



The International Treaty

ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE



Conservation and Sustainable Use under the International Treaty





The International Treaty
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Conservation and Sustainable Use under the International Treaty

This is the second educational module in a series of training materials
for the implementation of the International Treaty on Plant
Genetic Resources for Food and Agriculture

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Foreword

The challenges we face are substantial: about one billion people are suffering from chronic hunger and malnutrition, while it is predicted that world food production needs to increase by 70 percent by 2050, relying on a natural resource base that is reaching its limits and with climate change adding further pressures on agriculture and acting as a main driver of crop diversity loss.

The good news is that a range of approaches and tools to overcome these challenges are within our reach. The food security of millions of resource-poor smallholder farmers in developing countries relies on diverse cropping systems as risk management strategies against pests and severe weather conditions. The need to adopt ecologically sound agricultural practices is being increasingly recognized by producers in industrialized countries. Many cost-effective techniques have been developed to conserve crop genetic resources safely in facilities such as gene banks, as well as in the surroundings where they have developed their distinctive traits. Modern plant breeding is essential for global food security in the context of climate change. Varieties that achieve higher yields and are resistant to pests and extreme weather events need to be developed. At the same time, the traditional knowledge of farmers is crucial for the development of varieties that are adapted to local conditions. Increasing linkages between gene banks, plant breeders and farmers is of particular importance to strengthen the continuum of conservation and sustainable use of crop diversity.

The International Treaty provides the agreed policy framework for concerted conservation efforts on farms and in gene banks, and for the promotion of measures for the sustainable use of crop diversity through research, plant breeding and cultivation. The Contracting Parties of the International Treaty have created a global gene pool of more than 1.3 million samples of crop genetic material that they govern collectively. This gene pool constitutes the basis of over 80 percent of the world's food derived from plants, and it is becoming our most important tool for adapting agriculture to climate change. Furthermore, the International Treaty's Benefit-sharing Fund directly supports projects that focus on climate change adaptation through on-farm management and sustainable use of crop diversity.

Ratification of the International Treaty by over 127 countries proves that most governments have recognized the importance of agricultural biodiversity for sustained food security, and are aware of the threats to crop genetic resources as well as the need to develop specific policies to ensure their conservation and wider use.

However, it is fundamental that the legal provisions of the International Treaty are translated into effective measures at international, regional, national and local level. The need for capacity development to that end has been voiced by a large number of Contracting Parties and other stakeholder groups. This educational module is one means by which the Secretariat seeks to strengthen stakeholders' capacities to promote conservation and sustainable use of crop diversity.

We are confident that these training materials will make a substantial contribution to the effective implementation of the International Treaty.



Shakeel Bhatti
Secretary

International Treaty on Plant Genetic Resources for Food and Agriculture

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This module is the second in a series of training materials on the International Treaty. We owe a lot to the experts in the area of capacity development that have shared their experiences with us during the conceptualization phase of the series, as well as the technical support group that has been involved in the elaboration of the curriculum outline for the modules. In this regard, we would like to thank in particular Elizabeth Goldberg and Gerald Moore from Bioversity International, Kakoli Ghosh from the FAO Plant Production and Protection Division, Mauricio Rosales from the FAO Right to Food Unit, Regine Andersen from the Fridtjof Nansen Institute, Kirsty McLean from the United Nations University, Wilhelmina Pelegrina from Southeast Asia Regional Initiatives for Community Empowerment and Clair Hershey from Cornell University, at the time working with FAO.

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Introduction

Capacity development is crucial for the effective promotion of the objectives of the International Treaty. This educational module is a tool that helps strengthening the development of both technical and functional capacities necessary for the implementation of the International Treaty among its key stakeholders, in particular in the area of conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA).

FAO's Corporate Strategy on Capacity Development defines 'capacity development' as the process of unleashing, strengthening and maintaining the ability of people, organizations and society as a whole to manage their affairs successfully. The FAO capacity development framework is based on the enhancement of technical and functional capacities across the three dimensions of individuals, organizations and the enabling environment.

Functional capacities refer to policy and normative capacities, knowledge management, partnering and programme implementation capacities. In the context of the International Treaty, this type of capacities is required to enable Contracting Parties, civil society organizations and other relevant institutions and key actors, to engage in policy dialogues and establish programmes and projects for the conservation and sustainable use of PGRFA. The various stakeholders that work in crop conservation and use in their daily activities, such as agricultural researchers, gene bank personnel, breeders and farmers, require technical capacities to carry out their respective roles in the conservation and the sustainable use of PGRFA.

National civil servants involved in the establishment of programmes to implement the international instruments that their governments have ratified often need to become fully acquainted with the technical details of these instruments. Technical stakeholders, in turn, often are not familiar with all legal aspects of the international policy framework within which they operate, and require further training. This educational module therefore aims at strengthening both technical and functional capacities, by presenting different conservation techniques and measures to promote the sustainable use of PGRFA, explaining the legal provisions of the International Treaty and providing examples of how these can be implemented by different stakeholder groups.

The module is designed to strengthen stakeholders' capacities for the operation of the International Treaty and to enhance information and raise awareness among other interested parties, including academia and the media. The material can be used for self-learning purposes, as a reference work on the International Treaty, and as an information resource for the development of awareness-raising material. Thus, it addresses the three capacity development dimensions of individuals, organizations and the enabling environment.

Development Process of this Module

The main features of the development process for this educational module were the following:

- The main target learner groups and their learning needs were identified.
- A draft curriculum outline with learning objectives and lesson outlines responding to these needs was designed by the Secretariat of the International Treaty.
- A support group of experts representing different stakeholders and target learner groups was established.
- Through an electronic consultation the support group provided guidance in shaping the outlines of the lessons and suggested possible authors and peer reviewers.
- Knowledgeable experts in the relevant technical areas were invited to act as authors and peer reviewers of the lessons.
- A peer review process was set up in order to ensure correctness, coherence and balance of the lessons.
- The Secretariat of the International Treaty coordinated the inputs of the peer reviewers into the draft lessons and ensured the editing and publication of the module.

The main target learner groups correspond broadly to the stakeholders of the International Treaty. Their needs were initially identified by means of a survey on capacity development needs carried out by the Secretariat, taking into account existing tools and materials, as well as the needs and gaps expressed in different resolutions of the Governing Body of the International Treaty, the Reports on the State of the World's Plant Genetic Resources for Food and Agriculture and the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture.

The support group of experts was established following the criteria of technical expertise in capacity development methodologies and the subject matters of conservation and sustainable use of PGRFA. In addition, the group responded to the criteria of regional balance.

The first module of this series ("Introduction to the International Treaty on Plant Genetic Resources for Food and Agriculture") was presented to Contracting Party delegates and other stakeholders in a launching event on the occasion of the Fourth Session of the Governing Body of the International Treaty in March 2011. The Governing Body welcomed the educational modules and encouraged the Secretariat to continue its work on training materials, including through collaborations with Bioversity International and other relevant institutions.

Target Learner Groups

As a capacity development tool for the effective implementation of the International Treaty, this module is targeted mainly at the International Treaty's stakeholder groups. In addition, the module also represents a valuable resource for the media and academia which play a particular role in raising awareness on the importance of the International Treaty for food security and climate change adaptation by popularizing it among the general public.

The main learner groups thus include:

- Policy makers and their staff;
- Civil servants;
- Gene bank staff;
- Plant breeders;
- Farmers' organizations;
- other civil society organizations;
- Media; and
- Academia.

The specific target learner groups are indicated at the outset of each lesson.

How to Use this Module

The range of different stakeholders involved in the implementation of the International Treaty is very broad, with different stakeholders having different backgrounds and roles and thus different learning needs.

Whereas Module I of this series of educational modules was designed for newcomers to the International Treaty and the crop diversity policy area from all learner groups, each lesson of this module is targeted at a more specific set of target learner groups.

Lesson 1, for example, focuses on technical aspects of conservation and sustainable use of PGRFA, which will be particularly relevant for civil servants that do not have a technical background in genetics or plant breeding. Lessons 2 and 3, in turn, explain the legal provisions of the International Treaty and decisions of its Governing Body, which will be useful to technical persons involved in gene bank management and plant breeding wishing to improve their understanding of the legal framework they are working in. Lesson 4 has something to offer for each one of the learner groups, as it brings all stakeholders together in the context of a fictitious Contracting Party.

This module builds on Educational Module I, in particular on sub-section 4.2.1. of its lesson 4 (Main Components and Governance of the International Treaty). However, learners that already have some basic knowledge of the International Treaty will be able to begin directly with the lessons of Module II. Each lesson contains cross-references to relevant other lessons.

The lessons are composed as follows:

- **Learning objectives** presenting the knowledge that learners will acquire throughout their lecture are indicated at the outset of each lesson.
- **Target learner groups** have been defined for each lesson. They are indicated on the same page as the learning objectives. Although the lessons have been designed for specific target learner groups, each of them may contain relevant information for learners of other groups, too. The lessons are cross-referenced accordingly.
- **Overview of the lesson.** Each lesson provides an overview of about one page, presenting the topics that are dealt with on the subsequent pages.
- **Key points to remember** are brought together after the main sections of the lessons in order to help learners remember the main contents and messages.
- **Cross-references** to related content of the other lessons and relevant internet resources are also indicated for each main section of the lessons.
- **Conclusive summary.** Each lesson ends with a conclusive summary of about one page, summarizing the key points of the lesson.
- **Bibliographic references** on which the lessons are based and that are useful for further reading on the topic can be found at the end of each lesson. For ease of reference Internet links are provided for the resources, where available.

Overview

LESSON 1

What is Conservation and Sustainable Use?

Page 1

This lesson familiarizes learners with the technical background on conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA). It discusses the importance of crop diversity for global food security and presents complementary conservation methods and their relative advantages and disadvantages. The lesson further elaborates on the concept of sustainable use of crop diversity, and highlights the linkage between conservation and sustainable use.

LESSON 2

The Provisions of Articles 5 and 6 of the International Treaty

Page 43

Lesson 2 explains the measures to promote conservation and sustainable use of PGRFA as contained in the provisions of articles 5 and 6 of the International Treaty in detail. It indicates for each measure the corresponding priority activities of the Second Global Plan of Action where detailed policy recommendations can be found. The lesson is further illustrated with examples of projects supported by the Benefit-sharing Fund that focus on on-farm management and sustainable use.

LESSON 3

Further Components of the International Treaty Supporting Conservation and Sustainable Use

Page 81

Complementary to lesson 2, this lesson provides the learner with insight on further components of the International Treaty that directly support articles 5 and 6. It focuses in particular on the role of the Second Global Plan of Action as a key instrument for the implementation of the provisions on conservation and sustainable use of the International Treaty, and presents the main decisions of the Governing Body with regard to conservation and sustainable use of PGRFA.

LESSON 4

Options and Examples for Implementation of Articles 5 and 6 from a Users' Perspective

Page 105

This lesson illustrates a range of options for the implementation of articles 5 and 6 of the International Treaty, presenting concrete activities that contribute to the conservation and sustainable use of crop genetic resources. The lesson takes the learner to the fictitious country of Develania where a number of Develanian stakeholders, including a gene bank manager, a plant breeder, a chairman of a farmers' association and a chef, guide the learner through their respective activities.

What is Conservation and Sustainable Use?



LESSON 1



Learning objectives

At the end of this lesson, the reader will be able to:

- recognize the necessity to conserve crop diversity for the use of present and future generations;
- summarize different conservation techniques;
- recognize the need for a complementary approach to *in situ* and *ex situ* conservation;
- describe the concept of sustainable use of crop diversity;
- illustrate the strong linkage between conservation and sustainable use of crop diversity by means of some concrete real-world examples.



Target learner groups

Policy makers and their staff, civil servants, as well as other interested parties and institutions.



Solanum melongena, eggplant, by Elizabeth Blackwell (1739)

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1.1. Overview of the Lesson

Crop diversity is one of the most fundamental resources on earth, on which the food security and well-being of humankind depend. In recognition of the threats posed by global changes, the world community has taken measures with the aim to ensure that crop genetic diversity is properly conserved and used sustainably. Most notably, conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA) are among the three main objectives of the International Treaty on Plant Genetic Resources for Food and Agriculture (hereafter “International Treaty”). The third objective is the fair and equitable sharing of benefits that arise from the use of PGRFA.¹ This lesson will examine the nexus between conservation and sustainable use and provide examples of how this linkage can be further strengthened.

The first section discusses the importance of crop diversity to food security and the threats it faces. Among them are the impacts of climate change on crop diversity and the genetic vulnerability of agricultural production systems resulting from the widespread adoption of the same improved

varieties over millions of hectares. The two major methods for conservation of crop diversity will be described, and different techniques for conserving crop diversity *ex situ* (seed banks, field gene banks, *in vitro* storage, cryopreservation, DNA storage, botanical gardens) and *in situ* (conservation of crop wild relatives (CWR) in wild habitats and of traditional crop varieties on-farm) will be explained. The relative advantages and disadvantages, as well as the complementarities of *in situ* and *ex situ* conservation methods, will also be discussed.

In the last section, the concept of sustainability is explained as it relates to the use of crop genetic diversity. The extent of use of collections of PGRFA is discussed and reasons provided as to why PGRFA are often not optimally utilized. Some examples of how the crop diversity that is conserved both in gene banks and *in situ*/on-farm can be better used to cope with climate change are given as an illustration of how the linkage of conservation and sustainable use can and needs to be further strengthened.

Cross-references:

- For the **text of the International Treaty** see: <ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf>
- To learn more about the **objectives of the International Treaty** refer to sub-section 2.2.1. of lesson 2 of Module I (Objectives, Scope and Basic Concepts).
- For more detailed background information on the **global challenges of crop diversity, food security and climate change**, and the ways the International Treaty addresses these challenges, refer to section 1.2. of lesson 1 of Module I (A Global Treaty for Food Security in an Era of Climate Change).
- For working **definitions of terms and concepts** such as crop diversity, PGRFA, food security, etc, refer to section 2.3. of lesson 2 of Module I (Objectives, Scope and Basic Concepts).

¹ International Treaty on Plant Genetic Resources for Food and Agriculture (2001), Article 1.





1.2. Complementary Conservation Methods

1.2.1. Importance of Crop Diversity Conservation for Present and Future Food Security

Crop diversity is one of the most fundamental and essential resources to humankind, as we depend entirely on it for our food security and well-being. Since the beginning of agriculture about 10 000 years ago, plant diversity has been the raw material that enabled farming systems and agriculture to evolve. Food plants have been collected, domesticated, used and improved through traditional systems of selection over many generations. Today, however, 75 percent of the world's food is generated from just 12 plant and five animal species. Of the 4 percent of the 250 000 to

300 000 known plant species that are edible for humans, we only use 150 to 200 and only three - rice, maize and wheat - contribute nearly 60 percent of the calories and proteins we obtain from plants.²

The diversity of genetic resources resulting from the selection processes practiced by early farmers now forms the basis on which modern high-yielding and disease-resistant varieties are being produced.³ Indeed, breeding and agronomic improvements have, on average, achieved a linear increase in food production globally, at an average rate of 32 million metric tons per year over the period 1961 to 2007.⁴ About half of this increase is attributable to plant breeding.



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² FAO (2005), p. 3.

³ Plucknett (1987).

⁴ Tester and Langridge (2010), p. 819.



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The improvement of crop performance has also increasingly relied on the use of genes from wild relatives of domesticated crops.⁵ Without the genes from CWR, many useful traits, such as pest and disease resistance, abiotic stress tolerance or quality improvements, would not exist in today's crops. For example, genes from *Oryza nivara*, a wild relative of rice, are providing strong and extensive resistance to grassy stunt virus on millions of hectares of rice fields in South and Southeast Asia.⁶ A chickpea cultivar with wild genes conferring drought and heat tolerance yields about 40 percent more than competing cultivars.⁷

Crop diversity is of particular importance to food security as diversity within a field or within a production system is likely to enhance stability in overall food production. A diverse cropping system helps to buffer against the spread of pests and diseases and the vagaries of weather, which are more likely to occur in a monoculture of a uniform variety. In other words, crop diversity helps to reduce

'genetic vulnerability'. This is a term used to describe the condition that results when every individual of a widely planted crop is uniformly susceptible to a given pest, pathogen or environmental hazard. Genetic uniformity creates a potential for widespread crop losses.⁸ In the global context, the phenomenon of genetic vulnerability represents a major risk with regards to the capacity of our agricultural system to ensure sustainable food security, as well as to the livelihoods of farmers.

Therefore, in its Article 6.2f), the International Treaty calls for the conservation and the wider use of crop diversity and the creation of strong links to plant breeding and agricultural development in order to reduce crop vulnerability and genetic erosion. Box 1.1 below provides an example of genetic vulnerability of taro in Samoa. Other examples where crop uniformity led to crop failures through pest and diseases include the cases of the destruction of maize crop in the United States by a race of maize leaf blight⁹, susceptibility of Cadenvish banana by the

⁵ Hajjar and Hodgkin (2007), p. 1.

⁶ Barclay (2004), p.15.

⁷ Hajjar and Hodgkin, *Op. cit.*, p. 6.

⁸ NRC (1972), p. 6.

⁹ *Idem*, pp. 5-16.





Box 1.1: An Example of Genetic Vulnerability – the Case of Taro Leaf Blight in Samoa

Taro was a very important cash crop for Samoan farmers until the early 1990s. More than 90 percent of households grew taro, mostly of the Nuie variety, which was thus planted uniformly across very large areas. In June 1993 an outbreak of the taro leaf blight disease severely affected the crops, resulting in a loss in the export market of around US\$ 4 million per year with a similar decline in domestic supplies. The blight destroyed the whole taro industry and Samoans abandoned taro cultivation and shifted to planting sweet potatoes.¹⁰

The impact of this blight led to the development of a project called ‘Taro Genetic Resources: conservation and utilization’ (hereafter “TaroGen”). TaroGen is a regional project working with national programmes to develop a regional strategy for taro genetic resources conservation and crop improvement, working on disease control and ways to prevent further loss of genetic resources and spread of the disease, through the development of improved lines and resistant varieties.

This example illustrates clearly the devastation that a disease can cause when diversity is not consciously integrated into production systems, and highlights the vulnerability of widely distributed uniform taro populations that were cultivated for decades in the absence of the disease.

fungal disease Black Sigatoka, and cotton crop by Cotton Leaf Curl Virus.¹¹

The above examples serve to illustrate the vulnerability of uniform agricultural production systems. Thereby, they highlight the importance of conserving genetic diversity of crops, to stabilize crop production and reduce the risk of crop failures due to pests and diseases through plant breeding and crop diversification. Many agricultural communities consider local crop diversity a critical factor for the long-term productivity and viability of their agricultural systems.¹² For example, interweaving multiple varieties of rice in the same paddy has been shown to increase productivity by lowering the loss from pests and pathogens.

Maintaining crop diversity is also a key strategy for farmers around the world to guarantee their sustenance. Many studies have shown that crop genetic diversity in the form of traditional varieties continues to be maintained on-farm by poor, small-scale

farmers who rely on traditional crop varieties to meet their livelihood needs.¹³ Such diversity is vital to cope with the vagaries of climate for farmers who depend on rainfed agriculture. It is common to find poor farmers growing many varieties of the same crop to increase the likelihood of producing a crop to feed their families, regardless of the specific weather conditions in a given year. For example, a farmer in Papua New Guinea mentioned that he grows 50 different varieties of sweet potato on his farm.¹⁴

In addition, many plant species growing in wild ecosystems are valuable for food and agriculture and often play an important cultural role in local societies. They can provide a safety net when food is scarce and are increasingly marketed locally and internationally, providing an important contribution to household incomes.¹⁵ Further, CWR provide genetic variability that can be crucial for overcoming outbreaks of pests and pathogens and new environmental stresses.¹⁶

¹⁰ Chan *et al.* (1998).

¹¹ FAO (2010), p. 184.

¹² MEA (2005), p. 73.

¹³ Bezançon *et al.* (2009); Kontoleon, Pascual and Smale (2009); Rana *et al.* (2007); Sadiki *et al.* (2007).

¹⁴ Prem Mathur, personal communication.

¹⁵ FAO *Op. cit.*, p. 31.

¹⁶ Maxted *et al.* (2008).

Cross-references:

- For more detailed explanations of the **measures to promote conservation and sustainable use of PGRFA put forward in articles 5 and 6 of the International Treaty**, refer to lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).

The Need for Conservation of Crop Diversity

In a changing world where climate change, rising food prices and other drivers are affecting food security and the environment, the conservation and use of crop diversity for food and agriculture is becoming increasingly important. FAO estimates that food production will need to be increased by 70 percent in order to meet the food demands of the expected 9.2 billion people by 2050 and that much of this increase will

have to come from the further use of crop diversity.¹⁷

Many threats or drivers of change in biodiversity have been recognized and found to have intensified in recent years.¹⁸ With regard to agriculture, the most important ones include changes in land use, replacement of traditional varieties by modern cultivars, agricultural intensification, increased population, poverty, land degradation and environmental change (including climate change).¹⁹



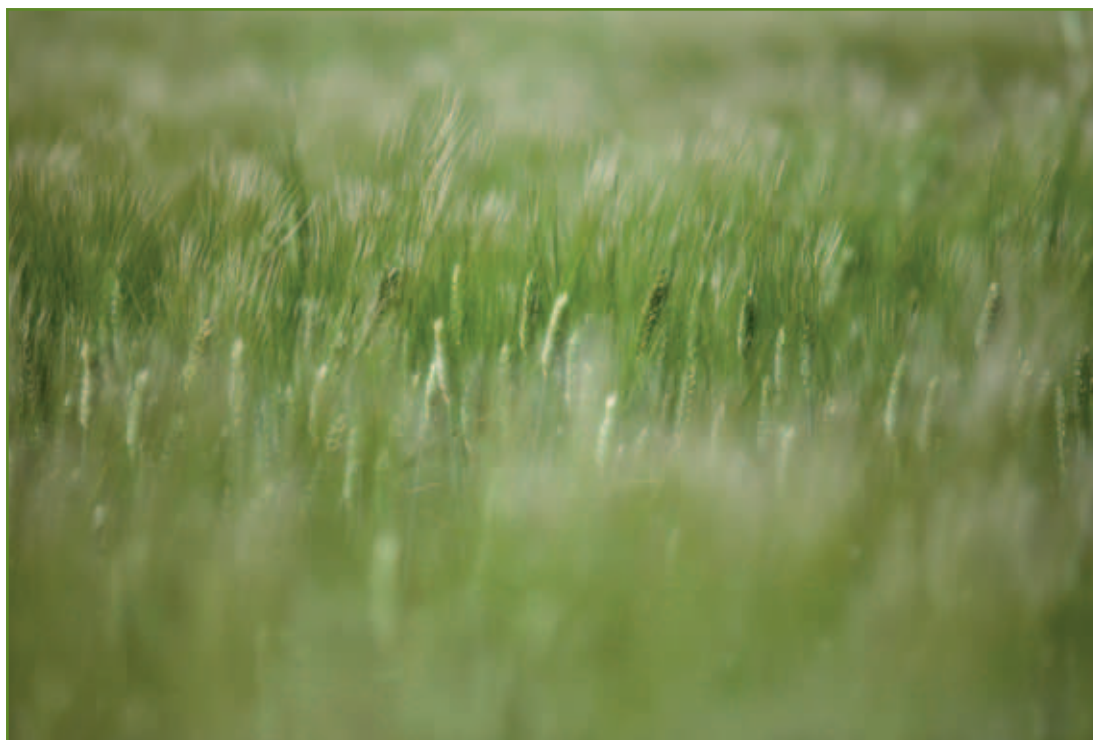
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¹⁷ FAO (2010), p. 183.

¹⁸ MEA (2005), pp. 14-16.

¹⁹ FAO, *Op. cit.*, pp. 43-44; Dulloo, Hunter and Borelli (2010), pp. 123-124; Van de Wouw *et al.* (2009).





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The introduction of improved varieties of crops (i.e. ‘modern crops’) is one of the major factors affecting crop diversity in agricultural production systems. FAO reports that this is a major issue in more than 40 countries. For example, Pakistan reported that the release of certain high yielding varieties of black grams, chickpea, lentils and mung beans has led to the loss of local varieties from farmers’ fields.²⁰ The replacement of local varieties with modern varieties may also increase genetic vulnerability and thus the propensity for crop failures.

Appropriate breeding methods that allow to breed desirable resistance and adaptation traits into modern varieties are one way to reduce vulnerability. This will often include the use of a broad genetic base in the breeding process and the close participation of farmers in establishing selection criteria. Another strategy to reduce crop vulnerability, however, is to use a range of locally adapted varieties in the same field, especially for farmers in the developing

world that live in marginal areas, as it presents a more easily applicable solution that does not require extensive technical knowledge.

It is predicted that climate change will have a significant impact on agriculture, with temperatures rising on average between 2 and 4 degrees Celsius over the next 50 years, causing significant changes in regional and seasonal patterns of precipitation.²¹ Recent climate projections²², and comparisons of current global suitability maps for cultivation of 43 crops with those projected for 2050, revealed that suitable areas for those crops may decline by more than 50 percent. Evidence based on bioclimatic modelling suggests that climate change could cause a marked contraction in the distribution ranges of CWR. In the case of wild populations of peanut, potato and cowpea, studies suggest that 16-22 percent of these species may become extinct by 2055, with most species possibly losing 50 percent of their range.²³

²⁰ FAO (2010), p. 44. The reported high yielding varieties were *Vigna mungo* (L.) Hepper, *Cicer arietinum* (L.), *Lens culinaris* Medikus and *Vigna radiata* (L.) R. Wilczek, respectively.

²¹ Burke, Lobell and Guarino (2009); IPCC (2007), p. 13.

²² Lane and Jarvis (2007).

²³ Jarvis, Lane and Hijmans. (2008), p. 8. The wild species referred to belong to *Arachis* spp., *Solanum* spp. and *Vigna* spp., respectively.



These threats or drivers of change are likely to lead to loss of agricultural biodiversity and consequently its genetic variability.²⁴ Information regarding the threat from and rate of genetic erosion among various components of agricultural biodiversity is important, yet very little work has been carried out to quantify the magnitude of any

trends.²⁵ The availability of large gene pools, including CWR, is becoming even more important as farmers will need to adapt to changing conditions that result from these pressures. It is likely that many of the genetic traits which will be necessary to adapt our crops to changing climate will be found in CWR.

Key points to remember:

- Food plants that have been domesticated and selected by farmers over the last 10 000 years are the raw material for today's modern plant breeding.
- Plant breeding has accounted for half of the steadily growing yield increases since the 1960s. The role of plant breeding for crop diversity will become even more important as food production needs to be increased by 70 percent by 2050.
- Crop diversity contributes to reducing genetic vulnerability, as diverse farming systems are more resistant to pests, diseases and environmental stresses.
- Many farmers, especially smallholders in developing countries, rely on crop diversification as a strategy to minimize the risk of crop failure.
- Wild edible plants contribute to household incomes and can provide safety nets when food is scarce.
- The continuing trend of replacing genetically diverse traditional varieties with improved uniform varieties in many countries, and the increasing impacts of climate change, are main drivers of genetic erosion.
- CWR provide genetic variability that can be crucial for overcoming outbreaks of pests and pathogens and new environmental stresses. It is likely that many of the traits necessary to adapt our crops to climate change will be found in CWR.
- The International Treaty calls for the conservation and wider use of crop diversity, and the creation of strong links to plant breeding and agricultural development, to reduce crop vulnerability and genetic erosion, for global food security.

Cross-references:

- For the **text of the International Treaty** see: <ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf>
- For a general overview of the **importance of the International Treaty** to cope with the triple challenge of countering the loss of crop diversity and using it more effectively to achieve and maintain food security under the growing pressures of climate change, refer to section 1.2. of lesson 1 of Module I (A Global Treaty for Food Security in an Era of Climate Change).

²⁴ MEA (2005), pp. 37, 41, 62. ; Van de Wouw *et al.* (2009).

²⁵ Dulloo, Hunter and Borelli (2010), p. 124; Frankham (2010).



1.2.2. Different Methods and Techniques of Conservation

There are two main methods of conservation of crop diversity: *ex situ* and *in situ* conservation. Different techniques for both methods of conservation are outlined below. In its Article 2, the International Treaty defines *ex situ* conservation as “the conservation of plant genetic resources for food and agriculture outside their natural habitats” and *in situ* conservation as “the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated plant species, in the surroundings where they have developed their distinctive properties”.

Ex Situ Conservation Techniques

Ex situ conservation is usually carried out in gene banks and botanical gardens. Different types of gene banks have been established for the storage of plant diversity, depending on the type of plant material conserved.

These include seed banks (for seeds), field gene banks (for live plants), *in vitro* gene banks (for plant tissues and cells), pollen and Deoxyribonucleic acid (DNA) banks.²⁶ The form of *ex situ* conservation used is largely determined by the method of reproduction of the species being conserved and the purpose of the conservation and use of the plant material. Currently, there are about 7.4 million PGRFA accessions conserved in over 1750 gene banks. More than 2500 botanical gardens grow over 80 000 plant species.²⁷

Seed Banks

Seeds are usually the most convenient and easiest material to collect and to maintain in a viable state (i.e. capable of germination) for long periods of time, and are therefore often the preferred option for conserving PGRFA.²⁸ Seeds are typically conserved at moisture content between 3-7 percent, and stored at 4 degrees Celsius for short-term conservation, and between -18 and -20 degrees Celsius for long-term conservation.²⁹ Seeds that can be conveniently stored under such conditions are known as ‘orthodox’ seeds.



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²⁶ Engelmann and Engels (2002); Thormann and Dulloo (2006).

²⁷ FAO (2010), pp 55, 85.

²⁸ Roberts (1973).

²⁹ FAO/IPGRI (1994), p. 4; Rao *et al.* (2006a, p. 1; 2006b).

However, not all seeds can be conserved under these conditions.³⁰ Many seeds of tropical origin are known to lose viability and die on drying or when exposed to cold. These are said to be ‘recalcitrant’, and are typically fleshy and large. Examples of such crops include cacao, coconut, mango, oil palm and rubber. In these cases, if conserved *ex situ*, the species need to be conserved as live plants in field gene banks or as plant material other than seeds, e.g. in tissue culture.

Field Gene Banks

A field gene bank is a collection of plants assembled and grown in a field or very often in pots in a screen house or green house. Field gene banks are the most common means of conserving diversity in crops which cannot be conserved as seeds, such as species having recalcitrant seeds or those which are not propagated by seeds, like roots and tubers, and other vegetatively propagated crops.³¹ Vegetative propagation is the ability of plants to reproduce without sexual

reproduction, by producing new plants from existing vegetative structures.

