Food and Agriculture Organization of the United Nations

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Voluntary Guidelines for the Conservation and Sustainable Use of Farmers' Varieties/Landraces

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Contents

Foreword

To attain the goals of the 2030 Agenda for Sustainable Development, our global food system and nutrition, currently threatened by climate change and other drivers, must become resilient to shocks. The more diverse a crop production system is, including within and among species, the more unlikely that it would be affected uniformly by biotic and abiotic stresses. For our food systems to be sustainable, farmers must, therefore, grow the most genetically diverse set of crops and varieties that are suited to their agroecologies, production systems and end-users' preferences.

However, on the contrary, our food systems are now characterized by the ever-increasing uniformity of crops and varieties on-farm, whereby a narrow set of a few modern varieties are cultivated – with the concomitant steady decrease in the cultivation of farmers' varieties and landraces that are typically genetically diverse and adapted to the local farmers' agroecosystems. Yet, it stands to reason that cropping systems, which include a significant proportion of farmers' varieties and landraces, would be more resilient than those underpinned by monocrops. It is worrisome, in fact, that humans rely on only three crops (maize, wheat and rice) for 51 percent of our plant-based food. This is more so as plants account for more than 80 percent of the human diet, implying that the continuing reduction in crop diversity poses a particularly severe threat to global food security and nutrition, potentially undermining our efforts to attain the goal of eradicating hunger and malnutrition by 2030.

The *Voluntary Guidelines for the Conservation and Sustainable Use of Farmers' Varieties/Landraces,* developed under the auspices of FAO's Commission on Genetic Resources for Food and Agriculture, provides guidance that national governments may use for conserving and sustainably using farmers' varieties and landraces.

I recommend these guidelines for use by governments to develop their *National Plan for the Conservation and Sustainable Use of Farmers' Varieties/Landraces*. Development practitioners, researchers, students and policy-makers that are interested in these themes will also find the guidelines and the well-researched reference resources extremely useful.

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Acronyms and abbreviations

CBD	Convention on Biological Diversity
Commission	FAO Commission on Genetic Resources for Food and Agriculture
ELC	Ecogeographical land characterization
FAO	Food and Agriculture Organization of the United Nations
FIGS	Focused Identification of Germplasm Strategy
GIS	Geographical Information System
GPA	Global Plan of Action [Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture]
GSPC	Global Strategy for Plant Conservation
IUCN	International Union for Conservation of Nature
National Plan	National Plan for the Conservation and Sustainable Use of Farmer Varieties/Landraces
NGO	Non-governmental organization
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
Treaty	International Treaty on Plant Genetic Resources for Food and Agriculture

Executive summary

Farmers' varieties/landraces are often genetically and phenotypically heterogeneous, are adapted to the environmental conditions of the areas of their cultivation, suited to the production systems and local culinary preferences and are generally associated with traditional farming systems. Many adaptive traits of farmers' varieties/landraces have arisen through repeated grower selection. They are recognized with local names and are closely associated with the traditional uses, knowledge, habits, dialects and celebrations of the people who grow them. Enhanced within-species diversity of crops, usually found in farmers' varieties/landraces, confers resilience on crop production and reduces vulnerability to shocks. This local crop diversity is therefore particularly relevant in the context of food security, rural development and resilience of farming communities.

A significant amount of this crop diversity is only maintained in farmer's fields, orchards or home gardens. Farmers' varieties/landraces may grow mixed with other farmers' varieties/landraces and/or in proximity to close wild relatives, with which gene exchange can occur. Local communities share and exchange farmers' varieties/landraces. The dynamism and continuing adaptation of these genetic resources, grown on farms worldwide, mean that they are constantly adapting to environmental and management changes. As such, farmers' varieties/landraces are potential sources of traits for crop improvement, especially for developing varieties tolerant to biotic and abiotic stresses.

Vast numbers of farmers' varieties/landraces have been replaced by modern cultivars in recent decades. As these are replaced, the genetic diversity that farmers' varieties/landraces contain can be lost if not properly conserved on-farm or/and *ex situ*. Consequently, the total number of different varieties grown is reduced and/or

those grown by farmers become increasingly genetically similar to each other, making the farming systems less resilient and therefore more vulnerable to abiotic and biotic stresses. The Food and Agriculture Organization of the United Nations, under the guidance of its Commission on Genetic Resources for Food and Agriculture, therefore prepared the *Voluntary Guidelines for the Conservation and Sustainable Use of Farmers' Varieties/Landraces* (Guidelines). These guidelines, intended as reference materials for preparing a National Plan for the Conservation and Sustainable Use of Farmers' Varieties/Landraces, will contribute to addressing this continuing loss in diversity. The guidelines are therefore a useful tool for development practitioners, researchers, students and policy-makers who work on the conservation and sustainable use of these valuable resources.

The Guidelines are organized into nine chapters. The first two chapters provide context and deal with the requisites, i.e. what needs to be in place for developing a national plan. Chapter I, **Introduction**, describes the importance of these unique plant genetic resources, the threats that they face and the relevant global policy instruments. These serve as the backdrop against which the case is made for countries to develop viable national plans. Chapter II, **Stakeholders and Timeline,** underscores the importance of a coordinating mechanism and identifies the important constituencies both for the development of the plan and, as importantly, its implementation.

Chapter III, **Understanding the Country Context,** assists in the generation of the evidence base that will underpin the national plan. It provides guidance on benchmarking the relevant prevailing policy and legal systems as well as the status of the conservation and sustainable use of these resources in the country. The fourth chapter, **Strengthening the Farmer's Variety/Landrace Knowledge Base,** describes the technical activities that are recommended for inclusion in a national plan and the methodology for preparing a checklist, an inventory, and ecogeographical and genetic databases.

Chapter V, **Establishing Conservation Priorities,** describes the technical activities recommended for determining the targets of a national plan, which include the assessments of threats and the gaps in conservation. The elaboration of the conservation priorities help formulate the strategic actions of the National Plan. Chapter VI, **Preparing the National Plan**, provides guidance on developing each of the necessary elements of the plan based on clearly defined goals and objectives. Under Chapter VII, **Implementation**, the guidelines detail how to execute the activities identified, including linkages with *ex situ* conservation efforts and the promotion of their enhanced sustainable use. Chapter VIII contains information on **Monitoring Farmer's Variety/Landrace Diversity and Reporting**. It provides the

basis and methodologies for both the monitoring of the targeted diversity of farmers' varieties/landraces and the management of the ensuing data. An overview of the relevant international commitments is also presented, the implementation of which is enhanced by having a national plan.

As there may be needs for customized training programmes to suit particular local circumstances and address identified needs, Chapter IX, **Capacity Building**, provides an inventory of relevant learning tools. The Annexes to the chapter list important resources for Farmers' Varieties/Landraces.

1. INTRODUCTION

Maize landrace, Rwanda
©FAO/L. Borgen Nilsen

Genetic diversity represents a critical resource to achieve and maintain global food security. Plant genetic resources for food and agriculture (PGRFA) comprise modern cultivars, breeding lines, genetic stocks, obsolete cultivars, ecotypes, farmers' varieties/landraces, weedy races, as well as crop wild relatives and wild harvested species. With a genetic reservoir of alternative traits and characteristics, these resources enable diversification of crops, foods and farming methods, and provide genes for targeted plant breeding.

Cropping systems throughout the world rely on PGRFA and thus substantially contribute to the conservation and sustainable use of global crop diversity. In fact, farmers,[1] especially the small-scale ones, continue to cultivate the diverse array of well-adapted farmers' varieties/landraces on account of preferred agronomic, culinary, quality or even locally important cultural values. The dynamic management of farmers' varieties/landraces, including their exposure to different production regimes, environments, farmers' selection and seed exchange systems, maintains a reservoir of continuously evolving genetic variability. Unfortunately, this plant diversity is threatened by urban encroachment on farmland, unsustainable use of natural resources, the promotion of genetically uniform varieties in replacement of local varieties, introduction of alien invasive species, changing pattern of human consumption, absence of or inappropriate legislation and policy, and climate and other environmental changes.

These important resources therefore represent a source of food/feed and income and constitute a potential source of basic genetic material for adapting crops to changing environmental conditions, and for improving crop productivity and quality. Maximizing genetic diversity within crop production systems is a way to reduce risks resulting from changing biotic and abiotic stresses. However, the crop diversity found in farmers' fields are inadequately documented, valued and studied, and only partially conserved in genebanks. In addition, few farmers and local communities receive information and support in relation to the conservation and sustainable use of these genetic resources in their fields.

To prevent losses and maximize the availability of a wide range of plant genetic resources for the future, a more systematic approach to conservation and sustainable use of PGRFA on-farm is needed at both the country and local levels. This need has been recognized by international organizations and instruments, including the Convention on Biological Diversity (CBD),[2] the Food and Agriculture

1 For the purpose of this document, the term farmers includes home gardeners, fruit producers and other maintainers of PGRFA on-farm.

2 http://www.cbd.int/convention/text/

Organization of the United Nations (FAO)[3] and its International Treaty on Plant Genetic Resources for Food and Agriculture (Treaty)[4] and the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA).[5] The CBD, the Treaty and the Second GPA each underline the commitment of governments to ensuring that the conservation and sustainable use of plant genetic resources continue to be key elements in the efforts to alleviate poverty, increase food security and provide a genetic diversity safety net for the future of agriculture. They also highlight the need to develop and implement national strategies and action plans to enhance the conservation and sustainable use of PGRFA.

These voluntary guidelines, adapted from the *Resource Book for the Preparation of National Plans for Conservation of Crop Wild Relatives and Landraces* (Maxted *et al*., 2013), were prepared at the request of FAO's Commission on Genetic Resources for Food and Agriculture (Commission).[6] The guidelines outline the process for preparing a National Plan for Conservation and Sustainable Use of Farmers' Varieties/Landraces (National Plan), with the aim to support national authorities in developing a systematic approach to the management of these genetic resources. A series of decisions and actions that could be helpful to follow in developing such a plan are outlined. Through a step-by-step approach, these guidelines focus on the common elements that could ensure a systematic, national approach to conservation and sustainable use of farmers' varieties/landraces. Aspects of these processes were validated in the course of the implementation of the project, entitled "Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding" (PGR Secure).[7]

However, it must be noted that the goals and strategic actions a country wishes to take will naturally depend on the national context, including the availability of baseline data, the existing policy framework, the remit of the agencies responsible for formulating and implementing such a plan, the perspectives of famers and local communities, as well as the human and financial resources available for its implementation.

