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)

Table of Contents

Author: **Niels Louwaars.** At the time of drafting the lesson Mr Louwaars was Senior Scientist Biopolicies at Wageningen University. When he did the final review he was Managing Director at Plantum.

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

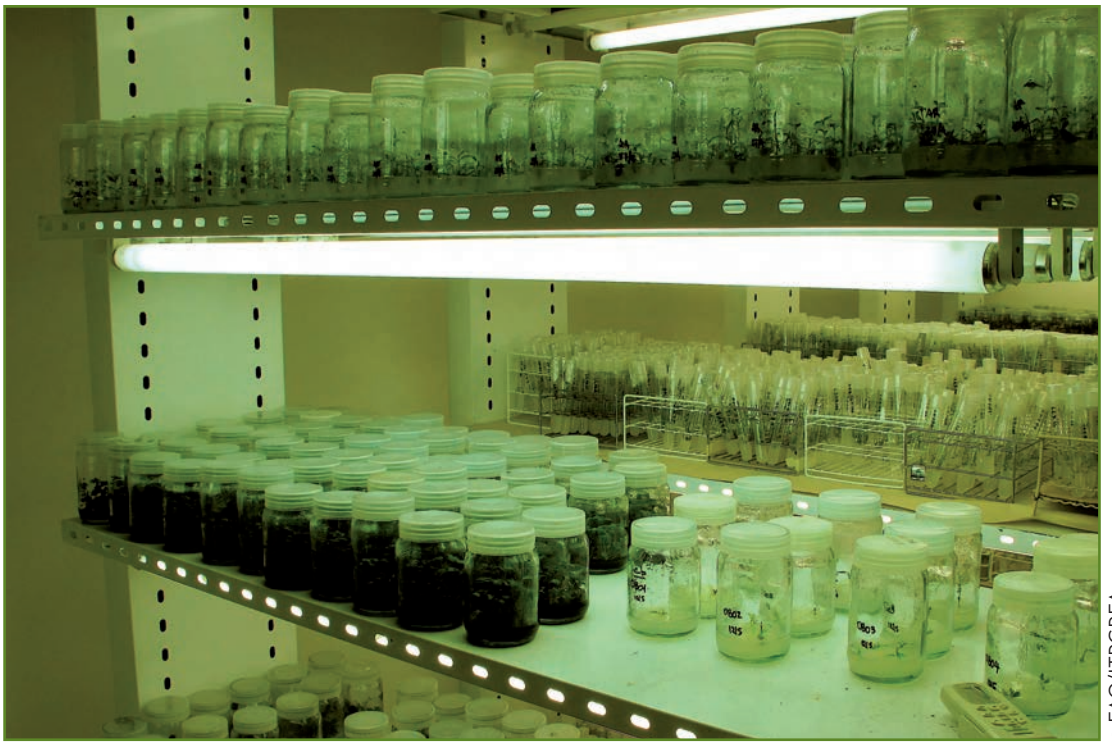
Standardizing Methodologies and Quality Management

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



© FAO/ITPGRFA

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.

© FAO/Paballo Thekiso

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.

© FAO/H. Zhang

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.

© FAO/Giulio Napolitano

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).

© FAO/Caroline Thomas

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.

© FAO/Giulio Napolitano

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.

© Katia Covarrubias

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

© FAO/Roberto Faidutti

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]

© FAO/Florita Botts

[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' Rice[22]

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).

© FAO/Yasuyoshi Chiba

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.

© FAO/Giulio Napolitano

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 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.

© FAO/Seyllar Diallo

- **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 fur 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.

© FAO/Giulio Napolitano

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/

© FAO/Munir Uz Zaman

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.

4.4. Bibliographic References

Almekinders, C. and Hardon, J. 2006. "Bringing Farmers Back Into Breeding. Experiences with Participatory Plant Breeding and Challenges for Institutionalization", *AgroSpecial* 5.
Available at: http://documents.plant.wur.nl/cgn/literature/reports/BringingFarmersBackIntoBreeding_2006.pdf (accessed 13 October 2011).

Bioversity International and the Rural Development Administration of Korea. 2009. *A Training Module for the International Course on Plant Genetic Resources and Genebank Management*.
Available at: http://cropgenebank.sgrp.cgiar.org/index.php?option=com_content&view=article&id=389&Itemid=556&lang=english (accessed 5 October 2011).

Centre for Indian Knowledge Systems (CIKS). 2011. *The CIKS Seed Bank Project*.
Available at: http://www.ciks.org/seedbanks.htm (accessed 5 October 2011).