Field gene banks have the advantage that the material can be readily used for characterization and research in the field, compared to other forms of *ex situ* conservation, where the plant material must first be germinated/regenerated and grown before it can be used for those purposes. Characterization refers to the recording of highly heritable characters that can be easily seen and are expressed in all environments. However, although field gene banks do not need costly equipment and sophisticated technology, they are normally more expensive to maintain compared to any other form of *ex situ* conservation, such as seeds or cryopreservation (see Box 1.2).³² The maintenance of living collections requires large inputs of labour and time, and vast areas of land to contain adequate samples of the genetic variability of the species. They are vulnerable to pests and diseases and bad weather conditions, and only limited genetic material can be conserved because of the space factor.³³



Courtesy Flickr/Mavis

³⁰ Hong and Ellis (1996), pp. 10-20.

³¹ Reed *et al.* (2004), pp. 10-15.

³² Dullo *et al.* (2009).

³³ Dullo *et al.* (2001).





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In Vitro Storage

In vitro storage is an alternative method which is complementary to field gene banks for the storage of vegetatively propagated species and has good potential for species with recalcitrant seeds. It involves the maintenance of cells or plant tissue transferred to a sterile, pathogen-free environment with a synthetic nutrient medium, usually in a test tube or glass jar.³⁴

It is possible to establish a working tissue culture facility with minimal resources. The major pre-requisites for *in vitro* conservation are, however, the availability of skilled personnel and reasonably equipped laboratory facilities. *In vitro* stored material can be rapidly propagated and disseminated. However, the technique requires suitable crop-specific (sometimes species-specific) protocols to be developed. A protocol is a set

Box 1.2: Cost-effectiveness of Cryopreservation

The cost-effectiveness of cryopreservation as compared to field collections as a long-term conservation method has been demonstrated in a study on coffee genetic resources. This study compared the per unit costs of maintaining one of the world's largest coffee field collections at the Tropical Agricultural Research and Education Centre (CATIE) in Costa Rica, with those of establishing a coffee cryo-collection, also at CATIE. The results indicated that, although the per-accession establishment costs of a cryo-collection (US\$ 95.00 per accession) were higher than those of establishing a field collection (US\$ 69.62 per accession), the per-accession annual costs for maintenance of the cryo-collection of 300 accessions (US\$ 8.00 per accession) were significantly less than those of the field collection of 1992 accessions (US\$ 15.00 per year per accession). The cost forecast for conserving 2000 accessions (comparable to the current field collection) was even lower on a per unit basis (US\$ 3.00 per year per accession).³⁵



³⁴ Reed *et al.* (2004), pp. 10-15.

³⁵ Dulloo *et al.* (2009).

of guidelines, or rules, in this case step-wise guidelines on how to propagate a specific crop or species *in vitro*. One major drawback of *in vitro* conservation is the possibility of genetic instability in plant material, which can occur during the culture process.³⁶

Cryopreservation

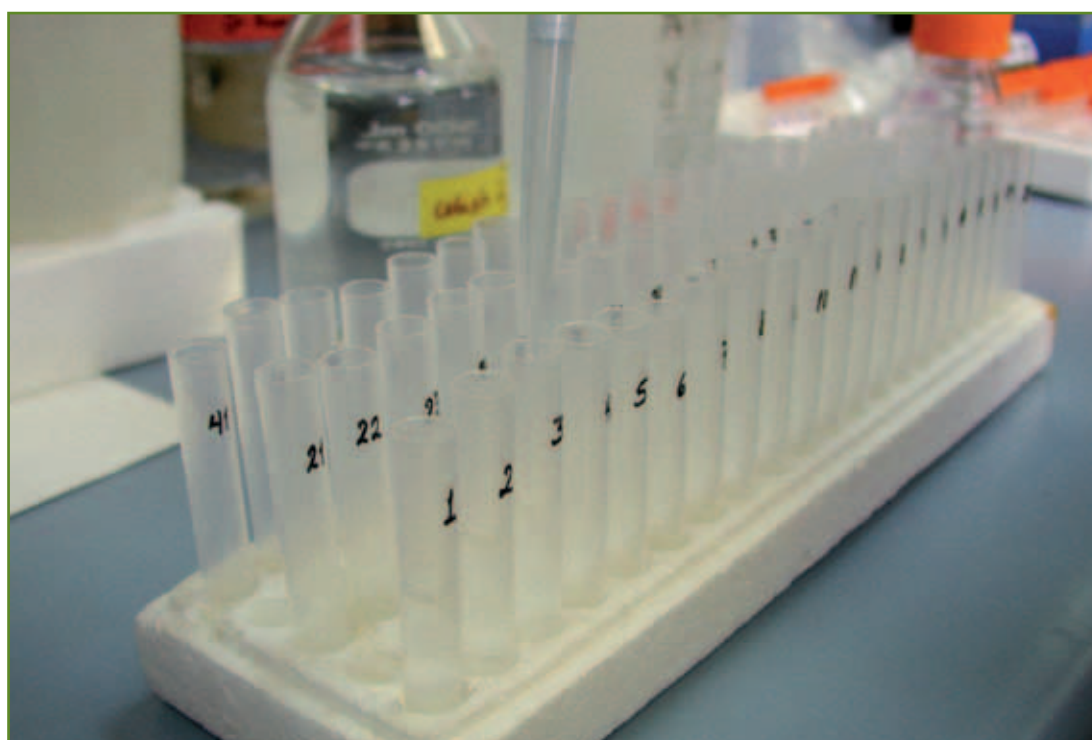
Cryopreservation is a form of *in vitro* storage that involves the storage of living tissue at extremely low temperatures, usually at -196 degrees Celsius in liquid nitrogen, at which cell metabolism is reduced by arresting cell division activities. This guarantees long-term preservation of germplasm in a genetically unaltered state. However, cryopreservation protocols, like *in vitro* culture techniques, are species-specific.

Significant progress has been made in cryopreservation research over the past 20 years and has enabled the development of a number of analytical tools, which allowed a more scientific and rational approach to the establishment of cryopreservation protocols.

Such tools include thermal (Differential Scanning Calorimetry), biochemical (sugars, lipids, proteins) and histo-cytological analyses. These advances have led to the development of cryo-protocols for conserving more than 200 plant species.³⁷ It is now realized that cryopreservation methods can offer great security for long-term conservation of PGRFA, including orthodox seeds. One of the most important advantages of cryopreservation is that it occupies very little space. This makes it very cost-effective over the long term (see Box 1.2).³⁸

DNA Storage

DNA storage is becoming an increasingly important method of conservation of genetic material, especially as a 'back-up' to traditional *ex situ* collections such as seed and tissue gene banks. This is due to the rapid development of technological and analytical tools, as well as to the demand for DNA material from molecular laboratories and breeders for use in molecular breeding.³⁹ DNA material can be maintained at very



Courtesy Flickr/CIMMYT

³⁶ Reed *et al.*, pp. 35-65.

³⁷ Dussert and Engelmann (2006); Engelmann (2004); Engelmann and Takagi (2000); Engelmann and Panis (2009); Panis, Piette and Svennen (2005).

³⁸ Dulloo *et al.*, (2009).

³⁹ De Vicente and Andersson (2006), pp. 12-16.



low temperature and its associated sequence information may be a cost effective form for conserving germplasm, depending on the objective of the conservation and the type of use to which it would be applied.

For example, the Royal Botanic Gardens Kew in the United Kingdom (hereafter “Kew Gardens”) holds approximately 40 000 samples of plant genomic DNA (as at the beginning of 2010), all stored at -80 degrees Celsius. For many species that are difficult to conserve by conventional means (either by seeds, or vegetatively) or that are highly threatened in the wild, DNA storage may provide the ultimate way to conserve the genetic diversity of these species and populations in the short term.

Efforts made to establish plant DNA banks include Missouri Botanical Garden (United States), the Kew Gardens, Australian Plant DNA Bank and Trinity College Dublin (Ireland).⁴⁰ They can provide an efficient

and simple method to conserve the genetic information that overcomes many physical limitations and constraints that characterize other forms of storage. However, there are still problems with subsequent gene isolation, cloning and transfer. The current technology also does not permit the regeneration of original live organisms from isolated DNA or electronic information.

Botanical Gardens

Botanical gardens, like field gene banks, maintain their plant material traditionally as living collections in the garden landscape. Botanical gardens have a strong focus on wild species, and CWR are well represented.⁴¹ It is estimated that there are over 2500 botanical gardens known in the world, in 148 countries, conserving more than 6 million accessions in their living collections.⁴² Botanical gardens have played a key role in the collection and exchange of seed and other propagules with other gardens.⁴³ Propagules can be defined as any structure with the capacity to give



Courtesy Flickr/ IITA Image Library



⁴⁰ Hodkinson *et al.* (2007); Rice, Henry and Rossetto (2006).

⁴¹ See notably table 3.8 on p. 86 in FAO (2010).

⁴² *Idem*, p. 85.

⁴³ Heywood (2009).

rise to a new plant, whether through sexual or asexual (vegetative) reproduction. This includes seeds, spores, and any part of the vegetative body capable of independent growth if detached from the parent. Many botanical gardens maintain *ex situ* collections in the field or in green houses. Some have seed banks for medium- to long-term storage. Very few use *in vitro* or cryopreservation techniques for conservation. The role of the gardens in conserving diversity within species is, however, limited because most

conserve only a few representatives of each species.

Regarding both botanical gardens as well as field gene banks it is important to note that although these techniques may conserve PGRFA in fields and/or garden landscapes, they are considered *ex situ* conservation techniques insofar as the PGRFA are conserved outside their natural habitat and not in the surroundings where they have developed their distinctive properties.

Key points to remember:

- There are two main methods of conservation of crop diversity: *ex situ* and *in situ*.
- *Ex situ* conservation is usually carried out in gene banks and botanical gardens, however different types of gene banks have been established depending on the type of crop genetic materials to be stored and the purpose of conservation.
- Seed banks are used to maintain orthodox seeds in dry conditions at temperatures below zero over long periods of time.
- Recalcitrant seeds are seeds that cannot be easily stored under such conditions.
- Species with recalcitrant seeds and crops that are vegetatively propagated (i.e. not by seeds) are most commonly conserved as live collections in field gene banks.
- Another means to conserve vegetatively propagated species and species with recalcitrant seeds *ex situ* is *in vitro* storage. It involves the maintenance of plant tissue in a sterile environment with a synthetic nutrient medium, usually in a test tube.
- Cryopreservation is a specific form of *in vitro* storage at extremely low temperatures, usually at -196 degrees Celsius in liquid nitrogen. This guarantees long-term preservation of germplasm in a genetically unaltered state.
- DNA storage is becoming increasingly important as a 'back-up' to traditional *ex situ* collections. However, there are still problems with gene transfer and the current technology does not permit to regenerate original live organisms from isolated DNA.
- Botanical gardens and field gene banks maintain their plant material traditionally as living collections. Nevertheless, they are *ex situ* techniques as they do not conserve PGRFA in the surroundings where they have developed their distinctive properties.

Cross-references:

- Refer to sub-section 2.2.1. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty) for an explanation of **Article 5.1e) dealing with *ex situ* conservation** and to learn more about **characterization**.





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***In Situ* Conservation Techniques**

As mentioned above, *in situ* conservation is used mainly for wild species including CWR in wild habitats (*in situ* conservation in the strict sense), as well as for traditional and locally adapted varieties of crops on-farm (referred to as on-farm conservation).

In situ Conservation of Wild Plant Species

The aim of *in situ* conservation of wild plant species is to ensure that populations of targeted species are maintained in the natural habitats where they evolved and that their continued survival is not threatened. The most commonly used method for *in situ* conservation is to protect the natural habitats, by declaring these sites to be protected areas and taking appropriate measures to ensure their conservation. Depending on the purpose of conservation there are different types of protected areas, as defined by the International Union

for Conservation of Nature (IUCN), as well as different levels of management interventions (see Box 1.3).⁴⁴

In the broader context of conserving plant genetic diversity, *in situ* conservation may involve the creation of ‘genetic reserves’ where the ultimate goal is to ensure that the maximum possible genetic diversity is maintained and available for potential utilization.⁴⁵ It should be emphasized here that most protected areas around the world have been established to preserve particular ecosystems, exceptional scenery or habitats for particular charismatic species, but very seldom for CWR.⁴⁶ Nevertheless, a few examples exist: Erebuni State Reserve in Armenia was established in 1981 specifically to protect wild cereals;⁴⁷ the Sierra de Manantlán Reserve in Mexico was established specifically for the conservation of the endemic perennial wild relative of maize;⁴⁸ wild emmer wheat is conserved in the Ammiad reserve in Israel;⁴⁹ and various

⁴⁴ Heywood and Dulloo (2005); Maxted *et al.* (2008); Stolton *et al.* (2006).

⁴⁵ Maxted *et al.* (2008), p. 9.

⁴⁶ *Idem*, pp. 13-15.

⁴⁷ Avagyan (2008), p. 64.

⁴⁸ FAO (2010), p. 34. The scientific name of this endemic wild relative of maize is *Zea diploperennis* H. H. Iltis *et al.*

⁴⁹ Anikster, Feldmann and Horowitz (1997); Safriel, Anikster and Waldmann (1997). The scientific name of this wild emmer wheat is *Triticum turgidum* subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell.



Box 1.3: The IUCN Protected Area Management Categories

The IUCN has developed a series of definitions for different categories of protected areas:⁵⁰

Category Ia Strict Nature Reserve: area managed mainly for science or wilderness protection – an area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

Category Ib Wilderness Area: area managed mainly for wilderness protection – large area of unmodified or slightly modified land and/or sea, retaining its natural characteristics and influence, without permanent or significant habitation, which is protected and managed to preserve its natural condition.

Category II National Park: area managed mainly for ecosystem protection and recreation – natural area of land and/or sea designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III Natural Monument or Feature: area managed mainly for conservation of specific natural features – area containing specific natural or natural/cultural feature(s) of outstanding or unique value because of their inherent rarity, representativeness or aesthetic qualities or cultural significance.

Category IV Habitat/Species Management Area: area managed mainly for conservation through management intervention – area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats to meet the requirements of specific species.

Category V Protected Landscape/Seascape: area managed mainly for landscape/seascape conservation or recreation – area of land, with coast or sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the area's protection, maintenance and evolution.

Category VI Protected Area with Sustainable Use of National Resources: area managed mainly for the sustainable use of natural resources – area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while also providing a sustainable flow of natural products and services to meet community needs.

crop and forest CWR reserves have been established in Turkey.⁵¹

Whatever the type of protected area, in general, *in situ* conservation involves a range of activities which include:⁵²

- setting priorities for target species and their populations and extent of

genetic diversity;

- planning, design and setting up of conservation areas;
- management and monitoring of *in situ* populations; and
- policy and legal support.

The sheer numbers and diversity of CWR for any given crop requires some form of priority

⁵⁰ IUCN (2008), pp. 7-23.

⁵¹ Firat and Tan (1997); Tan (1998); Tan and Tan (2002).

⁵² Heywood and Dulloo (2006); Iriondo, Maxted and Dulloo (2008).





Courtesy Flickr/Kew on Flickr

setting. This requires knowledge of the numbers of CWR for any given taxon, their distribution patterns, and variation between and within their *in situ* populations. Often these are gathered through ecogeographic surveys.⁵³ This in turn helps the design and planning of protected areas which takes into account the individual species' geographical, ecological and physiological (including reproductive biology) attributes, as well as activities of both human and other biotic components within and in the vicinity of the proposed reserves.⁵⁴ Figure 1.1 below illustrates global priority reserve locations for wild relatives of 12 selected food crops.

Prescriptions for management and mechanisms for monitoring populations of the targeted species form an integral part of *in situ* conservation.⁵⁵ This usually involves the establishment of management plans for the genetic reserve aimed at defining the management interventions required to safeguard the *in situ* population. This, for example, may involve getting rid of invasive

species, as is the case in the conservation of wild coffee species in Mauritius⁵⁶ or controlling the collection of wild plants, as is the case for wild yams in Madagascar in the Ankarafantsika National Park, and wild cinnamon in the Kanneliya Forest Reserve, Sri Lanka.⁵⁷

Protected area systems normally have institutional, legal and policy frameworks that provide the legal status of the protected area in question and ensure the long-term land tenure required for *in situ* conservation to be effective. Moreover, it is also important to develop effective working partnerships between agriculture, protected area staff and local and indigenous communities, without which *in situ* conservation would not be effective. Box 1.4 provides a good example of the importance of partnerships in the *in situ* conservation of CWR as illustrated by a CWR *in situ* conservation project of the United Nations Environment Programme (UNEP) and the Global Environment Facility (GEF), led by Bioversity International.

⁵³ Maxted, Van Slageren and Rihan (1995).

⁵⁴ Dulloo *et al.* (2008).

⁵⁵ Maxted *et al.* (2008); Iriondo, Maxted and Dulloo (2008).

⁵⁶ Dulloo *et al.* (1998).

⁵⁷ Hunter and Heywood (2010). The scientific name of the wild cinnamon referred to is *Cinnamomum cappara-coronde* Blume.



Box 1.4: *In situ* Conservation of CWR through Enhanced Information Management and Field Application

This UNEP/GEF CWR project consisted of a partnership that included nearly 60 national and international agencies. Planning, implementation and monitoring was conducted through a series of local and national committees, coordinated and guided by Bioversity International through an international steering committee made up of representatives from all participant countries and international organizations. Partnerships at the national level brought together academia, government departments, protected area administrations, local and indigenous groups, civil society organizations, botanical gardens, natural history museums and research agencies. For example, two major sectors where there is traditionally not much collaboration, i.e. agriculture and biodiversity conservation, were brought to work together. Close collaboration with protected area authorities allowed to develop species management plans for CWR in selected protected areas.

Involvement of rural communities was essential to address overcollecting of wild plants in the Erebuni State Reserve in Armenia. The reserve is located near a highly urbanized area and is rich in biodiversity. It is home to 292 species of vascular plants, representing 196 genera from 46 families. Despite sustained conservation efforts, the distribution of wild plants in the protected area is under threat as wild plants are collected for food and medicinal purposes and for sale in Yerevan City markets. Plant collectors frequently trespass within the protected area to harvest wild crops. As a result, many species of plants existing in the area have been included in the Red Data Book of Threatened Plants of Armenia.

Through community consultations, a lack of awareness of the importance of CWR was identified as the major factor influencing overharvesting. For this reason, the UNEP/GEF CWR project, in 2007, implemented a series of workshops with local communities, followed by community surveys, to gather information about the collection, use and conservation of a range of wild plants. Discussions highlighted that rural communities, and women in particular, continue to collect a variety of wild plants for use in local dishes and for medicinal purposes. The participatory process, carried out over a one-year period, revealed the need to train local communities on the healthy utilization of certain plant species. The local communities surrounding the protected area are engaged and aware of the benefits of conserving CWR in their natural environments and the threats posed to their well-being by overharvesting.⁵⁸

A significant number of wild species of PGRFA occur outside conventional protected areas and consequently do not receive any form of legal protection.⁵⁹ Cultivated fields, field margins, grasslands, orchards and roadsides may all harbour important CWR. Plant diversity in such areas faces a variety of threats including the widening of roads, removal of hedgerows or orchards, overgrazing, expansion in the use of herbicides or even just different regimes for the physical control of weeds.⁶⁰

The effective conservation of PGRFA outside protected areas requires social and economic issues to be addressed. This may require, for example, specific management agreements to be concluded between owners of prospective sites and conservation agencies. Such agreements are becoming more common in North America and Europe, an example being the establishment of micro-reserves in the Valencia region of Spain.⁶¹ Unfortunately there appear to be no agreements yet in place in most priority centres of CWR diversity.

⁵⁸ Hunter and Heywood (2010).

⁵⁹ Heywood and Dulloo (2005), pp. 69-73; Maxted and Kell (2009), p. 69.

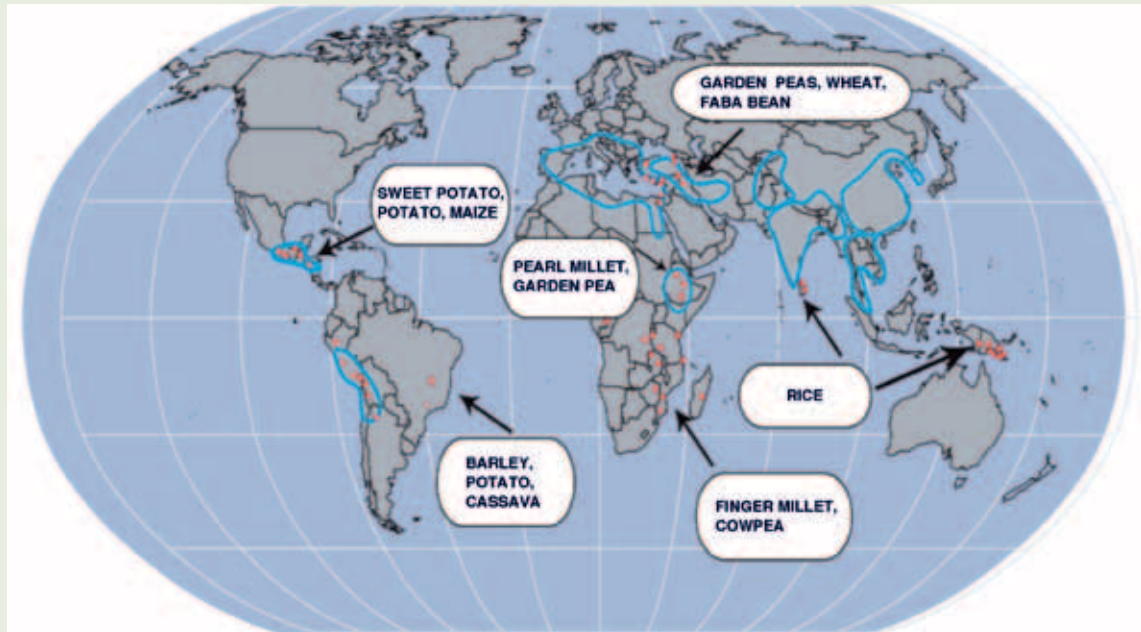
⁶⁰ Maxted and Kell. *Op. cit.*, p. 12.

⁶¹ Laguna (1999).





Figure 1.1: Global Priority Genetic Reserve Locations for Wild Relatives of 12 Food Crops



Source: FAO (2010), p. 10.

On-farm Conservation

In situ conservation on-farm, commonly referred to as on-farm conservation or on-farm management, can be understood as “the continuous cultivation and management of a diverse set of populations by farmers in the agro-ecosystems where a crop has evolved”.⁶² On-farm conservation concerns entire agro-ecosystems, including immediately useful species (such as cultivated crops, forages and agroforestry species), as well as their wild and weedy relatives that may be growing in nearby areas.

Practices that support the maintenance of diversity within agricultural production systems include agronomic practices, seed production and distribution systems, as well as the management of the interface between the wild and cultivated ecosystems. A widespread practice – or set of practices – that conserves traditional varieties is through production in home gardens. Farmers often use home gardens as

a site for experimentation, for introducing new cultivars, or for the domestication of wild species. Useful wild species may be moved into home gardens when their natural habitat is threatened, e.g. through deforestation.

Informal seed systems are a key element in the maintenance of crop diversity on-farm, which in some countries can account for up to 90 percent of seed movement.⁶³ Informal seed systems are small-scale, farmer managed traditional systems developed over time in response to farmers demand for seed. They transmit planting material developed by farmers or previously developed, saved, and transferred by farmers. However, with policies often favouring improved varieties, farmers are cultivating less and less local landraces and traditional varieties. There is a need to provide incentives to farmers to continue to cultivate these varieties and maintain their diversity on-farm, for example through the creation of markets for local products

⁶² Bellon *et al.* (1997).

⁶³ FAO (2010), p. 40.

derived from these varieties. Activities that directly support on-farm conservation are: community seed banks, local germplasm collections, reintroduction of traditional and locally adapted varieties, diversity fairs and community biodiversity registers.⁶⁴

The interface between wild and agricultural plants and ecosystems is highly complex and can result in both positive and negative effects regarding the maintenance of genetic diversity. The natural transfer of new genes into crops can expand the diversity available to farmers. The natural transfer of genes between crop varieties and their wild relatives has been a significant feature of the evolution of most crop species and continues to be important today in the development and introduction of new

genotypes by farmers.⁶⁵

Many CWR species grow as weeds in agricultural, horticultural and silvicultural systems, particularly those associated with traditional cultural practices or marginal environments. In many areas such species may be particularly threatened as a result of the move away from traditional cultivation systems. Several governments in developed countries provide incentives, including financial subsidies, to maintain these systems and the wild species they harbour. While such options are largely unaffordable and unenforceable throughout most of the developing world, opportunities do exist for integrating on-farm management of landraces and farmer varieties with the conservation of CWR diversity.⁶⁶



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⁶⁴ For detailed information on these activities see Almekinders (2001); Jarvis *et al.* (2008); Sthapit *et al.* (2002).

⁶⁵ Prescott-Allen and Prescott-Allen (1988).

⁶⁶ FAO (2010), p. 35.



Key points to remember:

- *In situ* conservation is mainly used for wild species including CWR in wild habitats, as well as for traditional and locally adapted varieties of crops on-farm.
- The most commonly used method for *in situ* conservation is to protect the natural habitats, by declaring these sites to be protected areas.
- *In situ* conservation involves a range of activities, including:
 - setting priorities for target species and their populations and extent of genetic diversity;
 - planning, design and setting up of conservation areas;
 - Active management and monitoring of *in situ* populations; and
 - providing policy and legal framework
- Effective *in situ* conservation requires working partnerships between agriculture, protected area staff and local and indigenous communities.
- A significant number of CWR occur outside conventional protected areas, requiring specific management agreements to ensure effective conservation of PGRFA .
- On-farm conservation can be understood as the continuous cultivation and management of a diverse set of populations by farmers in the agro-ecosystems where a crop has evolved.
- Activities that directly support on-farm conservation include, *inter alia*, the production in home gardens, community seed banks, local germplasm collections, reintroduction of traditional and locally adapted varieties, diversity fairs and community biodiversity registers.
- A further key element to conserve crop diversity on-farm especially for smallholder farmers in developing countries are informal seed systems, i.e. small-scale traditional systems to transmit farmer-developed and/or previously saved seed.

Cross-references:

- For explanations of the **provisions of the International Treaty dealing with *in situ* and on-farm conservation**, refer to sub-section 2.2.1. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- To learn more about **options for on-farm conservation and management** refer to sub-section 4.2.3. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective) and to Box 4.1 of lesson 4 of Module I (Main Components and Governance of the International Treaty).



1.2.3. The Complementary Roles of *In situ* and *Ex situ* Conservation

Traditionally, *in situ* conservation has been used for the conservation of forests, wild species and areas valued for their wildlife or ecosystems, while *ex situ* conservation has been a predominant method for the conservation of PGRFA.⁶⁷ The concept of *ex situ* conservation is fundamentally different to that of *in situ* conservation, however both are important complementary methods for conservation and both are referred to in Article 5 of the International Treaty. The principal difference (and hence the reason for the complementarity) between the two lies in the fact that *ex situ* conservation implies the maintenance of genetic material outside of the ‘normal’ environment where the species has evolved and aims to maintain the genetic integrity of the material at the time of collecting, whereas *in situ* conservation (maintenance of viable populations in their natural surroundings) is a dynamic system

which allows the biological resources to evolve and change over time through natural or human-driven selection processes. It should be noted that *in situ* conservation on-farm requires the maintenance of the agro-ecosystem along with the cultivation and selection processes on local varieties and landraces, and *in situ* conservation in the wild involves the maintenance of the ecological functions that allow species to evolve under natural conditions.⁶⁸

Articles 5 and 6 of the International Treaty refer to both methods, including the collection and *ex situ* conservation of PGRFA under threat or of potential use, on-farm management of farmers’ PGRFA in their fields, and *in situ* conservation of CWR in protected areas. It is now widely accepted that the use of one single conservation strategy to conserve PGRFA diversity incurs a risk. For example, extreme weather conditions can cause the extinction of target populations in a protected area, prolonged power cuts can jeopardize germplasm conserved in a gene bank’s cold store, and war and natural



⁶⁷ Brown (2000).

⁶⁸ Dulloo, Hunter and Borelli (2010); Heywood and Dulloo (2005); Maxted, Ford-Lloyd and Hawkes (1997).





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catastrophes can affect diversity whether conserved *ex situ* or *in situ*.

A conservation strategy that uses a combination of *ex situ* and *in situ* techniques, taking into account their respective advantages and disadvantages (see Box 1.5 below) is therefore most likely to secure the diversity for future use. A complementary conservation strategy involves the combination of different conservation actions, which together lead to an optimum sustainable conservation of genetic diversity in a target gene pool.⁶⁹

The ultimate purpose of germplasm conservation is to be able to use PGRFA now and in the future for agricultural research, plant breeding, cultivation and finally consumption, in order to ensure global food security. Consequently, any conservation strategy should include mechanisms that will also ensure access to the germplasm by relevant stakeholders (particularly breeders and farmers). It is not always evident that

material conserved in gene banks can readily be made available to users of germplasm.

Article 10 of the International Treaty recognizes the sovereign rights of states over their own PGRFA, including the authority to determine access to these materials. It calls upon Contracting Parties to facilitate access to their PGRFA through the Multilateral System of Access and Benefit-sharing (hereafter “Multilateral System”) of the International Treaty so that breeders, for example, can obtain the crop diversity they need for crop improvement and farmers can obtain varieties they need to meet their needs. Under the Multilateral System, the exchange of germplasm is facilitated through the Standard Material Transfer Agreement (SMTA). A conservation strategy should also include a proper documentation system that provides all the essential information attached to the accession in terms of passport information, collection, characterization and other socio-economic information.



⁶⁹ Dulloo *et al.* (2005).

Box 1.5: Relative Advantages and Disadvantages of *Ex situ* and *In situ* conservation**Advantages*****In situ* conservation**

- Avoids storage problems associated with field gene banks and recalcitrant seeds.
- Allows evolution and enhancement to continue through exposure to pests and diseases and other environmental factors.
- Indirect benefits, including ecosystem support.
- Sustainable use by local people.
- Does not require high-tech conservation facilities and laboratories.

***Ex situ* conservation**

- Rescue of threatened germplasm.
- Requires limited space to conserve large numbers of accessions.
- Conserves an adequate representative sample of CWR populations.
- Ease of accessibility and exchange of germplasm.
- Facilitates evaluation and documentation.
- No exposure to pests, diseases or other hazards (except for field collection and botanical gardens).
- Almost indefinite maintenance of germplasm.
- Cost-effectiveness.

Disadvantages***In situ* conservation**

- Requires extensive areas for effective conservation.
- Generally has a limited coverage of the genetic diversity of the target species.
- Exposes natural populations to a wide range of natural catastrophic events.
- Materials cannot be readily used and may be difficult to access.
- Subject to conflict with management by landowners.
- Expensive to maintain.