3 http://www.fao.org/home/en/

4 http://www.planttreaty.org/content/texts-treaty-official-versions

5 http://www.fao.org/docrep/015/i2624e/i2624e00.htm

6 http://www.fao.org/nr/cgrfa/cgrfa-home/en/

7 http://www.pgrsecure.org/helpdesk_lr

Farmers' varieties/landraces

The role of farmer's variety/landrace diversity for sustainable agriculture, food security and economic development

Population growth, changing and extreme weather patterns and their direct and indirect effects, along with other drivers of food insecurity, are increasingly threatening PGRFA and challenging the production of more food sustainably with fewer inputs. In such a scenario, it is imperative to conserve PGRFA more broadly than in the past.

A significant amount of local crop diversity is only maintained in farmer's fields, orchards or home gardens. This diversity is adapted to specific ecosystems, climatic conditions and farming practices. Farmer's variety/landrace diversity constitutes the livelihood for millions of farmers throughout the world. Local crop diversity is therefore particularly relevant in the context of food security, rural development and resilience of farming communities. There is inadequate information available on the diversity, number and status of farmers' varieties/landraces on-farm; their use in crop improvement is also limited (FAO, 2010).

Farmers' varieties/landraces are often genetically and phenotypically heterogeneous and adapted to the environmental conditions of the area of cultivation and are associated with traditional farming systems. They often have not undergone "formal" crop improvement, are recognized with local names and are closely associated with the traditional uses, knowledge, habits, dialects and celebrations of the people who developed and continue to grow them. Farmers' varieties/landraces have often developed their characteristics through adaptation to local agro-environments and repeated *in situ* grower selection in traditional farming systems. Farmers' varieties/landraces may grow mixed with other farmers' varieties/landraces and/or in proximity to close wild relatives, with which gene exchange can occur. Local communities experiment with, share and exchange farmers' varieties/landraces. The dynamism and continuing evolution of these genetic resources, grown on farms worldwide, mean that they are constantly adapting to environmental and management changes.

The importance of farmers' varieties/landraces for increased production and sustainable agriculture is two-fold: on the one hand, different crops and varieties, and the use of heterogeneous varieties in farming systems, can be adopted as a mechanism to reduce risk and increase overall production stability and resilience; on the other hand farmers' varieties/landraces constitute a potential source of basic genetic material for developing better adapted varieties. Furthermore, farmers' variety/landrace production associated with niche marketing may increasingly

be a means of sustaining traditional farming systems within otherwise intensive production systems.

Farmers' varieties/landraces have multiple roles to play in ensuring food security, as a source of food and livelihoods, and by providing farmers with more options that can enhance their income generation and development. At the crop level, farmers can diversify with respect to the crops and varieties they grow and at the farm level, farmers' varieties/landraces can be incorporated into a diversity of enterprises, such as food processing, agroforestry or agritourism. Diversification across activities is also an important risk management strategy.

The causes and consequences of farmer's variety/landrace erosion

Vast numbers of farmers' varieties/landraces have been replaced by modern cultivars in recent decades. When farmers' varieties/landraces are replaced by modern cultivars, the unique combination of genetic diversity farmers' varieties/landraces contain can be lost, if not properly conserved *ex situ* or on-farm. As a consequence, the total number of different varieties grown is reduced and/or cultivars grown by farmers become increasingly genetically similar to each other, making the farming systems less resilient and therefore more vulnerable to abiotic and biotic stresses. Not all farmers' varieties/landraces are conserved systematically for all crop species, e.g. in an *ex situ* genebank collection. Therefore the genetic diversity and unique traits they contain might be permanently lost. The main factors contributing to the genetic erosion of farmers' varieties/landraces are:

- changes in agricultural practices and land use, including mechanization, use of pesticides, herbicides and irrigation – all of which favour the replacement of farmers' varieties/landraces with modern varieties;
- changes in consumption habits, favouring introduced crops and varieties;
- subsidies, incentives, national registration and certification systems that promote the use of uniform, and possibly higher yielding, cultivars, e.g. seed and certification systems that limit the sale of crop seeds unless the variety is included in the national or regional varietal list, or free distribution of seeds of modern cultivars;
- food standards that limit entry of landrace varieties and their products into markets;
- rural depopulation, migration to urban centres and consequent loss of traditional knowledge of farmers' varieties/landraces and farming systems due to ageing of farmers;

- lack of awareness and recognition of the value of plant genetic resources as a local, national and global resource, and limited research on the useful traits of farmers' varieties/landraces;
- war, civil unrest, political instability and natural disasters and the provision of non-indigenous replacement planting materials; and
- changes in climate and weather patterns, directly affecting the crops and cropping patterns, particularly in marginal environments where farmers' varieties/landraces are often grown near their cultivation limits.

The loss of farmers' varieties/ landrace diversity can also be seen as a form of 'local cultural erosion'. This relates to the fact that the loss of particular farmers' varieties/ landraces may lead to the loss of specific cultural activities which are linked to them, their use and related traditions.

Conservation and sustainable use of farmers' varieties/landraces

The genetic diversity of farmers' varieties/landraces is conserved and used directly by the farmers maintaining them. This diversity also has potential for use by plant breeders or other users. The majority of efforts to counter genetic erosion have concentrated on conservation of PGRFA in genebanks (*ex situ*), and considerable progress has been made in this area. In fact, genebanks play a central role in the conservation of farmers' varieties/landraces. Many landraces would have been lost forever if not preserved in genebanks and many have been re-introduced to on-farm activities from genebanks. Therefore, national genebanks are an essential complement to on-farm management of PGRFA for a country and their activities are an essential part of a national strategy (FAO, 2015).

However, despite the improved systematic conservation of PGRFA in *ex situ* genebanks, there are still large gaps in the collections. It is unlikely that *ex situ* conservation will ever be sufficiently comprehensive to conserve the full range of genetic diversity of all plant populations relevant to food and agriculture. Genebank collections are also vulnerable to loss and damage due to civil strife, mismanagement, inadequate funding and natural disasters.

Farmers' varieties/landraces that are actively managed on-farm (including orchards and home gardens) are serving as a repository of this diversity; a proportion of them are backed-up within *ex situ* collections worldwide. Agrobiodiversity conservation strategies combine *in situ* conservation, on-farm management and *ex situ* conservation practices. On-farm management of farmers' varieties/landraces is defined as all practices for the conservation and sustainable use of these genetic resources within the agricultural systems in which they have evolved.

Central to the concept of on-farm management of farmers' varieties/landraces is the continuing use of these resources by farmers, often resource poor with limited livelihood options, as well as connecting all stakeholders such as amateur gardeners, gardener networks, seed companies, breeders, indigenous peoples and local communities, community seed banks, seed associations and genebanks. Farmers keep farmers' varieties/landraces in their fields for a variety of reasons, such as culture, food preference, risk avoidance, local adaptation, and niche market opportunities. This contributes to farmers having a wider range of options for livelihood diversification and enhances farmers' capacity to adapt to change. In some cases, however, farmers continue to grow farmers' varieties/landraces because they lack alternatives.

A fundamental principle for successful on-farm management is that it be beneficial both to the farmers and to their communities. Support for on-farm management presents a particular challenge in that it may be in conflict with the development aspirations of the local community. For example, a local community may choose to switch to alternative crops or improved varieties that may be better suited to meet their immediate needs. Support for agrobiodiversity conservation and on-farm management of farmers' varieties/landraces should never restrict or deny these aspirations, but should be able to help farmers develop alternative niche markets for specific crops and varieties, raising the value of the resource and so sustaining their conservation and sustainable use. Breeding programmes should also consider the improvement of farmers' varieties.

A. Global policies for plant genetic resources for food and agriculture

Major policy developments have taken place in recent decades to promote and regulate the conservation, use and exchange of PGRFA. The most important ones include:

- In 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development – including 17 Sustainable Development Goals (SDGs)[8] and 169 targets. The Agenda commits the international community to end poverty and hunger and achieve sustainable development in all three dimensions (social, economic and environmental). **Target 2.5**[9] of the **Sustainable Development Goal 2**[10] highlights the importance of conserving plant varieties at risk of extinction, and supports the development and updating of strategies for the conservation and sustainable use and development of those genetic resources. It refers to the importance of genetic diversity for agricultural productivity as it improves adaptation to diverse production systems, changing climates and new pests and diseases.

- **The Second GPA** was agreed by the Commission and adopted by the FAO Council, on behalf of the Conference, in 2011. Based on the findings of the *Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture* (FAO, 2010), the Second GPA contains an agreed set of priority activities that directly address the new developments, opportunities and challenges facing plant conservation and sustainable use in the 21st century. It includes 18 priority activities guiding action and progress at the community, national, regional and international levels. The Second GPA is a supporting component to the Treaty. Throughout the Second GPA, there are specific references to farmers' varieties/landraces, highlighting: the need to strengthen their improvement and management on-farm; enhance their documentation and conservation *ex situ*; create a better understanding of their value and potential use in breeding programmes; assess genetic erosion and threats; promote their development and commercialization; and develop management strategies in relation to these activities.

- **The Treaty** was adopted by the FAO Conference in 2001 and entered into force in 2004. The Treaty is a legally binding agreement on the conservation and sustainable use of PGRFA and the fair and equitable sharing of the benefits arising from their use, in harmony with the CBD. The Treaty makes specific

8 http://www.fao.org/sustainable-development-goals/en/

9 By 2020 maintain genetic diversity of seeds, cultivated plants, farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at national, regional and international levels, and ensure access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge as internationally agreed.

10 Sustainable Development Goal 02. End hunger, achieve food security and improved nutrition and promote sustainable agriculture. https://sustainabledevelopment.un.org/sdg2

reference to the management of farmers' varieties/landraces and calls for an integrated approach to the exploration, conservation and sustainable use of PGRFA. In Article 5 (conservation), the Treaty refers to survey and inventory of PGRFA and to the promotion or support, as appropriate, of efforts by farmers and local communities to manage and conserve on-farm their PGRFA. Many of the measures listed in Article 6 (sustainable use) are also supportive of expanding the use of PGRFA to meet the needs of farmers and to broaden the genetic base of crops, which entails, *inter alia*, a wider use of farmers' varieties/landraces. The Treaty recognizes the enormous contribution that the local and indigenous communities and farmers of all regions of the world, particularly those in the centres of origin and crop diversity, will continue to make for the conservation and use of PGRFA. Article 9 of the Treaty focuses on Farmers' Rights, which recognizes the significant contribution of local and indigenous communities and farmers to conservation and use of local crop diversity. The responsibility of realizing such rights rests with national governments.

The Treaty's **Multilateral System of Access and Benefit-sharing** (Multilateral System) is also relevant to promote the management of farmers' varieties/landraces at national level. For many crops, landraces are amongst the PGRFA most conserved in genebanks and made available through the Multilateral System and the Treaty contains specific provisions to provide facilitated access to these PGRFA. The development and implementation of a National Plan for the conservation and sustainable use of farmers' varieties/landraces provides a possible pathway for Contracting Parties of the Treaty to support the implementation of several articles at the national level. The Treaty mechanisms, such as the Funding Strategy and the Multilateral System, can be used by countries to support the implementation of such a National Plan.