Cooper, H.D., Spillane, C., and Hodgkin, T. 2001. *Broadening the Genetic Base of Crop Production*.
See: http://www.cabi.org/cabebooks/FullTextPDF/2001/20013016603.pdf (accessed 5 October 2011).

Costa Rican Biodiversity Law. 1998.
Available at: http://eelink.net/~asilwildlife/costa.pdf (accessed 5 October 2011).

International Plant Genetic Resources Institute (IPGRI). 2003. "A Guide to Effective Management of Germplasm Collection", *IPGRI Handbooks for Genebanks* No. 6.
Available at: http://cropgenebank.sgrp.cgiar.org/images/file/learning_space/genebankmanual6.pdf (accessed 5 October 2011).

Ethiopian Proclamation on Access to Genetic Resources and Community Knowledge, and Community Rights. 2006.
Available at: http://www.wipo.int/wipolex/en/text.jsp?file_id=179080 (accessed 5 October 2011).

European Directive on the Legal Protection of Biotechnological Inventions. 1998.
Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31998L0044:EN:NOT (accessed 7 October 2011).

FAO. 2004. *A Summary and Analysis of Existing International Plant Genetic Resources Networks*. Background Study Paper No.16 of the Commission on Genetic Resources for Food and Agriculture.
Available at: http://www.planttreaty.org/content/summary-and-analysis-existing-international-plant-genetic-resources-networks (accessed 22 September 2011).

FAO. 2004. *An Analysis of Effectiveness in Plant Genetic Resources Networks*. Background Study Paper No. 23 of the Commission on Genetic Resources for Food and Agriculture.
Available at: http://www.planttreaty.org/content/analysis-effectiveness-plant-genetic-resources-networks (accessed 22 September 2011).

FAO. 2011. *Pre-breeding for Effective Use of Plant Genetic Resources – E-learning Course.*
Available at: http://km.fao.org/gipb/ (accessed 6 October 2011).

Farmers' Rights Project. 2006. *Community Seed Fairs in Zimbabwe*.
Available at:
http://www.farmersrights.org/bestpractices/success_benefit-sharing_2.html (accessed 5 October 2011).

Farm Radio International. 1994. *Starting a Community Seed Bank: Part 1 – A Good Idea?*.
Available at: http://www.farmradio.org/english/radio-scripts/33-3script_en.asp (accessed 5 October 2011).

Farm Radio International. 1994. *Starting a Community Seed Bank: Part 2 – Organizing Workers, Collecting Seed*.
Available at: http://www.farmradio.org/english/radio-scripts/33-4script_en.asp (accessed 5 October 2011).

Farm Radio International. 1994. *Starting a Community Seed Bank: Part 3 – Keeping Records, Storing Seeds*.
Available at: http://www.farmradio.org/english/radio-scripts/33-5script_en.asp (accessed 5 October 2011).

Hajjar, R., and Hodgkin, T. 2007. "The Use of Wild Relatives in Crop Improvement: a Survey of Developments over the Last 20 years", *Euphytica* 156. pp. 1-13.
Available at: http://www.springerlink.com/content/p122468633546675/fulltext.pdf (accessed 5 October 2011).

Halewood, M., *et al*. 2007. *Participatory Plant Breeding to Promote Farmers' Rights.*
Available at: http://www.bioversityinternational.org/fileadmin/bioversity/publications/pdfs/1254.pdf?cache=1320746395 (accessed 8 November 2011).

ICARDA. 2006. *Assessing the Benefits and Costs of Participatory and Conventional Barley Breeding Programs in Syria.*
Available at: http://www.icarda.org/Participatory_Research/PDF/Cost-Benefit-of-PPB.pdf (accessed 6 October 2011).

Indian Biological Diversity Act. 2002.
Available at: http://www.nbaindia.org/act/pdf/Biological_Diversity_Act_2002.pdf (accessed 5 October 2011).

International Development Research Centre (IDRC). 2003. *Bridging the Gap Between Scientists and Farmers in China*.
Available at: http://idl-bnc.idrc.ca/dspace/bitstream/10625/29650/1/119259_e.pdf (accessed 5 October 2011).

International Treaty on Plant Genetic Resources for Food and Agriculture. 2001.
Available at: ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf (accessed 7 October 2011).