***Ex situ* conservation**

- Freezes the evolutionary process.
- Difficult to ensure adequate sampling (intra-specific variability).
- Total genetic integrity cannot be ensured due to human error, selection pressure during re-generation.
- Only limited numbers of accessions can be conserved in field gene banks.
- Natural catastrophes could affect field gene banks.
- *In vitro* genetic instability and loss of capacity for tissues to regenerate into the plant.

Since the needs of users and conservation technologies may change over time, a conservation strategy should be flexible enough to allow such changes to be taken into consideration.⁷⁰

⁷⁰ For a possible framework for developing a complementary conservation strategy using coconut as an example, see Dulloo *et al.* (2005). The process involves first defining the options for conservation of the target species, taking into account the feasibility of conserving it *in situ*, its seed storage behaviour, whether or not the species can be conserved as seeds, whether or not protocols for *in vitro* or cryopreservation are developed or whether the species can only be conserved as live plants in a field gene bank or botanical garden.



Key points to remember:

- The reason for the complementarity of *ex situ* and *in situ* conservation methods lies in their main difference: while the former implies the maintenance of genetic material outside of the 'normal' environment where the species has evolved and aims to maintain the genetic integrity of the material at the time of collecting, the latter is a dynamic system which allows the biological resources to evolve and change over time through natural or human-driven selection processes.
- Articles 5 and 6 of the International Treaty refer to both methods, including the collection and *ex situ* conservation of PGRFA under threat or of potential use, on-farm management of farmers' PGRFA in their fields, and *in situ* conservation of CWR in protected areas.
- A complementary conservation strategy involves the combination of different conservation actions, which together lead to an optimum sustainable conservation of PGRFA.
- The ultimate purpose of germplasm conservation is to ensure the ability to use PGRFA now and in the future for agricultural research, plant breeding, cultivation and finally consumption, for global food security. The International Treaty therefore provides for facilitated access to the genetic material included in its Multilateral System.

Cross-references:

- For an in-depth elaboration of the **contents of articles 5 and 6 of the International Treaty** refer to lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- To learn more about the **Multilateral System and the SMTA** refer to sub-section 4.2.3. of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- To study the **Multilateral System in-depth** refer to the forthcoming Module IV (The Multilateral System of Access and Benefit-sharing).
- To learn more about **how the Multilateral System contributes to the conservation and sustainable use of PGRFA** refer to sub-section 3.2.2. of lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use).
- For more information of the **International Treaty's provisions dealing with collection, characterization and documentation of PGRFA**, refer to sub-section 2.2.1. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).



1.3. Conservation and Sustainable Use of Crop Diversity: Two Sides of the Same Coin

1.3.1. Concept of Sustainability and Meaning of Sustainable Use

In essence, ‘sustainability’ refers to the rational (or wise) use of any renewable resource in such a manner that the resource is not depleted for future use. The concept of sustainable use is derived from the Brundtland report’s definition of sustainable development, i.e. “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.⁷¹ In the context of PGRFA, sustainable use can be broadly defined as the use of genetic resources in support of sustainable agriculture, which requires a system of agriculture that produces and facilitates access to sufficient food for

all people and contributes to livelihoods and socio-economic development while protecting the environment.⁷²

Sustainable use of PGRFA is one of the three main objectives of the International Treaty, which devotes an entire article to it. Article 6 proposes a series of measures to promote sustainable use of PGRFA and calls upon Contracting Parties to develop and maintain appropriate policy and legal measures to that end. The proposed measures are targeted to ensure the maintenance of diverse farming systems, to maximise intra and inter-specific variation for the benefit of farmers, to promote participatory plant breeding, to broaden the genetic base of crops and the expanded use of local and adapted crops, to reduce genetic



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⁷¹ Brundtland Commission of the United Nations (1987), chapter 2.

⁷² Lipper and Cooper (2009), pp. 27-28.





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vulnerability and erosion and promote increased food production through the use of a wider diversity of varieties and species, and to review breeding strategies and regulations concerning variety release and seed distribution. Thus article 6 provides a broad framework for a policy environment that enables the sustainable use of PGRFA.

Let us discuss here more precisely what is commonly understood by sustainable use of PGRFA and in what ways PGRFA are deployed to ensure food security and to improve farmers' livelihoods. PGRFA can be used directly by farmers through selection of the crops and varieties they cultivate and maintain on their farms. This selection process by farmers has occurred over many generations in a sustainable way which has allowed local varieties to evolve over time, adapt to their local conditions and continue to be productive making full use of the natural variation in traits.

On the other hand, PGRFA can be sustainably used in crop improvement programmes through the breeding of high yielding improved varieties by breeders. The aim is to produce a sustainable crop production

over time in different agro-ecosystems. This requires a wide range of crop genetic resources to provide resistance genes to biotic and abiotic stresses to adapt to particular environmental conditions. Plant breeding relies on using the genetic variation available naturally among individuals in a population of a particular species. This potentially includes germplasm from primary, secondary and tertiary gene pools, from elite material to distantly related species, which can be introduced into the breeding programme.

In conventional crop improvement, plant breeders make crosses between parents with desirable traits - usually found in well-adapted and agronomically desirable types. However, as traits of interest may not always be found in well-adapted elite varieties, breeders may need to look for traits in more distantly related species and genera. The process by which desirable traits are transferred from non-adapted sources like CWR is called 'pre-breeding'. They subsequently select progeny with incremental improvements in combinations of the sought-after specific traits such as yield, quality or pest resistance. Most breeding programmes focus on the improvement of major crops that can be adapted to grow



in different agro-ecosystems by using external inputs, including irrigation and fertilizer. Biotechnology is also increasingly being used by breeders as complementary technique to conventional breeding to improve effectiveness and efficiency of breeding strategies. These may make use of a range of technologies including tissue culture, micro-propagation, mutation breeding, double haploids and the use of marker assisted selection.

Very few programmes address ‘subsistence crops’ (often underutilized species) which are important to resolve problems of hunger and poverty for resource poor farmers living in marginal areas. Therefore, plant breeding often leads to a narrowing of the genetic base, as materials are crossed and selected to obtain elite varieties with desirable traits. Thus there is a constant need to inject new

germplasm to broaden the genetic base again in order to reduce genetic vulnerability to different stresses.

Farmer participation in the selection and breeding processes can help to tailor efforts to the needs of farmers and take advantage of their traditional knowledge. Participatory plant breeding activities aim at achieving crop development while at the same time ensuring on-farm conservation of local crop genetic diversity, including underutilized crops. Local seed systems also facilitate the sustainable use of local and adapted improved varieties, while playing an important role in maintaining and shaping crop diversity on-farm.⁷³ Initiatives such as on-farm seed production, distribution of seed kits, demonstration plots, seed fairs and community seed banks can significantly improve local seed supply.⁷⁴

Key points to remember:

- Contracting Parties of the International Treaty commit themselves to take measures to promote the sustainable use of PGRFA. Article 6 of the International Treaty proposes a set of such measures.
- Sustainable use of PGRFA can be understood as the use of PGRFA in support of a system of agriculture that produces and facilitates access to sufficient food for all people and contributes to livelihoods and socio-economic development while protecting the environment.
- The ‘use’ of PGRFA commonly refers to either the selection of PGRFA by farmers through cultivation, or their use by scientific plant breeders in crop improvement programmes.
- Plant breeders make crosses between parents with desirable traits and subsequently select progeny with incremental improvements in combinations of the sought-after specific traits such as yield, quality or pest resistance.
- Conventional plant breeding often leads to a narrowing of the genetic base, as materials are crossed and selected to obtain elite varieties with desirable traits.
- Participatory plant breeding aims at achieving crop development while ensuring on-farm conservation of locally adapted and underutilized crop genetic diversity.

⁷³ Bellon *et al.* (1997).

⁷⁴ For detailed information on these activities see Almekinders (2001).



Cross-references:

- For the **Brundtland report** see: <http://www.worldinbalance.net/intagreements/1987-brundtland.php>
- For in-depth explanations of the **measures proposed under Article 6 of the International Treaty**, refer to sub-section 2.2.2. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For **practical illustrations of options to promote sustainable use of PGRFA** refer to section 4.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).
- For more information on **pre-breeding** refer to sub-section 4.2.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).
- To learn more about the **International Treaty's provisions dealing with participatory plant breeding** refer to sub-section 2.2.2. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For more information on different **methodologies and objectives for participatory plant breeding**, refer to section 4.2.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).

Linking Conservation to Sustainable Use

The essence of crop genetic resources conservation is not only for the conservation of the intra-specific diversity contained within them, but also for their sustainable use to improve agricultural production as described above. The improvements in agriculture have been possible due to the use of diversity within early crop varieties, including their wild relatives. However, as agriculture has progressed, the extensive use of uniform improved varieties has led to the loss of crop genetic diversity in the fields and has triggered a conservation movement focused on the collection and conservation of threatened PGRFA.⁷⁵ Pioneers like Nicolai Vavilov and Otto Frankel realized that improvements in agriculture will not be sustainable unless the crop diversity is properly conserved, characterized, evaluated and used. As we have seen above, much progress has been made in the last decades in conserving plant genetic diversity both *ex situ* and *in situ*.⁷⁶

Although the diversity stored in gene banks is the raw material for plant breeding, it is not evident to what extent the conserved diversity is used by agricultural researchers, breeders and farmers. There are various reasons that may limit the utilization of these resources: on the one hand many accessions in gene banks are not well documented, characterized and

evaluated, which is needed to allow breeders to identify accessions of potential use. On the other hand some breeders prefer to use their own breeding collections (often with a much narrower genetic diversity), which already have the right genetic background and do not require lengthy pre-breeding activities. Breeders are nevertheless recognizing that local varieties and CWR offer the breadth of genetic diversity needed to meet the novel challenges of climate change and rapidly-changing consumer demands. This calls for a greater linkage and integration between the needs for conserving diversity and actively seeking the valuable traits found within wild relatives and local varieties.

The environment in which we live is constantly changing and is subject to periodic natural calamities such as hurricanes, tsunamis, floods and droughts. The crop diversity we conserve in our gene banks and the crop varieties that are cultivated on farms may well have the required adaptive traits breeders are looking for to face these problems, as well as to resist new pests and diseases. Gene banks have a potential role to play in combating these risks by providing breeders with new diversity to make future varieties more resistant. In Ethiopia, for example, Bioversity International is undertaking a pilot project sponsored by the World Bank Development Marketplace on

⁷⁵ Scarascia-Mugnozza and Perrino (2002).

⁷⁶ FAO (2010), p. xix.



adaptation to climate change, which aims at demonstrating the value of gene bank material in providing options to poor farmers in adapting to climate change (see Box 1.6).

Gene banks can also provide germplasm material for restoration of lost crops after natural or man-made catastrophes. For example, after the tsunami in Malaysia in 2004, rice growers were able to obtain from gene banks salt-tolerant varieties of rice not normally grown in that area. Gene bank accessions of CWR are particularly valuable as gene providers, and many examples exist to show the use of CWR in crop improvement.

For example, a recent study has shown that wild relatives of sorghum with different mechanisms of resistance can be used as sources of alternate genes to increase the levels and diversify the basis of resistance to shoot fly.⁷⁷ Scientists from the Agricultural Research Service of the United States Department of Agriculture have developed a new russet potato breeding line that naturally resists the attack of the Columbia Root-knot Nematodes, which inflicts huge losses on the potato industry.⁷⁸ These examples show how conservation efforts undertaken in the past can be used to resolve present problems and offer options for future food security.

Box 1.6: Seed for Needs - Adapting Agriculture to Climate Change in Ethiopia

Climate change poses a serious threat to future food security. Increases in temperatures and changes in rainfall patterns are expected to increase food shortages, especially in Africa. Ethiopia is a country where climate change will be the most affected in East Africa and has a rich heritage of local varieties of some crops, in particular wheat, barley and teff, that can be used to adapt to climate change. An award winning project supported by World Bank Development Marketplace 2009 aims to develop a low cost innovative approach to use locally adapted varieties conserved in gene banks to help women farmers cope with climate change.

The premise of the project is that farmers will require seeds of new varieties to sustain their crop production and continue to feed their families. Currently, farmers obtain their seeds principally from local seed systems over relatively very short distances. But with climate change they may have to go a long distance to obtain the local varieties that will grow in their new climate conditions. Seeds which are currently conserved in the national gene banks at the Institute of Biodiversity and Conservation (IBC) can provide a solution to farmers. These are seeds that have been collected all over Ethiopia and conserved in IBC. The collections represent a storehouse of diversity that, if properly evaluated with farmers in a participatory manner for adaptation to climate change and made easily accessible, can provide farmers with climate-ready varieties in much less time than is required for breeding and releasing new improved varieties. Thus, even in the face of uncertain future conditions, varieties suited to projected future climates can be selected from gene banks and be made available to farmers.

The project recognizes and seeks to strengthen the role of women farmers as seed custodians. This is accomplished by national and international scientists working side-by-side with women farmers to identify and evaluate locally adapted crop varieties better-suited for production in hotter, drier conditions. The project uses its findings to match and map different crop varieties to the predicted climate change scenarios in Ethiopia. The resultant map showing which crop varieties will perform well under new climatic conditions will be a useful tool for helping farmers select and plant crop varieties best suited to their local environmental and climatic conditions, with the assurance of good yields. The map will also serve as an important policy tool for the government, guiding design and implementation climate adaptation programmes.

⁷⁷ Kamala *et al.* (2009). The scientific name of the shoot fly is *Atherigona soccata*.

⁷⁸ Brown *et al.* (2009).



Key points to remember:

- The essence of conserving PGRFA is to maintain the ability to use the diversity of traits they contain in a sustainable way for improvements in agricultural production.
- For improvements in agriculture to be sustainable, crop diversity needs to be properly conserved, characterized, evaluated and used.
- Local varieties and CWR offer the breadth of genetic diversity needed to cope with the risks posed by novel challenges such as climate change.
- Gene banks have a potential role to play in combating these risks by providing breeders with new diversity to make future varieties more resistant.

Cross-references:

- For a working **definition of the concept of sustainable use** refer to section 2.3. of lesson 2 of Module I (Objectives, Scope and Basic Concepts).
- To learn more about the **linkages of the measures for conservation and sustainable use** that are put forward in the International Treaty, refer to lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For **practical illustrations of options to promote the conservation and sustainable use** of crop diversity, refer to section 4.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).



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1.4. Conclusive Summary

Crop diversity underpins agricultural production and has made a huge contribution to the improvement of crop varieties and to food security. Yet humankind still only relies on a tiny fraction of edible plants. Farmers' traditional and locally adapted varieties, developed over generations of selection, have contributed significantly to the increase in crop yields through their contributions as ancestors in the development of improved varieties. However, the expansion of improved varieties in production systems is one of the major drivers of loss in crop diversity. There are important risks of genetic vulnerability associated with the large-scale cultivation of highly uniform crops, thus the need for more diverse cropping systems to stabilize crop production. In addition to the changes in land use, replacement by improved varieties, increased human populations, poverty and land degradation, climate change is set to have a major impact on agriculture and food security. In order to help alleviate these impacts, it is critical to ensure the conservation and sustainable use of crop diversity.

Crop diversity needs to be conserved both *in situ* as well as *ex situ* as these two methods are complementary. Different *ex situ* techniques are used depending on the species biology and the objectives of conservation. Each has its advantages and disadvantages. Two kinds of *in situ* conservation are recognized (*in situ sensu stricto* and on-farm), depending on the target species and the selection pressures exerted on their populations. For wild species,

including CWR, natural habitats are usually protected by the establishment of protected areas and preparation of management plans for the effective conservation of the target populations. On-farm diversity is largely under the management control of farmers.

The International Treaty aims at promoting both *in situ* and *ex situ* conservation. While quite some progress has been made over the last decades in both areas of *ex situ* and *in situ* conservation, quite a lot still remains to be done.⁷⁹ There is a need for greater rationalization among *ex situ* collections globally and many collections still lack adequate documentation, characterization and evaluation. With regard to *in situ* conservation, greater attention is required for developing appropriate policies, legislation and procedures for collecting CWR, for establishing protected areas and for better coordination of these efforts. Further, there is a need to improve farmers' management of diversity on farms. This is why on-farm conservation is one of the priorities for projects to receive funding under the Benefit-sharing Fund of the International Treaty.

Sustainable use of PGRFA contributes directly and indirectly to their conservation, just as increased and better use of PGRFA provides incentives for more effective conservation. Conservation is a strategy for ensuring food security and improving peoples' well-being and livelihoods; this requires an optimum use of both the diversity conserved in *ex situ* collections and existing on farms and in nature.

³⁸ FAO (2010), pp. 45-46, 87-88.



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The Provisions of Articles 5 and 6 of the International Treaty



LESSON 2



Learning objectives

At the end of this lesson, the learner will be able to:

- describe the International Treaty's provisions on conservation and sustainable use of crop diversity;
- identify appropriate policy, legal and technical measures for the promotion of conservation and sustainable use; and
- recognize the linkages between the Second Global Plan of Action and the International Treaty.



Target learner groups

Technical personnel including gene bank staff and plant breeders, as well as civil servants and other interested parties and institutions.



Citrus limon, lemon, by Elizabeth Blackwell (1739)

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2.1. Overview of the Lesson

The International Treaty on Plant Genetic Resources for Food and Agriculture (hereafter “International Treaty”) is the internationally agreed legally binding framework for conservation and sustainable use of all plant genetic resources for food and agriculture (PGRFA). It carefully balances the interests of developed and developing countries as well as a broad range of further stakeholders involved in PGRFA conservation and use, such as, *inter alia*, public and private agricultural researchers and plant breeders, gene banks and farmers’ organizations. The International Treaty requests Contracting Parties to promote measures for effective conservation and sustainable use of PGRFA and establishes transparent internationally accepted regulations for cross-border transfers of a number of the world’s most important PGRFA for food security for research and breeding purposes.

This lesson explains the measures to promote conservation and sustainable use of crop diversity that are proposed in articles 5 and 6 of the International Treaty. It does so in particular for technical stakeholders engaged in conservation and sustainable use activities, to help them understand the legal framework

they are working in. However, the lesson is also useful for political stakeholders whose task it is to translate the commitments their governments have made under the International Treaty into national policies. For each measure, the lesson points to the relevant guidance contained in the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (hereafter “Second Global Plan of Action”).

The lesson highlights the International Treaty’s complementary approach to *ex situ* and *in situ* conservation and links conservation to sustainable use. The priorities of on-farm conservation and sustainable use of the Benefit-sharing Fund of the Funding Strategy (hereafter “Benefit-sharing Fund”) of the International Treaty are further illustrated by various initiatives that received funding under its first project cycle.

At the end of this lesson, the learner will be able to describe the International Treaty’s provisions on conservation and sustainable use of crop diversity, and to identify appropriate policy, legal and technical measures for their implementation.

Cross-references:

- For the **text of the International Treaty** see: [ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf](http://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf)
- For more details on the **objectives of the International Treaty**, an overview of the main advantages for countries of being a Contracting Party to the International Treaty, and a working definition of the concept of ‘sustainable use’ refer to lesson 2 of Module I (Objectives, Scope and Basic Concepts).
- To learn more about the **operation of the Multilateral System for Access and Benefit-sharing** and how it facilitates transfers of crop genetic resources refer to sub-section 4.2.3. of lesson 4 of Module I (Main Components and Governance of the International Treaty) and forthcoming Module IV.
- To learn more about the **technical aspects of conservation and sustainable use activities** refer to lesson 1 of this module (What is Conservation and Sustainable Use?).
- For more **illustrations of options to promote conservation and sustainable use** of crop diversity refer to lesson 4 of this module (Implementation of Articles 5 and 6 from a Users’ Perspective).
- For the **text of the Second Global Plan of Action** see: http://typo3.fao.org/fileadmin/templates/agphome/documents/PGR/GPA/GPA2/GPA2_en.pdf
- Refer to sub-section 4.2.4. of lesson 4 of Module I (Main Components and Governance of the International Treaty) for more information on the **operation of the Benefit-sharing Fund**.
- For an in-depth account on the Funding Strategy and practical information for applicants on **how to apply for resources under the Benefit-sharing Fund**, refer to forthcoming Module V.



Box 2.1: The Provisions of Articles 5 and 6 of the International Treaty**Article 5 - Conservation, Exploration, Collection, Characterization, Evaluation and Documentation of Plant Genetic Resources for Food and Agriculture**

5.1 Each Contracting Party shall, subject to national legislation, and in cooperation with other Contracting Parties where appropriate, promote an integrated approach to the exploration, conservation and sustainable use of plant genetic resources for food and agriculture and shall in particular, as appropriate:

- a) Survey and inventory plant genetic resources for food and agriculture, taking into account the status and degree of variation in existing populations, including those that are of potential use and, as feasible, assess any threats to them;
- b) Promote the collection of plant genetic resources for food and agriculture and relevant associated information on those plant genetic resources that are under threat or are of potential use;
- c) Promote or support, as appropriate, farmers and local communities' efforts to manage and conserve on-farm their plant genetic resources for food and agriculture;
- d) Promote in situ conservation of wild crop relatives and wild plants for food production, including in protected areas, by supporting, inter alia, the efforts of indigenous and local communities;
- e) Cooperate to promote the development of an efficient and sustainable system of ex situ conservation, giving due attention to the need for adequate documentation, characterization, regeneration and evaluation, and promote the development and transfer of appropriate technologies for this purpose with a view to improving the sustainable use of plant genetic resources for food and agriculture;
- f) Monitor the maintenance of the viability, degree of variation, and the genetic integrity of collections of plant genetic resources for food and agriculture.

5.2 The Contracting Parties shall, as appropriate, take steps to minimize or, if possible, eliminate threats to plant genetic resources for food and agriculture.

Article 6 - Sustainable Use of Plant Genetic Resources

6.1 The Contracting Parties shall develop and maintain appropriate policy and legal measures that promote the sustainable use of plant genetic resources for food and agriculture.

6.2 The sustainable use of plant genetic resources for food and agriculture may include such measures as:

- a) pursuing fair agricultural policies that promote, as appropriate, the development and maintenance of diverse farming systems that enhance the sustainable use of agricultural biological diversity and other natural resources;
- b) strengthening research which enhances and conserves biological diversity by maximizing intra- and inter-specific variation for the benefit of farmers, especially those who generate and use their own varieties and apply ecological principles in maintaining soil fertility and in combating diseases, weeds and pests;
- c) promoting, as appropriate, plant breeding efforts which, with the participation of farmers, particularly in developing countries, strengthen the capacity to develop varieties particularly adapted to social, economic and ecological conditions, including in marginal areas;
- d) broadening the genetic base of crops and increasing the range of genetic diversity available to farmers;
- e) promoting, as appropriate, the expanded use of local and locally adapted crops, varieties and underutilized species;
- f) supporting, as appropriate, the wider use of diversity of varieties and species in onfarm management, conservation and sustainable use of crops and creating strong links to plant breeding and agricultural development in order to reduce crop vulnerability and genetic erosion, and promote increased world food production compatible with sustainable development; and
- g) reviewing, and, as appropriate, adjusting breeding strategies and regulations concerning variety release and seed distribution.



2.2. An Integrated Approach to Conservation and Sustainable Use

Conservation and sustainable use of crop diversity are two sides of the same coin in order to achieve the International Treaty's overall goal of global food security. Our continued ability to make use of crop diversity requires adequate measures for its conservation, while the purpose of conservation only remains valid as long as PGRFA keep being used - in a sustainable way. This linkage is reflected at various points in the text of the International Treaty, including most prominently in the chapeau of Article 5 which provides that Contracting Parties shall “promote an integrated approach to the exploration, *conservation and sustainable use*” of PGRFA. In this sense, the measures to promote conservation and sustainable use of PGRFA contained in articles 5 and 6 can be understood as a continuum.

2.2.1. Conservation (Article 5)

The Food and Agriculture Organization of the United Nations (FAO) describes ‘gene resources conservation’ as “the conservation of species, populations, individuals or parts of individuals, by *in situ* or *ex situ* methods, to provide a diversity of genetic materials for present and future generations”.¹

The full title of Article 5 reads “Conservation, Exploration, Collection, Characterization, Evaluation and Documentation” of PGRFA. By presenting characterization, evaluation and documentation as integral elements of effective conservation, the text of the International Treaty links conservation to sustainable use, as these are key for the subsequent use of collected and conserved PGRFA for agricultural research and



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¹ FAO (2001).



Cross-references:

- Refer to section 2.3. of lesson 2 of Module I (Objectives, Scope and Basic Concepts) for a working **definition of the concepts of sustainability and sustainable use** in the context of PGRFA.
- For the legal **definitions of the terms *ex situ* and *in situ* conservation** refer to sub-section 2.3.6. of lesson 2 of Module I (Objectives, Scope and Basic Concepts).
- For an in-depth study of **different *ex situ* and *in situ* conservation techniques**, including their respective advantages and disadvantages, refer to sub-section 1.2.2. of lesson 1 of this module (What is Conservation and Sustainable Use?).

breeding. As the above-mentioned elements relate to both *in situ* and *ex situ* conservation, they will be explained before we move on to an examination of the references to *ex situ*, *in situ* and on-farm conservation in Article 5 of the International Treaty.

Exploration (Article 5.1a)

The term ‘exploration’ is generally referred to as the act of searching a particular plant species to establish its range of variability and geographic distribution.² All rational attempts to conserve PGRFA, be it through *in situ* or *ex situ* conservation measures, are preceded by such exploration that typically includes surveying and inventorying PGRFA.

In the text of the International Treaty,

exploration of PGRFA is covered by Article 5.1a), according to which Contracting Parties shall “survey and inventory plant genetic resources for food and agriculture, taking into account the status and degree of variation in existing populations, including those that are of potential use and, as feasible, assess any threats to them”.

Contracting Parties need to know what PGRFA exist in their countries before being able to develop policies and strategies for their conservation and sustainable use. Surveys help identify areas with high natural plant genetic diversity and areas where diversity is at risk, as well as the state of *ex situ* and national collections. Inventories are needed to ensure complementarity between *in situ* and *ex situ* conservation.³



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² EAPGREN (2005).

³ Moore and Tymowski (2005), p. 42.



Courtesy Flickr/Luigi Guarino

The emphasis that Article 5.1a) puts on the degree of variation in existing populations reflects the importance of both intra-species and inter-species diversity of PGRFA for plant breeding. Intra-species diversity refers to the number of different varieties within the same crop species, whereas inter-species diversity means the number of different crop species. In this context it is also to note that in its Article 5.1f) the International Treaty foresees that Contracting Parties shall “monitor the maintenance of the viability, degree of variation, and the genetic integrity of collections of plant genetic resources for food and agriculture”. The reference to ‘potential use’ in Article 5.1a) evidences the precautionary approach adopted by the International Treaty.⁴

Since 1996, most countries have carried out specific surveys and inventories. Switzerland, for example, completed a national inventory of its CWR in 2009 in which 142 species were identified as being of priority for conservation and use. Most surveys, however, have been

limited to small groups of species or to restricted areas. A particular need remains to improve inventories on landraces, CWR and other useful wild species, including forages, to better target conservation action.⁵

It is important to note that according to Article 5.1a) Contracting Parties are also to assess any threats to PGRFA. This can be read in connection with Article 5.2 which places a positive obligation on Contracting Parties to “take steps to minimize or, if possible, eliminate threats” to PGRFA. The assessment of threats to PGRFA provides the basis for adaptation and mitigation action. PGRFA collections in gene banks may be under threat where there is a lack of sustainable funding for the maintenance of facilities. There is a particular need for more studies on possible threats to existing diversity on farms and *in situ*.⁶ It is the very aim of the International Treaty to counter such threats through conservation and sustainable use of PGRFA, both in gene banks and in natural and agricultural ecosystems. In this

⁴ Moore and Tymowski (2005), p. 42.

⁵ FAO (2010), pp. 31-32, 45-46.

⁶ *Idem*, p. 46.





sense, Article 5.1a) provides the rationale for identifying the PGRFA to be collected under Article 5.1b). Box 2.2 lists the main threats to crop diversity as identified by the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (hereafter "Second State of the World Report").

Priority activity 1 of the Second Global Plan of Action contains policy guidance and recommends strategies for surveying and inventorying PGRFA, also with the aim to identify and assess threats to PGRFA, particularly from land-use and climate changes.

Collection (Article 5.1b)

The term 'collection' refers to the action of gathering together, assembling, or grouping similar things into one place, usually with a particular focus. In the context of the International Treaty it means collecting crop genetic resources from natural and agricultural ecosystems. A PGRFA collection brings together the germplasm of domesticated plants, and related wild or

weedy species.⁷

Article 5.1b) requests Contracting Parties to "promote the collection of plant genetic resources for food and agriculture and relevant associated information on those plant genetic resources that are under threat or are of potential use".

Collection of PGRFA peaked in modern times in the early 1970s in the course of the Green Revolution. For the most part, PGRFA collections are held in gene banks, however collections are also held in other facilities such as botanical gardens and field gene banks, and important PGRFA varieties are also conserved *in situ*. Article 5.1b) highlights the importance of collecting PGRFA that are under threat and/or of potential use. This provides guidance to Contracting Parties to prioritize their collecting activities accordingly. However, this does not mean that exclusively threatened crop varieties should be collected. PGRFA that are not threatened and/or are under active use may equally be included in collections in order to facilitate their availability and exchange for further research and breeding.⁸

Box 2.2: Main Drivers of Crop Diversity Loss

The Second State of the World Report lists the following main drivers of crop diversity loss:⁹

- Climate change: *ex situ* conservation will become increasingly important as a safety net for conserving PGRFA, while PGRFA conserved in gene banks will become increasingly important in underpinning the efforts of plant breeders as they develop varieties adapted to the new conditions. *In situ* conservation, because of its dynamic nature, will also become more important in the future as a result of climate change.
- Habitat change: cultivated land already covers one-quarter of the Earth's terrestrial surface and a further 10-20 percent of land currently under grass or forest will be converted to agriculture by 2050. This poses a major threat especially to CWR.
- Invasive alien species: invasive alien species, including pest and disease organisms, constitute a remarkable threat to wild PGRFA. The problem has been exacerbated in recent years due to increased international trade and travel.
- Replacement of traditional with modern varieties: the replacement by farmers of traditional varieties with new, improved modern varieties, remains one of the main drivers of crop genetic erosion in many countries.

⁷ De Vicente, López and Fulton (2004).

⁸ Moore and Tymowski (2005), p.43.

⁹ Box 2.2 is adapted from FAO (2010), pp. 43-44. The drivers are presented in the same order as they appear in FAO (2010).