- **The CBD** was established in 1992 as a global and legally-binding framework on biodiversity conservation, sustainable use and benefit sharing. In 2010, the CBD adopted a revised and updated Strategic Plan for Biodiversity for the 2011-2020 period, including 20 targets, known as the Aichi Biodiversity Targets.[11] Several of the Aichi Targets are relevant to crop diversity, in particular Targets 1, 7 and 13.[12] In 2010, the Conference of the Parties to the CBD also adopted the Nagoya

11 http://www.cbd.int/sp/targets

12 Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use.
Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.
Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity,[13] a legal framework for the implementation of the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. In 2011, the CBD also adopted the 16 updated targets of the Global Strategy for Plant Conservation (GSPC) 2011-2020,[14] where Target 9 refers specifically to the conservation and management of crop diversity.[15] The CBD requires that each Contracting Party "shall develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity", explicitly including its agrobiodiversity.

B. The rationale for a National Plan for the Conservation and Sustainable Use of Farmers' Varieties/Landraces

- Agrobiodiversity strategies and specifically the management of farmers' varieties/landraces take different forms in different countries, depending on the diversity present, traditions, farmers and farming communities, policies, incentives and support provided from the Government and other organizations. The increased attention and interest in PGRFA has not yet led to a clear global strategy for how crop diversity should be conserved and sustainably used on-farm, and many countries lack strong national programmes in this area. Some of the key elements governing the conservation and sustainable use of farmers' varieties/landraces in a country are the relevant policy and legal framework, along with strategic plans agreed upon by stakeholders. A system is required to: (a) assess the genetic diversity that exists in farmers' varieties/landraces using botanical/genetic methods to have a baseline for conservation and decisions making; (b) demonstrate the benefits of local PGRFA retention; (c) promote retention by providing policy incentives that support farming communities and farm-related institutions to sustain their PGRFA; and (d) identify and address any existing policies that might hinder the conservation and sustainable use of these resources. National and local understanding of the issues related to conservation of PGFRA and policy development, including development of tools, guidelines and capacity development for policy-makers are therefore a priority, including recognition of Farmers' Rights, as appropriate. On this basis it is necessary to explore how national authorities can support the conservation and sustainable use of farmers' varieties/landraces, and the farmers and their communities that grow farmers' varieties/landraces:

13 http://www.cbd.int/abs/

14 http://www.cbd.int/gspc/

15 70 percent of the genetic diversity of crops including their wild relatives and other socio-economically valuable plant species conserved, while respecting, preserving and maintaining associated indigenous and local knowledge.

- A National Plan is a tool to increase the collaboration and coordination among stakeholders at the national level, allowing the implementation of better planned activities and programmes. With a National Plan, activities and interventions related to the conservation and sustainable use of farmers' varieties/landraces could be conducted in a more systematic manner, with a strategy to guide stakeholders in their actions. More concerted interventions in these areas would allow gaps and challenges to be addressed more systematically and with greater efficiency.
- A National Plan could stimulate the creation of partnerships and stronger linkages, both among stakeholders and among sectors, which is a requisite for finding more appropriate ways of managing crop diversity.
- A National Plan will be an important step in ensuring complementarity between various conservation approaches (e.g. *ex situ* conservation and on-farm management), and increase the synergies between conservation and sustainable use.
- A National Plan may also lead to a review of existing national policies and legal instruments with a view to strengthen the conservation and sustainable use of farmers' varieties/landraces.
- The development of a National Plan is a clear message from the authorities regarding the importance and priority of conservation and sustainable use of farmers' varieties/landraces at the national level. It will also be a catalyst for attracting greater funding and support to these areas of endeavour.

C. The purpose of these voluntary guidelines

These voluntary Guidelines are specifically aimed to serve as a reference for national authorities developing and strengthening the conservation and sustainable use of farmers' varieties/landraces. They are primarily intended for staff associated with national PGRFA programmes, but may also be of use for universities and research organizations, non-governmental organizations (NGOs), farmers and/or farmers' organizations and other partnering institutions of national authorities. The guidelines consist of a simple set of steps and methods to guide the formulation of a National Plan. To promote systematic, coordinated and integrated *ex situ* conservation and on-farm management of farmers' varieties/landraces, the guidelines consist of a simple set of steps and methods to guide the formulation of a National Plan for Conservation and Sustainable Use of Farmers' Varieties/Landraces. The following chapters are included in the guidelines:

- **Stakeholders and timeline.** The starting point for developing the National Plan will be the appointment of a National Focal Point or Coordinator to guide the process. Early on Stakeholders that can support the process of developing the National Plan will need to be identified early in the initial stages and contacted; the list of stakeholders will increase as more information is gathered. To ensure the process of developing the National Plan has the necessary momentum to be completed and implemented, an agreed time frame will be needed.
- **Understanding the country context.** To formulate any strategic plan, it is necessary to analyse the country's policy context and the status of local crop diversity conservation and sustainable use. This will provide the basis for the priority issues to be addressed and guide the formulation process of the National Plan.
- **Strengthening the farmer's variety/landrace knowledge base.** For a National Plan to be effective, it must be based on relevant, reliable and up-to-date information and data on occurrence and management of farmers' varieties/landraces in the country. To support strengthening the knowledge base in the country, this chapter describes the methodology for preparing a checklist, an inventory and ecogeographical and genetic databases.
- **Establishing conservation priorities.** The establishment of conservation priorities will involve assessments of threats and conservation gaps. The elaboration of the conservation priorities will in turn help formulate the strategic actions of the National Plan.
- **Preparing a National Plan.** A National Plan is a document that describes what the country wants to do to ensure appropriate handling of farmers' varieties/

landraces, and how this should be accomplished. The National Plan can be structured in a variety of ways, but should include certain common elements, such as clearly defined goals and objectives, strategic actions to achieve the objectives and a timeline, management responsibilities and monitoring system for the implementation of the National Plan.

- **Implementing strategic actions.** Implementing a National Plan requires taking actions towards accomplishing set objectives. The actions taken should as much as possible follow the outline of the National Plan. The three main areas of focus are: (1) promoting and establishing on-farm management of local crops and varieties; (2) formulating and implementing a collecting programme for complementary *ex situ* conservation, characterization and diversity assessments of farmers' varieties/landraces involving genebanks (FAO, 2014); and (3) promoting sustainable use of local crops and varieties.
- **Monitoring farmer's variety/landrace diversity.** Monitoring crop diversity requires the systematic collection of data over time to detect changes, determine the direction of those changes and measure their magnitude. The monitoring of local crops and varieties in farmer's fields aims at providing data for modelling trends in agriculture, crops and farming systems. Based on the monitoring data, changes in management plans can be introduced as appropriate, including new goals and objectives and alternatives for achieving them.

2. STAKEHOLDERS AND TIMELINE

Local species diversity, Bolivia
©Bioversity International/S. Padulosi

Stakeholders

Once it has been decided that a National Plan is required, a National Focal Point or Coordinator to develop and implement the National Plan should be appointed. Most of the stakeholders that are likely to be involved directly or indirectly with farmers' varieties/landraces will have some relationship with the Ministry of Agriculture; therefore the National Focal Point would most likely be appointed by the Ministry of Agriculture. Once appointed, the National Focal Point will need to assemble a supporting team. The support team will provide back-up in arranging meetings, correspondence, logistics and database development.

The National Focal Point and support team will need to identify the relevant stakeholders across the country that are necessary to help in the development and implementation of the National Plan. Particular attention should be paid to involving farmers, farming communities and other stakeholders, as the conservation and sustainable use of farmers' varieties/landraces requires their knowledge and affects their livelihoods. This implies that mechanisms are developed, through which farmers can be active participants in the development and implementation of the national plans. These could include resource mobilization for capacity building and for active engagement of farmers and other stakeholders in participatory monitoring and evaluation, and mechanisms for community validation of the national inventory of farmers' varieties/landraces and conservation priorities.

How useful a National Plan is depends on the preparatory steps that lead to its formulation, the provisions made for its implementation and the commitment of stakeholders. In this context, a stakeholder refers to an organization, network or individual that is actively involved in a specific project, process or sector relevant to the conservation and sustainable use of farmers' varieties/landraces, and whose interests may be affected positively or negatively by the development of the National Plan. In order to ensure appropriate stakeholder involvement and inter-sectoral collaboration, the formulation process needs to be conducted in a participatory manner, where all relevant stakeholders are consulted and involved. The stakeholders may include:

- government, including ministries and authorities relevant to the agriculture sectors, and agricultural extension workers;
- farmers, farmers' groups and organizations, indigenous peoples and local communities;
- local authorities;

- national or international research institutions, including genebank curators, plant taxonomists and plant breeders;
- universities and other educational institutions;
- civil society organizations, such as farmer- or community-based organizations;
- NGOs, such as professional development and conservation organizations;
- private sector;
- regional and international organizations, research centres and networks;[16] and
- UN agencies and bilateral technical cooperation or funding agencies, especially those involved in PGRFA conservation, use and management.

It is recommended to arrange a stakeholders' meeting, involving all stakeholders with knowledge or interest in farmers' varieties/landrace conservation and sustainable use, at an early stage in developing the National Plan. The aim of this meeting will be to inform participants about, and discuss the preparation of, the National Plan, sharing knowledge and strengthening the existing network, as well as to consider the priorities and suggestions from the stakeholders, particularly those of farmers and indigenous peoples and local communities in the National Plan.

Grape farmers, Afghanistan
©USAID Afghanistan

16 Building upon existing networks such as the European Cooperative Programme for Plant Genetic Resources (ECPGR): http://www.ecpgr.cgiar.org/.

The objectives of such an initial meeting can include:

- providing an introduction to the project, i.e. the preparation of a national plan, and to discuss the proposed project strategy and objectives;
- sharing knowledge of previous and ongoing interventions related to the inventory, conserving and using of farmers' varieties/landraces;
- discussing how to achieve the project objectives, including gathering information, development of information and knowledge management tools, and elaboration of goals and objectives;
- providing examples of existing successful projects supporting on-farm management and/or collection of farmers' varieties/landraces for *ex situ* conservation;
- providing examples of successful reintroductions of landraces highly demanded by farmers; and
- providing examples of the use of farmers' varieties/landrace germplasm in formal crop improvement programmes that can be used for reference purposes.

The National Focal Point and their support team might need to consider at the first stakeholders' meeting how to organize participating stakeholder involvement. A core group of stakeholders might be people with a particular expertise or that can represent a wider group of stakeholders, for example a core stakeholder to represent NGOs, the private sector or agricultural extension services. The core stakeholders would be a group regularly contacted for advice on all aspects of the National Plan development and implementation, with a responsibility to communicate with the group of stakeholders that they represent.

