financing: USD 7.5 million
Total cost: USD 16.53 million
Project start: 2002
Completion: 2010

Below-ground biodiversity: abundant, powerful and neglected

The diversity of life below-ground is probably greater than above-ground biodiversity. Despite its richness and the vital services it provides, below-ground biodiversity has generally been ignored in biodiversity studies or soil surveys, especially in tropical ecosystems.

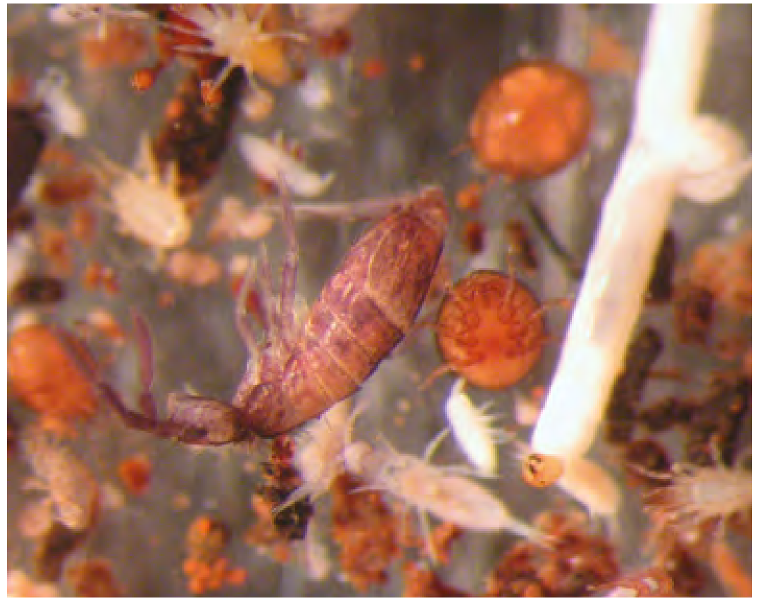
This project has generated information and knowledge that can be used to better manage and conserve below-ground diversity to improve agricultural productivity in tropical landscapes. Benchmark areas were selected in seven tropical countries, all considered biodiversity hot spots. To better compare the effect of land and forest conversion and land use intensification on below-ground biodiversity, focus was placed on forest margins, where the land is characterized by a mosaic of different land uses.

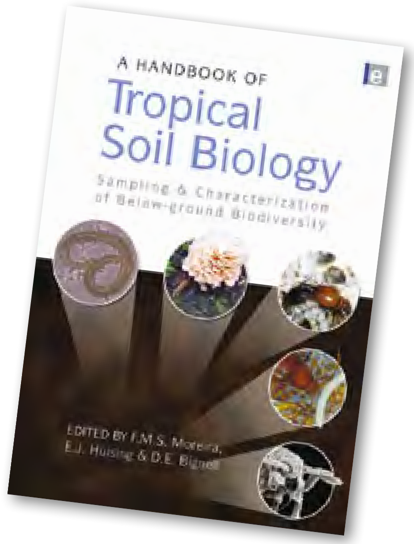
Setting standards

International and national partners developed standardized methods for sampling and characterizing below-ground biodiversity. The key output of this collaboration is the Handbook on Tropical Soil Biology. The Handbook provides the tools and methods for carrying out systematic inventories of below-ground biodiversity, establishing baselines assessments and monitoring losses. The methods have all been developed and piloted under field conditions in the benchmark areas.

The Handbook groups soil biota into eight categories. These categories are based on each organism's broad taxonomic identity, but also correspond to its major function in the soil ecosystem and the services it helps provide. Because its categories are functional, the Handbook is valuable not just for taxonomic experts and general biologists, but also for soil ecologists, agriculture specialists and technical staff with all levels of training.

The project also applied and validated methods for defining a soil quality indicator that integrates different aspects of soil's biological, chemical and physical qualities. This allows for monitoring of soil quality and loss of below-ground biodiversity at a local or regional scale.





Handbook on Tropical Soil Biology

Top left: Collecting litter for the below-ground biodiversity in the Los Tuxtlas Biosphere Reserve, Mexico (Isabelle Barois Boullard)

Top right : Collembola (Arne Fjellberg)

Preceding page: Soybean showing nitrogen-fixation nodules (Peter Okoth)

Inventory and evaluation

Using the methods outlined in the Handbook, national teams carried out comprehensive and systematic assessments of below-ground biodiversity in the benchmark areas. These inventories provide a baseline and reference point for future assessments. In this regard, they constitute a crucial contribution to the knowledge base.

New species have been discovered in the Brazilian Amazon and in Los Tuxtlas region in Mexico. In addition, in many countries, previously unreported species have been noted for the first time. Results from the inventory indicate that in general below-ground biodiversity is lost with increasing land use intensity and conversion of forests. However, it is difficult to draw general conclusions as individual species respond differently to disturbances to their environment. Diversity and abundance of particular functional groups may even increase, as is the case with beneficial organisms like arbuscular mycorrhizal fungi. Information on the inventories is available on the project following web sites: **http://www.bgbd.net**

Demonstrating good management practices and assessing value

Establishing pilot demonstration sites was another major component of the project. One of the key successes in this area has been the demonstrated use of various types of inoculums. Farmers in Ugandan have started growing soybean using rhizobia inoculums, and the extension service is now expanding to communities outside the project's benchmark areas. In Mexico, inoculums have been developed with material sourced from

Banana plants showing signs of poor phosphorus intake due to a lack of arbuscular mycorrhizal fungi (Joyce Jefwa)

Following page: Collecting data on lilies in the experimental plot in the Los Tuxtlas Biosphere reserve in Mexico (Isabelle Barois Boullard)

the benchmark areas and used in experiments with maize and 'palma comedor' (an ornamental plant). Alternative management practices, based on biological control and use of biofertilizers have been demonstrated to successful control fungal and viral infections that attack lily bulbs. In Indonesia, a plant with antagonistic properties to a fungus that causes white root disease in rubber trees was used as a control method.

Project partners in several countries developed and tested innovative methods for below-ground biological biodiversity valuation. As economic evaluation is probably most straight forward for rhizobium inoculation, efforts concentrated mostly on these techniques.

Building capacity and raising awareness

Participants from each country engaged in technical training courses. These courses developed general skills in taxonomy, ecology as well as methods for taking inventory for the various functional and taxonomic groups, determining their ecological importance and analyzing data. Participants also received basic training in advanced molecular techniques for identifying rhizobium strains. For each of the country project components, students were involved in research activities, with about 120 MSc and PhD students completing their degrees.

In all the 15 benchmark sites farmers have been involved in the implementation of the project. Demonstration and experiments have been implemented on farmers' fields with the active participation of the farmers. Results have been evaluated in a participatory manner, so that farmers could assess and appreciate the effects of the various treatments. In specific cases, training materials (and games) were developed for raising awareness on the role of soil organisms of maintaining soil health. Booklets on the importance of soil biodiversity have been prepared for school children.

An assessment found that farmers and other stakeholders have generally very little knowledge and awareness about alternative productions techniques. The project demonstrated to farmers that alternative management options are often available to address common crop production problems, such as decreasing soil fertility and higher incidences of pests and diseases, and restore a healthy soil biological population. These options are especially important for smallholder farmers to increase their efficiency and reduce their dependence on external inputs.