Article 5.1b) further provides for the collection of ‘relevant associated information’ related to the PGRFA that are collected. This comprises mainly the information collected through characterization, evaluation and documentation, as suggested in Article 5.1e) of the International Treaty and described below, including also information provided by farmers.

Under the Convention on Biological Diversity (CBD), countries have agreed on certain principles for international transfers of genetic resources that have to be respected when germplasm is being collected. The two central conditions are that the prior informed consent of the party holding the genetic resources to be collected has been obtained, and that the terms upon which access to the material is granted, as well as for the sharing of the benefits between the parties, are mutually agreed-upon. In addition, the International Code of Conduct for Plant Germplasm Collecting and Transfer proposes minimum responsibilities of collectors, providers, gene bank managers and users of collected germplasm, in the collection and transfer of plant germplasm.

Such regulations are necessary, however they may add transaction costs to transfers and collecting missions of PGRFA. It is therefore important that governments establish clear and effective measures to comply with their international engagements and facilitate collection and transfer of genetic material for research and breeding. The Standard Material Transfer Agreement (SMTA) of the International Treaty is a standardized contract between providers and recipients in transfers of crop genetic material of 64 of the most important crops for food and agriculture that are listed in Annex I of the International Treaty. The SMTA facilitates access to PGRFA as it renders bilateral negotiations on the terms of access unnecessary, thereby lowering transaction costs. By using the SMTA, both providers and recipients in transfers of germplasm comply with the conditions of prior informed consent and mutually agreed terms.

The Second Global Plan of Action contains policy guidance and recommends strategies for supporting targeted collection of PGRFA in its priority activity 5.



Alexander von Humboldt



Characterization, Evaluation and Documentation

The term ‘characterization’ refers to the description of the essential properties of an organism or system.¹⁰ In the context of PGRFA it involves systematic recording and categorization of data on plant traits that are highly heritable, easily recognizable by the eye (such as the colour of a flower), independent of environmental factors¹¹ and thus equally expressed in all environments.¹²

‘Evaluation’, on the other hand, relates to the assessment of the agronomic characteristics of the material, generally using descriptors of quantitative traits that are affected by the environment, such as disease or drought resistance.¹³ Evaluation is carried out through measurement, observation and analysis of PGRFA, including by molecular technologies, usually with a view to detecting their potential use.¹⁴

‘Documentation’ of PGRFA is the procedure by which information on germplasm is identified, acquired, classified, stored, handled

and disseminated.¹⁵ The term documentation also refers to the totality of the information that should be kept available together with collected PGRFA samples.¹⁶

Characterization and evaluation data are of prime importance to subsequent users of collected material, primarily to breeders – including public, private and farmer breeders – who aim at developing new varieties by incorporating desirable traits, such as high yields and drought resistance, from different parent varieties. Often, characterization, evaluation and documentation may be carried out in collaboration between facilities that hold crop genetic materials and users; this allows sharing the costs between gene banks and breeders.

In its priority activity 8 the Second Global Plan of Action recognizes that the lack of adequate characterization and evaluation data and the capacity to generate and manage them, represent major constraints to the use of many germplasm collections, especially those containing underutilized species and CWR.

Key points to remember:

- The International Treaty presents exploration, collection, characterization, evaluation and documentation as integral elements of effective conservation, highlighting that they are key for promoting the sustainable use of PGRFA.
- All rational attempts to effectively conserve PGRFA are preceded by exploration activities that typically include surveying and inventorying of threatened PGRFA that are of potential use; there is a particular need to improve inventories on landraces, CWR and other useful wild species to better target *in situ* conservation action.
- PGRFA collections bring together the germplasm of domesticated plants and their related wild and weedy species.
- Characterization involves systematic recording and categorization of data on plant traits that are highly heritable, easily recognizable by the eye and equally expressed in all environments.
- Evaluation relates to the assessment of the agronomic characteristics of the material, generally using descriptors or quantitative traits that are affected by the environment, such as disease or drought resistance.

¹⁰ FAO (2001).

¹¹ FAO (1999).

¹² De Vicente, López and Fulton (2004).

¹³ Moore and Tymowski (2005), p. 47.

¹⁴ CIAT (2007).

¹⁵ *Ibid.*

¹⁶ Moore and Tymowski, *Op. cit.*, p. 47.



Cross-references:

- For more **technical information on ex situ and in situ conservation** techniques, including their respective advantages and disadvantages, refer to section 1.2.2. of lesson 1 of this module (What is Conservation and Sustainable Use?).
- To learn more about the **Green Revolution** and its impacts on crop diversity, refer to sub-sections 1.2.1. and 1.2.2. of lesson 1 of Module I (A Global Treaty for Food Security in an Era of Climate Change) and sub-sections 3.2.1. and 3.2.2. of lesson 3 (History of the International Treaty) of Module I.
- For more information on the **relationship of the International Treaty with the CBD** and the International Code of Conduct for Plant Germplasm Collecting and Transfer refer to sub-section 5.2.2. of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- For the **text of the CBD** see: <http://www.cbd.int/convention/text/>
- For the **text of the International Code of Conduct for Plant Germplasm Collecting and Transfer** see: <http://www.fao.org/docrep/x5586E/x5586eok.htm>
- For the list of the 64 food crops and forages contained in **Annex I of the International Treaty** see: <http://www.planttreaty.org/content/crops-and-forages-annex-1>
- Refer to Box 4.2 of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective) for an **illustration of how partnerships can help reducing the cost of obtaining evaluation data**.

Ex Situ Conservation (Article 5.1e)

Under Article 5.1e) of the International Treaty, Contracting Parties commit to “cooperate to promote the development of an efficient and sustainable system of *ex situ* conservation, giving due attention to the need for adequate documentation, characterization, regeneration and evaluation, and promote the development and transfer of appropriate technologies for this purpose

with a view to improving the sustainable use of plant genetic resources for food and agriculture”.

This provision reiterates the need for adequate characterization, evaluation and documentation as a means for improving the sustainable use of PGRFA. In fact, the accessibility of germplasm and whether it can be readily used by agricultural



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researchers, breeders and farmers, depends to a large extent on the availability and adequacy of this information.¹⁷ It is crucial for sustainable conservation efforts that are linked to use, allowing breeders, for example, to identify desirable traits and breed them into new varieties. Information technology tools that help locate PGRFA samples and provide related passport data play an important role in enhancing the use of crop diversity. In partnership with Bioversity International on behalf of the Consultative Group of International Agricultural Research (CGIAR), and the Global Crop Diversity Trust (hereafter “Crop Trust”), the Secretariat of the International Treaty has therefore launched Genesys, a plant genetic resources portal that offers a single access point to information of about a third of the world’s gene bank accessions.

Policy guidance and recommended strategies for promoting the characterization and evaluation of PGRFA collections is contained in priority activity 8 of the Second Global Plan of Action.¹⁸

The provision also stresses the need to develop an efficient system of *ex situ* conservation. It is estimated that over 7.4 million PGRFA samples are currently stored in over *ex situ* facilities worldwide. Almost 90 percent of the total is stored in national gene banks, with further important collections held by the International Agricultural Research Centers of the CGIAR (hereafter “CGIAR Centres”). This represents a 20 percent increase from 1996 to 2010. It may seem that the system of *ex situ* conservation is strong and has significantly strengthened over the past years. However, this is not necessarily enough as a lot of duplication occurs, i.e. samples of the same genetic material are stored in various different gene banks. Whereas a certain degree of duplication contributes to minimizing the risk of losing a given PGRFA, the maintenance of duplicate collections also has a cost. The fact that over 70 percent of PGRFA samples held in *ex situ* gene banks worldwide are duplicates illustrates the scope for rationalization of the international gene bank system.¹⁹



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¹⁷ Adapted from Moore and Tymowski (2005), p. 47.

¹⁸ FAO (2011b), paras. 142-161.

¹⁹ FAO (2010), p. 4.



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Rationalizing the international *ex situ* conservation system will improve the efficiency of gene bank management. Resources saved through cost reductions from such rationalizing, for example, could be used to maintain and expand conservation activities of new samples of different species and varieties, especially for developing countries facing funding problems that at times put their collections in danger.²⁰ According to the Second State of the World Report, efforts to rationalize collections have been reported by several gene banks and networks. One example is AEGIS, an initiative of the European Cooperative Programme for Plant Genetic Resources (ECPGR) to rationalize European PGRFA collections that are dispersed over approximately 500 holders and 45 countries. The identification of undesirable duplicates is an important component of the initiative.²¹

The Multilateral System of Access and Benefit-sharing (hereafter “Multilateral

System”) of the International Treaty contributes importantly to the strengthening of the international gene bank system. It does so by creating a global pool of a number of the world’s most important crop genetic resources to which users based in countries that are Contracting Parties of the International Treaty enjoy facilitated access. Contracting Parties, the CGIAR Centres and other organizations up to date have included over 1.3 million samples of mostly *ex situ*-held PGRFA that they make available under the facilitated conditions of a SMTA. Being able to easily access PGRFA located in different gene banks around the world diminishes the need for maintaining large amounts of duplicates especially for smaller institutions.

Priority activity 6 of the Second Global Plan of Action contains policy guidance and recommends strategies for rationalizing, sustaining and expanding *ex situ* conservation of germplasm.

²⁰ Moore and Tymowski (2005), p. 46.

²¹ FAO (2010), pp. 8-9.



Cross-references:

- For more **information on Genesys** refer to Box 5.3 of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- **Access Genesys** here: <http://www.genesys-pgr.org/>
- For more **information on AEGIS** see http://aegis.cgiar.org/about_aegis.html
- Refer to sub-section 4.2.3. of lesson 4 of Module I (Main Components and Governance of the International Treaty) for **an introduction to the Multilateral System and the SMTA**.
- For an in-depth study of the Multilateral System refer to the forthcoming Module IV.

***In Situ* Conservation (Article 5.1d)**

As illustrated in lesson 1 of this module, *in situ* conservation comprises two main methods of conservation: *in situ* conservation in the strict sense, which involves mainly conservation of wild PGRFA in natural surroundings, and on-farm conservation which can be understood as the conservation of mostly cultivated PGRFA in the agro-ecosystems where they have evolved. Article 5.1d) of the International Treaty refers to *in situ* conservation in the strict sense, while on-farm conservation and management is addressed in articles 5.1c) and 6.2f), and presented below.

According to Article 5.1d) of the International Treaty, Contracting Parties shall “promote *in situ* conservation of wild crop relatives and

wild plants for food production, including in protected areas, by supporting, *inter alia*, the efforts of indigenous and local communities”.

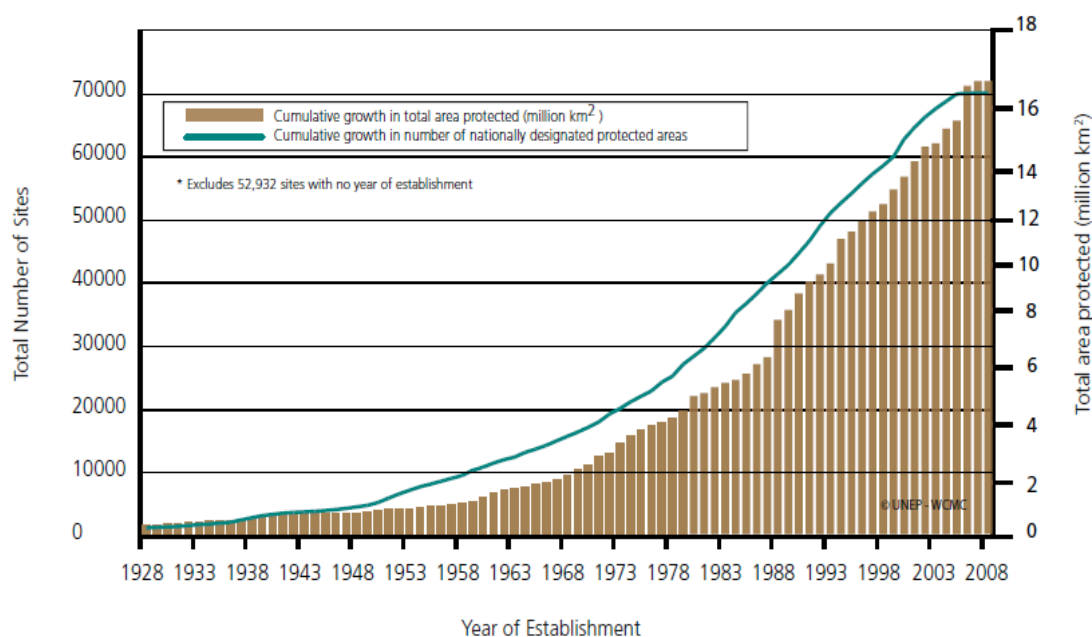
In situ conservation often takes place in protected areas of habitats, targeted at species or the entire ecosystem in which they occur. It is a particularly important conservation method for species that are difficult to conserve in gene banks, as is the case with many crop wild relatives (CWR). CWR are wild plants that are closely related to domesticated plants. Often they are wild ancestors from which crops are derived. Approximately 700 CWR species are considered of highest priority for the improvement of the world’s most important food crops, and in particular their adaptation



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Figure 2.1 Growth in Nationally Designated Protected Areas (1928-2008)



Source: FAO (2010), p. 33

to climate change. *In situ* conservation of CWR is thus also important for plant breeding and food security. In addition, many plant species growing in wild ecosystems are valuable for food and agriculture, especially in developing countries and poor areas, as they can provide an important contribution to household incomes and a safety net when food is scarce.²² This does not imply by any means that CWR cannot and should not in addition be conserved in gene banks. In fact, it is very useful to conserve CWR also under *ex situ* conditions, in order to make them more readily available for use in plant breeding, for example.

Figure 2.1 above shows the steady growth in nationally designated protected areas. However, in spite of this overall increase, the

range of genetic diversity of target species within them remains inadequately represented and many of the ecological niches that are important for wild PGRFA remain outside of protected areas.²³

There has been some progress over the last decade with initiatives at national and international level identifying specific sites especially suited for *in situ* conservation of CWR and priority activities where CWR are at risk. In Peru for example, farming communities have signed an agreement with the International Potato Center (CIP) to establish a park near Cusco where the genetic diversity of numerous potato varieties is protected by local indigenous people who own the land and who are also allowed to control access to these local genetic

²² FAO (2010), p. 31.

²³ *Idem*, pp. 32, 34-35.



resources.²⁴ The Potato Park is also among the first projects to have received funding under the Benefit-sharing Fund. The main activities and achievements of the project are presented in Box 2.3 below.

The Second Global Plan of Action contains policy guidance and recommends strategies for the promotion of *in situ* management of CWR and wild food plants in its priority activity 4.

Box 2.3: Supporting the Efforts of Indigenous Communities to Promote *In Situ* Conservation - The Potato Park in Cusco

Peru's Potato Park, a unique 15 000 ha reserve high in the Andes, was established to conserve the region's potato biodiversity, a task that has become increasingly difficult as warming climates have altered the growing patterns of some of the area's local varieties. The reserve is home to six indigenous Quechua communities whose 8000 residents manage their communal lands jointly for their collective benefit. The communal activities are spearheaded by the organization known as the 'guardian of native potatoes', the Papa Arariwa Collective.

In the Potato Park, which is considered a centre of origin of potato, a typical farmer may grow more than 200 varieties, most of which are for local consumption or regional barter. Because of warming climate, local potato farmers now experiment at higher altitudes where the temperatures are lower. Ironically, they are using many varieties that had already disappeared from their fields but had been saved in the gene bank of the International Potato Center (CIP). The Benefit-sharing Fund project of the International Treaty is working with the local farmers as they repatriate varieties from the gene bank into their fields. More than 1345 varieties can be found in the Potato Park, of which 779 were collected locally, 410 were repatriated from CIP and 157 were received through seed exchanges.²⁵

Cross-references:

- For more **technical details on *in situ* conservation**, refer to sub-sections 1.2.2. and 1.2.3. of lesson 1 of this module (What is Conservation and Sustainable Use?).
- For an **illustration of how *in situ* and CWR conservation can be linked to gene banks** refer to sub-section 4.2.1. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).
- For the **text of the Second State of the World Report** see:
<http://www.fao.org/docrep/013/i1500e/i1500e.pdf>



²⁴ FAO (2010), p. 35.

²⁵ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2011a).



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On-farm Conservation and Management (Articles 5.1c and 6.2f)

On-farm conservation and management of PGRFA is considered a form of *in situ* conservation, as crops are conserved in the agro-ecosystems where they have developed their distinctive properties or in systems where they are adapting to new conditions. In essence, on-farm conservation and management implies that PGRFA are being conserved by being cultivated, adapted and improved. This is a further concrete illustration of the linkage between conservation and sustainable use of crop diversity.

Two provisions of the International Treaty, one listed under conservation and the other under sustainable use, refer to on-farm conservation and management of PGRFA. Article 5.1c) of the International Treaty requests Contracting Parties to “promote or support, as appropriate, farmers and local communities’ efforts to manage and conserve on-farm” their PGRFA, and Article 6.2f) proposes to Contracting Parties to support “the wider use of diversity of varieties and species in on-farm management, conservation and sustainable use of crops”.

Farmers who produce in traditional farming systems generally rely heavily on local varieties and often diversify the crops they produce as strategies to reduce the risks that result from market fluctuations and volatile international food prices, as well as from weather, pests and diseases. In many traditional farming communities, women play a particular role in variety selection and as custodians of crop genetic diversity. The maintenance of genetic diversity within local production systems also helps to conserve traditional knowledge and *vice versa*.

However, throughout most of the developed world and increasingly also in many developing countries, the majority of food is now supplied by industrialized production, which has resulted in a considerable degree of uniformity in cultivated crop varieties. As a result, diversity in farmers’ fields is still in decline at least for some crops and in certain countries. To counter these trends, promoting and supporting on-farm conservation and management of genetic resources in farmers’ fields, home gardens, orchards and other cultivated areas of high diversity, has become a key component of many crop conservation strategies.



Consequently, on-farm conservation and management of PGRFA is one of the three first priorities of the Benefit-sharing Fund.²⁶ Box 2.4 below illustrates the on-farm conservation and management activities of a project in Senegal that received funding under the first round of the project cycle of the Benefit-sharing Fund.

One of the major findings of the Second State of the World Report with regard to *in*

situ conservation, including both ‘in the wild’ and on farms, is that the involvement of local communities is essential and traditional knowledge systems and practices need to be fully taken into account.

Policy guidance and recommended strategies for supporting on-farm conservation and management of PGRFA is contained in priority activity 2 of the Second Global Plan of Action.

Box 2.4: A Participatory Approach to On-farm Management: A Project Supported by the Benefit-sharing Fund in Senegal

In Senegal, 90 percent of the farming area is dedicated to cereal production. Yet three of the main crops – millet, maize and sorghum – are facing progressive loss of genetic diversity in the fields and low variability which has dire effects on the abilities of farmers to achieve good results in their harvesting seasons. Thus, the Benefit-sharing Fund project of the International Treaty in Senegal pulled 340 samples of millet, maize and sorghum from a database to discuss their merits with local farmers. They specifically chose samples that still are found in farmers’ fields, not those that only exist in gene banks. This allowed local farmers to offer practical advice as to which ones would be best to include in on-farm testing that would determine which ones were best adapted to climatic conditions and also which ones met the taste demands of consumers. The farmers chose 55 varieties.

The project offers a combination of research into and promotion of local varieties, in terms of raising the awareness of farmers and policy-makers of the need to conserve local cereal biodiversity. The focus is on increasing productivity by using a participatory, on-farm conservation approach with the ultimate goal of broadening the genetic base of local crops and increasing the diversity of plant genetic material available to farmers.

In addition to studying the 55 selected varieties in local farmers’ fields, selected farmers worked in the experimental fields of two research stations which had planted the 55 selected varieties. This enabled the farmers to add their insight to production methods and their assessments of the crops’ quality in terms of yield, water use and resistance to atmospheric conditions, disease and pests, as well as taste and ease of production.²⁷

Cross-references:

- For more **technical details regarding on-farm conservation and management** refer to sub-section 1.2.2. of lesson 1 of this module (What is Conservation and Sustainable Use?).
- For examples of **activities that support on-farm conservation** of crop diversity refer to lesson 4 of this module (Implementation of Articles 5 and 6 from a Users’ Perspective).



²⁶ ‘On-farm Conservation’ is partly adapted from FAO (2010), p. 4.

²⁷ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2011b).

Key points to remember:

- Contracting Parties of the International Treaty are committed to adopting and maintaining an integrated approach to conservation and sustainable use of PGRFA, promoting both *in situ* and *ex situ* conservation in a complementary manner.
- The Multilateral System of the International Treaty strengthens the international gene bank system very importantly; however, there is still a need for further rationalization of the international *ex situ* conservation system.
- Involvement of local communities and due consideration of traditional knowledge systems and practices are essential for any *in situ* conservation and on-farm conservation and management effort.
- On-farm conservation and management of a diversity of traditional and local PGRFA in farmers' fields, home gardens, orchards and other cultivated areas of high diversity, is often used as a strategy to increase food security in traditional farming systems and has become a key component of many crop conservation strategies.



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2.2.2. Measures to Promote the Sustainable Use of Crop Diversity (Article 6)

Article 6 constitutes an obligation for Contracting Parties to develop and maintain appropriate policy and legal measures to promote the sustainable use of PGRFA. This obligation is similar to the requirement under the CBD to develop national biodiversity strategies and action plans (NBSAPs), as presented in Box 2.5 below. Article 6.2 therefore contains a non-exhaustive list of measures Contracting Parties can adopt to achieve their commitments. Very much in the same way as the measures for conservation of PGRFA proposed under Article 5, Article 6 is largely based on the priority activities and recommendations of the Global Plan of Action.

Agricultural Policies that Promote Diverse Farming Systems (Article 6.2a)

The first measure that the International Treaty mentions in its Article 6.2a) reads “pursuing fair agricultural policies that promote, as appropriate, the development

and maintenance of diverse farming systems that enhance the sustainable use of agricultural biological diversity and other natural resources”.

The main focus of this paragraph is the promotion of farming systems that enhance the sustainable use of *agricultural biodiversity and other natural resources* through appropriate agricultural policies. This proposed measure thus reaches beyond the International Treaty’s general scope of PGRFA, providing a sound base to Contracting Parties to promote a broad range of sustainable agricultural policies. By referring to the broader term of ‘agricultural biodiversity’, the provision accounts for the fact that also other components of agricultural biodiversity such as micro-organisms and pollinators, are of crucial importance for the sustainable use of PGRFA. Equally, any farming system depends on a range of natural resources including, *inter alia*, healthy soils and clean water. Micro-organisms can improve soil nutrients for plant growth and protect plants from diseases. Pollinators such as bees are indispensable for the cultivation of some 87

Box 2.5: National Biodiversity Strategies and Action Plans and their Relevance for the Implementation of Articles 5 and 6 of the International Treaty

The Convention on Biological Diversity (CBD) is the international legal framework for the conservation and sustainable use of biodiversity, comprising all (except human) genetic resources. The CBD requires its member countries to develop or adapt “national strategies, plans or programmes” to integrate conservation and sustainable use of biodiversity into sectoral and cross-sectoral activities. Consequently, a great majority of member countries of the CBD have developed so-called National Biodiversity Strategies and Action Plans (NBSAPs).

In many countries the elaboration of NBSAPs falls under the purview of environment ministries, which is why in some cases the specific needs of agricultural biodiversity have not been properly reflected. However, the importance of agricultural biodiversity as an integral part of larger biodiversity has been increasingly recognized also by the environment community and a programme of work on agricultural biodiversity was endorsed under the CBD in 2000.

With the adoption of the Aichi Biodiversity Targets for the period 2011-2020, the decision-making body of the CBD urged its member countries to revise their NBSAPs. For countries that have not done so yet, this provides a timely opportunity to integrate the measures proposed by the International Treaty and the policy recommendations of the Global Plan of Action in a mutually supportive manner into their NBSAPs.





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out of the 115 leading global food crops.²⁸ Services like pollination and the provision of clean water are also known as ‘ecosystem services’. Article 6.2a) thus establishes a sound base for countries that wish to reflect an ecosystem approach in their agricultural policy. Box 2.6 below explains the concepts of ecosystems approach and ecosystem services. Figure 2.2 provides a general framework of possible relationships between agriculture and ecosystem services.

By referring to the farming system level, this paragraph even touches upon social dimensions of agricultural policies for the enhancement of agricultural biodiversity. This may require policy measures that allow smallholder farmers to remain profitable in order not to be driven out of the market. At the same time, it is to note that the reference to ‘fair’ agricultural policies

points to the need to ensure that agricultural policies do not have distorting effects on trade through the granting of subsidies disguised as measures to promote traditional farming and sustainable agriculture.²⁹

One methodology that aims at the local level that has been put forward by researchers to promote diverse farming systems through strengthened on-farm management and conservation is Community Biodiversity Management (CBM). CBM guides practices that contribute to the conservation and sustainable use of agricultural biodiversity, focusing on the process of enabling communities to secure their access and control over genetic resources through increased decision-making power. CBM is often applied in relation with participatory plant breeding (PPB), which is dealt with further below.

Cross-references:

- For **examples of policies that promote diverse farming systems** refer to sub-section 4.2.5. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users’ Perspective).
- For an overview of selected **examples of legislation for the conservation and sustainable use of crop diversity** refer to Box 3.2 of lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use).
- To learn more about **NBSAPs** see: <http://www.cbd.int/nbsap/training/>

²⁸ TEEB (2010), p. 34.

²⁹ Moore and Tymowski (2005), pp. 51-52.



Box 2.6: The Ecosystem Approach and Ecosystem Services

An ecosystem is a dynamic complex of plant, animal and micro-organism communities and the nonliving environment interacting as a functional unit. Examples range from relatively undisturbed ecosystems, such as natural forests, to landscapes with mixed patterns of human use, to ecosystems intensively managed and modified by humans, such as agricultural land and urban areas.

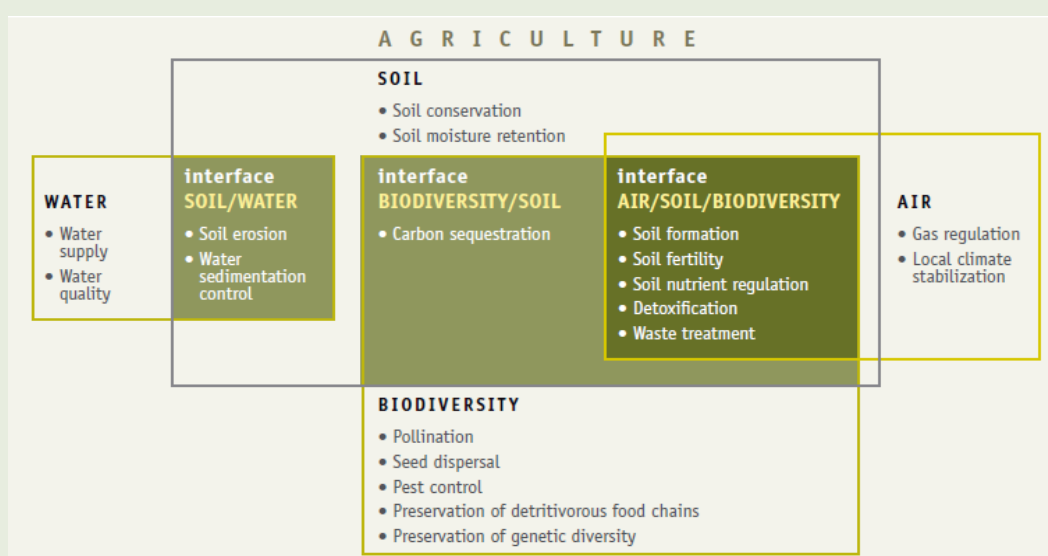
The ecosystem approach is a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach involves a focus on the functional relationships and processes within ecosystems, attention to the distribution of benefits that flow from ecosystem services, the use of adaptive management practices, the need to carry out management actions at multiple scales, and intersectoral cooperation.³⁰

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.³¹

For example, the total economic value of insect pollination has been estimated at € 143 billion, representing 9.5 percent of world agricultural output in 2005.³²

As illustrated, Article 6.2a) thus also *situ* conservation. In this sense, policy exhibits linkages with some provisions on conservation of PGRFA under Article 5, especially those dealing with on-farm conservation and management and *in situ* conservation. In this sense, policy guidance and recommended strategies for implementing Article 6.2a) can be found in priority activities 2 and 4 of the Second Global Plan of Action.

Figure 2.2: Ecosystem Services, Occurring in Different Ecological Compartments (Air, Soil, Water and Biodiversity)



Source: FAO (2011c), p. 12.

³⁰ CBD (2000).

³¹ MEA (2005), pp. v-vi.

³² TEEB (2010), p. 8.



Research which Enhances Biological Diversity for the Benefit of Farmers (Article 6.2b)

Under its Article 6.2b) the International Treaty proposes the following measure: “strengthening research which enhances and conserves biological diversity by maximizing intra- and inter-specific variation for the benefit of farmers, especially those who generate and use their own varieties and apply ecological principles in maintaining soil fertility and in combating diseases, weeds and pests”.

The main purpose of this proposed measure is to support research that contributes to the enhancement and conservation of agricultural biodiversity. This could be, for example, research that is carried out by international and national agricultural research institutes, gene banks and other institutions carrying out agricultural research. Research should facilitate the conservation and sustainable use of both the variation within a crop species (range of different varieties) as well as of the variation between crop species. It could also focus on crop improvement and adaptation to changing conditions. In addition, the primary beneficiaries of the research should

be farmers, in particular farmer breeders that apply sustainable farming principles.

Diversity in cropping systems is often of particular importance from the standpoint of pest control. Traditional farming systems tend to be more agriculturally diverse and smallholder farmers – especially in developing countries – often rely on sustainable practices for soil improvement and pest management, as they lack the necessary financial resources for the procurement of chemical fertilizers, pesticides and herbicides.³³

This implies that the research should focus on sustainable agricultural practices such as crop diversification and integrated pest management which support a wide range of beneficial insects, soil micro-organisms, and other factors that add up to overall farm health, and to making the research results available to farmers who apply such practices through farmer field schools and extension services.

The Second Global Plan of Action contains recommendations with regard to research and technology for supporting plant breeding, genetic enhancement and base-broadening efforts in its priority activity 9.

Cross-references:

- For working **definitions of terms** including ‘biodiversity’, ‘agricultural biodiversity’, ‘species’, ‘varieties’, please refer to section 2.3. of lesson 2 of Module I (Objectives, Scope and Basic Concepts).
- For **examples linking research to farmers** refer to sub-section 4.2.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users’ Perspective).

³³ Moore and Tymowski (2005), p. 52.