In addition, the wider stakeholder list will include, to the extent possible, all those that may be impacted by the National Plan, including local and national experts who can assist with its development and implementation. The list of potential stakeholders may be very long, but it is necessary to be as inclusive as possible in developing the National Plan so that all stakeholders feel committed to helping implement the Plan successfully. At key stages in the National Plan development, open meetings with all stakeholders should be arranged for inputs and support.

Timeline

A logical series of steps are outlined in the sections that follow to assist with the development and implementation of the National Plan. It is important to stress that there is no single method for developing a national plan, and that its formulation and implementation will differ from country to country. Nevertheless, the process of developing a national plan can be viewed as a series of decisions and actions that follow the same basic pattern in all countries. These guidelines should thus be viewed as a framework for this exercise, bearing in mind that the suggested steps do not necessarily have to be followed in the same predefined order. However, stakeholders should agree early on in the process on a timeline to accomplish specific objectives so that momentum can be built up to achieve implementation of the National Plan.

3. UNDERSTANDING THE COUNTRY CONTEXT

Quinoa farmer, Bolivia
©Bioversity International/S. Padulosi

A national plan needs to be based on the specific context and situation in the country where it will be prepared and implemented. This is highly influenced by the existing policy framework, national priorities, the current state of the conservation and sustainable use of farmers' varieties/landraces, and the range and commitment of farmers, agricultural-related workers and other stakeholders. Before any specific farmer's variety/landrace assessments are conducted, a country assessment related to PGRFA would be helpful to guide the development of the National Plan. This chapter provides guidance for such preparatory work.

A. Constitutional, legal and institutional framework

A national plan needs to be in line with national goals and priorities, and based on the environmental and agricultural policy contexts of the country. An assessment of the constitutional, legal and institutional frameworks should include:

- identifying which regional and international agreements, relevant to conservation and sustainable use of PGRFA, that is binding on the country, e.g. the CBD and the Treaty;
- preparing an overview of the key programmes, national stakeholders, networks and other PGRFA-related activities at the regional and subregional levels, including across multiple sectors;
- preparing an overview and analysis of the established overarching, national policy framework in place that might include development plans, poverty reduction strategies, climate change adaptation plans, agricultural and environmental policies;
- assessing existing policies that might be hindering the conservation and sustainable use of on-farm biodiversity (for example subsidies to particular plant varieties or species);
- laws and strategies governing the conservation and sustainable use of PGRFA at the national and local levels, including sector-specific strategies and national programmes;
- laws and policies promoting or discouraging the conservation and sustainable use of farmers' varieties/landraces, e.g. national variety registration legislation; and
- priorities, programmes and activities within the National PGRFA Programme.

It is important to align sector-specific strategies fully with the overall national policy objectives and existing strategies in the country. The National Plan should be in harmony with any National PGRFA Strategy in place.

B. State of conservation and sustainable use of farmers' varieties/landraces

An assessment of the current status of conservation and sustainable use of farmers' varieties/landraces will reveal apparent gaps and help to identify needs and priorities in the initial phase of developing the National Plan. In many cases relevant assessments may already be available, either as part of a Country Report on the State of PGRFA[17] or as an independent research project targeting diversity. If these types of assessments are lacking, no longer valid, or include little information about farmers' varieties/landraces, it is recommended to conduct a brief review of the status of farmers' varieties/landraces in the country prior to the elaboration of the National Plan. The following points could be considered in the review:

- the general agricultural and environmental situation in the country;
- an overview of the known crop diversity in the country, including the main factors affecting the diversity;
- the current availability and active management of farmers' varieties/landraces in farmers' fields, orchards or home gardens;
- the identification of valuable on-farm genetic resources that require *ex situ* complementary measures;
- the current links between *ex situ* conservation of farmers' varieties and on-farm management;
- the current conservation status of farmers' varieties/landraces in *ex situ* collections, including type and state of the germplasm, storage facilities, collection missions, etc. This may include national germplasm conserved in other international, regional or national genebanks; and
- the current level of characterization and evaluation of farmers' varieties/landraces, the knowledge about their phenotypic and genetic diversity and their use in pre-breeding and breeding activities.

17 Available at http://www.fao.org/docrep/013/i1500e/i1500e00.htm and http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/sow/sow2/reports-sow1/en/

C. Scope of the National Plan

The scope of the National Plan will define what it sets out to accomplish and help stakeholders to plan the necessary steps for its formulation and implementation. The following aspects should be considered carefully when deciding the scope of a national plan.

What constitutes a farmers' variety/landrace?

The definition of what constitutes a farmers' variety/landrace is of crucial importance when formulating a national plan. Often, farmers' varieties/landraces have developed unique characteristics through repeated farmer selection and have never been subjected to formal plant breeding. Alternatively, a particular variety may have been developed in the formal plant breeding sector and subsequently crossed with farmers' varieties/landraces and become a different variety when compared with the original obsolete cultivar.

Since the common understanding of what a farmers' variety/landrace is may vary among stakeholders, it is necessary to develop a common definition for the purpose of compiling a coherent national plan. Common elements of a working definition of a farmers' variety/landrace for a national plan may include some or all of the following:

- recognizable, distinct crop variety;
- dynamic population character;
- lack of formal crop improvement;
- genetically heterogeneous;
- locally adapted;
- associated with local cultural, historic or religious values; and
- associated with traditional farming systems.

Since it should not be expected that a farmers' variety/landrace conforms to all of the criteria listed above, a pragmatic decision needs to be taken on what components will be included in the working definition.

Once the definition is agreed upon, the stakeholders should decide whether to recognize a farmers' variety/landrace based on its nomenclature (i.e. where two varieties with different names are assumed to be distinct), or whether a stricter recognition based on genetic/phenotypic distinction is required. A distinction based on nomenclature relies on the assumption that actual genetic/

phenotypic distinction is related to names, which might not always be the case. It is recommended that the relationship between local nomenclature and genetic diversity are considered when studying diversity. If resources are available, a genetic data analysis is recommended in order to be able to distinguish and identify varieties correctly.

Crops and farmers' varieties/landraces to be considered

In determining which crops and farmers' varieties/landraces are relevant for the National Plan, countries can choose to focus on all farmers' varieties/landraces or a specific set of farmers' varieties/landraces of prioritized crops. There are two distinct approaches: (i) focusing on priority farmers' varieties/landraces within a geographical area (e.g. those most important to food security, livelihood development, poverty reduction, sustainable agriculture, environmental resilience and/or socio-economic activities at the country level); and (ii) including all farmers' varieties/landraces in a geographical defined area. Which approach is chosen for the National Plan will depend on the quantity and quality of existing data, the human and financial resources available, as well as the goals and priorities of the authorities and the indigenous peoples and local communities involved. To the

Terrace farming, Nepal
©CIFOR/M. Edliadi

extent possible, the National Plan should cover the largest possible range of farmers' varieties/landraces. To maximize the conservation and sustainable use of farmers' varieties/landraces further, a combination of both approaches could be considered, e.g. preparing a national plan encompassing all farmers' varieties/landraces in the country, and in addition developing specific strategies for the highest priority crop and farmers' varieties/landraces combinations.

Geographical coverage

It is also crucial to choose an appropriate breadth of coverage for the National Plan, with regards to its geographical coverage. It is highly recommended that the geographical scope of the National Plan be the whole country. However, in some cases, for instance where the country is very large, very diverse or very divided, it may be more logical and more efficient to choose a different approach, e.g. to develop separate strategies for specific regions of the country, or focus on one particular region. To maximize the conservation and sustainable use of farmers' varieties/landraces, a combination of these two approaches can be considered, e.g. to prepare a national plan which is valid for the entire country, and, in addition, develop specific strategies for areas of particular interest or concern (e.g. a centre of domestication or an area with a particularly high level of crop diversity).

Complementarity with national, regional and global strategies

A national plan should be in harmony with the National PGRFA Strategy (if developed), and be complementary to other national, regional and global conservation strategies or initiatives. Ensuring harmonization between interacting conservation plans at the earliest stage possible will facilitate the formation of partnerships contributing to common goals.

Content of the National Plan for Conservation and Sustainable Use of Farmers' Varieties/ Landraces

The Second GPA, with its 18 Priority Activities[18] serves as a guide for elaborating the content of the National Plan. It is not a requirement that the National Plan cover all 18 priority activities, but each country will need to assess and prioritize the activities they consider most relevant based on the country context.

18 http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/gpa/priority-areas/en/ and see Box 7 in Chapter 8.

Complementarity between *ex situ* conservation and on-farm management

Management of farmers' varieties/landraces on-farm should not be viewed as an alternative to *ex situ* conservation, but rather as a complementary approach to safeguarding and using PGRFA. The need for such complementarity should be emphasized in all plans and strategies relevant to PGRFA, so that the most comprehensive and holistic approaches can be implemented.

Conservation linked to sustainable use

The concept of use is fundamental to the management of PGRFA and acts as a bridge between conservation of genetic resources and delivery of adapted/improved varieties to farmers. Sustainable use encompasses a wide range of actions, *inter alia* characterization/evaluation; pre-breeding, including genetic enhancement and base-broadening; diversification of crop production; development and commercialization of varieties; supporting seed production and distribution; and developing new markets for farmers' varieties/landraces and products. The National Plan should encourage and promote sustainable use of farmers' varieties/landraces by strengthening the links between those stakeholders working in *ex situ* conservation and on-farm management with those involved in research, plant breeding, crop production, seed production, etc.

Financial and human resources for implementation

To implement a national plan, funding and commitment from a large range of stakeholders and partners is needed. If the financial resources in the country are limited or unreliable, the scope of the plan might need to be adjusted accordingly. Similar considerations should be made if the country has limited human resources or few committed stakeholders to drive the implementation of the strategy.

4. STRENGTHENING THE FARMERS' VARIETY/LANDRACE KNOWLEDGE BASE

Artichoke landrace, Italy
©FAO/A. Noorani

To determine how to conserve and use farmers' varieties/landraces more sustainably and effectively, it is necessary to know which farmers' varieties/landraces exist in the country, where they are and what management measures should be adopted to protect and use them most efficiently. A national plan should therefore be as specific as possible, targeting farmers' varieties/landraces of priority crop species and locations. This chapter provides a guide for developing a knowledge base of the diversity of farmers' varieties/landraces in the country. Five approaches to developing a knowledge base are discussed: checklist; inventory; ecogeographical diversity data; characterization data; and genetic analysis (Table 1). These five approaches provide increasingly greater resolution of information on farmers' varieties/landraces.

Table 1. Databases for strengthening knowledge of farmers' varieties/landraces

Database name	Focus data
Checklist	Farmer's variety/landrace names
Inventory(1)	Farmer's variety/landrace names, Farmer information, Site data, Crop data, Socio-economic data
Ecogeographical survey(1)	Environmental and ecological data that affects distribution of farmers' varieties/landraces
Agro-botanic survey	Agro-botanical characterization of intra-specific diversity
Genetic analysis	Molecular characterization data

Notes: (1) Inventory data may include much ecogeographical data, so allow for overlap.