CROP WILD RELATIVES

***In-situ* Conservation of Wild Crop Relatives through Enhanced Information Management and Field Application**

Countries
Armenia | Bolivia | Madagascar | Sri Lanka | Uzbekistan

Executing Agencies
Armenia: Ministry of Nature Protection; Ministry of Agriculture; Institute of Botany of the National Academy of Sciences
Bolivia: General Directorate on Biodiversity, Vice Ministry of Environment, Natural Resources and Forest Development
Madagascar: Ministry of Scientific Research, National Centre for Agricultural Research for Rural Development
Sri Lanka: Ministry of Environment; Ministry of Agriculture, Plant Genetic Resources Centre
Uzbekistan: State Committee on Science and Technology, Institute of Genetics and Plant Experimental Biology
Global: Bioversity International

International Partner Institutions
Botanic Gardens Conservation International (BGCI), FAO, International Union for Conservation of Nature (IUCN), United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), German Federal Agency for Agriculture and Food (BLE)

Project cost
GEF financing: USD 6.2 million
Co-financing: USD 6.5 million
Total cost: USD 12.7 million
Project start: 2004 **Completion:** 2010

What are crop wild relatives?

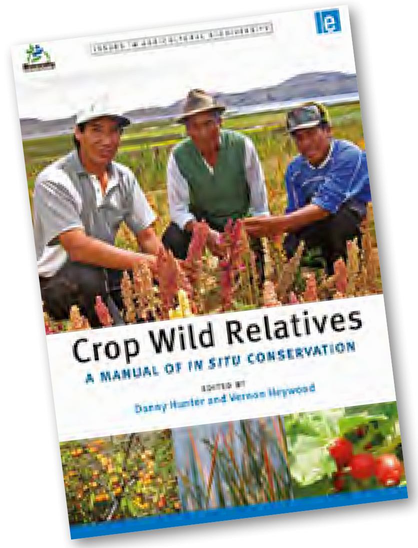
As the name suggests, a crop wild relative is a wild plant species related to a domesticated crop. For centuries crop wild relatives have provided farmers with the genetic material to improve the nutritional quality of crops, enhance productivity and provide cultivated varieties with resistance to pests and diseases. Their estimated value in increasing crop yields worldwide is as much as USD 115 billion per year.

Despite their importance, the *in situ* conservation of wild crop relatives has been neglected, partly because they fall between two conservation sectors. Ecological conservation efforts tend to focus on habitats or on rare and threatened wild species, while agricultural conservationists tend to focus on already domesticated crops. As a result, crop wild relatives have rarely been targeted for *in-situ* conservation.

Building partnerships and enhancing capacities

By building effective partnerships among institutions that formerly had not worked together, the project addressed many of the institutional obstacles that had limited efforts to conserve crop wild relatives *in situ*. Across the five countries, the partnerships included over 60 national and international agencies as well as individuals from a broad range of institutions, including, universities, herbaria, government departments of agriculture, environment and biodiversity, protected areas administrations, local and indigenous community groups, non-governmental organizations, extension and outreach agencies, botanical gardens, museums of natural history and research agencies.

Global partners worked with country partners to provide tools and build national capacities to manage information systems, engage in participatory decision-making and carry out conservation actions. As a result, the participating countries are now well-placed to act as regional hubs for crop wild relative conservation. A manual for in situ conservation of crop wild relatives based on the experiences gained through this project has been prepared and will serve as an important tool in sustaining and scaling-up future conservation activities.



Crop Wild Relatives a manual of in situ conservation

Top left: Potato stall in La Paz market, Bolivia (Annie Lane)

Top right: Crop Wild Relatives Global Portal home page

Below right: Studying wild and weedy rice in Sri Lanka (Anura Wijesekara)

Preceding page:
Cyphomandra benensis
(Saul Job Altamirano Azurduy)

Global and national information systems

Information management was a major component of the project. All five countries brought together existing information on crop wild relatives that previously had been scattered in a many different places and stored in many different formats. They also gathered new data through numerous field surveys. Using a standard set of descriptors, all the information was entered into national information systems. A global portal on crop wild relatives was also developed, which provides access to the national inventories and to information at the global level. The global portal can be reached at: **www.cropwildrelatives.org.**

Assessments and conservation actions

Country assessments on the distribution of native crop wild relative species covered 36 priority genera and documented their uses and the threats they face. This work constitutes probably the largest set of assessments ever done on crop wild relatives and represents a major contribution to the knowledge base on the subject. More than 310 crop wild relatives species were Red List assessed according to IUCN guidelines. Bolivia published the first IUCN Red List specifically dedicated to crop wild relatives.

Erebuni Nature Reserve, Armenia (Andreas Melikyan)

Following page: Preparing herbarium samples on an ecogeographic survey in Madagascar (V. Jeannoda)

Each country developed strategies for the *in situ* conservation of crop wild relatives that included the development of national inventories, methods for prioritizing conservation activities and adapting existing protected area management plans to include crop wild relatives. Each country also formulated specific management and monitoring plans for particularly important crop wild relatives. These plans cover:

- five species of wild yam in Ankarafantsika National Park, Madagascar;
- a wild relative of cinnamon in Kanneliya Forest Reserve, Sri Lanka;
- a wild almond variety in Chatkal Biosphere Reserve, Uzbekistan;
- four wild relatives of wheat in Erebuni State Reserve, Armenia; and
- wild cacao species in Isiboro Sécure National Park and Indigenous Territory, Bolivia.

Climate change studies

Because the genetic diversity of these wild species gives breeders and farmers the resources they need to ensure that agricultural ecosystems can adapt to changing conditions and remain productive, the conservation of crop wild relatives becomes even more critical during a period of climate change. Project partners developed tools for investigating how different climate change scenarios might affect the future distribution of crop wild relatives. The results of these studies on the possible impact of climate were important not only for national efforts to conserve crop wild relatives, but also have profound implications for global efforts to safeguard biodiversity in general. For more details, refer to the Key Results to Date section.

Raising awareness

Innovative communication tools were used to put crop wild relative conservation higher on the agenda of decision-makers and bring it to the attention of the wider public. One of the best examples are the two agriculture information parks the Sri Lankan Department of Agriculture established in Peradeniya and Bataata, where visitors can learn about conventional crops as well as wild relatives. The Bataata Park attracts 8,000-10,000 visitors per month.

Other approaches included the organization of media tours, which resulted in substantial media coverage on the subject and the integration of aspects of crop wild relative into educational curricula.

FRUIT TREE DIVERSITY IN CENTRAL ASIA

***In Situ*/On-farm Conservation of Agricultural biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asia**

Countries
Kazakhstan | Kyrgyzstan | Tajikistan | Turkmenistan | Uzbekistan

Executing Agencies
Kazakhstan: The Academy of Agricultural Science
Kyrgyzstan: Research Institute of Farming; “Bioresurs” Public Foundation of Research and Innovation Centre of Phytotechnology of Kyrgyz National Academy of Sciences Research Institute of Farming
Tajikistan: Research and Production Association ‘Bogparvar’
Turkmenistan: Academy of Science of Turkmenistan
Uzbekistan: Institute of Genetics and Plant Experimental Biology
Global: Bioversity International

Project cost
GEF financing: USD 6.1 million
Co-financing: USD 6.2 million
Total cost: USD 12.3 million
Project start: 2006 **Expected Completion:** 2011

Focusing on farmers as custodians of diversity

Central Asia is the centre of origin and domestication for many temperate fruit and nut species of global significance. However, the richness of this genetic diversity is under threat. While part of the Soviet Union, Central Asian countries adopted farming practices that relied heavily on uniform high-yield varieties. Forested areas, home to wild populations of fruit and nut trees, are threatened by overgrazing and deforestation.