Participatory Plant Breeding (Article 6.2c)

As a further measure to enhance sustainable use, Article 6.2c) proposes to promote “plant breeding efforts which, with the participation of farmers, particularly in developing countries, strengthen the capacity to develop varieties particularly adapted to social, economic and ecological conditions, including in marginal areas”.

As a minimum, farmers interact with breeders by buying the varieties they choose to cultivate in their fields. If they do not like the planting material that is offered by the seed sector they would stop buying it and thus there would be no incentive anymore for the seed sector to continue selling that material. This does not hold true, however, for countries where the seed sector is highly monopolized and where farmers do not have access to an efficient formal seed sector that would offer them better alternatives.

Particularly in developing countries formal seed sectors tend to be weak. In

such situations, parastatal and commercial seed companies sometimes have difficulty supplying seed of varieties specifically adapted to unique and local conditions. Often they cannot offer the range of varieties, or seed of so-called ‘minor’ crops, on which many farmers, especially those producing on marginal lands, rely. There is thus a need to strengthen capacities among farmers and local institutions to produce and distribute seed of many crop varieties, including some landraces/farmers’ varieties, that are useful for diverse and evolving farming systems.³⁴

Therefore, PPB has the objective of developing improved cultivars that conserve adaptive and other traits of local importance. While presenting an effective strategy for promoting sustainable use of PGRFA especially in developing countries, PPB is at the same time a useful approach to on-farm conservation and management of PGRFA, illustrating once more the continuum of conservation and sustainable use. Box 2.7 illustrates the power of PPB by an example from Nepal.

Box 2.7: Participatory Rice Breeding in the Mid-hills of Nepal

An example of rice breeding in the mid-hills of Nepal illustrates the use of locally adapted germplasm and the importance of taking into account the needs of farmers and consumers. In this case, the breeding goal was to incorporate the good taste and yield potential of the most popular variety among consumers in the mid-hills, Khumal-4 (derived from the local landrace Pokhereli Masino and IR28) into the locally adapted landrace Mansara, which, however, is rather poor in taste. Resource-poor households grew Mansara rice despite its poor taste, low yield and poor market value, as it grew in marginal areas where no other rice varieties performed well.

For its excellent local adaptation, the Mansara landrace was thus chosen as a parent for the development of improved locally adapted varieties. This was only possible because the PPB process involved smallholder farmers in setting the breeding goals. The adaptive trait of the Mansara landrace was highly valued among local farmers for its performance in marginal lands. Consequently, the traditional knowledge related to this landrace has been used in the breeding process to develop the improved varieties Mansara-4 and Mansara-5, which grow well in the marginal rice fields of the Nepalese mid-hills, and in addition incorporate the good taste and yield traits of Khumal-4.

³⁴ Moore and Tymowski (2005), p. 59.





Courtesy Flickr/IRRI Images

Often, PPB and related activities such as participatory variety selection are carried out in the broader methodological framework of CMB that was introduced earlier. In this context, the major outcomes of PPB are increased utilization of on-farm diversity and empowering farmers and rural communities to promote on-farm conservation as part of national programmes on PGRFA. PPB could thus also be applied as a strategy contributing towards the implementation of certain aspects of Farmers' Rights, allowing farmers to actively participate in the scientific process of crop improvement and share in the results obtained.

Developing farmers' capacities to breed locally adapted crop varieties also falls in the purview of Article 13.2c) of the International Treaty. This article lists the strengthening of programmes for scientific and technical capacity development in conservation and sustainable use of PGRFA as an option for non-monetary benefit-sharing under the Multilateral System of the International Treaty.

Priority activity 9 of the Second Global Plan of Action contains policy guidance and recommends strategies for supporting plant breeding, including PPB.

Cross-references:

- For more information on **different methodologies and objectives for PPB**, refer to section 4.2.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).
- To learn about **how the International Treaty's provisions on Farmers' Rights support the provisions on conservation and sustainable use**, refer to sub-section 3.2.1. of lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use).
- For more information on how PPB can contribute to the realization of Farmers' Rights, refer to forthcoming Module III.



Broadening the Range of Genetic Material Available to Farmers (Article 6.2d)

The measure proposed under Article 6.2d) is closely linked to the one under 6.2b) and described above. It reads “broadening the genetic base of crops and increasing the range of genetic diversity available to farmers”, which can be understood as increasing the intra- and inter-specific variation of crops.

Farmers over time have developed landraces that are particularly adapted to local social, economic and ecological conditions. This has led to a large degree of intra-specific diversity which, as we have seen above, is particularly important in enhancing crops’ resistance to disease, pest or local conditions such as drought. With the large-scale introduction of high yielding improved varieties, locally adapted landraces have often been marginalized and disappeared.

Thus the need for broadening the genetic base of crops, including by incorporating some of the genetic traits present in wild species and landraces hitherto used, into the new improved varieties to allow them to respond better to particular local conditions and other current or future ecological

challenges. Pre-breeding is one means to broaden the genetic base of crops, whereby breeders identify desirable traits from non-adapted materials and transfer these to an intermediate set of materials that they can use for breeding new varieties for farmers. Such so-called ‘genetic enhancement’ is necessary to allow putting to use much of the conserved germplasm. Public financial and policy support is necessary to promote such plant breeding efforts where the private sector has no interest in or cannot accomplish this on its own. Due to their local knowledge and access to locally adapted landraces, the participation of local farmers is also particularly useful.³⁵

Again, PPB is a very valuable strategy in this regard as it encourages the creation of synergies between the formal breeding sector and farmers’ breeding efforts. Other means to broaden the genetic base are the promotion of seed fairs where farmers and breeders can showcase and exchange their crop genetic materials and knowledge.

The Second Global Plan of Action contains policy guidance and recommends strategies for supporting base-broadening efforts in its priority activity 9.

Cross-references:

- For examples of **base-broadening efforts** and more information about **pre-breeding**, refer to sub-section 4.2.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users’ Perspective).



³⁵ Moore and Tymowski (2005), pp. 54-55.



Promotion of Locally Adapted and Underutilized Crops (Article 6.2e)

Under Article 6.2e) the International Treaty proposes “promoting, as appropriate, the expanded use of local and locally adapted crops, varieties and underutilized species”.

Neither ‘locally adapted’ nor ‘underutilized’ crops are defined in the text of the International Treaty. Local and locally adapted crop varieties can be understood as varieties that have their origin and/or have developed their distinctive traits in the specific areas where they are cultivated, and are therefore particularly well-adapted to the agro-ecological conditions of this area. Underutilized crops can be understood as “plant species that are used traditionally for their food, fibre, fodder, oil or medicinal properties, and that have an under-exploited potential to contribute to food security, nutrition, health, income generation and environmental services.”³⁶ Underutilized crops were once more widely grown but are falling into disuse for a number of reasons. Farmers and consumers are using these

crops less because they are in some way not competitive with other crop species in the same agricultural environment. The decline of these crops may erode the genetic base and preventing the use of distinctive useful traits in crop adaptation and improvement.³⁷

Article 6.2e), too, is closely linked to the preceding measures presented above. The use of locally adapted and underutilized crops can be promoted through adequate agricultural policies and by investing in agricultural research. PPB can be a means to promote the use of locally adapted crop varieties in a targeted way, and the expanded use of locally adapted and underutilized crops contributes directly to broadening the genetic base of crops and to increasing the range of the genetic diversity available to farmers. Plant breeding processes that aim at enhancing the capacities of grassroots institutions and farmers to assess existing diversity, select niche specific plant materials, produce sufficient quality seed, and distribute this within the communities, is also known as ‘grassroots breeding’.

³⁶ ICUC (2006).

³⁷ Bioversity International (2011).





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Many local and underutilized crops have potential for more widespread use, particularly in areas where the cultivation of major crops is economically marginal. The International Treaty strongly encourages programmes for conservation, research and development to promote these crops and varieties. An example from a project in India

that has received financial support from the International Treaty's Benefit-sharing Fund is presented in Box 2.8 below. However, it is important to note that the expanded use of local and underutilized crops is not a goal in itself, especially in cases where such expanded use could jeopardize the food security, nutrition and health of the local populations.³⁸

Box 2.8: Locally Adapted Crops Face Climate Change Conditions and Improve Nutrition and Incomes

The women who participated in the Benefit-sharing Fund project of the International Treaty in Kerala, India, have improved their family nutrition and food security through producing high-yielding and drought-resistant local varieties of cassava identified by the project. The women, as well as other farmers, had the benefit of project activities that ranged from identifying isolated farms that still cultivated local crops, to training in cultivation and propagation techniques and support in distributing planting materials of locally adapted varieties.

In 1964, Kerala farmer Ambakkadan Thommi noticed that one of his cassava tubers had an unusual skin colour. He boiled it, liked the taste and, the next season, planted 25 cuttings. When he found the variety was high yielding as well as drought tolerant, he gave cuttings to his neighbours. Now named for him, the Ambakkadan cassava remained popular among local farmers until the 1980s when it was replaced by hybrid and short-duration varieties. In the 1990s, with the increased price of food crops, local farmers remembered the Ambakkadan but found no planting materials available. In answer to this, the International Treaty's Benefit-sharing Fund project in India identified isolated farms still growing Ambakkadan and embarked on cultivating and disseminating the planting material. This will increase the ability of farmers in the region to face climate change conditions as well as improve their nutrition and incomes.³⁹

³⁸ Adapted from Moore and Tymowski (2005), p. 58.

³⁹ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2011c).





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One means to promote the use of locally adapted and underutilized crops is to create better market opportunities and supportive policies, to increase the incentive for farmers to continue to use these crops and varieties and thus to conserve crop diversity through its sustainable use.⁴⁰ Raising awareness among the general public on the health, nutritional or environmental benefits of consuming certain locally adapted and underutilized crops can also promote market opportunities. In this context, article 6.2e) can also provide a basis for developing marketing strategies that may help to increase consumer demand for local and underutilized crops and varieties.

Promoting the expanded use of such crops will also require the development of capacities for farmers, local communities, scientists and extension specialists in identifying underutilized crops with potential for increased sustainable use, the development of sustainable management practices, developing post-harvest processing methods and developing marketing methods.⁴¹

Policy guidance and recommended strategies for promoting the development and commercialization of farmers' varieties and underutilized species is contained in priority activity 11 of the Second Global Plan of Action.

Cross-references:

- For an illustration of how **acting on consumer choice** can be a means to enhance the use of traditional and locally adapted crops refer to sub-section 4.2.4. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).

⁴⁰ Moore and Tymowski (2005), p. 58.

⁴¹ *Ibid.*



Support of On-farm Diversity and Agricultural Development (Article 6.2f)

The measure proposed in Article 6.2f) reads “supporting, as appropriate, the wider use of diversity of varieties and species in on-farm management, conservation and sustainable use of crops and creating strong links to plant breeding and agricultural development in order to reduce crop vulnerability and genetic erosion, and promote increased world food production compatible with sustainable development”.

Again, the continuum of conservation and sustainable use of PGRFA is stressed in this provision. The provision notably focuses on broadening the use of crop diversity managed on farms, in particular as a strategy to promote increased world food production through sustainable agricultural development. In response to

Article 5.2 which calls upon Contracting Parties to minimize and/or eliminate threats to PGRFA, Article 6.2f) proposes on-farm management, especially when linked to plant breeding, e.g. through PPB, as a way to reduce genetic erosion.

So in essence, the goal of the proposed measure is to enhance and create livelihoods by producing more food using a greater diversity of crops and varieties, through sustainable agricultural practices. This is completely in line with the new paradigm of sustainable crop production intensification (SCPI) advocated by FAO. SCPI is the first strategic objective of FAO. It has been defined as producing more from the same area of land while reducing negative environmental impacts and increasing contributions to natural capital and the flow of environmental services.⁴² Box 2.9 elaborates the logic of SCPI.

Box 2.9: The Key Principles of Sustainable Crop Production Intensification

SCPI applies the basic principles of the ecosystem approach to the sector of crop production. It is characterized by a systemic approach to managing natural resources, and founded on a set of science-based environmental, institutional and social principles.

- **Environmental principles:** SCPI is based on agricultural production systems and management practices that include maintaining healthy soil to enhance crop nutrition; cultivating a wider range of species and varieties in associations, rotations and sequences; using well adapted, high-yielding varieties and good quality seeds; integrated management of insect pests, diseases and weeds; and efficient water management.
- **Institutional principles:** Translating the environmental principles into large-scale, coordinated programmes of action will require institutional support at both national and local levels. The formulation of policies and strategies for SCPI must be improved at national level. Small-holder farmers need access to efficient and equitable markets, and incentives that encourage them to manage other ecosystem services besides food production.
- **Social principles:** SCPI will require significant strengthening of extension services, from both traditional and non-traditional sources, to support its adoption by farmers. Mobilizing social capital for SCPI will require people's participation in local decision-making, ensuring decent and fair working conditions in agriculture and the recognition of the critical role of women in agriculture.⁴³



⁴² FAO (2011a), p. 9.

⁴³ Box 2.9 is adapted from FAO (2011a), pp. 11-12.



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In order to achieve its objective of SCPI, FAO has endorsed the ecosystem approach in agricultural management. There is now widespread awareness that applying the ecosystem approach is an effective means that must underpin intensification of crop production. For example, a review of agricultural development projects in 57 low-income countries found that sustainable agricultural practices had led to average crop yield increases of almost 80 percent.⁴⁴

Priority activity 10 of the Second Global Plan of Action contains policy guidance and recommends strategies for promoting diversification of crop production for sustainable agriculture.

Reviewing Breeding Strategies and Regulations Concerning Variety Release and Seed Distribution (Article 6.2g)

The last of the proposed measures to support the sustainable use of PGRFA listed in the International Treaty reads “reviewing, and,

as appropriate, adjusting breeding strategies and regulations concerning variety release and seed distribution”.

Seed regulatory frameworks aim to promote varietal and seed quality, and thereby to protect farmers from planting sub-standard seed. Seed laws commonly regulate variety testing and release, seed certification and seed quality control, and they establish the institutional framework of national seed councils and certification agencies. Seed laws are not usually intended to influence the direction of plant breeding, but often they are determined at least partly by economical management strategies. However, there are significant indirect effects of the variety release systems and of seed certification requirements on plant breeding methodologies and the resulting varieties. Breeders tend to target favourable farming conditions, wide adaptation and varietal uniformity as a result.⁴⁵

⁴⁴ FAO (2011a), pp. 9-10.

⁴⁵ Moore and Tymowski, pp. 59-60.



There are a number of options for regulatory reform. Depending on national circumstances, government policies that provide an enabling environment for the development of different seed systems, including small-scale and specialized seed enterprises, may need to be formulated. Efforts may focus on crops and varieties needed by resource-poor farmers, and complemented by policies that facilitate the development of commercial seed companies to meet the needs of larger scale, commercial farmers. Where not already in place, legislative measures that create adequate conditions for the acceptance of

varieties developed through PPB and for the deployment of farmers' varieties and underutilized species could be adopted. In plant breeding, more emphasis could be put on farmers' involvement, decentralizing variety testing, breeding for particular niches, and making site selection, trial management and analysis that is more representative of farmers' conditions.⁴⁶

The Second Global Plan of Action contains policy guidance and recommends strategies related to breeding strategies, variety release and seed distribution in its priority activity 12.

Key points to remember:

- Article 6 constitutes an obligation for Contracting Parties to develop and maintain appropriate policy and legal measures that promote the sustainable use of PGRFA.
- Addressing PGRFA in their wider context of agricultural biodiversity and ecosystem services, Article 6 provides a sound basis to promote sustainable agricultural policies and to apply the ecosystem approach.
- Article 6 also foresees the strengthening of research on a wide range of factors that add up to overall farm health, and making results available to farmers.
- The International Treaty also promotes participatory plant breeding, which aims at developing improved cultivars that conserve traits of local importance.
- Broadening the genetic base of crops implies the incorporation of desirable genetic traits of landraces and CWR into new improved varieties, including through pre-breeding, thereby increasing the intra- and inter-specific variation of crops.
- Underutilized crops are plant species with an under-exploited potential to contribute to food security, health, income generation and environmental services; their use can be promoted by creating better market opportunities and supporting policies.
- The International Treaty suggests measures that increase world food production by reducing crop vulnerability and genetic erosion through on-farm management of PGRFA and plant breeding.
- Variety release and seed certification regulations tend to target favourable farming conditions and wide adaptation and therefore often favour varietal uniformity. The International Treaty thus suggests Contracting Parties to review seed laws and regulations, as appropriate.

Cross-references:

- For **examples of cases where more flexibility has been introduced into new seed laws**, refer to Box 4.11 in lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).



⁴⁶ FAO (2011b), para. 209.

2.3. Conclusive Summary

Conservation and sustainable use of crop diversity are intrinsically linked. This linkage is highlighted at various points in the text of the International Treaty and particularly in the measures proposed under its articles 5 and 6. These measures can be seen as a continuum.

Under Article 5 Contracting Parties commit to apply an integrated approach to conservation and sustainable use. Exploration, collection, characterization, evaluation and documentation of PGRFA are presented as integral elements of effective conservation efforts. In particular characterization, evaluation and documentation of PGRFA mark the connection between conservation and sustainable use. Agricultural researchers and breeders depend heavily on the availability of this information related to crop genetic resources in order to identify desirable traits for the development of new crop varieties. Strengthening databases on information related to conserved PGRFA and making this information available together with the crop genetic material is thus of utmost importance in order to promote the use of PGRFA.

All rational attempts to effectively conserve PGRFA are preceded by exploration activities that typically include surveying and inventorying of threatened PGRFA that are of potential use. According to the Second State of the World Report there remains a particular need to improve inventories

on landraces, CWR and other useful wild species to better target conservation action.

Contracting Parties of the International Treaty further commit to promote the conservation of crop genetic resources in gene banks and on farms, as well as in protected areas. In this regard, the Second State of the World Report notably calls for further rationalization of the international *ex situ* conservation system. Particularly for *in situ* and on-farm conservation and management efforts the involvement of local communities is essential and due consideration should be given to traditional knowledge systems and practices.

Article 6 of the International Treaty constitutes an obligation for Contracting Parties to develop and maintain appropriate policy and legal measures that promote the sustainable use of crop diversity. The provisions under Article 6 propose a number of such measures which in turn draw from the priority activities of the internationally agreed Global Plan of Action. The measures range from strengthening agricultural research for the benefit of farmers to the promotion of participatory plant breeding and formal breeding, increasing the intra- and inter-specific variation of crops by broadening their genetic base, the promotion of the use of locally adapted and underutilized crop varieties, on-farm management of crop diversity, and the creation and adjustment of laws and policies that are supportive of biologically diverse and ecologically sound farming systems.



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Further Components of the International Treaty Supporting Conservation and Sustainable Use



LESSON 3



Learning objectives

At the end of this lesson, the learner will be able to:

- identify provisions of the International Treaty that are of direct relevance to conservation and sustainable use of crop diversity other than those of articles 5 and 6;
- apply the Second Global Plan of Action as an instrument to implement the provisions of the International Treaty related to conservation and sustainable use of crop diversity; and
- summarize the main achievements of the Governing Body of the International Treaty regarding conservation and sustainable use of crop diversity.



Target learner groups

Technical personnel including gene bank staff and plant breeders, as well as civil servants and other interested parties and institutions.



Solanum tuberosum, potato, by Elizabeth Blackwell (1739)

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3.1. Overview of the Lesson

This lesson complements lesson 2 (The Provisions of Articles 5 and 6 of the International Treaty), by presenting provisions of the International Treaty on Plant Genetic Resources for Food and Agriculture (hereafter “International Treaty”) that directly relate to conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA), other than those contained in articles 5 and 6.

The section on Farmers’ Rights presents the interrelations between sustainable use of crop diversity and the protection of traditional knowledge and the right to participate in decision-making. The lesson further shows that the Multilateral System of Access and Benefit-sharing (hereafter “Multilateral System”) of the International Treaty facilitates access to samples of a number of the most important crops for food security with the aim to promote their use. The section on the Funding Strategy underlines in particular the priorities of on-farm management and conservation and sustainable use of the Benefit-sharing Fund of the Funding Strategy (hereafter “Benefit-sharing Fund”) of the International Treaty.

The lesson then proceeds to give an overview of the International Treaty’s supporting components that contribute to the conservation and sustainable use of PGRFA. It focuses in particular on the role of the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (hereafter “Second Global Plan of Action”) in the framework of the International Treaty. It explains how the Second Global Plan of Action translates the International Treaty’s broadly formulated measures into elaborate policy recommendations and strategies. A table illustrates how the priority activities of the Global Plan of Action correspond to the provisions of the International Treaty dealing with conservation and sustainable use of PGRFA.

Finally, in its last section, the lesson gives a summary of the main decisions for the furtherance of the conservation and sustainable use of crop diversity that the Contracting Parties of the International Treaty have taken so far and provides an outlook on upcoming developments.

Cross-references:

- For the **text of the International Treaty** see: <ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf>
- Refer to section 4.2. of lesson 4 of Module I (Main Components and Governance of the International Treaty) for more **background on Farmers’ Rights, the Multilateral System and the Funding Strategy**.
- For the **text of the Second Global Plan of Action** see: http://typo3.fao.org/fileadmin/templates/agphome/documents/PGR/GPA/GPA2/GPA2_en.pdf



3.2. Provisions of Relevance to Conservation and Sustainable Use other than those Contained in Articles 5 and 6

In addition to articles 5 and 6, the International Treaty contains a number of other provisions that are of direct relevance to conservation and sustainable use. These include some of the Farmers' Rights provisions, several of the provisions related to the Multilateral System, provisions related to the Funding Strategy, as well as the supporting components under part V of the International Treaty.

3.2.1. Farmers' Rights

Farmers' Rights are dealt with under Article 9 of the International Treaty. Some of the provisions of Article 9 are directly related to certain provisions of articles 5 and 6, and *vice versa*. A combined reading provides for a more comprehensive understanding of the International Treaty's approach to conservation and sustainable use of PGRFA.

For example, traditional knowledge of farmers, indigenous and local communities on PGRFA is often of direct relevance for the use of the materials, as it can exhibit information on valuable traits and purposes. However, as indigenous and local communities increasingly switch to modern lifestyles, and many landraces have been replaced by modern improved varieties, much of the traditional knowledge linked to PGRFA has been lost. Collection of information associated to PGRFA, when carried out with due diligence concerning ownership, access and use, as provided for by Article 5.1b), is a measure that can contribute to the protection of traditional knowledge of relevance to PGRFA, which is foreseen in Article 9.2a). Likewise, the promotion of on-farm management and conservation of PGRFA and *in situ* conservation of CWR and wild food plants as reflected in articles 5.1c), 5.1d) and 6.2f) can contribute to the protection of



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the traditional knowledge related to these plant genetic resources. This will only be the case, however, as long as farmers have sufficient incentive to continue managing traditional crop varieties and CWR *in situ* and no barriers are introduced to the continuous use and transfer of knowledge from one generation to the next.

Article 9.2c) provides that Contracting Parties should take measures to protect and promote the right of farmers to participate in making decisions on matters related to conservation and sustainable use of PGRFA. This could be done, for example, by including farmers' representatives in decision-making processes that lead to the adoption of such

policy and legal measures for the promotion of the sustainable use of PGRFA that Article 6.1 is asking for, and that are exemplified under Article 6.2a). Also participatory plant breeding (PPB), as proposed by Article 6.2c), increases farmers' capabilities to decide on the kind of breeding materials they want to use and the varieties they develop.

Finally, national seed regulations regarding quality control and variety release, as referred to in sub-section 2.2.2. of lesson 2 of this module, have a direct impact on the rights that farmers may or may not have, depending on national circumstances, to save, use, exchange and sell farm-saved seed, to which the International Treaty refers in Article 9.3.

Cross-references:

- For detailed explanations of **the measures to promote conservation and sustainable use of PGRFA as contained in articles 5 and 6** of the International Treaty, refer to lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- Refer to sub-section 4.2.2. of lesson 4 of Module I (Main Components and Governance of the International Treaty) for more background on **the International Treaty's provisions on Farmers' Rights**.
- For an in-depth account on the International Treaty's provisions on Farmers' Rights, the history of their negotiation and examples of implementation at national and local level, refer to forthcoming Module III.
- For more information on **PPB** refer to sub-section 2.2.2. of lesson 2 (The Provisions of Articles 5 and 6 of the International Treaty) and to sub-section 4.2.2. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).
- For a description of **the International Treaty's provisions that relate to seed regulations** refer to sub-section 2.2.2. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).



3.2.2. The Multilateral System

The Multilateral System is established by articles 10-13 of the International Treaty. It can be thought of as a global pool of PGRFA shared and managed jointly by all Contracting Parties. Contracting Parties, the International Agricultural Research Centers of the Consultative Group for International Agricultural Research (CGIAR Centres) and other organizations holding PGRFA collections share samples of a number of their most important food crops with each other under the Multilateral System. The Multilateral System is an important component of the international system of *ex situ* conservation, but comprises also crop diversity conserved *in situ* and on-farm.

The Multilateral System has been established to further the objectives of conservation and sustainable use. It does so by facilitating access to the crop diversity contained in

the Multilateral System for the purposes of conservation of the material, or its use in research, breeding and training for food and agriculture. In addition, under the Multilateral System monetary and non-monetary benefits arising from the use of PGRFA are shared with stakeholders that support the conservation and sustainable use of PGRFA, primarily farmers in developing countries.

In addition, the *exchange of information* on PGRFA in the form of catalogues and inventories including characterization and evaluation data, the *transfer of technologies* for the conservation, characterization, evaluation and use of PGRFA, and the *development of capacities and facilities* for conservation and sustainable use of PGRFA, including scientific research, are recognized as mechanisms for non-monetary benefit-sharing to support the conservation and sustainable use of PGRFA within the framework of the Multilateral System.

Cross-references:

- For more information on the **Multilateral System** refer to sub-section 4.2.3. of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- For an in-depth presentation of the operation of the Multilateral System, refer to forthcoming Module IV.



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3.2.3. The Funding Strategy

The Funding Strategy is provided for in Article 18 of the International Treaty. It is of major relevance to the conservation and sustainable use of PGRFA. Its very aim is to facilitate the realization of the objectives of the International Treaty, i.e. the conservation and sustainable use of PGRFA and the sharing of benefits arising from their use. Especially developing countries depend largely on the availability of financial resources in order to cope with their commitments under the International Treaty by implementing, *inter alia*, the measures proposed in articles 5 and 6 and the policy guidance contained in the Second Global Plan of Action.

In particular the Benefit-sharing Fund of the Funding Strategy is a crucial mechanism that supports the conservation and sustainable use of PGRFA at the international level. Basically, any governmental or non-governmental organization, including gene banks and research institutions, farmers and farmers' organizations, and regional and international organizations, based in Contracting Parties that are developing countries, may submit project proposals and apply for funds from the Benefit-sharing Fund for the promotion of the conservation and sustainable use of PGRFA.¹ The first round of the project cycle of the Benefit-sharing Fund was launched in 2009. In August 2011, a second portfolio of 18 projects was approved for immediate

Box 3.1: Rebuilding Farmers' Safety Nets in Tanzania through On-farm Conservation

Tanzania's fields are losing their safety nets of plant genetic diversity, due to ongoing environmental challenges, changing farming systems, and even changes in taste preferences. In Tanzania, more than 80 percent of the population depends on agriculture for their livelihoods. In many parts of the country, this means subsistence agriculture practiced by smallholders who have traditionally mitigated the risks of extreme weather events, pests and market fluctuations by relying on the diversity of their locally adapted traditional crops. Biodiversity constituted a kind of insurance. However, as they adopted improved crop varieties in recent decades, they abandoned their local seeds.

The project of the Benefit-sharing Fund strengthens the on-farm conservation of crop diversity, by operating in eight districts of Tanzania's most drought prone areas. Farmers in these districts face a 33 percent decrease in annual grain yield due to projected temperature increases and rainfall decreases. The project recognizes that farmers' use of locally adapted crop species has the potential to mitigate the situation and works to strengthen on-farm conservation. Without well adapted crops, these areas of Tanzania could be rendered unsuitable for agricultural production.

Eating a diverse diet also provides the vitamins, minerals and micro-nutrients necessary for family nutrition and for sustaining patients dealing with the effects of HIV and AIDS. Thus, this project is designed to contribute to the overall improvement of food security through improving yields as well as improving both the nutritional quality of the production and the livelihoods of the resource poor farming communities.²

¹ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2009d).

² Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2011d).





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disbursement from the Benefit-sharing Fund. An example of a project that received funding under the first round of the project cycle prioritizing on-farm conservation is presented in Box 3.1.

The funding priorities of the Benefit-sharing Fund are: on-farm management and conservation of PGRFA; promotion of characterization and evaluation of collections and the diversification of crop production, genetic enhancement and broadening of the genetic base of crops; and the development

of national capacities for the conservation and sustainable use of PGRFA.³

Another essential element of the Funding Strategy is the Global Crop Diversity Trust, (hereafter “Crop Trust”), notably in relation to *ex situ* conservation and availability of PGRFA. The Crop Trust is an endowment fund with the aim to conserve crop diversity in perpetuity. Its work focuses on strengthening the global system of *ex situ* conservation by supporting the activities of gene banks around the world.

Cross-references:

- For more information on the **Funding Strategy and the Benefit-sharing Fund** refer to sub-section 4.2.4. of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- For more information on **projects funded by the Benefit-sharing Fund** under the first two rounds of the project cycle, including maps and lists of projects, see: <http://www.planttreaty.org/content/benefit-sharing-fund>
- For an in-depth presentation of the Funding Strategy, the project cycle of the Benefit-sharing Fund and the procedures to apply for funds under the Benefit-sharing Fund, refer to forthcoming Module V.
- For more information on the **Crop Trust** and its linkages to the Funding Strategy of the International Treaty, refer to sub-section 4.2.4. of lesson 4 of Module I (Main Components and Governance of the International Treaty) and sub-section 5.3.2. of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).

³ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2007a).



3.2.4. Supporting Components

The ‘supporting components’ relate to instruments, organizations and processes that are central to the furtherance of the International Treaty’s objectives, but fall not under the direct authority of the Governing Body. The first of these is the Global Plan of Action, which is presented in more detail under sub-section 3.2.5 below. The other supporting components are the *ex situ* collections of the CGIAR Centres and other international institutions, international plant genetic resources networks and the global information system on PGRFA.

Ex Situ Collections of PGRFA held by the CGIAR Centres and other International Institutions (Article 15)

The provisions under Article 15 provide the basis for CGIAR Centres and other relevant international institutions to participate in the Multilateral System, by entering into agreements with the Governing Body to officially include their PGRFA in the Multilateral System and to access the

material that is contained therein. By the end of 2011, eleven CGIAR Centres and six further international institutions holding PGRFA collections had entered into such agreements. In fact, the bulk of PGRFA samples contained in the Multilateral System, about 700 000 out of the over 1.3 million notified inclusions, are from the CGIAR Centres alone. An overview of the inclusions of germplasm samples from the different international institutions as notified by the end of 2011 is provided in Table 3.1.