Kalloo, G., and Chowdhury, J.B. 1992. "Distant Hybridization of Crop Plants", *Experimental Agriculture* 30, no. 1.
See: http://journals.cambridge.org/action/displayAbstract;jsessionid=AE77C6221705656DA9ED1F350FC9EB79.journals?fromPage=online&aid=1608232 (accessed 13 October 2011).

Louwaars, N. P. 2005. "Biases and Bottlenecks – Time to Reform the South's Inherited Seed Laws?", *Seedling*.
Available at: http://www.grain.org/seedling_files/seed-05-07-2.pdf (accessed 5 October 2011).

Oniang'o, R. K., Mutuku, J. M., and Malaba S. J. 2003. "Contemporary African food habits and their nutritional and health implications", *Asia Pacific Journal of Clinical Nutrition* 12, no. 3.
Available at: http://apjcn.nhri.org.tw/server/APJCN/volume12/vol12.3/fullArticles/Oniango.pdf (accessed on 5 October 2011).

Organization of African Unity (OAU). 2000. *African Model Law for the Protection of the Rights of Local Communities, Farmers and Breeders, and for the Regulation of Access to Biological Resources.*
Available at: http://www.africa-union.org/root/au/auc/departments/hrst/biosafety/DOC/doc1/AML%20ON%20COMM%20RTSLAW-Eng-Communities%20Rights-Access.doc (accessed 10 October 2011).

Peruvian Law on the Conservation and Sustainable Use of Biodiversity. 1997.
Available (in Spanish) at: http://www.wipo.int/wipolex/en/text.jsp?file_id=184339 (accessed 5 October 2011).

Practical Action. 2009. *Seed Fairs – Technical* Brief.
Available at: http://practicalaction.org/practicalanswers/product_info.php?cPath=24_80&products_id=61&attrib=1 (accessed 5 October 2011).

Ronnie, V. 2003. *Seeds that Give – Participatory Plant Breeding*.
Available at: http://www.idrc.ca/openebooks/014-4/ (accessed 22 September 2011).

SEARICE. 2008. *Revisiting the Streams of Participatory Plant Breeding.*
Available at: http://www.searice.org.ph/images/stories/pdf_files/Revisiting_the_streams_of_PPB.pdf (accessed 13 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2007. *Compilation and Analysis of Submissions by Contracting Parties and Other Relevant Organizations Concerning the Implementation of Article 6*. Working Document 13, Second Session of the Governing Body.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb2/gb2w15e.pdf (accessed 5 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2007. *Information Document on Activities Related to the Supporting Components of the Treaty*. Information Document 15, Second Session of the Governing Body.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb2/gb2i7e.pdf (accessed 5 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2007. *Information Received from Relevant Organizations Concerning the Implementation of Article 6 - Contribution from the System-Wide Genetic Resources Programme (SGRP) on Behalf of the International Agricultural Research Centres of the Consultative Group on International Agricultural Research (CGIAR)*. Information Document, Second Session of the Governing Body.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb2/gb2i8e.pdf (accessed 5 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2007. *Information Received from Relevant Organizations Concerning the Implementation of Article 6 - Contribution from FAO*. Information Document, Second Session of the Governing Body.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb2/gb2i8e1.pdf (accessed 5 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2009. *Implementation of Article 6*. Working Document, Third Session of the Governing Gody.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb3/gb3w16e.pdf (accessed 5 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2009. *Compilation of Submissions Sent by Contracting Parties, Other Governments, and Relevant Institutions and Organizations on the Implementation of Article 6*. Information Document, Third Session of the Governing Body.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb3/gb3i05e.pdf (accessed 5 October 2011).

Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture. 2009. *Compilation of Submissions Sent by Contracting Parties, Other Governments, and Relevant Institutions and Organizations on the Implementation of Article 6 – Addendum 1*. Information Document, Third Session of the Governing Body.
Available at: ftp://ftp.fao.org/ag/agp/planttreaty/gb3/gb3i05a1e.pdf (accessed 5 October 2011).

Smolders, H., 2006. *Enhancing Farmers' Role in Crop Development - Framework Information for Participatory Plant Breeding in Farmer Field Schools*.
Available at: http://documents.plant.wur.nl/cgn/literature/reports/EnhancingFarmersRoleinCropDevelopment.pdf (accessed 5 October 2011).

Van den Berg, Henk. 2004. *IPM Farmer Field Schools – A Synthesis of 25 Impact Evaluations.*
Available at: http://www.fao.org/docrep/006/ad487e/ad487e00.htm (accessed 10 October 2011).