To address this situation, the project focused directly on farmers and forest dwellers, the traditional custodians of fruit tree diversity. The project targeted 12 fruit and nut crops and their wild relatives: apple, apricot, almond, cherry-plum, grapevine, fig, pear, peach, pomegranate, pistachio, sea-buckthorn and walnut.

Building partnerships and increasing capacities

The project’s central goal is to build lasting partnerships among policy-makers, researchers, agricultural extension workers, farmers and their associations, local communities, and non-governmental organizations. Because many government scientists and researchers were unfamiliar with working in a collaborative way with farmers, enhancing their capacity to employ participatory approaches in agricultural biodiversity conservation was ground-breaking and essential. Together global and national partners developed and field tested guidelines for carrying out participatory assessments of fruit and tree diversity and obtaining quantifiable data on the diversity levels in farmers’ orchards and diversity management practices.

National project teams prepared and delivered training programs on a wide range of agricultural biodiversity conservation topics for researchers and educators, farmers, managers of protected areas, and policy makers. Five regional training centres dealing with specific aspects of biodiversity conservation have been established at existing national research institutes.

Drying apricots on stones in Isfara, Tajikistan (Bahodir Tashmatov)

Top: Applying new technologies in reforestation with wild nut species (Yevgeniy Butkov)

Preceding page: Diversity of pomegranate seeds (Nikolai Lutsian)

Conserving rare diversity

Farmer assessments carried through the project indicated farmers maintained a rich diversity of local varieties of fruit and nut trees, including:

- 160 grape varieties,
- 145 apple varieties,
- 103 apricot varieties,
- 40 walnut varieties,
- 32 pear varieties and
- 26 pomegranate varieties.

Nearly 70 forms of pistachio, currant, sea-buckthorn, almond, apple and cherry plum with promising traits were identified in wild populations. To reduce pressure of over-harvesting in natural forest stands, it was recommended that these varieties be multiplied for commercial planting. National teams found examples of old local fruit tree varieties that had been considered extinct by researchers and have since been able to multiply them.

Bringing benefits to the farmer

To assist farmers improve their productivity through the better management of fruit tree diversity, the project established 47 demonstration plots both in farmers’ orchards and in forested lands. By building bridges between wild fruit and nut tree populations and domesticated varieties, the project was able to reduce the vulnerability of threatened wild relatives and increase on-farm diversity. On project plots, multidisciplinary site committees, which included men and women farmers, representatives of village authorities coordinated the project activities in collaboration with various partner organizations and local communities. National scientists developed a set of 47 scientifically proved recommendations and guidelines for fruit tree multiplication, orchard management and technologies on adding value to fruit products for farmers use.

Through the project, farmers gained access to a wide range of planting materials. In Turkmenistan, 25,000 cuttings of local varieties of grapevine conserved in the field collection of the national research institute were provided to farmers. In Kazakhstan, Tajikistan and Uzbekistan, about 100,000 fruit tree saplings for planting were distributed among farmers at biodiversity fairs. National project teams also supported farmers in establishing nurseries, providing them with mother plants and rootstocks and grafting equipment. Farmers managing nurseries received training in grafting and pruning, selecting rootstock and mother plants, multiplying planting stock and controlling pests and diseases. More than 870 farmers benefited from these activities.

Because the project has a regional scope, farmers from different countries had the opportunity to exchange insights on

Wild *Pistacia vera* (Nikolai Lutsian)

Following page: Pomegranate nursery in Uzbekistan (Yevgeniy Butkov)

different aspects of the cultivation and processing of fruits and nuts. For example, in Uzbekistan, farmers were introduced to a new method for planting pistachio trees with covered root system that extends the planting season for two months. Apricot growers from Turkmenistan traveled to Tajikistan, a country known for the quality of its dried apricots, to learn from Tajik apricot farmers about traditional and improved processing methods.

Strengthening institutions and policy frameworks

The project's overarching goal was to improve the existing legal and policy frameworks so that the conservation of fruit tree biodiversity could be sustained over the long term. At the local level, four legally registered fruit tree farmers associations were established in Tajikistan and Kazakhstan. These associations have helped farmers overcome one of the main obstacles they face in the on-farm management of fruit tree diversity: a lack of understanding about their rights regarding access to land, water and other natural resources. In addition, they have provided farmers with information regarding access and exchange of fruit crop germplasm. Through these associations, farmers have also gained a stronger voice in expressing their views and promoted greater cooperation among producers and agricultural processors.

National partners made a careful review of existing legal frameworks related to on-farm maintenance of local diversity of fruit trees, the *in situ* conservation of their wild relatives and the protection of farmers' rights as conservers of biodiversity. National project teams are helping governments establish national nature parks in Kazakhstan, Kyrgyzstan, Uzbekistan and Turkmenistan, protect wild relatives of fruit crops and carry out conservation measures. Furthermore, in 2009, the Government of Kazakhstan began providing farmers with subsidies to establish new orchards and nurseries, with priority given to local fruit tree varieties. In the same year, national partners in Tajikistan prepared for the national Parliament a law on the conservation and sustainable use of plant genetic resources for food and agriculture, which covers genetic resources of fruit crops and wild fruit species.

These achievements were the result of the hard work of national teams to increase the awareness of farmers, policy makers, the media and the general public about the value of fruit tree diversity. Awareness raising activities included broadcasting television and radio interviews, publishing articles in local newspapers, organizing round table discussion and staging rural drama performances. Posters illustrating farmers' role as custodians of local fruit diversity and the organization of farmers' fairs with products made from of local fruit varieties also contributed to a broader recognition of the importance of farmers in agricultural biodiversity conservation.

CROP GENETIC DIVERSITY TO CONTROL PESTS AND DISEASES

Conservation and use of crop genetic diversity to control pests and diseases in support of sustainable agriculture, Phase I

Countries
China | Ecuador | Morocco | Uganda

Executing Agencies
China: Yunnan Agricultural University;
Ecuador: Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP);
Morocco: Institut Agronomique et Vétérinaire (IAV) Hassan II;
Uganda: National Agricultural Research Organisation;
Global: Bioversity International

International Partner Institutions
Swiss Agency for Development and Cooperation (SDC), US University consortium lead by Washington State University together with Oregon State University and Cornell University, University of Kassel, Germany

Project cost (phase I)
GEF financing: USD 3.8 million
Co-financing: USD 5 million
Total cost: USD 8.8 million
Project start: 2008
Expected Completion: 2010

Crop biodiversity: a resource for pest and disease control

One of the consequences of the introduction of new high-yield varieties of major crops to boost agricultural production has been the severe decline in genetic diversity in farmers' fields. Although production has increased, a greater dependence on genetically uniform crop varieties has put food security and farmers' livelihoods at greater risk, as an entire harvest can be lost due to a single pest or disease outbreak.