The inclusion of the materials of these international institutions into the Multilateral System contributes in particular to the development of an efficient and sustainable system of *ex situ* conservation referred to in Article 5.1e) of the International Treaty. By making their collections available under the facilitated terms of the SMTA to agricultural researchers and breeders based in any Contracting Party, these international institutions play an important role both for the conservation as well as for enhancing the sustainable use of crop diversity worldwide.

Table 3.1: Inclusions of Materials held by International Institutions

Name of Institutions	Number of Accessions
Africa Rice Center (ARC)	26 098
Bioversity International	1 284
International Center for Tropical Agriculture (CIAT)	65 721
International Wheat and Maize Improvement Center (CIMMYT)	164 326
International Center for Agricultural Research in the Dry Areas (ICARDA)	134 741
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	119 613
International Institute of Tropical Agriculture (IITA)	27 280
International Livestock Research Institute (ILRI)	19 215
International Potato Center (CIP)	16 061
International Rice Research Institute (IRRI)	117 417
World Agroforestry Centre (ICRAF)	1 996
Tropical Agricultural Research and Higher Education Center (CATIE)	entire collection
International Coconut Genebank for Africa and the Indian Ocean (ICG-AIO)	entire collection
International Coconut Genebank for the South Pacific (ICG-SP)	entire collection
Mutant Germplasm Repository of the FAO/IAEA Joint Division (MGR)	entire collection
International Cocoa Genebank (ICG)	entire collection
Centre for Pacific Crops and Trees (CePaCT)	entire collection





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International Plant Genetic Resources Networks (Article 16) and the Global Information System on Plant Genetic Resources for Food and Agriculture (Article 17)

Articles 16 and 17 are also directly related to Article 5.1e) related to the *ex situ* conservation system, that refers in particular to the need for the availability of adequate documentation, characterization and evaluation.

Under Article 16, Contracting Parties are to encourage relevant institutions holding PGRFA collections to participate in

international networks with the aim to achieve as complete coverage as possible of PGRFA. Article 17 provides for the creation of a global information system to facilitate the exchange of information on scientific, technical and environmental matters related to PGRFA.

Both international plant genetic resources networks and information systems contribute importantly to the sustainable use of crop diversity by facilitating access to PGRFA. The most comprehensive information system at the time is Genesys, containing information on about a third of the world's over 7.4 million gene bank accessions.

Cross-references:

- For the most up-to-date **status of inclusions** of PGRFA samples into the Multilateral System see: <http://www.planttreaty.org/inclusions>
- For more information on the **relationship of the CGIAR Centres and the International Treaty** refer to Box 3.1 of lesson 3 of Module I (History of the International Treaty) and lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- To learn more about the **importance of the availability of adequate documentation, characterization and evaluation** of PGRFA refer to sub-section 2.2.1. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For a **practical illustration of how documentation enhances the sustainable use of PGRFA** refer to sub-section 4.2.1. of lesson 4 of this module (Implementation of Articles 5 and 6 from a Users' Perspective).
- For more **information on Genesys** refer to Box 5.3 of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- **Access Genesys** here: <http://www.genesys-pgr.org/>



3.2.5. Global Plan of Action

The Global Plan of Action has formally been included in the framework of the International Treaty with Article 14 requesting Contracting Parties to promote its effective implementation.

The Global Plan of Action is also linked to the Funding Strategy and the Multilateral System, with Article 13.5 stating that the ability to fully implement the Global Plan of Action depends largely on the benefits that are shared under the Multilateral System and the Funding Strategy. Further, the funding target of the Funding Strategy has been established based on the needs set out in the Global Plan of Action, and the priorities for the disbursement of funds under the Funding Strategy are equally derived from the priority activities of the Global Plan of Action.

The first Global Plan of Action was adopted in 1996 as an instrument to identify the

technical and financial needs for ensuring the conservation and promoting the sustainable use of PGRFA. In its essence, it recommends a set of programmes and activities to address these needs at the community, national, regional and international level. It is a 'rolling instrument', which means that it is periodically updated according to evolving needs and priorities with regard to crop diversity.⁴

In fact, the International Treaty's provisions on conservation and sustainable use draw heavily on the priority activities of the Global Plan of Action, with the difference that they are formulated in broader terms as they are fixed once and for all. By embracing the Global Plan of Action, however, the International Treaty manages to retain the necessary flexibility to adapt to the evolving gaps and needs related to the conservation and sustainable use of PGRFA.

The updated Second Global Plan of Action was agreed upon by the FAO Commission on



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⁴ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2011a), pp. 76, 77, 130.



Genetic Resources for Food and Agriculture and approved by the FAO Council, as mandated by the FAO Conference, in 2011. It has 18 priority activities that are organized into the four main groups of '*In Situ* Conservation and Management'; '*Ex Situ* Conservation'; 'Sustainable Use'; and 'Building Sustainable Institutional and Human Capacities'.

The Second Global Plan of Action takes into account new developments and

trends in agriculture such as increasing urbanization and further concentration of the international seed trade, the impacts of climate change requiring more focus on CWR and measures including targeted involvement of farming communities in crop improvement activities, major scientific and technology advances including in the areas of information technologies and molecular and genomic methods, as well as major policy developments with respect to conservation and use of PGRFA.

Table 3.2: Priority Activities of the Second Global Plan of Action and the Corresponding Provisions of the International Treaty

SECOND GLOBAL PLAN OF ACTION	INTERNATIONAL TREATY
<i>In Situ</i> Conservation and Management	
1 Surveying and inventorying PGRFA	5.1a)
2 Supporting on-farm management of PGRFA	5.1c), 6.2f)
3 Assisting farmers in disaster situations to restore crop systems	12.6
4 Promoting <i>in situ</i> management of CWR and wild plants	5.1d)
<i>Ex Situ</i> Conservation	
5 Supporting targeted collection of PGRFA	5.1b)
6 Sustaining and expanding <i>ex situ</i> conservation of germplasm	5.1e)
7 Regenerating and multiplying <i>ex situ</i> accessions	5.1e), 5.1f)
Sustainable Use	
8 Expanding the characterization, evaluation and further development of specific collection sub-sets to facilitate use	5.1e)
9 Supporting plant breeding, genetic enhancement and base-broadening efforts	6.2b), 6.2c), 6.2d), 6.2f)
10 Promoting diversification of crop production and broadening crop diversity for sustainable agriculture	6.2.c), 6.2d), 6.2f)
11 Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species	6.2.c), 6.2d), 6.2e), 6.2f)
12 Supporting seed production and distribution	6.2.g)
Building Sustainable Institutional and Human Capacities	
13 Building and strengthening national programmes	6.1, 7.1
14 Promoting and strengthening networks for PGRFA	16
15 Constructing and strengthening comprehensive information systems for PGRFA	17.1
16 Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of PGRFA	5.1.f, 5.2, 17.2
17 Building and strengthening human resource capacity	7.2a), 8, 13.2c)
18 Promoting and strengthening public awareness on the importance of PGRFA	





The main aim of the Second Global Plan of Action is notably to strengthen the implementation of the International Treaty. Each provision of the International Treaty dealing with conservation and sustainable use of PGRFA corresponds to one or several of the priority activities of the Second Global Plan of Action. For each priority activity, the Second Global Plan of Action contains sections on the desired objectives, recommendations of national and international policies and strategic approaches to reach these objectives, as well as capacity development, research and technology needs.⁵

Consequently, the Second Global Plan of

Action is a key resource providing guidance to Contracting Parties for the attainment of their objectives and meeting their commitments related to conservation and sustainable use of PGRFA.

Table 3.2 links the priority activities of the Second Global Plan of Action with the respective provisions of the International Treaty. It is an indicative table only. More linkages than the ones shown exist, and it is strongly recommended to refer to the texts of the Second Global Plan of Action and the International Treaty in their entirety. This table may however be useful as a pointer to the most direct linkages between the two instruments.

Cross-references:

- For additional background on the **Global Plan of Action** refer to Box 3.3 of lesson 3 of Module I (History of the International Treaty).
- For the **text of the Second Global Plan of Action** see: http://typo3.fao.org/fileadmin/templates/agphome/documents/PGR/GPA/GPA2/GPA2_en.pdf

⁵ FAO (2011), pp. 9+11.



Key points to remember:

- A combined reading of Farmers' Rights and the provisions on conservation and sustainable use provides for a more comprehensive understanding of the provisions of the International Treaty; for example, collection of information associated to PGRFA can contribute to the protection of traditional knowledge related to PGRFA.
- The Multilateral System facilitates access to over 1.3 million PGRFA samples for their further conservation and use in research, breeding and training for food and agriculture, and promotes the information exchange, technology transfer and the development of capacities for conservation and sustainable use of PGRFA.
- The Benefit-sharing Fund of the Funding Strategy supports projects that focus on on-farm management and conservation and sustainable use of PGRFA; the Crop Trust is an essential element of the Funding Strategy to support *ex situ* collections around the world.
- By making their PGRFA available under the terms of the SMTA of the International Treaty, the CGIAR Centres and a number of other international institutions play an important role both for the conservation and for enhancing the sustainable use of global crop diversity.
- The main aim of the Second Global Plan of Action is to strengthen the implementation of the International Treaty. Each provision of the International Treaty dealing with conservation and sustainable use of PGRFA corresponds to one or several of the priority activities of the Second Global Plan of Action, which contains elaborate policy recommendations and strategies.



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3.3. Achievements and Decisions of the Governing Body that Relate to Conservation and Sustainable Use

As the objectives of the International Treaty are the conservation and the sustainable use of PGRFA, and the sharing of benefits that arise from their use, virtually all decisions of the Governing Body have a link to conservation and sustainable use of crop diversity.

The establishment and strengthening of the International Treaty's main mechanisms, the Multilateral System (with the adoption of the SMTA, entering into agreements with international institutions under Article 15 and receiving further inclusions of PGRFA from Contracting Parties and other relevant organizations, elaborating the Third Party Beneficiary Procedures, etc) and the Funding Strategy (the adoption of the Funding Strategy, its priorities, eligibility criteria, operational procedures, and launching notably the first two rounds of projects under the Benefit-sharing Fund,

etc), contributed very importantly towards increased conservation and sustainable use of crop diversity. In addition to that, the Governing Body has taken some decisions that are directly linked to articles 5 and 6 of the International Treaty.

The Governing Body notably stressed the importance of implementing Article 6 in the light of its linkages with other articles, in particular Article 5, and decided that the implementation of Article 6 should be a component of its programme of work and a standing priority item on its agenda. As a basis to assess progress in implementing Article 6, the Governing Body regularly invited Contracting Parties, other governments and relevant organizations to submit to the Secretary information on their views and experiences with regard to the implementation of Article 6, including on



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Box 3.2: Examples of Legal Measures for the Conservation and Sustainable Use of Crop Diversity

Several Contracting Parties of the International Treaty have enacted legislation that support the implementation of the provisions related to conservation and sustainable use of PGRFA at national level. What follows is a limited selection of examples:⁶

Syria: In 2009 Syria passed a law (Law No. 20) on PGRFA that includes provisions on access, benefit-sharing and Farmers' Rights. Among the main objectives of the law are the protection and preservation of PGRFA for academic purposes, scientific research, training and plant breeding for the development of new genotypes for commercial purposes.⁷

Ecuador: The National Constitution ratified in September 2008 strongly promotes the conservation of agricultural biodiversity. In particular, Article 281.6 holds the government responsible for "promoting the conservation and recovery of agricultural biodiversity and related ancestral wisdom, along with the use, conservation and free exchange of seeds".⁸

European Union: The European directive on 'conservation varieties' of June 2008 allows for marketing of seed and seed potatoes of old and locally used varieties that are threatened by genetic erosion, without the need to adhere to strict uniformity and stability rules nor possessing any proven value for cultivation and use.⁹

Mali: The Agricultural Orientation Law adopted in August 2006 encourages conservation, selection and breeding activities of local PGRFA. Particularly, its Article 141 provides for the definition of national seed policies to ensure the conservation and valorization of varieties threatened by genetic erosion, and foresees the establishment of a national seed catalogue.¹⁰

India: The 2001 Protection of Plant Varieties and Farmers' Rights Act provides for the registration of farmers' varieties on par with breeders' varieties. Farmers' varieties are required to meet the same criteria of distinctiveness, uniformity and stability, but are not required to meet the criterion of novelty. Furthermore, the Act introduced a 'Gene Fund' to support farmers who conserve or improve landraces or wild relatives of economic plants.¹¹

In addition, many of the International Treaty's currently 127 Contracting Parties have established national programmes for the implementation of the Global Plan of Action and 49 of its Contracting Parties participate in the World Information Sharing Mechanism on the Implementation of the Global Plan of Action.

policy and legal measures for the promotion of the sustainable use of PGRFA.¹² Box 3.2 presents a selected overview of examples of legal measures that have been reported to the Governing Body.

elements of the International Treaty, the Governing Body requested the Secretary to initiate a process towards the development of a programme of work on sustainable use of PGRFA.

At its fourth session, recalling that in many regions the implementation of Article 6 is lagging behind in comparison to other

It is foreseen that this programme of work will be based on the Second Global Plan of Action, in particular those elements that

⁶ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2009a) and FAO (2010), pp. 129-137.

⁷ For more information on the Syrian Law on Plant Genetic Resources for Food and Agriculture, Access and Benefit-sharing, and Farmers' Rights (2009) see: <http://www.gcsar.gov.sy/gcsarEN/spip.php?article260>.

⁸ Constitution of the Republic of Ecuador (2008), chapter 3.

⁹ Commission of the European Communities (2008).

¹⁰ Loi d'orientation agricole (2006), title 5, chapter 1.

¹¹ Ministry of Law, Justice and Company Affairs (2001).

¹² Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2006), paras. 20-26, (2007b), paras. 71-72, (2009c), para. 46, (2011b), para. 5.



support the sustainable use of crop diversity at national, regional and international level. The programme of work will be devised in a participatory manner by means of a broad stakeholder consultation, in consultation with the Bureau of the Governing Body and in collaboration with relevant international organizations and key actors engaged in sustainable use of PGRFA. In addition, the Governing Body decided to establish an *Ad Hoc* Technical Committee (AHTC) on Sustainable Use of PGRFA. The main tasks of this AHTC will notably include the identification of needs and opportunities to facilitate the sustainable use of PGRFA and

to advise the Secretary and the Bureau on the elaboration of the draft programme of work on sustainable use.

The AHTC will also take into account Resolution 6/2011 whereby the Governing Body requested, subject to the availability of financial resources, the organization of regional workshops to discuss national experiences with the implementation of Farmers' Rights. The reports of these workshops would be compiled, together with submissions of Contracting Parties and other relevant organizations, and submitted to the AHTC for its consideration.¹³

Key points to remember:

- At its fourth session, the Governing Body requested the Secretary to initiate a process towards the development of a programme of work on sustainable use of PGRFA.
- This programme of work will be based on the relevant elements of the Second Global Plan of Action, and devised by means of a broad stakeholder consultation and in collaboration with relevant international organizations and key actors engaged in sustainable use of PGRFA.
- The Governing Body also decided to establish an *Ad Hoc* Technical Committee (AHTC) on Sustainable Use of PGRFA, which will advise the Secretary and the Bureau on the elaboration of the draft programme of work on sustainable use.
- The AHTC will also consider reports of regional Farmers' Rights workshops and submissions of Contracting Parties and other relevant organizations on their experiences with the implementation of Farmers' Rights.

Cross-references:

- For background information on the **Governing Body** refer to sub-section 4.3.1. of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- For more information on the **World Information Sharing Mechanism** see: <http://www.pgrfa.org/gpa/selectcountry.aspx>
- Find all **submissions of Contracting Parties** regarding sustainable use as well as all **Governing Body resolutions** in the **Virtual Library** of the International Treaty's website: http://www.planttreaty.org/content/vl_panel

¹³ Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2011c).





3.4. Conclusive Summary

The lesson has shown clearly that conservation and sustainable use of crop diversity under the International Treaty is not restricted solely to its articles 5 and 6. All main components of the International Treaty including Farmers' Rights, the Multilateral System and the Funding Strategy, as well as its supporting components, are interrelated with the provisions under articles 5 and 6, and contribute directly to the conservation and the sustainable use of PGRFA.

The provisions on Farmers' Rights are closely linked with those on conservation and sustainable use, and they are in many ways mutually supportive. A combined reading of both topics therefore provides for a more comprehensive understanding of the International Treaty's approach to conservation and sustainable use. This is reflected in Resolution 6/2011 of the Governing Body, which encourages Contracting Parties to closely relate the realization of Farmers' Rights with the implementation of those provisions of the International Treaty that deal with *in situ* and on-farm management and conservation, and with sustainable use.

The Multilateral System comprises over 1.3 million PGRFA samples from Contracting Parties, CGIAR Centres and other institutions. By making their materials available to others under the facilitated terms of the SMTA through the Multilateral System, Contracting Parties, international organizations and other institutions holding PGRFA collections contribute very importantly to the enhanced and sustainable use of crop diversity.

The Funding Strategy has been developed with the aim to promote the full achievement of the objectives of the International Treaty, including namely the conservation and sustainable use of PGRFA. The Benefit-sharing Fund of the Funding Strategy supports projects that focus on on-farm management and conservation and sustainable use of PGRFA for food security and climate change adaptation. The Crop Trust - an essential element of the Funding Strategy - supports *ex situ* collections around the world.

The Global Plan of Action forms an integral part of the policy framework of the International Treaty, its main aim being to strengthen the International Treaty's implementation. It provides policy guidance and recommends strategies for the implementation of each of the provisions of the International Treaty dealing with conservation and sustainable use at international, regional, national and local level.

With a view to further promote the implementation of articles 5 and 6 by prioritizing and establishing clear goals and activities, the Governing Body, at its fourth session, requested the Secretary to initiate a process towards the development of a programme of work on sustainable use of PGRFA. This programme of work would notably be based on the Second Global Plan of Action, and devised with the participation of a wide range of stakeholders and in collaboration with relevant international institutions. The Governing Body also established an *Ad Hoc* Technical Committee to advise the Secretary and the Bureau in the development of such a comprehensive programme of work.



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Implementation of Articles 5 and 6 from a Users' Perspective



LESSON 4



Learning objectives

At the end of this lesson, the learner will be able to:

- describe a number of initiatives for the conservation and sustainable use of crop diversity at local, national and international level; and
- identify concrete illustrations of implementation of articles 5 and 6 that could be adapted to other national and local settings.



Target learner groups

Stakeholder groups of the International Treaty including gene bank staff, plant breeders, academia, farmers' organizations and other civil society organizations, policy makers and their staff and civil servants.



Zea mays, maize, by Elizabeth Blackwell (1739)

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4.1. Overview of the Lesson

Various stakeholders of the agriculture sector were engaged in conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA) well before the International Treaty on Plant Genetic Resources for Food and Agriculture (hereafter “International Treaty”) was developed – crop diversity has always been essential for both farmers and plant breeders. However, as illustrated in lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty), the International Treaty formalizes these objectives which national governments commit to pursue, and proposes measures to Contracting Parties for the achievement of its objectives.

This lesson aims at enhancing a better understanding of possible actions and actors that may contribute to conservation and sustainable use of crop genetic resources. It therefore focuses on a set of different users of PGRFA, ranging from a gene bank manager to a plant breeder and a chairman of a farmers’ association. The lesson illustrates in a number of examples how stakeholder groups can contribute to the objectives of the International Treaty.

In sub-section 4.2.1. you will meet a gene bank manager, whose primary task is to conserve PGRFA but who chooses to make use of a wide array of possibilities to promote the use of the genetic resources in his collection. The following section presents

different options for plant breeders to use the genetic resources in their programmes. Sub-section 4.2.3. introduces farmers as users and custodians of crop diversity, followed by a section elaborating on the role of consumers as both users and promoters of diversity. The final two sections focus on the roles of governments and international institutions in promoting the use of PGRFA.

The lesson does not intend to be a comprehensive description of all ongoing initiatives, but should rather be seen as a source for inspiration. After its completion, the learner will be aware of a number of initiatives for the conservation and sustainable use of crop diversity that are carried out at local, national and international level by various stakeholder groups of the International Treaty. This will illustrate him or her some concrete options of how the measures proposed in the provisions of articles 5 and 6 of the International Treaty that are presented in lesson 2 of this module can be put into practice.

In this sense, this lesson aims at promoting similar initiatives – or the development of novel approaches – that can be adapted to different locations, crops and stakeholder groups. The initiatives have been brought together in the fictional country of Develania and are presented by a range of Develanian PGRFA users: a gene bank manager, a plant breeder, a chairman of a farmer’s association, and a chef.

Cross-references:

- To learn more about the **objectives of the International Treaty** refer to sub-section 2.2.1. of lesson 2 of Module I (Objectives, Scope and Basic Concepts).



4.2. Options for Promoting Conservation and Sustainable Use of Crop Diversity

4.2.1. The Contribution of a Gene Bank Manager towards the Implementation of Articles 5 and 6 of the International Treaty: Dr Eugene Banks

Eugene Banks is manager of the Seed Centre at the National Agricultural Research Institute of Develania. The Seed Centre originated from a joint service unit for breeding programmes that handles the working collections of breeders – i.e. those collections from which breeders choose parent varieties for their crossing programmes. It became a focal point for the implementation of the International Undertaking on Plant Genetic Resources in the 1980s and subsequently for the International Treaty.

By signing the International Treaty, Develania created a strong impetus to the further development of the Seed Centre with respect to conservation and sustainable use of crop diversity. The original task of the Seed Centre was to move from the management of restricted working collections towards

proper gene bank management. This was done by including also materials that do not only serve the immediate needs of breeders, such as traditional varieties, landraces and crop wild relatives (CWR), but that may become increasingly important for future plant breeding. At the level of conservation the operations needed to be professionalized and international linkages required strengthening.

In Eugene's view, the promotion of sustainable use is of growing importance for the Seed Centre. When discussing this with his colleagues, he discovers a wide range of options for promoting the sustainable use of PGRFA, including standardizing gene bank methodologies and improving quality management, improving documentation and increasing the availability of gene bank materials, and enhancing linkages between gene banks and on-farm conservation programmes.

By putting these options into practice in the Seed Centre, Eugene contributes in particular to the implementation of articles 5.1c), 5.1d) and 6.2f) of the International Treaty.

Cross-references:

- For the **text of the International Treaty** see: <ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf>
- For more information on the **International Undertaking** on Plant Genetic Resources and the history of the International Treaty refer to lesson 3 of Module I (History of the International Treaty).
- For the wording and comprehensive explanations of **articles 5.1c), 5.1d) and 6.2f)** dealing with *in situ* conservation and on-farm conservation and management, refer to sub-section 2.2.1. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For more information about **ex situ conservation techniques** refer to sub-section 1.2.2. of lesson 1 of this module (What is Conservation and Sustainable Use?).



Professionalization of the Conservation Roles of Gene Banks

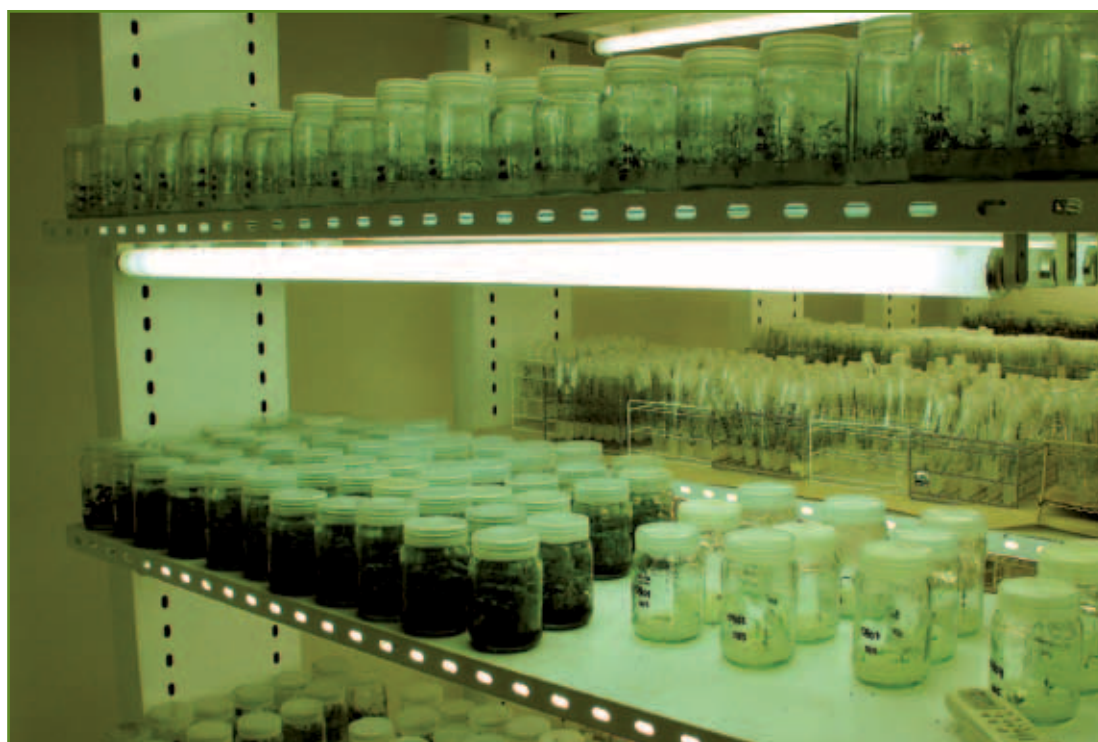
Standardizing Methodologies and Quality Management

Most basic operations of gene banks are focused on conservation activities. They include:

- the formulation and implementation of strategies for collection of PGRFA samples, including CWR;
- ensuring appropriate storage conditions that minimize the need for regeneration of the germplasm;
- careful planning and monitoring of multiplication protocols, to reduce both the loss of diversity within samples caused by genetic drift and the influx of genes caused by field isolation; and
- careful handling of the germplasm.

Eugene is very interested in monitoring plant genetic diversity during the multiplication process. He has found it very useful to follow the directions provided in some of the key literature on best practices for gene bank management (see cross-references hereafter). There are, however further steps that can be taken to make gene bank management more effective and efficient.

Gene bank management is a complex task. Many operations which extend over long periods of time and require maximum precision, such as handling large numbers of germplasm and associated information, make occasional human errors unavoidable. Well defined standards for gene bank processes are important tools to minimize mistakes and improve the quality of the stored germplasm. The Food and Agriculture Organization of the United



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Nations (FAO) and Bioversity International have therefore elaborated international ‘Genebank Standards’.

The Genebank Standards contain description of seed storage conditions and standards for the exchange and distribution of seeds from active collections.¹ Another example of a tool that helps optimizing operations is process certification through the International Standard Organization (ISO). Agricultural researchers and breeders that use PGRFA they receive from gene banks that respect internationally recognized standards can be more confident that they actually receive

the material they requested in acceptable quality. See Box 4.1 for an example of ISO certification of gene bank operations.

A technology that reduces mistakes of wrongly copying accession numbers or other data is the use of bar-coding systems. Bar-codes, which are also used widely for example in supermarkets and stores of vehicle spare parts, identify each container with a code that can be read by an electronic scanner. When used in a gene bank, a bar-coding system can identify all accessions, field numbers and other identifiers and connects operations directly with the gene bank database.

Box 4.1: ISO Certification of Gene Bank Operations

The Centre for Genetic Resources of the Netherlands (hereafter “CGN Netherlands”) was the first gene bank in the world to obtain a formal ISO certification for its operations. In order to obtain this recognition all processes had to be described in detail and all operations needed to be documented, including odd mistakes and the actions to be undertaken to correct such mistakes.

The quality assurance systems are regularly reviewed in order to monitor and update the operations. The aim of going through this rather laborious process of establishing and monitoring standards for all operations is to minimize the loss of genetic resources to serve the users of the gene bank material in an optimal way.

Another example of a gene bank that has implemented such a quality management system is the German gene bank in Gatersleben.

Cross-references:

- For more information on the **Genebank Standards** refer to sub-section 5.2.1. of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- For more information on the quality management system of the **German gene bank in Gatersleben** see: <http://www.ipk-gatersleben.de/Internet/QM>
- For more information on **ISO certification** see: <http://www.iso.org/iso/home.html>
- For **comprehensive manuals on gene bank management** refer to the Bibliographic References section, IPGRI (2003) and Bioversity International and the Rural Development Administration of Korea (2009).



¹ FAO (1993). The Genebank Standards were endorsed by the FAO Commission on Plant Genetic Resources (now Commission on Genetic Resources for Food and Agriculture). At the time of elaboration of the Genebank Standards, Bioversity International was called ‘International Board for Plant Genetic Resources’. The Genebank Standards are currently in the process of being revised by FAO in cooperation with the relevant international organizations to ensure up-to-date conservation of PGRFA.

Promoting Use of PGRFA - an Integral Component of Gene Bank Management

Documentation

For promoting the use of its crop genetic resources the Seed Centre puts a strong emphasis on documentation of the material. Each accession (i.e. unique sample) is stored together with its 'passport data', which contains basic information on the species the sample belongs to, where it was collected etc. Information that is obtained from grow-out plots, such as regenerations, multiplications and specific trials to identify important characteristics that prospective users may be interested in, including resistance to a specific disease, is called 'evaluation data'. Both types of data should be reliable and easily available, in order to facilitate and enhance the subsequent use of the material for agricultural research and plant breeding purposes. Freely accessible

and searchable online databases are extremely valuable tools in this regard.

Obtaining reliable evaluation data is a complex task and is ideally done under controlled conditions. Using well defined protocols is particularly useful when third parties are involved in data gathering (see Box 4.2).

Sharing gene bank information through online databases across borders greatly improves the use of PGRFA stored in gene banks, as they provide prospective users a one-stop access point for a wider diversity of materials. EURISCO is a European initiative to provide such a service; it has a web catalogue that receives data from national inventories and provides access to information of all *ex situ* PGRFA in Europe. Genesys provides an example of a PGRFA information portal at global scale.

Box 4.2: Partnerships for Reducing the Cost of Obtaining Evaluation Data

A possibility for gene banks to reduce the cost associated with obtaining evaluation data is to link up with public and/or private research institutions that perform laboratory tests as part of their research task or commercial interest. Plant quarantine organizations may be able to screen for diseases. In countries with professional seed industries, companies may be willing to multiply materials in their specialized facilities. The company receives first hand information on the materials and will know better which samples to request.

In such cases it is important that a clear material transfer agreement (MTA) is concluded between the gene bank and the company, respecting national and international regulations. For germplasm of food crops and forages that are listed in Annex I of the International Treaty, it is imperative for Contracting Parties and organizations and institutions that are based within their borders, to adhere to the terms of and use the Standard Material Transfer Agreement (SMTA). The SMTA is a standardized bilateral contract for the transfer of PGRFA under the Multilateral System of Access and Benefit-sharing of the International Treaty.