There are a number of features common to the five databases:

- Each database may be developed **independently, but in parallel or as a component of an integrated database**. Thus, for example, while making a checklist, as much farmers' variety/landrace data as possible should be included in the inventory.
- **Prior to developing** each database, the scope of the database should be determined based on human and financial resources, and be agreed upon among stakeholders.
- **Data sources** may be common to one or more of the databases so documenting different data sources in a single accessible place for ease of reference by those involved with developing different databases may increase efficiency and comprehensiveness of the databases.

- **Database consolidation** and validation or verification. Data validation is often carried out in consultation with all relevant stakeholders. The purpose of the validation is to present the final product (i.e. national inventory) and to ensure that it is correct and meets the set requirements. All stakeholders that have taken part in the process of compiling the inventory should participate in its validation.

A. National checklist of farmers' varieties/landraces

What is a national checklist of farmers' varieties/landraces?

A national checklist of farmers' varieties/landraces is a list of the names of the farmers' varieties/landraces present in the country. A checklist of farmers' varieties/landraces can be prepared for a particular geographical area, e.g. in a community or in a specific region. The checklist forms the basis of the inventory. It could also be useful to ascertain the origin and status of farmers' varieties/landraces conserved in genebanks.

Why develop a national checklist of farmers' varieties/landraces?

Preparing a checklist of farmers' varieties/landraces is a way of organizing essential information in a logical and retrievable way, and is therefore a fundamental tool for planning, facilitating and monitoring the conservation and sustainable use of farmers' varieties/landraces. By knowing what farmers' varieties/landraces exist and where, effective conservation and sustainable use strategies, including measures for potential reintroduction, can be determined. The checklist should be easy to access and exchange among stakeholders.

Methodology for creating a national checklist of farmers' varieties/landraces

The preparation of a national checklist of farmers' varieties/landraces is outlined below as a three-stage process.

1) Agree on a working definition of farmers' varieties/landraces and determine the scope

Whether the checklist should include all farmers' varieties/landraces within a geographically defined area, or focus on particular crops or farmers' varieties/landraces, depends on the goals and priorities of the National Plan. If a partial checklist of farmers' varieties/landraces is developed, at a later stage it can contribute to the compilation of a full national checklist.

2) Survey and elaboration of a draft checklist of farmers' varieties/ landraces

A number of methods can be used to retrieve information about farmers' varieties/ landraces, and a combination of literature/media reviews, surveys and in-person meetings is recommended. It should be kept in mind that not all local varieties may have been identified or are recognized as distinct farmers' varieties/landraces in existing information. Means for collecting information include:

- **Farmer interviews.** Farmers can be approached indirectly through advertisements, articles in farmers' magazines and local newspapers, radio or other non-print media, or directly via personal contacts.
- **Meetings with experts.** These experts are often associated with genebanks, research institutes, agricultural extension divisions, farmers' organizations, agricultural statisticians, commercial companies, non-governmental and local organizations and other professional networks.
- **Review of scientific literature**, including historical literature, research reports and crop studies.
- **Review of 'grey literature'** associated with genebanks, research institutes, seed companies, NGO newsletters, local farmers' society publications, and farm records.
- **Available checklists**, including regional or national crop checklists and special checklists such as crop lists for neglected or underutilized species.
- **Official documents**, for instance agricultural statistics or national varietal lists, genebank inventories and databases.

It is recommended to produce the checklist in digital form, such as in a spreadsheet or as a database, which can be easily analysed and shared throughout the consultation process.

3) Consultations and checklist validation

Once a draft checklist of farmers' varieties/landraces has been generated (in official and local languages, in close collaboration with farmers, indigenous peoples and local communities, as appropriate) it should be validated through consultation with all relevant stakeholders in order to resolve any potential errors or confusion. A final validation of the checklist is particularly important because it is the starting point for developing an inventory of farmers' varieties/landraces and may therefore be useful for a wide community of users and researchers. Having prepared a validated

checklist, a process of updating at regular intervals should be agreed upon. An example of developing a regional checklist for sorghum varieties in Ethiopia is described in Box 1. Similar examples of comprehensive checklists for all crops exist for Italy (Hammer *et al*., 1992a; 1999) and Cuba (Hammer *et al*. 1992b).

Box 1. Checklist of Sorghum landraces in South and Central Tigray, Ethiopia

There are a number of examples of partial national checklists prepared in countries, including in Ethiopia. Here a checklist and inventory of varieties of Sorghum landraces existing in the South and Central Tigray region was obtained through a farmer survey. In total, 93 selected farmers were interviewed using a structured questionnaire regarding various socio-economic aspects, as well as landrace characteristics and seed selection and management. A total of 165 samples from 31 locally named Sorghum varieties were collected and stored at Mekelle University. The socio-economic factors affecting varietal diversity, as well as conservation and incentives strategies were discussed.

Source: Tsehaye, Y., Abera, Z., Kebede, A. & Ghebremichael, B. 2009. A dynamic sorghum (Sorghum bicolor (L.) Moench) diversity management *in situ* and livelihood resilience in South and Central Tigray Region, Ethiopia. *Momona Ethiopian Journal of Science*, 1(2):67-94. https://www.ajol.info/index.php/mejs/article/view/46049

B. National inventory of farmers' varieties/landraces

What is an inventory of farmers' varieties/landraces?

An inventory of farmers' varieties/landraces includes the checklist, as well as associated information, such as management, cultivation, uses, characterization, evaluation, farmer-based knowledge data, threats and conservation. Each farmers' variety/landrace name will have only one entry in the checklist. In the inventory, however, one farmers' variety/landrace name may cover several farmers' varieties/landraces when the same name has different information or traits associated with it.

What is the value of a national inventory of farmers' varieties/landraces?

An inventory of farmers' varieties/landraces provides the baseline data vital for diversity assessments, monitoring exercises and planning of appropriate conservation actions (on-farm and *ex situ*). The inventory will provide useful information for policymakers, conservation practitioners, plant breeders and other user groups.

Methodology for creating a national inventory of farmers' varieties/landraces

A national inventory requires that a checklist already be available. If this is not the case, the compilation of the checklist and the inventory can proceed in parallel.

Scope of the inventory

As mentioned above, it is recommended that the inventory consider the broadest possible crop scope and cover the entire country. However, for practical or financial reasons, it may be that an inventory is only possible for a subset of the crops listed in the checklist. It may also be that one or several partial inventories already exist for farmers' varieties/landraces and therefore it may be possible to limit the number of crops or taxa to be assessed.

Prioritization of farmers' varieties/landraces to be included in the inventory may be necessary. Some common criteria that are often used in prioritization of farmers' varieties/landraces include: their importance to food security and sustainable livelihoods; socio-economic relevance at the national and local levels; their cultivation in a centre of diversity or origin; and adaptation to biotic and abiotic stresses. While prioritizing which crops and farmers' varieties/landraces the inventory should cover, it is necessary to avoid duplication of efforts. To help determine the scope of the inventory, it is recommended to review existing sources of information, such as:

- target taxon/crop experts;
- national flora;
- crop monographs;
- recent crop studies; and
- existing inventories and crop databases.

Surveying and data collection

- Farmers and farm communities play a key role in the management of many farmers' varieties/landraces and should be identified and contacted.
- Agricultural extension officers can be a direct link to farmers and farming communities.
- Experts (such as researchers in botany, taxonomy, agronomy, genetics and agrobiodiversity) can give advice on the location of important farmers' varieties/landrace collections and suggest relevant literature, crop databases and other important references.
- Breeders, agronomists with experience of different crops, and other users of PGRFA working in National Agricultural Research Systems familiar with documenting, interpreting and using genetic diversity at the infra-specific level, identifying gaps in existing collections, regions known or suspected to harbour interesting farmers' varieties/landrace germplasm, and traits to look for and pay particular attention to when in the field.
- Global and regional crop-specific networks, NGOs, governmental or international agencies working in rural development projects.
- Social scientists can provide information on farming systems and crops.

It is recommended to arrange an expert meeting before the activities of inventorying farmers' varieties/landraces begin in order to: inform and involve stakeholders; discuss where and how to make contact with farmers; agree on possible collaborative activities among stakeholders; and share knowledge on relevant information sources, including specific contacts, literature sources, government documents, relevant NGOs, commercial companies and genebanks.

Determine the type of data to include and create an inventory data collection form or questionnaire

An absolute minimum of data to be included in an inventory would be the crop name (or species), the **name of the farmer's variety/landrace**, the **growing site** (including, whenever possible, the exact or approximate coordinates) and the **farmer's name**. However, it is recommended that traditional and local knowledge associated with the specific farmers' variety/landrace maintenance and use also be collected and documented. Data that are commonly included in inventories are:

- *Farmer details:* Name, address, contact details, year of birth, gender, family structure, education, main source of income, owned or rented land, etc.
- *Farmer data:* How long the farmer has cultivated the farmers' variety/landrace, original seed source, how long the farmer will continue cultivation or conservation, whether someone (from younger generations, other relatives or neighbours) will continue to cultivate the farmers' variety/landrace.
- *Site geographical data:* Location, site coordinates, size of farm, site environmental data, such as cropping site type, altitude, landform, aspect, slope, soil texture, soil drainage, soil pH, temperature and rainfall.
- *Crop nomenclature:* Genus, species, authority, infra-specific epithet, infra-specific epithet authority, taxonomic rank, crop cultivar name, synonyms, vernacular name(s).
- *Socio-economic data:* Crop purpose and the contribution it makes to income and nutrition, usage (e.g. description of main usage, secondary usage, for home consumption including traditional recipes or for sale in markets, marketing, current and past values, member of grower or marketing cooperative), farmer-perceived value, source, country or region of origin, history of cultivation, crop qualities, local or national incentives to grow the farmers' variety/landrace.
- *Farmers' variety/landrace cultivation and management data:* Area currently sown, history of area sown, sowing date, cropping system (arable or mixed farming system), harvesting date, irrigation, fertilizer, fungicide and pesticide types, organic/low input status, crop resistance as noted by the farmer, propagation method, selection criteria for propagation, variation displayed by the farmers' variety/landrace with regard to characterization and evaluation traits, major agronomic problems faced by the crop (pest, diseases, drought, etc.), relationship to other farmers' varieties/landraces.
- *Distinctiveness of the farmers' variety/landrace,* i.e. grown on a single farm or with a more widespread, genetic distinction.
- *Farmers' variety/landrace conservation status:* Whether the crop is stored *ex situ*, method of selection of seed saved, method of seed storage, exchange frequency, whether it is adequately managed on-farm, threat of genetic erosion (e.g. incentives, lack of sustainability of farming system, lack of market), seed saving system, etc.
- *Characterization data:* e.g. leaf shape, flower colour, plant habit, seed colour using standard descriptors where available, local knowledge, or both.