Because improved crops lose their resistance to pests and diseases after a few planting seasons, constant investments are required to support breeding programs that can produce resistant varieties. Furthermore, cultivating these higher-yield crop varieties often requires considerable amounts of pesticides and other inputs that are not available to resource-poor farmers. Even when they are affordable for farmers, such inputs increase production costs, pose health risks to the community and create serious threats to the environment.

Using the pest and disease resistance in existing genetic diversity represents a possible alternative. Indeed, for many resource-poor farmers in marginal areas, the conservation and management of biodiversity found in traditional crop varieties is one of the few options they have for pest and disease control. However, the traditional knowledge that underpins these practices often is not documented and the opportunities for expanding them are lost.

To address this situation, this project has brought together farmers, scientists and development workers to document and demonstrate how the management of local biodiversity can be an economical and environmentally sustainable means of controlling pests and diseases efficiently. Originally designed to extend over a six-year period, the project has been divided into two phases due to lack of funding. The first three-year phase of the project ended in August 2010.

Targeting major crops in centres of diversity

The project targeted six major staple crops for the developing world:
- rice
- maize
- barley
- common bean
- faba bean
- banana and plantain

Moroccan farmer (Carlo Fadda)
Top left: Banana pest (Carlo Fadda)
Top right: Farmer inspecting his mixed maize field in Ecuador (Paola De Santis)
Preceding page: Barley pest (Carlo Fadda)

Each of the participating countries has areas of important crop genetic diversity for these crops. This diversity covers different types of resistance to major pests and pathogens in crop cultivars maintained in traditional farming systems. Twenty-two sites were selected in the four countries. With each country having at least two of the target crops in common with one other country, the project was able to link primary diversity centres to secondary diversity centres. The multi-country coverage also allows for different practices to be measured against each other to determine their relative strengths and weaknesses for controlling pests and diseases.

Developing diagnostic tools

The project's initial activities focused on developing:

- guidelines for focus group discussions to understand farmers' knowledge, practices, problems and needs for using diversity to control pests and diseases; and
- protocols for carrying out participatory assessment and combining them with laboratory and field analysis to determine when and where genetic diversity can be recommended to manage pest and diseases.

The production of these guidelines required agreements among partners on standardized procedures and terms for collecting, analyzing and using farmer and technical information across countries and crops. The guidelines was published in four different languages: Chinese, English, French and Spanish (Referenced earlier in the Key Results to Date section). Also, carrying out the focus group discussions demanded constant interaction among national level scientists, development workers in the social sciences and farmers to ensure that field surveys and farmer interviews were carried out simultaneously and at the proper time of the cropping season.

Ugandan Farmer showing bean diversity at a diversity fair (Carlo Fadda)

Following page: Ugandan farming family (Carlo Fadda)

Overall, farmer group discussions were attended by more than 2,000 farmers.

The focus group discussions and household surveys have put into comparable terms farmers' awareness of the resistance of the different varieties, how they manage genetic diversity to control different pests and diseases and the tradeoffs they make when selecting for resistance over other traits. They have identified high diversity sites, such as the maize site in Ecuador, where there is no significant use of pesticides and losses due to pests and diseases are low. They have also characterized seed systems through which farmers gain access to biodiversity and identified the challenges farmers face in acquiring desired planting material.

From diagnosis to practice through on-farm experiments

Experiments are now under way to determine what practices and procedures would make best use of crop diversity to reduce pest and disease outbreaks. Using seeds of varieties identified through the focus group discussions and household surveys, on-farm experiments have begun for rice and maize in China, beans and maize in Ecuador, beans in Uganda, and barley and faba bean in Morocco.

Farmers themselves, under the guidance of national field staff, are in charge of the on-farm experimental plots and evaluate the results. This participation develops farmers' capacity to manage biodiversity for pest and disease control and ensures that plots are tended according to farmers' management practices . Experiments are complemented by on station and glass house experiments in order to test resistance of different varieties and check it against pathogens from different sites. This simulates what would happen if a new pathogens arose in a given site. During the project's second phase, a set of recommendations will be made based on the experiments' results.

Progressing by building capacities

None of the projects activities could have been completed without building the capacities of partner institutes and local farmers. More than 70 people working at the 22 sites and more than 20 scientists received training in participatory approaches for conducting focus group discussions and household surveys.

The members of site coordination committees have been selected and trained. The committees, made up of national scientists, site coordinators and four farmers (two men and two women), organize and oversee the planned activities and provide a crucial bridge between national agricultural agencies and the local farming communities. In addition, an international agricultural biodiversity centre has been established in China through partner co-financing.

Conservation and Management of Pollinators for Sustainable Agriculture through an Ecosystem Approach

Countries
Brazil | Ghana | India | Kenya | Nepal | Pakistan | South Africa

Executing Agencies
Brazil: Brazilian Ministry of the Environment
Ghana: University of Cape Coast
India: G.B. Pant Institute of Himalayan Environment and Development
Kenya: National Museums of Kenya
Nepal: Ministry of Agriculture and Cooperatives, Gender Equity and Environment Division
Pakistan: Pakistan Agricultural Research Centre
South Africa: South African National Biodiversity Institute
Global: FAO

Project cost
GEF financing: USD 8.5 million
Co-financing: USD 19.6 million
Total cost: USD 28.1million
Project start: 2008
Expected Completion: 2013

POLLINATORS

Conserving pollinator diversity – ensuring pollination services

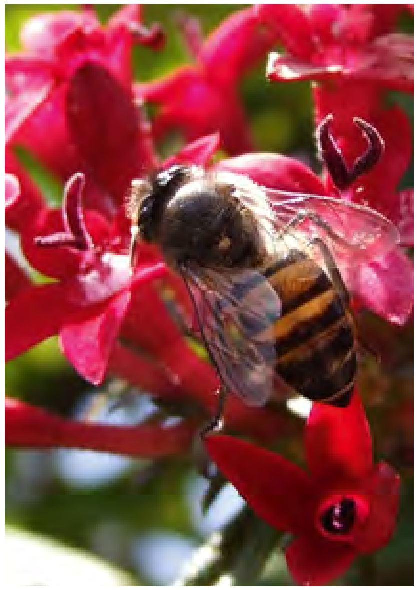
Every day birds, bees, bats and other animals pollinate millions of plants and flowers. This pollination is essential for maintaining biodiversity and sustaining the world's food supply. In 2005, a valuation of the pollination service provided by insect pollinators, mainly bees, to grow the world's main food crops, was about USD 208 billion, about 10 percent of the total value of global food production.

However, over the last 20 years, significant declines in pollinator diversity have been recorded. Recent collapses of honeybee populations have made headlines around the world. Stemming the decline in pollinator diversity and ensuring pollination services is an urgent matter of global importance. In response, the Conference of Parties of the CBD established the International Initiative for the Conservation and Sustainable Use of Pollinators. This GEF supported project has been designed to support the implementation of this international initiative by developing a set of tools, methodologies, strategies and best management practices that can be applied to pollinator conservation efforts worldwide. The immediate objective is to ensure that increased conservation of pollinator diversity and improved pollination services bring tangible benefits to those communities whose livelihoods depend on these services.