In addition, it is important in such partnerships that the gene bank retains the right to publish the evaluation results, in order to be able to make the data available to prospective user and thereby further promote the use of the material.





Courtesy Flickr/GCDT

Ordering Samples

An additional way to promote use is to make it easier to order samples for agricultural research and breeding. The CGN Netherlands website offers a good example in this regard. It operates a web-catalogue that allows users to add the materials they wish to order to a virtual shopping cart. Contractual obligations can be dealt with by accepting the terms of the SMTA of the International Treaty online, or alternatively the person ordering the material has the option to request to receive a hard copy of the SMTA by mail.

Eugene is keen to establish a similar system in the Seed Centre, to facilitate access to its

collection for all *bona fide* users who intend to use the materials for agricultural research and breeding from within and outside Develania.

Linking Gene Banks to On-farm Management and Conservation of PGRFA

A different set of skills and activities is needed to promote the conservation and sustainable use of PGRFA on-farm. The gene bank of Develania's Seed Centre concentrates on the storage of PGRFA, however it came to Eugene's ears that national gene banks of other countries are getting increasingly involved in supporting activities related to conservation and sustainable use on-farm. In



Cross-references:

- For more information on the **SMTA** refer to sub-section 4.2.3. of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- Forthcoming Module IV will provide detailed information on how to use the SMTA.
- **Access the EURISCO database** here: http://eurisco.ecpgr.org/home_page/home.php#
- **Access the Genesys database** here: <http://www.genesys-pgr.org/>
- For more **information on Genesys** refer to Box 5.3 in lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- To see how the online **ordering system of the CGN Netherlands** works see: <http://www.cgn.wur.nl/UK/CGN+Plant+Genetic+Resources/>

most of these cases gene banks contribute to activities that were initiated by other actors such as farmers' organizations, sharing the experiences, knowledge and information related to the crop genetic diversity that has been accumulated over the years within the gene bank organization.

In gene banks, PGRFA are conserved with scientific methods under controlled conditions, which facilitates to make them available to users worldwide; however a disadvantage may be that the conserved crop diversity is literally frozen and the natural evolution thereby halted. On-farm management and conservation, on the other hand, allows natural evolution to continue by exposing the crop diversity to the dynamics of natural and agricultural ecosystems. On-farm management of crop genetic diversity may also be used as a strategy to support resilience of crops to specific environmental conditions and stresses including pests and diseases, particularly in ecologically diverse conditions. However, to conserve material solely on farms would bear the risk of loss of specific diversity. A complementary approach making use of both gene bank

facilities and on-farm management thus seems to be the safest strategy for effective conservation.

Eugene's first entry point for establishing a linkage between the gene bank and on-farm activities is to allow a wide variety of prospective users to access the gene bank materials. These could be agronomists and social scientists working with farmers, but also civil society organizations, including farmers' organizations and cooperatives.

In some cases this may require a broader interpretation of the term '*bona fide* users'. To satisfy the requests of larger numbers of prospective users, Develania's Seed Centre will need to be prepared to make larger amounts of seeds and other propagation material available for use. However, for many of the users it will still be difficult to work with the small amounts of samples they can obtain from the gene bank. For this reason, Eugene seeks to establish a partnership with the Agricultural Research Institute of Develania, with the idea that it could assist with the multiplication of the germplasm.



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Promoting diversity on-farm may be linked to ecological farming, to participatory breeding strategies, broadening the genetic base of materials available to farmers and even to specific consumer preferences that may be linked to traditional and local products, as in the case of the Slow Food movement (see Box 4.10 below). For specific crops and varieties there may even be volunteer associations with the aim to maintain diversity in terms of cultural heritage in their fields and home gardens. In some countries, for example, old varieties of fruit trees such as apples or cherries are maintained because they are considered to fulfil a specific function in the landscape or because their products are used in regional products. Gene banks may be called upon to provide guidance and contribute knowledge towards such activities.

Examples of on-farm initiatives for conservation and use will be discussed in

the following sections. However, Eugene realizes that linking gene banks to on-farm activities is a challenging task, especially as his staff mainly has backgrounds in plant taxonomy and breeding. In order to optimally contribute to on-farm management of crop diversity he may need to hire additional people trained in communicating with farmer groups, civil society organizations and social scientists. Also, in order to hire additional staff to work in the field he needs to obtain additional funds. This, in turn, requires that the sponsors of the gene bank are open to interdisciplinary approaches. Luckily for Eugene, the Government of Develania has recognized the need to adopt a complementary approach to *ex situ* and *in situ* work and is willing to provide additional financial resources to support this kind of linkage between the Seed Centre and on-farm activities. See Box 4.3 for a brief real world example of a gene bank involved in on-farm activities.

Box 4.3: Gene Bank Participation in On-farm Management Activities led by Civil Society - the Institute for Biodiversity Conservation in Ethiopia

The Institute for Biodiversity Conservation (IBC) in Ethiopia is responsible for maintaining the national gene bank, one of the oldest institutions in this field in Africa, located in a diversity-rich country. It also actively participates in projects lead by civil society organizations with the aim to manage genetic diversity on-farm.

IBC is involved in training-of-trainers programmes and farmer-field-school activities that contribute to the management of crop genetic resources, notably durum wheat, sorghum, beans and the typically Ethiopian crops teff and noug.

Cross-references:

- To learn more about different **ex situ and in situ conservation techniques**, including their complementarities and respective advantages, refer to sub-sections 1.2.2. and 1.2.3. of lesson 1 of this module (What is Conservation and Sustainable Use?).
- For more information of the **on-farm activities of the IBC** see:
<http://www.ibc-et.org/conservation/fgbs/crop-community-genebanks/>



Key points to remember:

- Signing the International Treaty created a strong impetus to include also traditional varieties, landraces and CWR into Develania's gene bank.
- Options to promote the sustainable use of PGRFA in gene banks include:
 - Standardizing gene bank methodologies and improving quality management.
 - Improving documentation and increasing availability of gene bank materials.
 - Enhancing linkages with on-farm conservation programmes.
- The FAO Genebank Standards contain basic standards for the management, exchange and distribution of PGRFA. International process quality certifications and the use of bar-coding systems constitute further tools to optimize gene bank operations.
- To facilitate the use of gene bank materials it is crucial to ensure the documentation of passport and evaluation data for all samples contained in gene banks. Making samples and related documentation easily accessible through online catalogues, for example, will further facilitate their use.
- Enhancing linkages between gene banks and on-farm conservation programmes allows natural evolution to continue by exposing the crop diversity to the dynamics of natural and agricultural ecosystems. It also requires enhanced collaboration with a variety of actors.



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4.2.2. The Contribution of a Plant Breeder towards the Implementation of Articles 5 and 6 of the International Treaty:

Dr Barbara Reed

Barbara Reed is a professor in genetics and plant breeding at the University of Develania. The primary task of breeders is to produce good varieties for farmers, i.e. varieties that bring high yields and are resistant to a number of stresses.² Within this task, Barbara is especially interested in supporting diversity as a means to maintain and strengthen resilience of the crops she works on. She has entrusted a number of her students with a variety of initiatives that aim at promoting diversity through breeding.³ This includes promoting diversity of the food crops available to farmers, as well as the diversity of different varieties of food crops, and the genetic diversity *within* crop varieties.

Much of this work relates to research that contributes to the enhancement and the conservation of crop diversity, and to broadening the genetic base of crops available to farmers, and is carried out notably through participatory approaches. Thereby, Barbara and her students contribute in particular to the implementation of articles 6.2b), 6.2c) and 6.2d) of the International Treaty.

Breeding for Within-species Diversity: Pre-breeding

As mentioned above, the basic task of plant breeders is to develop new varieties. However, due to factors such as climate change and new markets creating demand for new traits, it becomes increasingly common that traits of interest cannot be found in

well-adapted varieties. As a consequence, it is necessary to look for traits in crops that are less well-adapted to local conditions, such as crops from different agro-ecological zones, or plants that are not domesticated, i.e. CWR. Making the desired traits of such ‘non-adapted’ plant material readily available so that they can subsequently be bred into acceptable new crop varieties may be achieved through pre-breeding activities.

Pre-breeding refers to all activities designed to identify desirable characteristics and/or genes from non-adapted materials that cannot be used directly in breeding populations (exotic or semi-exotic; wild species), and to transfer these traits to an intermediate set of materials that breeders can manipulate further in producing new varieties for farmers. These activities require collaboration between gene bank managers and the breeders.⁴

Pre-breeding therefore serves to broaden the genetic base of crops. Base-broadening, also called ‘genetic enhancement’, describes the development of new, genetically broad, adapted populations with large variation and acceptable performance level. The purpose is generally not to include specific traits, but to broaden the genetic diversity under the theory that a broader genetic base may reduce vulnerability of a crop to variations in the environment (for example, from pests and diseases, from soil variations, from water scarcity or excess).

Some of Barbara’s students do research on inter-specific crosses, i.e. crosses between crops of different species.⁵ Others work on assessing the intra-specific diversity between released varieties and gene bank samples of related varieties belonging to the

² Including abiotic stresses such as drought, heat and cold, and biotic stresses such as pests and diseases.

³ An extensive account of case studies and approaches to base-broadening efforts through plant breeding can be found in Cooper, Spillane and Hodgkin (2001).

⁴ FAO (2011), slide 8 of “1. Introduction to Pre-breeding”.

⁵ Kalloo and Chowdhury (1992); Hajjar and Hodgkin (2007), pp.8-9.





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same species, to identify possible parents for further breeding. Backcrossing of released varieties with a parent variety can be used to achieve offspring that contains a desirable trait contained in the parent variety.

New technologies provide new opportunities to broaden the genetic base of crops. Various genetic marker systems are available to assess diversity and to identify valuable traits and prospective parents, thus contributing to the continued use of a wide range of crop genetic resources for breeding activities.

Breeding for Diversity Within Varieties

Increasing the genetic diversity within a variety may bring advantages with regard to stress factors such as disease resistance. With respect to some important agronomic characteristics, such as the plant height and architecture (of importance in particular for mechanized farming) or the maturity period of a crop variety, a variety needs to be uniform to produce good yields. For other characteristics, however, diversity can increase resilience. One scientific methodology to employ such diversity is to create multi-line varieties. These are varieties that consist of different lines that are identical except for the disease

resistance genes. Some of Barbara's students are working on efficient methodologies to create such varieties. In addition, Barbara is collaborating with her agronomy and pathology colleagues to assess the potential contribution of such multi-line varieties in farming.

Breeding for Diversity Between Varieties

Conventional plant breeding commonly narrows down the diversity created or found in landraces to a single uniform variety. However, there are good reasons to invest in diversifying the output of plant breeding, i.e. to create incentives for breeders to focus on the development of more genetically diverse varieties, in order to meet the requirements of different agro-ecological zones, as well as consumer preferences. This particularly applies to breeding for ecological farming. Conventional varieties may not be optimally adapted to farming systems that do not use chemical fertilizers and pesticides – in industrialized countries mostly practiced to meet an increasing consumer demand for organic products, while especially smallholder farmers in developing countries often lack the financial means to afford such inputs. In ecological farming a range of varieties is often employed rather than



just one, in order to buffer against stresses. Ecological farming may also require special institutional settings and benefit from participatory approaches to plant breeding.

Participatory Plant Breeding

A wide range of methodologies and objectives are attributed to participatory plant breeding (PPB).⁶ This relates to the fact that PPB started from three distinct viewpoints in the scientific community:

The 'Breeding Efficiency Approach' to PPB

PPB was initiated in the mid-1980s by breeders in India and Syria in order to improve selection efficiency, particularly

in ecologically diverse environments, and to better target farmers' needs with regard to breeding. It was determined that testing varieties under well-managed research conditions may result in the selection of varieties that are particularly well suited to optimal management (good weeding, high soil fertility), however that may not yield very well under farmers' conditions, particularly those faced by poor farmers producing in marginal areas. This initially resulted in different types of participatory on-farm variety selection methods, with the aim to identify varieties and traits that are particularly adapted to local conditions. Box 4.4 illustrates the economic efficiency of PPB with an example from Syria.

Box 4.4: The Economic Benefits of Participatory Plant Breeding in Syria

Barley breeders from the International Centre for Agricultural Research in the Dry Areas (ICARDA) have focused on breeding for specific adaptation. This went against the trend of developing varieties with a broad adaptation that can do well across a wide range of ecologies. They found that farmers may have very different breeding objectives; for example that straw yield and quality can be as important as grain yield, and furthermore that growing segregating materials – the product of a cross between one or more parents – in farmers' fields exerts a different selection pressure than on well-managed research plots.

A comparative study on PPB in Syria found that no matter how many varieties are released by the formal seed system, and no matter how great the yield gains they provide over local varieties, farmers in marginal environments will not adapt them unless they are selected through a process that involves their participation.

The gross economic benefits accruing to society as a result of adopting participatory varieties were calculated to be US\$ 110.6 million, while those derived from adopting conventional varieties were calculated to be US\$ 77.6 million.⁷



⁶ For a good overview of PPB experiences and participatory variety selection see IDRC (2003) and Almekinders and Hardon (2006).

⁷ ICARDA (2006).



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The 'Empowerment Approach' to PPB

During the same period, social scientists also started to work on PPB. In addition to obtaining locally adapted materials, their key objective was to empower farmers to maintain and strengthen their abilities to select and breed crop varieties. A main component of this approach is for the social scientists and farmers to seek inputs and obtain feedback from scientific breeders with regard to breeding objectives. For example,

breeding for short, stiff straw in cereals may be beneficial in terms of grain yield, but may impair the use of straw and stubble for animal feed (sheep may harm their lips when the stubble is too hard). In farming systems where the value of animals is higher than the one of grain, this can lead to undesired outcomes, ranging from non-adoption of varieties to decreases in household incomes. An example of the 'empowerment approach' to PPB from Rwanda is provided in Box 4.5.

Box 4.5: CIAT's Experiences with Participatory Plant Breeding in Africa

The International Centre for Tropical Agriculture (CIAT) was one of the pioneers in the 'empowerment approach' type of PPB. CIAT's research brought together women seed specialists in Rwanda, and showed that their selections of beans performed better in their specific agro-ecosystems and farming systems than the varieties that were released by breeders.

The number of varieties that were selected by the Rwandan women was much higher than the number of varieties originating from the official release system. In addition, CIAT scientists found out that farmers that were used to growing mixed stands of beans included the selections in their mixtures, or constituted new mixtures of a range of new selections, thus contributing to diversity in the field.

CIAT's collaborative bean research for Africa has produced a wealth of high-yielding, stress-resistant bean varieties. These products are known to be effective and relevant for small-scale farming, because participating farmers at pilot sites have enthusiastically tested, adopted, and shared them with neighbouring farmers.



The 'Diversity Approach' to PPB

Genetic resources specialists, too, soon gained an interest in PPB for two main reasons. First, in order to enhance the sustainable use of underutilized and locally adapted crops they urged breeders engaged in participatory programmes to use local materials as a starting point for their activities, instead of relying entirely on foreign materials. The second reason was that the materials developed through PPB are typically more diverse than those resulting from conventional breeding.

Ideally, it is highly desirable that breeders, social scientists and genetic resources specialists work together in interdisciplinary teams. However, in many cases projects give more emphasis to one of the three approaches, depending on the initial perspective under which they were established.

Not all PPB methodologies necessarily aim at increasing diversity, but in most cases they contribute to a larger number or a greater mix of cultivated varieties. Thereby, they contribute to the promotion of conservation and sustainable use of PGRFA, particularly in ecologically diverse conditions and in marginal areas. However, the focus on breeding varieties that are adapted to specific sites hinders a wide application of the results. This, together with the remoteness of farming communities in many cases where PPB is practiced, often adds a high cost to such programmes. Key challenges to reduce costs include out-scaling, i.e. increasing the number of farmers participating in the programmes, as well as upscaling, i.e. adoption of the methodologies by national institutions.



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Education

Generally, conservation and use of crop genetic resources is a very minor component in most plant breeding curricula. Barbara changes this by placing diversity breeding in the centre of her teaching. Another important aspect in her teaching is the need for interdisciplinary approaches. Scientific

breeders may have problems communicating with other scientists and farmer communities if they do not have a background in social sciences. Barbara thus ensures that her students attend the relevant research presentations of other faculties and explicitly invites students from other study branches to interdisciplinary discussions and dialogues.

Key points to remember:

- Within their main task of developing high-yielding and stress-resistant crop varieties, plant breeders have a wide array of options to promote conservation and sustainable use of PGRFA, including:
 - Pre-breeding to broaden the genetic base of crops.
 - Strengthening research and breeding for inter- and intra-species diversity.
 - Participatory plant breeding.
- Pre-breeding refers to all activities designed to identify desirable traits from non-adapted materials and to transfer these traits to an intermediate set of materials that breeders can manipulate further to produce new varieties.
- Base-broadening describes the development of new, genetically broad, adapted populations with large variation and acceptable performance level, with the purpose to reduce crop vulnerability.
- Participatory plant breeding (PPB) combines traditional knowledge of farmers with modern plant breeding to develop locally adapted varieties that generally are genetically more diverse than varieties from conventional modern plant breeding.
- Pre-breeding strengthens collaboration between breeders and gene bank managers. Participatory plant breeding involves collaboration between farmers and plant breeders.

Cross-references:

- For the wording and comprehensive **explanations of articles 6.2b)** dealing with research that enhances biological diversity for the benefit of farmers, **6.2c)** dealing with participatory plant breeding and **6.2d)** dealing with broadening the range of genetic material available to farmers refer to sub-section 2.2.2. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For more information on **CIAT's experiences with PPB on beans in Africa** see: <http://webapp.ciat.cgiar.org/africa/beans.htm>



4.2.3. The Contribution of Farmers' and Development Organizations towards the Implementation of Articles 5 and 6: Paul Digger

Paul Digger is the chairman of a farmers' association in a remote area of Develania. Due to persistent droughts and occasional floods, seed security is a serious issue in this area. To cope with these problems, Paul's association has promoted activities and mechanisms including seed fairs and community seed stores, and joined forces with a local development organization for the establishment of farmer field schools. In addition, farmers have adopted crop diversification strategies: when rains are late, short season sorghums and millets are planted; when the season is good, maize grows well in the area. The use of locally adapted and genetically diverse varieties contributes significantly to the resilience of the farming system.

By promoting these activities, Paul's association contributes primarily to the conservation and management of crop diversity on-farm, as well as to the protection of the farmers' traditional knowledge related to their crop varieties. The provisions of the International Treaty that deal with on-farm conservation and management are contained in articles 5.1c) and 6.2f). Protection of traditional knowledge relevant to PGRFA is dealt with in Article 9.2a), under the provisions dealing with Farmers' Rights.

Seed Fairs

One of the most important activities of Paul's association is the organization of seed fairs. These provide farmers a platform where they can display their varieties and share their traditional knowledge of relevance to these varieties by explaining their history and the processes for their selection. Seed fairs offer also an opportunity to share samples and also support seed security among farmers. These activities arrived to Develania following good experiences in Southern Africa, Southeast Asia and Central America. An example from Zimbabwe is presented in Box 4.6.



Courtesy Flickr/IRRI Images



Box 4.6: Seed Fairs - an Example from the Community Technology Development Trust, Zimbabwe

To increase awareness on the value of crop genetic diversity from different sources and to facilitate the exchange of germplasm, the civil society organization Community Technology Development Trust (CTDT) in collaboration with farmer groups and with financial assistance from the International Fund for Agricultural Development (IFAD), conducted seed fairs in three consecutive years.

Farmers were encouraged to display the diversity of crops and varieties that they grow with prizes presented according to the following three criteria: diversity, seed quality and presentation. Prizes were sourced by CTDT from the private sector. They consisted of hoes, ploughs, blades, seeds etc and provided an incentive for farmers to collect and conserve crop diversity. Farmers expressed enthusiasm for the seed fairs as they provided a forum where farmers could meet, interact and exchange germplasm.⁸

Community Gene Banks

Paul's farmers' association has also developed community seed stores to cope with acute seed shortages. A local development organization supports them in also maintaining a basic community gene bank in those stores where small samples of the many different varieties are maintained together with information relevant to these varieties.

The community gene banks contribute both to maintaining the culture of the community and to serve as a source of seed for farmers who want to re-introduce older varieties. The researchers from the local development organization adapted the idea from activities in India they had read about (see Box 4.7) and from experiences from Kenyan farmers they heard about in the radio.⁹

Box 4.7: Community Seed Banks - the Example of the Centre for Indian Knowledge Systems (CIKS), India

The community seed bank project of CIKS is aimed at identifying important traditional seed varieties and orienting the agricultural community towards conserving and cultivating them. Currently, the project is focussing on indigenous paddy and vegetable varieties. The main aim is to enhance the livelihood security of small and marginal farmers through conservation of indigenous genetic resources and empower them with ecological farming technologies. Seed banks serve the exchange, distribution, and utilization of varieties among farmers and through collection, evaluation, documentation and multiplication activities contribute to *in situ* conservation and use.

Under this programme, more than 800 women farmers have established home gardens. In these home gardens they grow a combination of herbs and vegetables. Currently, 63 varieties of 10 different vegetable crops are conserved under the programme.¹⁰

⁸ Practical Action (2009) Farmers' Rights Project (2006).

⁹ Farm Radio International (1994a); (1994b); (1994c).

¹⁰ CIKS (2011).





Courtesy Flickr/Gumma Vijayakumar

Farmer Field Schools

The same local development organization has also set up farmer field schools (FFS) in the region. The FFS approach is a group-based learning process that was originally introduced by FAO for integrated pest management in Indonesia in the 1980s. FFS bring together concepts and methods from agroecology, experimental education and community development. Activities involve simple experiments, regular field observations and group analysis. The knowledge gained from these activities enables participants to make their own locally-specific decisions

about crop management practices.¹¹ An example of FFS from the Philippines is presented in Box 4.8.

Based on the fruitful partnership on the community gene bank, the local development organization supports the farming households that are members of Paul's association in carrying out variety trials using their own varieties, modern varieties, as well as re-introduced materials from the national Seed Centre that were once collected in the area and have in the meantime disappeared from farmers' fields.

Box 4.8: An Example of Farmer Field Schools: SEARICE - The Philippines

The Southeast Asia Regional Initiatives for Community Empowerment (SEARICE) have adapted the approach to support participatory plant breeding in rice. Farmers exchanged knowledge about their selection objectives and methods, and gradually obtained more and more technical expertise from professional plant breeders. Where the initial focus was on variety selection, some farmers take pride in making crosses and selecting the segregating populations in their own farming system and using their own selection priorities. The method has been used in other countries in the region as well, and participating farmers have even been invited to Ethiopia to share their experiences with their colleagues there.¹²

¹¹ For more information on the farmer field school approach see: Van den Berg (2004).

¹² SEARICE (2008). For more detailed information on participatory plant breeding in farmer field schools see Smolders (2006).



As the modern varieties that are available on the seed market in Develania do not perform well in the remote area where Paul lives, the local development organization has asked scientist plant breeders to join the evaluation of the variety trials. However, the scientists

were asked to listen to the farmers' needs and concerns before presenting their own points of view. Farmers' evaluation criteria may be quite different from those of breeders, so scientists need to be open to learn from farmers' experiences and local knowledge.

Key points to remember:

- Farmers' associations and other civil society organizations can play an important role for the promotion of conservation and sustainable use of crop diversity at the local level, including through activities like:
 - Seed fairs.
 - Community gene banks.
 - Farmer field schools.
- Seed fairs offer farmers a platform to display their varieties and traditional knowledge and samples of PGRFA.
- Community gene banks can be a source for farmers who want to re-introduce older varieties.
- The farmer field school approach is a group-based learning process aimed at enabling participants to make their own locally-specific decisions about crop management practices.
- By managing traditional and locally adapted crop diversity on-farm, farmers also contribute towards the conservation of the traditional knowledge related to these varieties.

Cross-references:

- For the wording and comprehensive **explanations of articles 5.1c) and 6.2f)** dealing with on-farm conservation and management, refer to sub-section 2.2.1. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- To learn more about the **linkages of Farmers' Rights under the International Treaty and its provisions on conservation and sustainable use**, refer to sub-section 3.2.1. of lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use).
- For more **technical background regarding on-farm conservation and management** refer to sub-section 1.2.2. of lesson 1 of this module (What is Conservation and Sustainable Use?).
- For more information on the **Centre for Indian Knowledge Systems** see: <http://www.ciks.org/seedbanks.htm>



4.2.4. Promoting the Conservation and Sustainable Use of Crop Diversity by Acting on Consumer Choice: Geoff Quizzine, Chef

A rather recent development is the support for greater diversity from a more indirect stakeholder group of the International Treaty, including chefs and finally consumers that depend on PGRFA for their daily nutrition. Geoff Quizzine runs a civil society organization that stimulates the use of traditional food in Develania and liaises with like-minded organizations across borders.

The work of Geoff's organization contributes towards the objectives of the International Treaty, as it focuses on the promotion of local and traditional produce, ecological production and on-farm management of crop diversity. The provisions of the International Treaty that deal with the promotion of locally adapted crops and on-farm conservation and management are contained in articles 5.1c), 6.2e) and 6.2f).

Geoff's motivation came from his observation that people in rural areas started to increasingly rely on cheap food that often had low nutritional values and was made of crops that did not grow in the region. The developments Geoff observed were that rural people forgot more and more about their local varieties of finger millet, legume and oil crops. At the same time, city dwellers in urban environments of Develania were increasingly adopting foreign food cultures based on pasta and potato fries, totally forgetting about the richness of their traditional dishes.

Geoff's organization has been quite successful with some of the large tourist hotels in Develania. Most of them had previously focused on foreign cuisine, which was popular among Develania's upper class for the organization of celebrations and meetings. In a first step Geoff's organization focused on sensitizing tourists for local flavours by organizing food tasting tours and traditional food fairs. Tourists responded very positively and increasingly asked for local cuisine.



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Box 4.9: Promoting Local Leafy Vegetables in Western Kenya

Africa is endowed with a wide diversity of food crops, but in many countries city dwellers have become used to western style diets containing cabbage and tomato instead of the many vegetable species and varieties traditionally grown in Africa. The Rural Outreach Programme for example, a Kenyan civil society organization, supported the creation of effective value chains for several leafy vegetables from western Kenya to the major cities, initially to roadside markets, but eventually to Nairobi's major supermarkets.

The initiative faced many constraints, such as assuming reliable quality, deterioration during transport, and the need for expeditious marketing of such perishable products. But ultimately it is the demand side that drives the chain. Making such vegetables acceptable or even 'fashionable' on the plates of city dwellers is one pathway to enhancing the use of crop diversity in the field and increasing nutritive value of diets.¹³

Amazingly, even the local upper class regained the taste of Develania's traditional foods, however often prepared in innovative ways and mixed with ideas from foreign dishes. This is called 'fusion cooking' where traditional products are used to create modern dishes. The urban middle class is now also adopting this trend, which has been further spread through one of Develania's most popular TV show. The cumulative effect of these initiatives has been the creation of a new market for traditional products in supermarkets, which were previously only sold at roadside stands. Two real world examples of how conservation and sustainable use of crop diversity can be promoted by acting on consumer choice are provided in Box 4.9 and Box 4.10, respectively.

Geoff's organization has spread throughout Develania in recent years, increasing partnerships along the entire gastronomy

chain, from producers to restaurants and hotels. Geoff has also been able to enter in contact with similar initiatives in other countries in order to exchange experiences and best practices. Increasingly, his organization does not only promote traditional dishes, but also local and ecological production. Ecological production has the potential to promote diversity in the agro-ecosystem. To ensure soil fertility and to effectively counter disease outbreaks, farming systems that support crop resilience are required. Locally adapted varieties and varieties with a broad genetic base often exhibit traits for resistances against environmental stresses. In that sense, ecological farming often contributes to on-farm diversity. The ecological farmers that supply their local produce to restaurants that participate in the programme supported by Geoff's organization typically cultivate a higher level of diversity than their colleagues that engage in conventional agriculture.

¹³ Oniang'o, Mutuku and Malaba (2003).



Box 4.10: The Slow Food Movement

Slow Food is an international movement for the preservation of regional cuisine and the growing of products that are characteristic to local ecosystems and traditions. The movement was founded in 1986 in Italy in response to the opening of the first fast food chain restaurant in Rome, and from there expanded worldwide. It promotes diversity in the kitchen and on the table – and thus in markets and farmers’ fields.

By the end of 2010, Slow Food had over 100 000 members joined in 1300 local chapters in 150 countries worldwide. Slow Food originates in the kitchen culture, but includes in its objectives the conservation of ‘heirloom varieties’ of crops, i.e. old varieties that come from a particular geographic region. However, the promotion of local products stimulated the sustainable use of genetic resources, both in terms of local and sometimes almost forgotten crops and of local types and varieties of major crops. It even contributed to the formal recognition of such varieties in European seed regulations.

Key points to remember:

- Especially in the developed world, but also in developing countries, acting on consumer choice can be an effective strategy for the promotion of traditional, local and genetically diverse varieties.
- The promotion of local and traditional produce is often coupled with ecological production and promotes on-farm management of crop diversity.
- Innovative collaborations, including with hotels, restaurants and TV shows, can help to create new markets for old and genetically diverse food crops.

Cross-references:

- For the wording and comprehensive **explanations of articles 5.1c) and 6.2f)** dealing with on-farm conservation and management **and Article 6.2e)** dealing with the promotion of local and locally adapted crops and varieties, refer to sub-sections 2.2.1. and 2.2.2. of lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- For more information on the **Rural Outreach Programme** see: http://www.ropkenya.org/index.php?option=com_content&view=category&layout=blog&id=4&Itemid=6
- For more information on the **Slow Food movement** see: <http://www.slowfood.com/>



4.2.5. The Role of Governments in Implementing Articles 5 and 6 of the International Treaty

As direct stakeholders of the International Treaty, the governments of Contracting Parties have an important role in creating and maintaining enabling environments for the different stakeholder groups that conserve and sustainably use PGRFA within their borders, through appropriate policies and legislation. This is reflected in articles 5.1 and 6.1 of the International Treaty. The wording of Article 6.1 is particularly strong and unconditional in that respect, stating that “the Contracting Parties shall develop and maintain appropriate policy and legal measures that promote the sustainable use of plant genetic resources for food and agriculture”.

Policies

The policy area of crop diversity is particularly complex as it touches upon a range of policy areas that are typically dealt with by different ministries. In the case of Develania, for example, the Environment Ministry is in charge of biodiversity policies,

while the Ministry of Agriculture oversees national seed policies. To a certain extent, crop genetic resources even fall within the mandate of the Ministry of Culture, as it is responsible for the promotion of local products.