- *Evaluation data*: e.g. pest and disease resistance/tolerance, abiotic stress resistance, performance comparison with modern varieties.
- *Photographs.*

Some of this information may have implications for data protection, and privacy of the data needs to be checked and verified in each specific case. It is, however, important not to anonymize all the information, so that individual collections can be associated with providers. This will allow farmers' varieties/landraces to be traced if desirable traits are found.

Choose or agree on an inventory database structure

It is highly recommended that the inventory be organized as a database. If a relevant database does not already exist, a simple structure will need to be designed for this purpose. Several database software packages are available, including PostgreSQL, Microsoft Access, OpenOffice Base and MySQL. The database structure should be aligned with the data collection form and use standardized data descriptors. The following points are recommended when an inventory database structure needs to be created:

- A reflection on the types of data to be included in the database should precede its creation. The collecting form (when surveying farmers for farmers' variety/landrace information) should be linked to the database, meaning that all fields in the collecting form should be included in the database structure.
- Data descriptors and data standards should be determined. The data format should be standardized (Box 2). To the greatest extent possible, agreed international standards should be applied, facilitating information exchange and information storage.
- The database software package should be both user-friendly and able to accommodate the complexity of a database of this kind.
- An inventory will have the greatest potential use when it includes extensive validated information. The database structure should allow expansion (e.g. of the geographical area or farmers' varieties/landraces included), as well as addition of relevant information.

Box 2. Development and use of standardized descriptors

A descriptor may be defined as "an identifiable and measurable trait, characteristic or attribute observed in an accession that is used to facilitate data classification, storage, retrieval and use".[1] The use of well-defined, tested and rigorously implemented descriptor lists considerably simplifies all operations concerned with data entry, updating, retrieval, exchange, analysis and transformation. When data are recorded, they should therefore be classified and interpreted with a list of standardized and clearly defined descriptors and descriptor states. The use of standardized descriptors facilitates data analysis and comparisons, while reducing errors and problems associated with vague or unclear states, categories or classes.

In recent years the application by genebanks of standard germplasm data descriptors such as the FAO/Bioversity Multi-Crop Passport Descriptors V.2.1 has overall increased.[2] Descriptors specifically developed for Web-enabled national *in situ* landrace inventories have also been developed for one region by independent projects, such as the European Union-funded PGR Secure project, and Bioversity – The Christensen Fund project, USA.[3] These descriptors have been designed to document on-farm materials, as well as to describe aspects of farm management practices (e.g. agricultural system, cropping management and farm labour division by gender). Descriptors to characterize the seed supply system, farmer criteria for distinguishing farmers' varieties/landraces, selection criteria, seed storage practices and crop uses, among others, are included. Additionally, the Digital Object Identifiers of the Global Information System of the Treaty allow for the permanent and unique identification of material and the establishment of connections between the material conserved *in situ* and on-farm conditions with the *ex situ* material.[4]

1 FAO. 2014. *Genebank Standards for Plant Genetic Resources for Food and Agriculture*. Rev. ed. Rome: http://www.fao.org/3/a-i3704e.pdf.

2 Alercia, A., Diulgheroff, S. & Mackay, M. 2015. *FAO/Bioversity Multi-Crop Passport Descriptors V.2.1 [MCPD V.2.1].* https://www.bioversityinternational.org/fileadmin/user_upload/online_library/publications/pdfs/FAOBIOVERSITY_MULTI-CROP_PASSPORT_DESCRIPTORS_V.2.1_2015_2020.pdf

3 Descriptors developed under the EC-funded PGR Secure project are available at http://www.pgrsecure.bham.ac.uk/sites/default/files/documents/helpdesk/LRDESCRIPTORS_PGRSECURE.pdf. The Bioversity/The Christensen Fund project has provided descriptors for farmer's knowledge of plants and are available at http://www.bioversityinternational.org/e-library/publications/detail/descriptors-for-farmers-knowledge-of-plants

4 Information on Digital Object Identifiers, descriptors and guidelines of the Treaty's Global Information System are available at: http://www.fao.org/plant-treaty/areas-of-work/global-information-system/en/

Surveying and data collection

- *Review existing sources:* It is recommended to start collecting data by reviewing scientific and grey literature. Genebank databases can be used to find information related to *ex situ* collections and conservation actions, as well as potential sources of farmers' varieties/landraces.
- *Conduct a field survey:* Most of the data to include in the inventory may need to be collected through field surveying. It is therefore relevant to approach and engage farmers when possible. It can also be useful to contact taxon or crop experts and people with specialised knowledge of the crops in the target area. The agreed data collection form should be used in the field survey.

It should be noted that farmers' varieties/landraces may consist of several populations or accessions in the case of *ex situ* collections, as different farmers can grow the same farmers' varieties/landraces. Therefore, it is important to link farmers' variety/landrace populations to specific sites or farmers to ensure that the local intra-varietal diversity is recognizable. Passport data[19] should be available for every farmers' variety/landrace accession. Characterization and evaluation data are usually not available and may require specific trials. However, when available, characterization and evaluation data will help contribute to the identification and determination of possible uses of the farmers' variety/landrace.

Ensure validation and dissemination

Once a draft inventory of farmers' varieties/landraces has been generated, it should be agreed upon through a broad stakeholder consultation process to reach a consensus. When the inventory is agreed upon, it is necessary to make stakeholders aware of its existence and make sure it is accessible to all. Ideally, the inventory should be made available through a web-enabled database.

19 Passport data is data collected at the growing or collecting site of germplasm and should include comprehensive site location data and site environmental data as well as information on the germplasm itself. Refer also to Alercia *et al.*, 2012.

C. Ecogeographical analysis

The inventory of farmers' varieties/landraces may provide some of the data needed for ecogeographical analysis. Some key features of ecogeographical analysis are discussed below.

What is an ecogeographical analysis?

Ecogeography is the study of environmental and ecological effects on the distribution of living things. The process of collating geographical, agroecological, taxonomic and genetic data and using it to help plan conservation is called an ecogeographical survey. An ecogeographical analysis refers to the interpretation of this information.

Why is an ecogeographical analysis useful?

Analysis of ecogeographical data is an integral part of formulating and implementing conservation priorities, e.g. by helping to identify priority farmers' variety/landrace populations, suitable sites for on-farm management and locations or populations from where samples should be collected for *ex situ* conservation.

Methodology for developing an ecogeographical survey and its analysis

In the methodology described below, we assume that an inventory including ecogeographical information has already been elaborated.

Determine the scope

Before ecogeographical analysis is conducted, the scope of the study, especially related to crops, farmers' varieties/landraces and geographical coverage, must be discussed and agreed upon. The selection of target crops and farmers' varieties/landraces should be made in collaboration with farmers and other experts. Conduct an ecogeographical survey using existing information to the extent possible, including floras, crop monographs, crop studies and crop databases. Some criteria for prioritization of farmers' varieties/landraces to be included in the study are important for national and local food security, livelihood development and poverty reduction.

Identification of taxon and crop expertise

The resource persons would be the same as listed in Chapter IV, Section B. In addition, depending on the particular context of the target area, it can also be relevant to involve social scientists or professionals working outside the direct remit of conservation and management of PGRFA.

Determine the type of data to include and create an ecogeographical data collection form and questionnaire

If the inventory is incomplete, or only includes basic information, an extensive ecogeographical survey is recommended. An absolute minimum of data to be included in an ecogeographical survey would be the distribution of the farmers' variety/landrace, its habitat and ecology. It is essential that this information be directly linked to an inventory. Standard descriptors should be used as much as possible. The types of data to be collected in an ecogeographical survey are:

Crop level information

- *Taxonomy and nomenclature:* Genus, species, intraspecific taxonomy if available, taxonomic rank, synonyms, crop name, vernacular name(s).
- *Biology:* Descriptive information, phenology,[20] pollination, autecology,[21] synecology.[22]
- *Distribution:* Known geographic distribution.
- *Ecology:* Altitude, aspect, slope, soil texture, soil drainage, soil pH, temperature, rainfall, habitat, vegetation type, associated species, human pressures.
- *Threat status:* Threat status of crop using the International Union for Conservation of Nature (IUCN) Red List categories,[23] where applicable, and threats facing crop, e.g. urbanization, intensification of agriculture, competition from alien species, etc.

Farmers' variety/landrace population-level information

- *Identification:* Accepted identification(s).
- *Occurrence:* Geo-referenced location, coordinates, geographical range and altitudinal range.
- *Characteristics:* Size, age structure and genetic diversity.
- *Ecology:* Altitude, aspect, slope, soil texture, soil drainage, soil pH, temperature, rainfall, habitat, vegetation type, associated species, human pressures, specific threats and land use data.

20 Phenology is the study of periodic plant life cycle events and how these are influenced by seasonal and inter-annual variations in climate, as well as habitat factors.

21 Autecology is the study of the interactions of an individual organism or a single species with the living and non-living factors of its environment.

22 Synecology is the study of groups of organisms associated as a community.

23 http://www.iucnredlist.org/technical-documents. See also Hammer and Khoshbakht, 2005.

- *Conservation status:* Legislation, on-farm and *ex situ* conservation status, method of selecting seeds for conservation and storage, exchange frequency and management on-farm.
- *Characterization and evaluation data:* Leaf shape, flower colour, plant habit, seed colour, chromosome number, plant height, days to maturity, etc.
- *Utilization potential:* Previous and potential use as trait donor in pre-breeding and breeding activities and other known uses.
- *Image:* Photographs, illustrations or links to digital images.

Design and creation of the ecogeographical, characterization, evaluation and farmer-based knowledge database structure

The database structure should follow the process described in Chapter IV Section B. The database containing ecogeographical information may be directly linked to the national inventory of farmers' varieties/landraces through a unique identifier number (name of farmers' variety/landrace or farmers' variety/landrace ID); alternatively, they can be two independent products.

Collection of ecogeographical information – the ecogeographical survey

- *Review existing sources:* To collect ecogeographical information, it is most appropriate to start by reviewing scientific and grey literature. Seek information from experts and people with specialised knowledge of the agriculture and crops of the target area. Genebank curators will be able to provide and verify the information related to stored accessions.
- *Conduct a field survey:* If the amount of ecogeographical data is limited, or data are insufficient to undertake a meaningful analysis, data will need to be collected through field surveys. A field survey may also be necessary to verify information collected from other sources. When collecting information, the data collection form needs to be aligned with the database structure, and standardized data descriptors should be used. It is essential to involve farmers in the ecogeographical surveying. It can also be useful to contact taxon and crop experts and people with specialist knowledge of the crops in the target area. While undertaking the field survey, farmers' variety/landrace populations should be geo-referenced by using, for example, global positioning systems, maps or Google Earth.