Consolidating the knowledge base

A key component of the project is the consolidation of the global knowledge base integrating both traditional and scientific knowledge on pollinators and pollination services. Towards this end, a Pollination Information Management System (PIMS) has been built to organize and deliver accurate information on managing pollination services of key crops to farmers, farm advisors and land managers. On-line since October 2009, the PIMS web site is designed to help users to answer the following questions:

- What are the pollination needs of a particular crop?
- What is the current understanding of managing the pollination of a particular crop?



Yields of cocoa are highly dependent (up to 90 percent) on visitation by pollinators (Barbara Gemmill-Herren)

Top: Asian honeybee (*Apis cerana*) (© Stuart Roberts, 2008)

Preceding page: Bumblebee visiting tomato flower (©Mace Vaughan, Xerces Society, 2008)

- What studies have been carried out on the pollination of this crop?
- What is known about the pollinators of this crop?

The PIMS web site can be reached at: http://www.internationalpollinatorsinitiative.org/pims.do

Because the understanding of plant pollination needs and deficits is a newly developing field, the project has developed and tested a protocol to detect and assess pollination deficits in field situations in a standard and statistically testable way. A handbook to apply the protocol in a diversity of cropping situations is being drafted. In addition, a user-friendly key to identifying bee families has been completed.

Promoting pollinator-friendly practices

The project will establish demonstration sites to show how pollinator diversity can be conserved and pollination services managed sustainably through an ecosystem approach. The project has recognized that successful interventions should be based on a comprehensive survey of existing land management and traditional knowledge practices that are beneficial for pollinator conservation and pollination services. These surveys need to be carried out in consultation with farmers, land managers and researchers.

The survey carried out during this project is based on the work presented in the FAO publication, 'Initial Survey of Good Pollination Practices'.

Capacity building in conserving pollinator diversity

Because pollination has not figured prominently in agricultural education, in many countries the level of capacity to conserve pollinator diversity and manage pollination services is very low. Formal and informal education, training methods, materials and curricula for pollinator conservation and management are virtually nonexistent.

The project has drafted a curriculum for trainers of farmers, and initial training of trainers activities have been carried out in two pilot sites in Ghana and Nepal. In addition, the project supports capacity building in pollinator research at the university level. Through partner co-funding, a post-graduate student has completed a study of cocoa pollination in Ghana. This study found that banana trees intermixed amongst cocoa provides breeding habitat for the small midges that pollinate cocoa and increases yields of cocoa pods.

CULTIVATED AND WILD TROPICAL FRUIT DIVERSITY

Conservation and sustainable use of cultivated and wild tropical fruit diversity: promoting sustainable livelihoods, food security and ecosystem health

Countries
India | Indonesia | Malaysia | Thailand

Executing Agencies
India: Indian Council of Agricultural Research (ICAR)
Indonesia: Indonesian Centre for Horticulture Research and Development (ICHORD)
Malaysia: Malaysian Agriculture Research and Development Institute (MARDI)
Thailand: Department of Agriculture (DOA)
Global: Bioversity International

Project cost
GEF financing: USD 4 million
Co-financing: USD 7.1 million
Total cost: USD 11.1 million
Project start: 2009 **Expected Completion:** 2014

Creating platforms for conserving tropical fruit tree diversity

In Asia, small-scale fruit tree farmers have a wealth of knowledge and technical skill for cultivating different species and different varieties of fruit trees. Governments however have invested very little resources in documenting and harnessing fruit tree genetic diversity. With demand growing for tropical fruits in local, regional and global markets, opportunities clearly exist for increasing farmers' incomes and safeguarding food security by capitalizing on the value of this diversity.

This project is working to establish a platform that integrates farmers' traditional knowledge and skills for maintaining fruit tree diversity into more formal conservation efforts undertaken by national agencies. The overall objective is to improve the *in situ* and on-farm conservation of tropical fruit tree genetic diversity in ways that bring tangible benefits to farming communities. The project targets two globally important and two regionally important tropical fruit tree crops: citrus, mango, mangosteen and rambutan. All four countries have unique food cultures that have contributed to creating this fruit diversity. However, no single country has the full range of genetic diversity of any of these fruits. By working together, partners in the four countries will benefit from sharing resources, knowledge and experiences. This regional project also builds international collaboration and cooperation to solve common problems and discussions on exchange of germplasm, which is currently non-existent.

Diversity Conserved

The project works with 36 communities to find ways to use and manage tropical fruit diversity sustainably while still meeting the needs of rural people. It focuses on enhancing the documentation of farmers' and users' knowledge and practices on *in situ* conservation and on-farm management of tropical fruit tree genetic resources. Care was taken to ensure the full participation of women in both the user groups and research teams. Diversity-rich populations of tropical fruit trees, populations under threat, and populations with key traits of potential development value are being identified and documented.

Preliminary community genetic diversity assessments revealed that farmers are still maintaining rich tropical fruit tree diversity. This trend however is limited to few major cultivars. The project has

Woman farmer brings home garden produce to local market (Bhuwon Sthapit)

Top: Social scientist showing unique mango variety in a farmer's orchard in Chittor, India (Bhuwon Sthapit)

Preceding page: Rambutan (Bhuwon Sthapit)

identified many farmers who maintain significant number of cultivars that have little commercial value but are important for home and local consumption. For example, one Indian farmer cultivates some 35 varieties of mango (including both pickling mango and fruit mango) and a half a dozen types of *Garcinia indica* (a genus of mangosteen). Initial activities have provided insights into a number of farmers' innovations that support the conservation of fruit tree diversity. Understanding the reasons and processes that determine how local people make use of the resources they have is key to the success of initiatives aimed at improving their conservation and management. In India, the project has documented and prepared a brief on the traditional practice of grafting of multiple varieties onto a single sapling by a progressive farmer and nursery owner in Uttar Pradesh state. Grafting multiple varieties onto a single tree is a low-cost practice that works well for nurseries and field genebanks with limited land and staff.

Rural communities benefit

The project works to identify gender-sensitive good practices to improve the availability of and access to high-quality planting materials of the target group of species and increase their demand and supply in local and national markets. It will try to identify market constraints and mitigate the negative effects they have on those who depend on the diversity of the tropical fruits targeted by the project for their livelihoods. Benefit-sharing mechanisms will be developed among national and local institutions and farming communities which will lead to policy recommendations and their implementation. Farmers are involved in identifying farmer's own elite materials for further multiplication and distribution through local nurseries and local development institutions. The project will also establish mechanisms to boost the value of products that make use of tropical fruit diversity, thereby encouraging their use and conservation. Market and non-market values of tropical fruit tree diversity for rural communities are being identified to create a basis for the development of environmental certification systems.

This knowledge will be used to develop or identify appropriate methodologies and gender-sensitive good practices that will assist in conservation of the diversity of the targeted fruits. In Malaysia for example, along with mangos and other fruits, fruit vendors at local markets commonly sell different varieties of mango seedlings with a list of their particular traits. This type of marketing approach, largely unknown in the project's other partner countries, spreads fruit tree diversity by encouraging consumers to grow their own preferred varieties in household gardens.