As Develania has ratified the International Treaty, it is committed to the conservation and sustainable use of crop diversity, and to share the benefits that arise from the use of PGRFA in a fair and equitable manner. However, the country also pursues a number of other important goals, such as economic development, trade and public health, which are also related to crop genetic resources management to some extent. Effective coordination and collaboration across all relevant ministries is therefore crucial to ensure policy coherence.

To ensure coherent implementation of the International Treaty with other national policies that may affect crop genetic resources management, Develania’s Ministry of Agriculture has created the Inter-ministry Working Group on Cultivated Plants (CPWG). The CPWG is led by the



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Ministry of Agriculture and open to all other interested ministries. It discusses policies for the promotion of the conservation and the sustainable use of PGRFA, and prepares draft legislation for the adoption by the Develanian Parliament. For the elaboration of sound and coherent policy and legal measures notably for articles 5 and 6 of the International Treaty, the CPWG bases its work broadly on the elaborate recommendations contained in the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (hereafter “Second Global Plan of Action”).

Legislation

The draft legislation prepared by the CPWG, once passed by Parliament, eventually leads to conducive legislation. Seed laws are an example of legislation that strikes a balance between the needs of different seed systems in a country. Some countries rely mainly on a private seed sector that focuses on commercial crops, with elaborate regulations on variety release, seed certification and seed quality control. In other countries, particularly in developing countries where the majority of farmers are smallholders of which many produce on marginal lands, so-called ‘informal seed systems’ that involve

the exchange of farm-saved seed among farmers play an important role in provisioning farmers with sufficient planting material.

Thus, while seed laws are an important tool to guarantee the quality of commercialized seed, seed laws that do not take into account the needs of smallholder farmers could possibly jeopardize their food security. Poorly drafted regulations may also obstruct initiatives that support on-farm management such as those supported by Eugene Banks, Barbara Reed, Paul Digger and Geoff Quizzine. Seed laws should thus be designed in such a way that these useful initiatives are not outlawed. The International Treaty therefore proposes Contracting Parties to review, and, as appropriate, adjust “breeding strategies and regulations concerning variety release and seed distribution”.¹⁴

Box 4.11 presents examples where more flexibility has been introduced into new seed laws. Box 4.12 provides an example from Nepal where relaxing testing guidelines regarding uniformity has allowed the registration and release of a new crop variety that was developed with the participation of local farmers.

Box 4.11: Opening up the Seed Laws

European seed laws generally only accept seed of certified varieties that are officially listed to be commercialized. In order for varieties to be listed they need to fulfil a number of criteria, most importantly they have to be sufficiently uniform. Many traditional and genetically diverse varieties do not fulfil the uniformity criteria and are therefore excluded from markets.

In response to the International Treaty, the European Commission initiated a process to acknowledge ‘conservation varieties’ for which seed should be allowed to be marketed. On the basis of the so-called Conservation Varieties Directive of 2008, countries have the possibility to allow for marketing of old and locally used varieties that are threatened by genetic erosion, without the need to adhere to strict uniformity and stability rules.

Also the Ethiopian Seed Proclamation of 2006 intends to safeguard informal seed systems.¹⁵ In many cases, however, existing seed laws can be rather strict, and tend to be tailored mainly to the needs of the formal – i.e. commercial – seed sector.¹⁶

¹⁴ International Treaty on Plant Genetic Resources for Food and Agriculture (2001), Article 6.2.g).

¹⁵ Ethiopian Proclamation on Access to Genetic Resources and Community Knowledge, and Community Rights (2006).

¹⁶ Louwaars (2005).



Similar questions may arise with regard to intellectual property rights and biosafety legislations. Patents on plant varieties or their components, while aimed at rewarding the developers of the variety, in many national settings represent an obstacle for the reproduction of seeds on-farm, especially for poor farmers in developing countries. Plant breeder's rights systems on the other hand include important exceptions which allow breeders to use protected material for further breeding ('breeder's exemption') and which may allow – subject to national law – farmers to freely reuse their seed ('farmers' privilege'). Some countries, for example India, explicitly refer to the concept of Farmers' Rights - as laid down in Article 9 of the International Treaty - in their laws to strengthen their farmers' opportunities to save, use, exchange and sell (on a non-commercial basis) their seed.¹⁷ The European

Biotechnology Directive of 1998 excludes plant varieties from patentability and contains explicit exclusions on farm-saved seed.¹⁸ Several countries notably in Africa implicitly or explicitly exclude plants from patentability.¹⁹

Several countries also include important aspects relevant to the conservation of crop genetic resources in their biodiversity laws and laws related to protection of traditional knowledge.²⁰ Often, such laws may have direct impacts on exchange of materials among farming communities, particularly across national borders. Hence, this illustrates once more the need for ensuring policy coherence and compatibility of different types of legislations including seed laws, intellectual property legislation, biodiversity laws and legislation on traditional knowledge.²¹



¹⁷ Indian Biological Diversity Act (2002).

¹⁸ European Directive on the Legal Protection of Biotechnological Inventions (1998).

¹⁹ OAU (2000), Article 9.

²⁰ Costa Rican Biodiversity Law (1998), especially chapters 4-10; Ethiopian Proclamation on Access to Genetic Resources and Community Knowledge, and Community Rights (2006), especially articles 3 and 13.1-13.4 ; Indian Biological Diversity Act (2002), in particular articles 13.1, 18, 23, 36-41; Peruvian Law on Conservation and Sustainable Use of Biodiversity (1997).

²¹ Further examples of policies and legislations for the implementation of Article 6 can be found in the compilations that were made in 2007 and 2009: Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (2007a); (2007b); (2007c); (2007d); (2009a); (2009b); (2009c).





Box 4.12: PPB in Nepal - the Case of 'Pokhareli Jethobudho' Rice²²

In 1999, various stakeholders started a participatory selection process in the Pokhara valley in the Western Development Region of Nepal with the objective of improving a local rice variety known as 'Jethobudho'. Many farmers cultivate Jethobudho on relatively large plots as its quality traits, such as aroma, taste, softness and other cooking properties are highly valued despite the variety's susceptibility to lodging, diseases and its low yield. In addition, production of Jethobudho does not meet demand, which pushes up its price. In many areas of the valley, the crop is sold even before harvest.

Stakeholders started by identifying plants with valuable characteristics by way of an extensive field diversity collection survey that was carried out at seven locations in the valley where Jethobudho is traditionally grown. A total of 338 lines from farmers' fields were then evaluated on their performance.

Farmers, traders and hoteliers established a list of trait characteristics of the ideal Jethobudho variety. The 338 lines were screened against these traits at several locations. In this process, farmers had a decisive role. The lines displaying most of the identified traits were judged on post-harvest quality traits and then selected. This brought down the number of lines to 46. From these 46 lines, six distinct lines that showed most of the identified traits were selected but kept separate. The six lines were mixed together and the resulting material was named 'Pokhareli Jethobudho' in order to relate it to its geographic origin. Over the years, overall performance of the enhanced Pokhareli Jethobudho was found to be superior to the farmers' own Jethobudho in a number of desirable traits such as uniformity in quality of post-harvest traits (milling recovery, taste and aroma), grain yield, straw quality and tolerance to blast and lodging. The comparison of the productivity of Pokhareli Jethobudho shows that improved accessions have higher grain yield potential than the highest range of productivity of this landrace in 1999. In order to obtain recognition and at least the right to commercialize Pokhareli Jethobudho, the stakeholders who had carried out the selection process decided to apply for release of Pokhareli Jethobudho under the regime of the Nepalese Seed Act 1988 (as amended in 1998 and 2001).

Although farmers are allowed to apply for variety registration and release under the Nepalese Seed Act, directives issued by the National Seed Board require that applicants have at least an MSc degree and set requirements for infrastructure to support breeding activities that practically rule out applications from farmers. In order to get co-recognition for participating farmers, the project team filed an application in the name of the project stakeholders, the six custodian farmers on whose land the six lines had been found and the Fewa farmers group, which grows and markets seeds of the enhanced variety in the Pokhara valley. The application of the testing guidelines concerning uniformity was relaxed by allowing the registration of a multi-line variety, thereby allowing Pokhareli Jethobudho to have a lower level of uniformity than might otherwise have been required. The variety was formally registered and released by the Variety Approval, Registration and Release Committee in June 2006 as 'Pokhareli Jethobudho'. The release symbolized the recognition of farmers as co-owners of a new variety for the first time in Nepal's history.

²² Halewood *et al.* (2007).



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Funding

The implementation of laws and policies for the *ex situ* conservation and on-farm management activities presented in this lesson also requires that governments allocate sustainable funding. Unless the Seed Centre managed by Eugene will be guaranteed long-term funding, the collections contained in the gene bank are under constant threat of being lost. Activities to promote the use of PGRFA, such as the development of documentation systems, may be carried out on a project basis, but the documentation systems require follow-up work and constant updating as well.

Barbara's research and breeding activities are also dependent on public funding for the most part, particularly those activities that focus on smallholder farmers and genetically diverse crops adapted to specific local conditions that do not generate considerable commercial interests. Equally participatory breeding, as it is mainly focused on meeting the needs of smallholder farmers, requires explicit funding support, whereas some breeding work may be done in public-private partnerships. Similarly, most commercial

seed companies consider pre-breeding as 'pre-competitive' and therefore primarily a task for the public sector.

Paul Digger has access to some project funding from civil society organizations, however certain government programmes may equally offer components from which his activities can benefit, such as funding for food security or capacity development.

Geoff Quizzine is used to working in an entrepreneurial environment, but as the Develanian Government has recognized the value of the activities of his organization, he has managed to receive financial support for some activities including cooking demonstrations for the preparation of traditional and underutilized crops in shopping malls and in the annual food industry fair. Even the Ministry of Tourism has started to pay attention to local food and to use it in its promotion campaigns abroad.

Important funding sources, especially for developing countries, are also channelled through bilateral and multilateral cooperation (see section 4.2.6. below).



Stakeholder Involvement

In the course of its work on the development of coherent policies to promote the conservation and sustainable use of PGRFA in Develania, the Ministry of Agriculture invited a broad range of stakeholder representatives of the country to a stakeholder hearing with the CPWG. The aim of the hearing was to obtain an overview of ongoing activities in the area of conservation and sustainable use of crop genetic resources and to ensure that policies respond to stakeholders' needs. Among the invited representatives were notably Eugene Banks, Barbara Reed, Paul Digger and Geoff Quizzine.

As an important side-effect, the hearing brought forward new partnerships and strengthened collaborations. Although the four persons had heard about each other's activities prior to the stakeholder hearing, neither of them was fully aware that they had much in common. Geoff being a very vocal person, his language was dominated by the notions of 'cultural heritage' and 'quality of food', whereas Paul Digger used terms such as 'equity', 'poverty reduction' and 'rural development'. Barbara was primarily

interested in capturing the knowledge and views of farmers to improve crops through PPB, particularly in order to contribute to ecologically diverse environments. Crop diversity conservation *per se* was of primary importance only to Eugene. However, in the course of the discussions, all four realized that their individual goals all contribute to their common objective of conservation and sustainable use of PGRFA.

Eugene and Barbara decided to set up a joint pre-breeding programme between the Seed Centre and the University of Develania. Paul took a lot of interest in Barbara's work on PPB and both agreed to engage in the joint organization of farmer field schools. Similarly, Geoff and Paul agreed to look into concrete possibilities for partnerships; notably, they understood that Geoff's organization could support Paul's farmers' association in the marketing of their local produce. Even Eugene suggested Geoff that they could work closer together, as the gene bank could help him re-introduce some old and largely forgotten crop varieties for chefs who want to use special products for their specific culinary qualities.



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The stakeholder hearing thus greatly contributed to the development of coherent policies related to crop diversity in Develania, and created a number of new collaborative actions. By demonstrating the complementarity and great potential for synergies between the activities of their activities, the stakeholder groups also managed to receive government support for their collaborative actions.

Key points to remember:

- Governments of Contracting Parties of the International Treaty have an important role in creating and maintaining enabling environments for the conservation and sustainable use PGRFA through appropriate laws and policies.
- Coordination across relevant ministries is crucial in order to ensure policy coherence when implementing the International Treaty at national level. The International Treaty is at the crossroads of policy areas including agriculture, environment, trade and culture, and it relates to, *inter alia*, national seed laws, intellectual property law and legislation on traditional knowledge and biodiversity.
- The involvement of all stakeholders in policy development is key to ensure that policies respond to stakeholders' needs.
- Increased stakeholder involvement in policy processes may further lead to the creation of new collaborative actions.

Cross-references:

- For the **text of the Second Global Plan of Action** see: http://typo3.fao.org/fileadmin/templates/agphome/documents/PGR/GPA/GPA2/GPA2_en.pdf
- The corresponding **policy recommendations and strategies put forward by the Second Global Plan of Action** are indicated for each measure of the International Treaty for the promotion of conservation and sustainable use of crop diversity explained in lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- Lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use) contains a **table that illustrates the links of the provisions of the International Treaty and the priority activities of the Second Global Plan of Action**.
- An **analysis of the new European seed legislation** can be found at: <http://www.farmseed.net/home/>
- For more **examples of legislation on conservation and sustainable use of PGRFA** refer to Box 3.2 of lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use).
- For more information on the **policy area of intellectual property rights in the domain of genetic resources** refer to sub-section 5.2.3. of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).



4.2.6. The Role of International Institutions

The previous parts of this lesson presented various stakeholder initiatives for the conservation and sustainable use of crop diversity at national and local level. All these initiatives operate within the overall policy framework of the International Treaty, in some cases even without being aware of it. There are often further international components to such initiatives, either through funding, technology transfer, the exchange of information or capacity development.

The main international institutions that promote the conservation and sustainable use of PGRFA include the following:

- **The International Treaty** provides the policy framework for the global efforts to conserve and sustainably use

PGRFA, by proposing a set of measures for the conservation and sustainable use. Contracting Parties commit to adopt and maintain policy and legal measures for the sustainable use of crop diversity. The International Treaty further creates a Multilateral System through which Contracting Parties share their PGRFA of a number of the most important food crops and forages according to the facilitated terms of a standardized contract – the SMTA – thereby contributing importantly to enhance the use of crop genetic resources. The International Treaty also directly contributes to the on-farm management and conservation and the sustainable use of crop diversity through its Benefit-sharing Fund. The Benefit-sharing Fund is a trust fund that supports initiatives for the conservation and sustainable use of PGRFA at local, national and regional level.



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- **The Global Crop Diversity Trust** (hereafter “Crop Trust”) is an essential element of the International Treaty’s Funding Strategy. In complementarity to the Benefit-sharing Fund, the Crop Trust focuses on providing funding for *ex situ* conservation of PGRFA.
- **The Consultative Group on International Agricultural Research** (CGIAR) has been at the forefront of conservation and sustainable use of PGRFA for many decades. CGIAR scientists have contributed greatly to the development of methodologies that broaden the genetic base of crops. New crop varieties and research results from the CGIAR’s activities are made widely available to individuals and organizations working for sustainable agricultural development throughout the world. Further, the CGIAR research centres hold large PGRFA collections that they have formally included into the Multilateral System of the International Treaty, thereby making them equally available for subsequent use under the facilitated terms of the SMTA of the International Treaty.
- **FAO and its Commission on Genetic Resources for Food and Agriculture** (hereafter ‘Commission’) have developed a number of very significant initiatives for the conservation and the sustainable use of PGRFA over the years. The Commission is a negotiation forum for the elaboration internationally agreed guidelines and policy instruments for food genetic resources management, including the Second Global Plan of Action mentioned above. Most prominently, the International Treaty has been negotiated within the Commission. Further, FAO has also been operational in establishing the International Board for Plant Genetic Resources which evolved into Bioversity International, one of the members of CGIAR. Through its regular programmes, FAO has also been instrumental in promoting breeding and promoting seed systems. Rather recently, FAO has established the **Global Partnership Initiative for Plant Breeding Capacity Building** (GIPB), with the aim to enhance developing countries’ capacities to improve crops for food security and sustainable development through better plant breeding and delivery systems.



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All these institutions receive policy guidance from their memberships and are supported by national governments through their funding arrangements on the one hand, and by other stakeholders such as researchers, development workers and farmers that implement their objectives at the field level, on the other hand.

There is also a wide range of networks that aim at promoting conservation and sustainable use of PGRFA. Such networks can focus, for example, on exchanging information, scientific consultations, collaborative research, and exchange of PGRFA. Some networks operate at international, regional and sub-regional level, and some focus on specific crops, on *in situ* conservation activities or other specific themes.²³ An example

of such a network at the international level is Genesys, launched by the Secretariat of the International Treaty in partnership with the CGIAR and the Crop Trust. Genesys is a plant genetic resources portal that offers a single access point to information of about a third of the world's gene bank accessions.

Strengthening PGRFA networks is an important element for enhancing conservation and sustainable use. Eugene is therefore undertaking the necessary efforts for linking Develania's Seed Centre to Genesys. This will contribute towards the implementation of Article 5.1e) of the International Treaty by further enhancing the availability of information on the materials contained in the Seed Centre, as well as Article 16 by strengthening international PGRFA networks.

Key points to remember:

- Several international initiatives contribute towards the conservation and sustainable use of PGRFA through the provision of funding, technology transfer, information exchange or capacity development.
- The International Treaty provides the policy framework for the global efforts to conserve and sustainably use PGRFA, facilitates access to and exchange of PGRFA through its Multilateral System, and through the Benefit-sharing Fund of its Funding Strategy provides funding to initiatives that focus on on-farm management and sustainable use of crop diversity.
- The Crop Trust is an essential element of the International Treaty's Funding Strategy in the field of *ex situ* conservation.
- The CGIAR research centres hold large PGRFA collections that they have formally included into the Multilateral System of the International Treaty.
- The FAO Commission is a negotiation forum for the elaboration internationally agreed guidelines and policy instruments for food genetic resources management, including the Second Global Plan of Action.
- Among its many initiatives for conservation and sustainable use of PGRFA, FAO has recently established the GIPB to enhance developing countries' plant breeding capacities for food security and sustainable development.



²³ For a summary and initial analysis of PGRFA networks refer to FAO (2004a) and FAO (2004b).

Cross-references:

- For the wording and comprehensive **explanations of the provisions of the International Treaty dealing with conservation and sustainable use of PGRFA**, refer to lesson 2 of this module (The Provisions of Articles 5 and 6 of the International Treaty).
- To learn more about **how Farmers' Rights, the Multilateral System and the Benefit-sharing Fund of the International Treaty contribute to the conservation and sustainable use of PGRFA**, refer to section 3.2. of lesson 3 of this module (Further Components of the International Treaty Supporting Conservation and Sustainable Use).
- For an introduction to the **main components of the International Treaty**, including Farmers' Rights, the Multilateral System and the Funding Strategy, refer to section 4.2. of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- For an in-depth consideration of the Multilateral System and the Funding Strategy refer to forthcoming Module IV and Module V, respectively.
- To learn more about the **Crop Trust** refer to Box 4.2 of lesson 4 of Module I (Main Components and Governance of the International Treaty).
- To learn more about the **relationship of the Crop Trust and the International Treaty** refer to sub-section 5.3.2. of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- For more information on the **work of the Crop Trust** see: <http://www.croptrust.org/main/>
- To learn more about the **CGIAR** refer to Box 3.1 of lesson 3 of Module I (History of the International Treaty).
- To learn more about the **CGIAR Centres' relationship with the International Treaty** refer to sub-section 5.3.3. of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- For more information on the **work of the CGIAR** see: <http://www.cgiar.org/>
- For more information on the **GIPB** see: <http://km.fao.org/gipb/>
- For more **information on Genesys** refer to Box 5.3 of lesson 5 of Module I (The Legal Architecture Governing Crop Diversity and Partnerships for Implementation).
- **Access Genesys** here: <http://www.genesys-pgr.org/>





4.3. Conclusive Summary

Conservation and sustainable use of crop genetic resources is not the responsibility of one particular person or stakeholder group. While some stakeholders have specific responsibilities at international, national and local level, effective linkage and coordination of the work of all stakeholder groups at all levels is required to ensure and enhance conservation and sustainable use. There are many options available to a wide range of stakeholders to contribute to these goals.

While in some agro-ecosystems, large-scale use of improved modern varieties may be the most efficient option to contribute to global food security, the use of diverse, locally adapted and traditional crops plays a crucial role in contexts where risk management is more important than yield maximization, or where consumers are willing to pay a premium for ecologically produced crops. Crop diversification can be a strategy for farmers to increase the resilience of their cropping system, particularly for smallholder farmers producing in marginal areas. Consumer choice can also be an important factor, and actors including chefs may be instrumental in promoting local products derived from diversity-rich crops.

Plant breeders are primary users of genetic resources, however there are much more options to use PGRFA for plant breeding than those that are generally practised by breeders. By developing new varieties which are adapted to stresses and exhibit

high yields, their work contributes very much to the crop diversity available to farmers. While often working at the local and national level, breeders' work in one place may have an impact on the use of PGRFA at the global level, for example through pre-breeding activities for broadening the genetic base of crops. Similarly, the managers of national gene banks, while contributing to the global conservation effort, have options to contribute to the promotion of conservation and sustainable use of PGRFA at local level if sufficient emphasis is given to fostering dialogue and effectively linking stakeholders within their national contexts.

Policy makers and their advisers play an important role in this regard by developing policies, laws and institutions with the aim to contribute to the conservation and sustainable use of PGRFA. Their task is to create an enabling environment that allows all stakeholder groups to effectively operate, that provides the right incentives, and that fulfils the international commitments their governments have made: most importantly in this context their obligations under the International Treaty. Consultation and active involvement of all relevant stakeholders in the policy development and implementation processes is of crucial importance for the success of such policies. This may even lead to new linkages among stakeholders that may further underpin the conservation and sustainable use of PGRFA.



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Selected Online Resources

This section provides a selection of resources related to the International Treaty and the policy area of conservation and sustainable use of crop diversity that are available online.

International Instruments

- International Treaty on Plant Genetic Resources for Food and Agriculture. 2001.
Available at: <ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf>
- Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture. 2011. Available at:
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Training Resources

- Educational Modules on the International Treaty
Available at: http://www.planttreaty.org/educational_modules
- Virtual Library of the International Treaty
Available at: http://www.planttreaty.org/content/vl_panel
- Crop Genebank Knowledge Base
Available at: <http://cropgenebank.sgrp.cgiar.org/>
- Bioversity International – Training Materials
Available at: http://www.bioversityinternational.org/training/training_materials/
- Collecting Plant Diversity: Technical Guidelines
Available at: http://cropgenebank.sgrp.cgiar.org/index.php?option=com_content&view=article&id=390&Itemid=557&lang=english#chapters
- *In Situ* Conservation of CRW – eLearning Modules
Available at:
http://www.cropwildrelatives.org/capacity_building/elearning/elearning.html
- Global Partnership Initiative for Plant Breeding Capacity Building
Available at: <http://km.fao.org/gipb/>
- E-learning course on pre-breeding for effective use of plant genetic resources
Available at: <http://km.fao.org/gipb/>
- Marker-assisted Breeding Learning Module
Available at: <http://www.generationcp.org/mab/>
- The International Treaty on Plant Genetic Resources for Food and Agriculture: Implementing the Multilateral System – Learning Module
Available at:
http://www.bioversityinternational.org/training/training_materials/international_treaty.html

All the above internet links were accessed on 7 November 2011.

Further Reading

For the list of reference materials on which the lessons of this educational module are based, refer to the Bibliographic References sections of each lesson. Below you find a selection of resources for further reading related to the topics dealt with in this module.

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Engels, J. M., and Visser, L. 2003. *IPGRI Handbooks for Genebanks No. 6: A guide to effective management of germplasm collections*.

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Available at: [http://portals.wi.wur.nl/files/docs/Sthapit%20et%20al,%202008a%20-%20Mobilizing%20and%20empowering\(2\).pdf](http://portals.wi.wur.nl/files/docs/Sthapit%20et%20al,%202008a%20-%20Mobilizing%20and%20empowering(2).pdf)

Sthapit, B. R. and Jarvis, D. I. 1999. *Participatory Plant Breeding for on-farm Conservation*.

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Von Lossau, A. and Li, Quingsong. 2011. *Sourcebook on Sustainable Agriculture Management*.

Available at: http://www.agrobiodiversity.cn/uploads/media/Sourcebook_EN.pdf

Witcombe, J. R., et al. 2011. "Impact of Introduction of Modern Varieties on Crop Diversity", in Lenné J. M. and Wood, D., *Agrobiodiversity Management for Food Security: A Critical Review*.

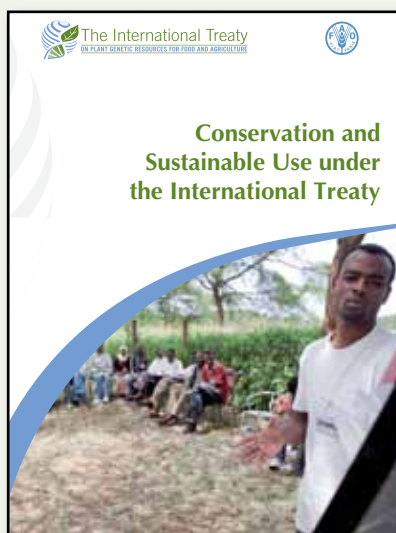
Available at: <http://books.google.com/>

All the above internet links were accessed on 7 November 2011.

Acronyms and Abbreviations

AEGIS	A European Genebank Integrated System for Plant Genetic Resources for Food and Agriculture
AHTC	<i>Ad Hoc</i> Technical Committee
Benefit-sharing Fund	Benefit-sharing Fund of the Funding Strategy (of the International Treaty on Plant Genetic Resources for Food and Agriculture)
CATIE	Tropical Agricultural Research and Higher Education Center
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CGIAR Centres	International Agricultural Research Centers of the Consultative Group on International Agricultural Research
CGN Netherlands	Centre for Genetic Resources of the Netherlands
CIAT	International Center for Tropical Agriculture
CIKS	Centre for Indian Knowledge Systems
CIP	International Potato Center
Commission	Commission on Genetic Resources for Food and Agriculture (FAO; until 1995 “Commission on Plant Genetic Resources”)
CBM	Community Biodiversity Management
Crop Trust	Global Crop Diversity Trust
CTDT	Community Technology Development Trust
CWR	Crop Wild Relatives
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer field schools
GEF	Global Environment Facility
GIPB	Global Partnership Initiative for Plant Breeding Capacity Building
Global Plan of Action	Global Plan of Action for the Conservation and the Sustainable Utilization of Plant Genetic Resources for Food and Agriculture

Governing Body	Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture
IBC	Institute of Biodiversity and Conservation (Ethiopia)
ICARDA	International Center for Agricultural Research in the Dry Areas
IFAD	International Fund for Agricultural Development
International Treaty	International Treaty on Plant Genetic Resources for Food and Agriculture
ISO	International Standard Organization
IUCN	International Union for Conservation of Nature
Kew Gardens	Royal Botanic Gardens Kew (United Kingdom)
MTA	Material transfer agreement
Multilateral System	Multilateral System of Access and Benefit-sharing (of the International Treaty on Plant Genetic Resources for Food and Agriculture)
NBSAPs	National Biodiversity Strategies and Action Plans
PGRFA	Plant Genetic Resources for Food and Agriculture
PPB	Participatory plant breeding
SCPI	Sustainable crop production intensification
SEARICE	Southeast Asia Regional Initiatives for Community Empowerment
Second Global Plan of Action	Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture
Second State of the World Report	Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture
SMTA	Standard Material Transfer Agreement
UNEP	United Nations Environment Programme



Module II - Conservation and Sustainable Use under the International Treaty

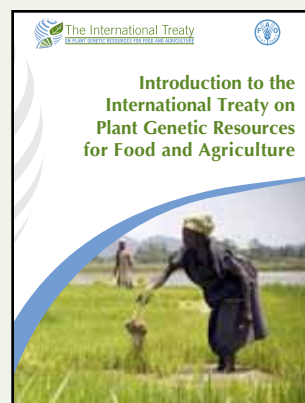
Module II explains the provisions of the International Treaty dealing with conservation and sustainable use of crop diversity and presents examples for their implementation.

The module provides technical aspects for learners with more of a political background in agriculture, and illustrates the legal framework of the International Treaty to learners that have more of a research and scientific background related to PGRFA.

Already appeared in this series:

Module I - Introduction to the International Treaty on Plant Genetic Resources for Food and Agriculture

This module was especially designed for newcomers to the crop diversity policy area. It outlines the main components of the International Treaty in the context of current global challenges and the broader legal framework governing crop diversity.



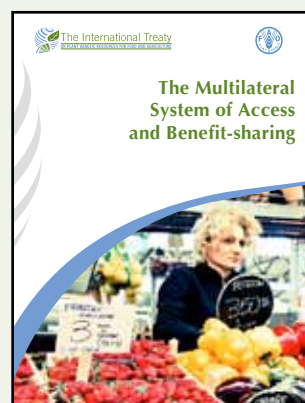
The full series will be further composed by:

Module III - Farmers' Rights

Module III will present the provisions of the International Treaty that deal with the rights of farmers with regard to crop diversity, and provide examples of the realization of Farmers' Rights in different national settings.

Module IV - The Multilateral System of Access and Benefit-sharing

This module will explain the operation of the Multilateral System of Access and Benefit-sharing, with a special focus on the Standard Material Transfer Agreement used in germplasm exchanges.



Module V - The Funding Strategy

Module V will present the Funding Strategy for the realization of the objectives of the International Treaty, with a particular focus on the operation of the project cycle of the Benefit-sharing Fund and how to apply for funds under this multilateral financing mechanism.

The development and publication of this educational module was made possible thanks to the Governments of Switzerland, Italy and Spain. Individual authors were in addition supported by Bioversity International, and the Government of the Netherlands through Wageningen University. For information on opportunities to contribute to the realization of further modules of this series please contact the Secretariat of the International Treaty. Donor recognition in all produced materials will be guaranteed. See contact details on the back of this publication.

“Conservation and Sustainable Use under the International Treaty” is the second in a series of educational modules being developed under the coordination of the Secretariat of the International Treaty to strengthen capacities for the effective implementation of the International Treaty among its stakeholder groups. The work on these training materials was officially welcomed by the Governing Body of the International Treaty at its fourth session.

The educational modules are aimed at all stakeholder groups of the International Treaty, including policy makers and their staff, civil servants, gene bank staff, plant breeders, farmers’ organizations and other civil society organizations. They are also designed as information and awareness raising materials for the use of media, academia, prospective donors and other interested institutions.

This publication is a limited release for stakeholder evaluation. An updated version is foreseen to be published together with the forthcoming modules of the series.

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