Verification and finalization of the ecogeographical survey

Once a draft ecogeographical survey has been generated, the collected data should be verified in order to ensure that it is correct. Verification of data can be done by broad consultations with stakeholders. During verification of the ecogeographical data, special attention should be paid to avoiding duplicates, errors and inaccuracies. Potential duplicates (e.g. genebank and field records with the exact same data) should be highlighted and checked. Spelling should also be carefully checked and the data format should be standardized.

Conduct an ecogeographical data analysis

The initial stage in ecogeographical data analysis is to document the diversity of farmers' varieties/landraces currently being conserved on-farm or *ex situ*. Analysis of these data should describe the distribution of farmers' varieties/landraces, of specific traits and their levels of variation (Guarino *et al.*, 2005). The data collected in the ecogeographical survey enable detailed ecogeographical profiles of the farmers' varieties/landraces to be prepared (see Box 3). The types of ecogeographical analysis that are useful for establishing conservation priorities include:

- the distribution of farmers' varieties/landraces in a country or region;
- the variation and distribution in the farmers' variety/landrace with regard to characterization and evaluation traits, e.g. pest resistance, frost tolerance, yield characteristics and consumer preferences;
- analysis of major agronomic constraints faced by the crop or farmers' variety/landrace (pest, diseases, drought, etc.);
- the mapping and detection of ecogeographical patterns (e.g. phenology of the crop in different areas, whether a particular farmers' variety/landrace occurs on a particular soil type, or whether the frequency of a character state changes along an environmental gradient);
- identification of populations at sites suitable for long-term on-farm management;
- target farmers' varieties/landraces with traits of interest for plant breeders or to complement existing *ex situ* conservation;
- identification of populations targeted for *ex situ* sampling and conservation; and
- spatial analysis and ecogeographical land characterization maps, using tools such as Geographic Information Systems (GIS), for example the DIVA-GIS computer program (Box 4).

Box 3. Ecogeographical tools

The International Treaty for Plant Genetic Resources for Food and Agriculture has funded the development of a series of tools under the framework of the programme CAPFITOGEN. These tools represent an effort to adapt and facilitate the use of methodologies for ecogeography and geographic information systems.

The CAPFITOGEN tools include:

1) TesTable: detects and corrects errors and problems in the input tables that will be used in the other tools;

2) GEOQUAL: performs quality assessment of the geo-referencing information of passport data (collecting sites);

3) ELC mapas: allows the elaboration of ecogeographical land characterization (ELC) maps and scenarios reflecting species adaptation for a country or region;

4) ECOGEO: produces ecogeographical characterizations of the germplasm collection sites;

5) Representa: calculates the (ecogeographical) representativeness of a germplasm collection;

6) DIV mapas: creates maps of eco-geographic, phenotypic and/or genotypic diversity that help detect diversity hotspots;

7) ColNucleo: allows the creation of core/nuclear ecogeographical germplasm collections based only on the coordinates of the collecting sites; and

8) FIGS_R: applies the 'filtering' method of the Focused Identification of Germplasm Strategy (FIGS) to seek for particular traits of interest for crop improvement without this trait being evaluated, partially or completely, in the original collection;

CAPFITOGEN also includes a number of *in situ* tools. More information is available at http://www.capfitogen.net/en/access/download-from-internet/

Box 4. DIVA-GIS

DIVA-GIS is a free Geographic Information System (GIS) computer program with documentation for mapping and geographical data analysis. DIVA-GIS can map nationally or locally where farmers' varieties/landraces are found. Free spatial data for the whole world is available that can be used in DIVA-GIS or other programs.

A discussion forum is available to ask questions, report problems, or make suggestions. A blog provides the latest news.

DIVA-GIS is particularly useful for mapping and analysing biodiversity data, such as the distribution of farmers' varieties/landraces, or other 'point-distributions'. It reads standard data formats such as Environmental Systems Research Institute (ESRI) shapefiles, so inter-operability is not a problem. DIVA-GIS runs on Windows and (with minor effort) on Mac OSX.

The program can analyse data, for example by making grid (raster) maps of the distribution of biological diversity, find areas that have high, low or complementary levels of diversity. Climate data can be mapped and queried.

More information available at www.diva-gis.org

Floating market, Thailand
©M. Haridi

Data synthesis, validation and dissemination

When ecogeographical data have been collected and analysed, the following products can be made available:

- ecogeographical survey database, containing raw data, linked to the inventory;
- ecogeographical conspectus, a summary of all data collated for each farmer's variety/landrace; and
- a report of the ecogeographical data analysis, containing the analysis and interpretation of the data.

Once the desired products have been created, they should be validated through broad consultation with stakeholders. It will be necessary to ensure that information on the validated products is easily available to all, such as through the Internet.

D. Agro-botanic assessments

Characterization and evaluation entails a detailed description of intraspecific crop diversity including assessment of morphological, phenological, biochemical and agronomic traits. This approach is an initial step useful for measuring and understanding the diversity of a crop genepool. Preliminary studies of farmers' varieties/landraces should preferably be undertaken directly in the farmers' fields. Detailed evaluation should be carried out by researchers (specialized in taxonomy, phenology, agronomy, etc.) on materials collected and deposited in genebanks. The results of these studies are relevant for usage of the material in the on-farm context, as well as for plant breeding and conservation. Such a holistic approach and results are understandable also for farmers working with the material on-farm.

A number of crop descriptor lists have been published by Bioversity International and FAO,[24] which include a minimum set of morphological traits that enable an easy and quick discrimination between phenotypes and characters such as yield, agronomic performance, and stress susceptibilities (see Box 2). Useful descriptors are also available from the International Union for the Protection Varieties of Plants[25] and of the National Plant Germplasm System of the United States Department of Agriculture.[26]

24 https://www.bioversityinternational.org/e-library/publications/categories/descriptors/

25 http://www.upov.int/test_guidelines/en/list.jsp

26 https://www.ars.usda.gov/research/publications/find-a-publication/

E. Genetic data analysis

What is genetic data analysis?

Genetic data analysis focuses on the use of molecular techniques to characterize species and varieties, study their genetic relatedness and assess the genetic composition or diversity within and between populations and species. Genetic data analysis is often done by using molecular markers, such as DNA fragments or sequences in genic or non-genic regions, neutral or adaptive genes. There are, however, many other approaches, such as the use of morphological or biochemical data.

Why is it useful to undertake genetic studies of farmers' varieties/ landraces?

Studies of genetic diversity are commonly used to:

- *Identify germplasm.* Poorly known crop genetic resources can be accurately identified and described, and the relationship between farmers' varieties/ landraces and their genetic distinction can be revealed. This includes clarifying situations in which farmers use the same name for farmers' varieties/landraces that are genetically distinct or use different names for the same farmer's variety/ landrace.

- *Provide genetic baseline information.* An understanding of the pattern of allelic richness and evenness across the geographical breadth of the crop or farmers' variety/landrace establishes a relative baseline against which changes can be measured. By assessing genetic diversity regularly over time, genetic erosion can be detected early and necessary population management measures can be implemented before significant loss or extinction occurs.

- *Identify populations for conservation.* The amount and patterns of genetic diversity both within and between populations of farmers' varieties/landraces can help identify the populations that should be targeted for *in situ* and *ex situ* conservation, such as those with the greatest amount of genetic diversity, or with interesting alleles for adaptation, or both.

- *Identify traits of interest for crop improvement.* The genetic diversity available within a crop represents a potential exploitable resource for human use, and encompasses the potential of the species to evolve and adapt within a changing environment. Novel genetic variability and traits of particular interest to plant breeders and farmers can be identified.

Planning genetic data analyses

The following sections address some steps and considerations that should be discussed prior to conducting a genetic analysis or molecular study, including reviewing pre-existing genetic studies, determining costs and the human capacity available for such studies.

Review existing studies

Numerous studies have been published on patterns of genetic diversity within crop species. There might therefore be genetic studies and genetic information already available for the target crop or farmers' variety/landrace. To determine patterns of genetic diversity among populations, it is also relevant to review studies concerning their breeding system, seed dispersal and other life history traits. If no genetic studies are available, it is highly recommended to conduct a genetic data analysis.

Consider financial resources, available staff and capacity

Molecular studies need to be undertaken by trained personnel and researchers. Such studies are still relatively costly and time consuming and require adequate laboratory facilities with relevant equipment and bioinformatics expertise. Funding to undertake the study, as well as availability of skilled researchers, need to be secured before any data collection or analysis starts. Appropriate research objectives for the molecular study need to be determined with personnel once they have been identified.. If the necessary facilities or personnel are not available, plant samples can be sent to an organization or institute willing to conduct the research. Bear in mind that technologies may be more advanced for large economically important crops, where an array of molecular tools are available and high resolution results are possible, than for minor crops, where little molecular genetic research is undertaken.

Define the scope and plan acquisition of material

Material from the farmers' varieties/landraces might already be available in *ex situ* collections, or they can be collected during specific collecting missions. Regardless of whether stored or newly collected samples are being used, they should adequately represent the ecogeographical range of the target germplasm.

The most important points that need to be agreed upon and planned prior to the assembly of material are: (i) which farmers' varieties/landraces should be analysed; (ii) from which areas or locations; (iii) how the required representative germplasm can best be acquired; and (iv) when the sampling should take place and by whom, if a field collection mission is necessary.

Based on the agreed scope of the genetic analysis and the expected level of diversity of the specific crops or farmers' varieties/landraces, the following information can help in planning the acquisition of material:

- Which farmers' varieties/landraces are prioritized for data analysis?
- Can the material be acquired from existing genebank collections?
- Does the material from the genebank collections cover the full ecogeographical range of the farmers' variety/landrace under study?
- If collecting missions are required, what should be the distribution and number of collection sites? The sites for collection should be chosen with a view to maximizing the genetic diversity of the samples.
- How many plants should be sampled at each site? Sampling can include seeds, leaves or other tissues.
- When should the collecting missions take place and how many visits will be needed?
- What information should be recorded at the time of the collection?

Maize landrace diversity
©CIMMYT

Determine the type of assessment and tools

The type of molecular markers to use should be determined based on the needs and expectations of the study but, in practice, is dependent on the existing tools for the given crop. As molecular biology is a field in constant development, expertise must be sought in each particular case to help decide on the best method to use for a particular species and study.

With regard to conservation and sustainable use of farmers' varieties/landraces, it can be relevant to assess both neutral and adaptive variation (Briggs and Walters, 2016). Neutral genetic variation refers to gene variants, which do not necessarily have any direct effect on fitness (Kimura, 1968). Being selectively neutral, an analysis of this variation tells us nothing about the adaptive or evolutionary potential of a population or a crop, but is well suited for investigating processes such as gene flow, migration or dispersal. Adaptive genetic variation refers to gene variants with a direct effect on fitness (under natural selection) and can tell us something about the crop's potential ability to adapt to changing environments. A decision on the approach to genetic analysis to be taken depends on the objectives, the resources (staff, budget and facilities) and genetic markers available (Hayward *et al.*, 2015; Grover and Sharma, 2016; Nadeem *et al.*, 2018).