Non-farming communities that depend on gathering cultivated and wild fruits on forested lands also tend to have practices that promote the survival of these fruit trees in the wild. For example, in Sarawak, Malaysia and South Kalimantan, Indonesia, farmer communities have specific harvest rights and agreements between families for certain trees in the forest surrounding their villages.

Citrus (Bhuwon Sthapit)

Following page: Floating fruit market in Bangkok, Thailand (Bhuwon Sthapit)

Building capacities of all stakeholders

Project interventions build and strengthen capacities of farmers and local communities to assess, evaluate and implement good practices that increase the value of tropical fruit tree genetic resources. Communities and local institutions have been organized to participate in decision-making activities and care has been taken to involve women farmers and users throughout theses processes. The project also works with local and national research and extension organizations to build their capacity to assess diversity and its value and to evaluate certification options. Regional training courses have been organized covering the following topics:

- good practices related to traditional knowledge documentation, community biodiversity registers and farmers' descriptors;
- participatory approaches in promoting conservation, sustainable use and community-based biodiversity management;
- socio-economic and agricultural biodiversity baseline surveys; and
- methodologies for assessing genetic diversity of wild and cultivated tropical fruit trees.

The project has also built the capacities of national and local educational institutes to train staff, both men and women, in participatory assessment, conservation, valuation and enhanced use of tropical fruit tree resources. As most partners are unfamilair with community-based participatory methods for biodiversity management, this initial capacity building has been crucial for the project's implementation. Project partners are working to establish a regional network on the conservation and use of tropical fruit tree species. The network will be linked to other forest and agricultural tropical tree networks.

Not just for farmers

Sites for demonstrating good practices were selected and validated during the project's PDF-B phase and further verified during the initial stages of full-scale project implantation. Project partners are now moving towards building the institutional working modalities for carrying out project activities at the demonstration sites and raising awareness about the project at the community level.

In all four countries, village meetings were held to introduce the project. At these well-attended meetings, local communities made it clear that for fruit tree conservation efforts to succeed and be sustainable it was important that participation not be limited to farmers. The involvement of private nurseries, local banks, financing agencies and schools was considered essential. With this input, national partners, in collaboration with local communities, have established multidisciplinary site teams to oversee the activities at the demonstration sites according to agreed upon work plans.

INDIGENOUS LIVESTOCK AND WILD RELATIVES

Development and Application of Decision-support tools to conserve and sustainably use genetic diversity in indigenous livestock and wild relatives

Countries
Bangladesh | Pakistan | Sri Lanka | Vietnam

Executing agencies
Bangladesh: Bangladesh Agricultural University, Department of Animal Breeding and Genetics
Pakistan: Pakistan Agricultural Research Council, Animal Sciences Division
Sri Lanka: University of Peradeniya, Department of Animal Science
Vietnam: National Institute of Animal Husbandry
Global: International Livestock Research Institute (ILRI)

Project cost
GEF financing: USD 2.4 million
Co-financing: USD 4 million
Total cost: USD 6.4 million
Project start: 2009 **Expected Completion:** 2014

Confronting the erosion of farm animal diversity

Almost 10 percent of the world's livestock breeds have become extinct in the last six years alone. FAO's review of farm animal genetic resources in 2008 classified about 20 percent of farm animal breeds at risk of extinction. This alarming loss of biodiversity is due largely to the substitution and cross-breeding of local breeds by a very limited number of exotic commercial breeds.

Even though a large proportion of smallholders and pastoralists rely on indigenous livestock breeds, these local breeds have rarely been studied and their traits are poorly documented. As a result, the potential to use these breeds to improve farm productivity and generate increased incomes for producers, processors and vendors is untapped. Policy-makers and development agencies often promote the use of exotic breeds from developed countries over local breeds. Small-scale producers whose livelihoods depend on local breeds have little capacity to lobby for their needs or influence policy.

This project brings together farmers, researchers, development agents, and decision-makers to address the major factors contributing to losses in farm animal genetic diversity: inadequate knowledge of the value of indigenous breeds and the lack of an appropriate policy framework for the sustainable management of farm animal genetic resources. A key hypothesis underlying the project is that local breeds are best conserved, whenever possible, through their sustainable use. *In situ* conservation, when combined with improved utilization at the community level, is likely to be more sustainable and cost-effective than setting up *in vitro* conservation programmes.

Target species in centres of domestication

The project focuses on three farm animal species; chicken, goats and pigs. In developing countries, these animals are extremely important for sustaining livelihoods in poor farming communities and for maintaining the health and well-being of their most vulnerable members: women and children.

Bangladesh, Pakistan, Sri Lanka and Vietnam possess a rich and widely representative diversity of farm animal genetic resources. These countries' richness in diversity is largely due

Bengal goat, a variant locally named 'Boragi or Tribal' (A.K.F.H. Bhuiyan)

Top left: Farmer feeding her pigs near the northern town of Meo Vac, Vietnam (ILRI)

Top right: Child holding indigenous black plumed chicken (A.K.F.H. Bhuiyan)

Preceding page: Jungle fowl captured for breeding with indigenous chicken in Son La, Vietnam (B. Rawlynce)

to their position as centres of origin of the domestic breeds. Pakistan is a historical centre of goat domestication. The countries of South East Asia, including Vietnam, are believed to be centres of chicken domestication. Recent molecular research has indicated that South Asia and South East Asia also contain several different areas of pig domestication. Sri Lanka, at the crossroad of the sea trading routes of South and South East Asia, has for centuries been a major trading centre for livestock from distant and neighboring regions. The participation of countries from these regions, as well as Bangladesh, which bridges the two regions, ensures wide representation of the gene pool of the three target species. Wild relatives of domestic livestock are also found in these countries. In cases of chicken and pigs, these wild relatives continue to provide new or additional reservoirs of diversity and to some extent, valuable genes to the domestic populations.

Building tools for better management of livestock biodiversity

Preliminary needs assessment studies on resources, policies, markets and legal aspects related to farm animal genetic diversity were carried out during the project's preparatory phase. Study reports are available on the project website at: www.fangrasia.org. Project partners are continuing to follow a systematic, participatory process to develop, apply and make available both within and outside the project countries, decision-support tools that can be used to identify and manage the priority farm animal genetic resources and their wild relatives. Anticipated project outputs include:

Indigenous Vietnamese pig (ILRI)

Following page: Farmer in Bangladesh feeding her indigenous chickens (A.K.F.H. Bhuiyan)

- breeding tools for low-input livestock production systems;
- tools for carrying out cost-benefit analysis of alternative breeding programmes for different indigenous breeds and populations under the existing and predicted future production systems; and
- analytical frameworks for assessing existing and potential policy and marketing options for farm animal genetic resources.

The project, through participatory processes, has already developed a set of baseline survey tools for assessing animal genetic biodiversity and constraints to conservation. The survey tool also assesses the role market agents and other stakeholders play in livestock management, the marketing opportunities that exist for various indigenous breeds and the contribution these breeds make to rural livelihoods.

In addition, project partners have developed a flock and herd monitoring tool to measure and quantify genetic and phenotypic diversity and track changes in diversity over time. This tool also captures the relationship of indigenous breeds with their wild relatives.

Increased capacity and strengthened institutions

Capacity building activities to implement these tools have been initiated in the project countries. Project partners have prepared training manuals for participatory rural appraisal, as well as household surveys and market agent surveys especially tailored to collect information on indigenous farm animal species. Project teams in each country have been trained in the use of these assessment tools. A shared database to store household level information on indigenous farm animal genetic resources has been developed and project teams have been trained on data entry, retrieval and system maintenance.

Stakeholders in the project sites, including farmers, extension agents, researchers and policy makers have been made aware of the project's objectives, activities and outcomes. Awareness raising activities have supported local institutions and involved them in the project. In Bangladesh the 'Indigenous Chicken Husbandry Association' and Indigenous Goat Husbandry Association' have been formed at the village level. In Vietnam, the 'Ho Chicken Association' has been strengthened by involving its members in the project's activities.

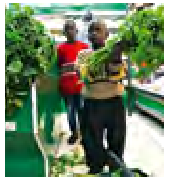
FORTHCOMING PROJECTS

Mainstreaming biodiversity conservation and sustainable use for improved human nutrition and wellbeing

Countries
Brazil | Kenya | Sri Lanka | Turkey

Executing agencies
Brazil: Ministerio do Meio Ambiente, Secretaria de Biodiversidade e Florestas
Kenya: Kenya Agricultural Research Institute, National Museums of Kenya, National Environment Management Authority of Kenya
Sri Lanka: Ministry of Environment and Natural Resources/ Department of Agriculture
Turkey: General Directorate of Agricultural Research
Global: Bioversity International

Project cost
GEF financing: USD 5.8
Expected Co-financing: USD 8.8
Total cost: USD 14.6
Expected start: 2011



Better nutrition from agricultural diversity

Brazil, Kenya, Sri Lanka and Turkey contain unique agricultural biological diversity that is crucial to the world's food supply. However, in these countries, as in almost every country, the contribution agricultural biodiversity makes to local food security and nutrition, especially in poor rural communities, is undervalued. As a result, precious opportunities to reduce hunger and malnutrition are lost and agricultural biodiversity is neglected because there is little incentive to engage in conservation efforts.
Through this project, planners from agriculture, health and environment sectors are working together to mainstream agricultural biodiversity into nutrition, food, and livelihood security strategies and programmes at the national and global level. This cross-sectoral collaboration will generate a portfolio of policy interventions that can serve as models applicable to a wide range of countries and ecosystems. In line with the CBD's cross-cutting initiative on biodiversity for food and nutrition, the project's activities will expand the global knowledge base by assessing the nutritional value derived from agricultural biodiversity, documenting traditional knowledge that sustains this biodiversity and making information available through a network of national and global databases and public awareness campaigns.

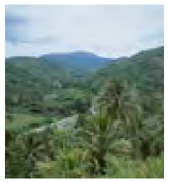
Left: MAB reserve 'Cuchillas del Toa' in Cuba (Frederik J.W. van Oudenhoven)
Right: Nairobi supermarket (S. Mann)

Agricultural biodiversity conservation and Man and Biosphere Reserves in Cuba: Bridging managed and natural landscapes

Country
Cuba

Executing agencies
Instituto de Investigaciones Fundamentales en Agricultura Tropical (INIFAT)
Centro Nacional de Areas Protegidas (CNAP)
Bioversity International

Project cost
GEF financing: USD 1.5 million
Expected Co-financing: USD 2.3 million
Total cost: USD 3.8 million
Expected start: 2012



Bridging managed and natural landscapes in Cuba

Much of Cuba's unique, native agricultural biodiversity can be found only in small pockets of land within and around the country's six Man and the Biosphere Reserves (MAB). This biodiversity, found nowhere else in the world, is threatened by environmental degradation caused by mining, logging and modern farm practices that rely on a limited amount of commercial crop varieties.
Farming communities have protected and nurtured this diversity for generations. However, current MAB management schemes do not take into account the ways farmers maintain this biodiversity and benefit from its use. This project creates a platform for planners from agriculture, environment, forestry and fisheries sectors to work together with local communities to produce an integrated system-wide management plan for Cuba's Biospheres; a cross-sectoral plan that can both ensure biodiversity conservation and safeguard the livelihoods of the rural poor in and around the country's Biosphere Reserves.

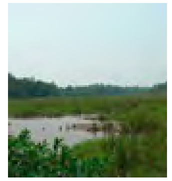
Mainstreaming agrobiodiversity conservation and use in Sri Lankan agro-ecosystems for livelihoods and adaptation to climate change

Country
Sri Lanka

Executing agencies
The Ministry of Environment and natural Resources
The Department of Agriculture
Bioversity International

International partners
The Platform for Agrobiodiversity Research

Project cost
GEF financing: USD 1.5 million
Expected Co-financing: USD 3.2 million
Total cost: USD 4.7 million
Expected start: 2011



Coping with climate change in Sri Lanka

Sri Lanka is home to a wealth of agricultural biodiversity that has both global significance and a central place in the livelihoods of traditional farming communities and indigenous peoples. This biodiversity is under threat from a variety of factors, in particular the introduction of high yielding varieties and unsustainable modern production practices. This has resulted in significant loss of diversity in major crops such as rice. Now climate change is compounding the problem.

The project aims to establish greater coordination among different national agencies so that agricultural biodiversity can be mainstreamed into strategies for ensuring the resilience and adaptability of the country's agricultural sector in the face of climate change. The project's first component provides support for the maintenance of existing practices that sustain on-farm diversity, such as informal seed systems, and for the development, testing and integration of a range of relevant adaptive management practices. The second component focuses on the livelihood and household economic aspects of agricultural biodiversity management. The third component involves the development of supportive policies and institutional frameworks.

Left: MAB reserve 'Cuchillas del Toa' in Cuba (Frederik J.W. van Oudenhoven)
Right: Owita agricultural ecosystem in Sri Lanka (Danny Hunter)

LESSONS LEARNED

On the right track

When this series of agricultural biodiversity projects began, it was understood that one of the main challenges would be bridging the large divide that has historically separated the agriculture and the environmental sectors; a divide exacerbated by the fact that current large-scale commercial agriculture is a leading driver of biodiversity loss. One of the major achievements of all the projects has been their contribution to bridging this divide in partner countries.

The notion that agricultural biodiversity can be a motor for environmentally sustainable economic growth has entered the mainstream. The rapid rise and high visibility of local food movements around the world indicate that a large part of the public embraces the concept that locally grown, traditional varieties of agricultural and forest products can support biodiversity conservation and make a contribution to improving the livelihoods of local producers. The public awareness work done by all the different partners and by the executing agencies involved in these projects has helped begin to move this idea from the margins to the mainstream.

The value of multi-country projects

This series of projects have also shown that multi-country projects, in comparison to single-country projects, deliver stronger global environmental benefits. The methodological and analytical tools, publications, articles, information systems and other outputs generated through these projects cover a wide range of ecosystems. They have been developed and disseminated according to standards agreed

◄ Children eating berries of *Physalis* sp. (Michael Hermann)

upon by teams of respected international and national experts working in close partnership with farming and forest communities. As a result, these outputs are relevant both regionally and internationally. They can be used by almost any country seeking to conserve and use its agricultural biodiversity and make their farming practices more sustainable. With suitable modifications to fit local conditions, good practices identified in these projects have great potential to be used in many other countries.

Multi-country projects also enable countries to address agricultural biodiversity that crosses national borders. Global and regional projects build international collaboration and cooperation to solve common problems and exchange of information. In addition, these projects provide opportunities to think 'out of the box' and come up with global solutions for sustainable conservation and use of biodiversity for food and nutritional security.

The need for an institutional memory

Although each project has addressed a particular technical component of agricultural biodiversity, these multi-country projects taken as a whole have also allowed for broader understanding of the 'generic' challenges involved in mainstreaming the conservation and sustainable use of biodiversity in agricultural production systems and in forest ecosystems.

Within the framework of each individual project, which are multi-sectoral and multi-institutional in nature, global and national executing organizations shared experiences on the particular organizational and social factors that influenced their activities. As each project faces similar institutional challenges, this sharing of information and experiences offers valuable opportunities for UNEP, GEF and the global and national executing agencies to formalize a regular exchange of experiences and insights gained during the implementation of agricultural biodiversity projects. The results of these formalized exchanges would generate an institutional memory that could be put to use to strengthen the design and implementation of future projects.

From genetic resources to ecosystem services

The UNEP-GEF agricultural biodiversity projects have always focused on both the valuable genetic materials and the important services derived from the conservation and sustainable use of agricultural biodiversity.

The landraces and crop wild relative project concentrated on inventories and *in situ* and on-farm conservation strategies for particular crop wild species of value for national agriculture. The ongoing regional projects related to fruit trees and livestock continue to assess and demonstrate the economic and market value of the 'goods' obtained from traditional agricultural biodiversity management practices.

On the other hand, the below-ground biodiversity project catalogued neglected below-ground biodiversity based on its functional role in agriculture and demonstrated the value of ecosystem services in production systems. The trend toward ecosystem services can be seen in the ongoing pest and diseases and pollination projects. The three most recent projects also address different types of functions and services that agricultural biodiversity can deliver to make farming systems more sustainable and valuable to local communities.

The interactions between organisms that provide ecosystem services for agricultural production, as well as other valuable social and environmental functions, are not limited to individual farms. They play out over the entire landscape. For this reason, the move toward services and functions is clearly aligned with the ecosystem approach to sustainable development. In addition, the management of biodiversity over an entire landscape is by necessity a community affair, and consequently the number of people involved in biodiversity conservation activities becomes significantly larger.

The need to confront climate change

The shift in emphasis to ecosystem services provided by agricultural biodiversity is particularly significant in the face of global climate change. Studies carried out in the project on crop wild relatives demonstrated how areas currently suitable for certain populations of wild crop relatives are expected to diminish and shift. All landscapes, 'natural' and 'agricultural' are likely to undergo profound transformations in their biodiversity as global climate changes.

As climate change transforms agricultural ecosystems, some crops may no longer be cultivated and biodiversity will be lost. Other factors, such as changes in global trade policies and food consumption patterns may also have profound consequences on the systems that determine the value of the goods derived from agricultural biodiversity. Under these changing circumstances, their value may not remain constant. What will remain constant in agricultural production systems, however, is the need for ecosystem services. While considering the impact of climate change on biodiversity, the greatest attention should be placed on its impact on the livelihoods of rural people. Will farmers, rural communities and markets will be able to adapt?

Maintaining the adaptability and resilience of production systems under changing environmental conditions will be one of the crucial services agricultural biodiversity will be relied upon to provide. The recent national project on climate change in Sri Lanka will explore this area.

▲ MAB reserve 'Cuchillas del Toa' in Cuba (Frederik J.W. van Oudenhoven)

Building bridges between natural and agricultural ecosystems

In concentrating more on conserving and using agricultural biodiversity to make production systems more adaptable and resilient, future projects may need to address more directly the interface between wild and domestic areas. As indicated earlier, the interactions among diverse organisms responsible for providing ecosystem services take place over a wide area. They do not recognize distinctions between protected and unprotected lands nor political borders.

By working in margins between protected and agricultural lands, future projects can support the conservation and use of both agricultural and natural biodiversity. Climate change may threaten populations of a number of species within a given protected area or a country. By building bridges between natural and agricultural ecosystems and increasing biodiversity-rich agricultural zones adjacent to protected areas, plant and animal species are accorded a wider set of options for adaptation to changing conditions. The most recent project in Cuba explicitly recognizes the importance of building bridges between managed and natural landscapes.

THE WAY FORWARD

More mainstreaming

Through GEF, UNEP will continue to support partner countries to explore innovative approaches for using agricultural biodiversity as an entry point for mainstreaming biodiversity conservation into many different sectors. The projects on crop wild relatives and fruit trees have provided opportunities for various sectors such as agriculture, forestry, environment to work together and learn from each other. Through the nutrition project, inroads are being made into the health, nutrition and education sectors. Climate change is expected to bring an increase in extreme weather events, such as hurricanes, droughts and flooding. Integrating agricultural biodiversity into disaster risk management planning could save lives and boost biodiversity conservation.

Becoming more holistic

The UNEP implemented GEF projects have dealt with distinct components of agricultural biodiversity. Often these components have been singled out by the COP as requiring special attention. However, it is now time to assist partner countries in designing projects that integrate the different components of agricultural biodiversity in ways that better reflect how it is used by farmers and foresters on the ground. A more holistic approach that addresses the relationship between the different components of agricultural biodiversity may be needed.

Up-scaling results

In implementing GEF supported projects, UNEP is interested not only in obtaining results during the project cycle. It is important that these results have an enduring value after the projects have come to a close.

◄ Floating fruit market in Bangkok, Thailand (Bhuwon Sthapit)

▲ Rice based agricultural ecosystem in Sri Lanka (Anura Wijesekara)

Up-scaling of project results is a priority for UNEP. This is why all UNEP implemented GEF projects place an emphasis on building the capacities of project partners and disseminating results and good practices to other regions. In the future, it will be important to monitor the efforts made by individual countries to build on project results to confirm whether up-scaling really happens on the ground.

Establishing a compendium of best practices

For agricultural biodiversity to be successfully conserved and sustainably managed, people from local communities must participate meaningfully in conservation efforts. For this reason, many UNEP-GEF projects have focused on identifying good practices for community-based conservation of agricultural biodiversity. In the future, it will be important to collect, document and categorize these good practices, along with descriptions of the context in which they were successful. This 'compendium', would ensure that researchers and development workers would not have to reinvent the wheel every time new agricultural biodiversity projects are developed and would contribute to building an institutional memory among national and international partner agencies. Such an on-line compendium would be dynamic resource, expanding as additional good practices are identified through new projects.

Carbon credits for agricultural biodiversity

Carbon credits are a key component of national and international attempts to mitigate the growth in concentrations of greenhouse gases. They provide a way to reduce greenhouse gas emissions by giving them a monetary value. Internationally tradable, they can be exchanged between businesses or bought and sold in the market place and used to help marginal projects become viable. The current system for carbon credit exchange does not credit agricultural biodiversity in tree farms, nurseries or fruit orchards for the conservation benefit that these lands provide. This is an area that may require further investigation. If partner countries are willing, it may be possible to examine whether some components of agricultural biodiversity could be eligible for claiming carbon credits.

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