Consider alternatives to genetic analyses

If resources or the availability of skilled staff, or both, are limited and a molecular or phenotypic genetic study is not feasible, it is possible to use farmers' perceived diversity and ecogeographical information as a proxy for genetic data. When using farmers' perceived diversity, the assumption is that different morphological characteristics imply different genetic characteristics. When using ecogeographical information, the assumption is that genetic diversity will correlate with ecogeographical diversity. The main categories of descriptors that can be used to document the diversity perceived by farmers are:

- highly heritable distinguishing traits (e.g. colour, shape or size of fruits and/or leaves);
- agronomic traits (e.g. days to maturity, yield);
- response to abiotic stresses (e.g. response to drought, high or low temperature);
- response to biotic stresses (e.g. susceptibility or resistance to pests and diseases);
- quality and organoleptic traits (e.g. taste, fragrance, cooking quality);
- nutritional qualities (e.g. starch composition); and
- market traits (e.g. marketability, transportability).

F. Information systems and data management

It is widely recognized that one major factor hindering effective conservation and sustainable use of farmers' varieties/landraces is the lack of easy access to data. For example, there have been historically many obstacles to information exchange between organizations, programmes and projects involved in the inventory and conservation of farmers' varieties/landraces. A large number of projects, programmes and organizations have developed stand-alone information systems to manage farmers' variety/landrace-related data. Lack of consistent organization and management of data is hindering the development of efficient strategies and interventions for conservation and sustainable use, leading to misunderstanding and duplication of effort.

Challenges for retrieving information on farmers' varieties/landraces

Information about farmers' varieties/landraces is available from a wide range of sources, but retrieving it presents a number of challenges. Common challenges include the following:

- Different scientists may have a different understanding of what constitutes a farmer's variety/landrace, and therefore classify the same variety differently.
- In many existing databases, farmers' variety/landrace accessions are not distinguished from modern varieties. However, the FAO/Bioversity Multi-crop Passport Descriptors and Digital Object Identifiers for plant genetic resources (see Box 2) allows for distinction between farmers' variety/landrace and other types of collection samples to minimize this occurrence.
- Information related to the nomenclature of a farmer's variety/landrace may not always be correct. Common mistakes are to assume that farmers' varieties/landraces with the same name come from the same genetic unit, and that farmers' varieties/landraces with different local names are in fact different. In some cases, modern varieties have also been given similar names to existing farmers' varieties/landraces. To avoid such confusion, it is necessary to gather all relevant information and in some cases also to carry out a genetic analysis.

Assess the current information and data management systems

In many countries there are information and management systems in place, such as partial checklists and inventories of farmers' varieties/landraces. These systems should be aligned and the information they contain should be verified and corrected. The systems should also be practical, user-friendly and easily accessible for all stakeholders. To review and suggest improvements for a national data

management system, it may be necessary to work with information specialists with a good command of database structures and development.

Verify and correct collected data on farmers' varieties/landraces

When the information and data management system is assessed, errors and gaps in information can be identified. It is therefore a good occasion to review the data, which commonly fall into four different categories:

- field population;
- ecogeographical;
- conservation management; and
- characterization and evaluation.

The data have most likely been retrieved from a variety of sources, including farmers, experts, governmental documents, NGOs, commercial companies, genebanks, published scientific literature, web sites, and directly from the field. In some cases it might be necessary to verify the data with the original sources. All data included should be according to standardized descriptors (see Box 2). A meeting involving all relevant stakeholders can be arranged to review, discuss and verify the data.

Designing the farmer's variety/landrace database: descriptors and structure

Based on the assessment of the information and data management system, as well as the verification and correction of data, it may be necessary to update the current system or establish a new one. If this is identified as a need, it is important that sources of funding are secured, as well as the commitment of stakeholders. The database structure should be designed to include all the relevant information, including passport data, ecogeographical data, conservation and curatorial data, and descriptive data. It is further recommended that the information management system is made available through an open, web-enabled database, to ensure wider access.

5. ESTABLISHING CONSERVATION PRIORITIES

Quinoa diversity
©Bioversity International/D. Astudillo

To be able to establish conservation priorities an assessment of threats and conservation gaps is recommended.

A. Threat assessment

What is a threat assessment of farmer's variety/landrace diversity

A threat assessment of farmers' variety/landrace diversity refers to the process of formally evaluating the degree of threat to a farmer's variety/landrace or a farmers' variety/landrace population, estimating the likelihood of genetic erosion or extinction. The assessment of threats to diversity can be carried out at the agrogeographical level, the individual crop or farmer's variety/landrace level, or at the genetic level, and can be done at differing geographical scales (national or local).

Why should a threat assessment be undertaken?

A threat assessment of diversity will help to identify farmers' varieties/landraces or populations of farmers' varieties/landraces that are especially prone to genetic erosion and extinction, and is therefore an important criterion when establishing conservation priorities.

Methodology for farmer's variety/landrace threat assessment

A threat assessment of farmers' variety/landrace diversity can either be conducted at the farmer's variety/landrace level (i.e. extinction of the farmers' variety/landrace), or at the genetic level (i.e. allelic loss within a farmer's variety/landrace). The threat assessment is described below as a three-stage process, with a focus on the farmers' variety/landrace level only. A threat assessment can be done at the same time as the farmers' variety/landrace inventory is being prepared. When conducting such threat assessment, close collaboration should be sought with indigenous peoples and local communities and farmers cultivating farmers' varieties/landraces.

Identify criteria that indicate threats

It is recommended to use a combination of criteria from various categories to estimate the relative threat to specific farmers' varieties or landrace populations. The criteria must be defined in each specific case and the combination that is considered most relevant should be chosen. To be able to select the most relevant criteria, a preliminary assessment is normally necessary.

Some commonly used criteria indicating threats to a farmer's variety or landrace population include:

- *Climate Change:* The consequences of climate change, such as erratic and extreme events, including drought, elevated temperatures and flooding, can render the affected areas unsuitable for the continued cultivation of a farmers' variety/landrace.
- *Total growing area:* A farmer's variety/landrace can be considered less threatened if the area dedicated to growing the farmer's variety/landrace (often as a percentage of total regional area of the crop) is large, or if the trend in area of cultivation of the farmers' variety/landrace is increasing.
- *Distinctness of the farmers' variety/landrace:* A farmer's variety/landrace can be considered less threatened if it is widespread rather than growing at a single site.
- *Cultivation system:* A farmer's variety/landrace can be considered less threatened if it is grown in sustainable farming systems, which are less likely to be changed or altered. Farmers' varieties/landraces that are only found at subsistence-farm level can be considered more threatened, as the likelihood for replacement, seed loss, etc., is higher than in commercial farming systems, for instance.
- *Socio-economic indicators:* Farmers' varieties/landraces can be considered less threatened if they contribute significantly to the income and nutrition of farmers, if the perceived value is high, or if there are market prospects to commercialize the farmers' variety/landrace or farmers' variety/landrace products.
- *Access to seed planting materials:* Farmers' varieties/landraces can be considered less threatened if many farmers produce or maintain seed of the farmers' varieties/landraces or if seeds are available through community seed banks (easy to access), than if few farmers maintain the seeds (difficult to access).
- *Level of plant use:* A farmer's variety/landrace can be considered less threatened if it has more than one type of use, this may be reflected in the number of plant parts of the farmers' variety/landrace that are used.
- *Value to breeders and seed companies:* A farmer's variety/landrace can be considered less threatened if it is known to have traits of interest to breeders and companies that provide seeds and planting materials (e.g. resistance to biotic stresses) and/or is currently used in breeding programmes.
- *Farmers' variety/landrace conservation status:* A farmer's variety/landrace can be considered less threatened if it is actively managed *in situ* (including on-

farm or in other forms of managed or protected areas), or conserved in *ex situ* collections (for possible reintroduction).

- *Historical indicators:* A farmer's variety/landrace can be considered less threatened if historical data (e.g. 50–150 years) indicates positive long-term trends in cultivation, stable use, social acceptance, etc.
- *Multiplication ability:* Farmers' varieties/landraces can be considered less threatened if they produce abundant seeds or are propagated vegetatively, than if they produce few seeds or are difficult to propagate vegetatively.

Agree on type of threat assessment and category of threat

Assessing the severity of threats facing a particular farmer's variety/landrace can be done in a variety of ways, ranging from subjective, expert-led assessments, to rule-based scoring systems. An agreed set of criteria defining threats to a farmers' variety/landrace should be the starting point. If a scoring system is developed, it can be a simply point-based or rule-based, where the chosen criteria (or a combination of criteria) are weighed according to the priorities of stakeholders.

The most commonly used rule-based system for classifying threats to species is the IUCN system.[27] Based on the pre-2001 IUCN Red List Categories, a set of threat categories have been proposed as follows (Antofie *et al.*, 2010):

- Extinct On-Farm (ExF);
- Endangered On-Farm (EF);
- Endangered for *Ex situ* (EE);
- Vulnerable On-Farm (VF);
- Vulnerable to *Ex situ* Conservation (VE);
- Rare (R);
- Least Concern (LC); and
- Indeterminate (I).

27 http://www.iucnredlist.org/technical-documents. See also Hammer and Khoshbakht, 2005.

Categorization of those crop species, varieties and landraces managed on-farm can also be based on a combination of criteria such as population, ecological, social, modernization and use. A study by Joshi *et al.* (2004) proposed a practical analogy of the red list threat categories for farmers' varieties/landraces:

- Extinct (Seed is locally not available for exchange or planting);
- Endangered or threatened (Few households growing varieties in small areas);
- Conservation dependent (Many households growing the variety in small areas or vice versa);
- No risk (Commonly grown by many households);
- Not evaluated or data not available.

Identify sources and collect information

If a detailed inventory exists, most of the information needed to conduct a farmers' variety/landrace threat assessment will have been gathered. Relevant additional information can be collected by contacting stakeholders. Some information can also be gained from published, personal communications and Internet sources.

Produce the threat assessment

Based on the criteria, assessment method and collected information, the threat assessment can be compiled and should include the following parts:

1) **Identification of criteria** on which threat assessment is based, e.g.
    - growth area;
    - socio-economic and cultural importance;
    - conservation status;
    - direct use value; or
    - value to breeders.

2) **A vulnerability assessment**, including an estimation or calculation of the likelihood that the threat has a negative effect on the farmers' variety/landrace.

3) **An impact assessment**, indicating the final "threat category" of the farmers' variety/landrace, such as:

   - endangered or threatened;
   - conservation dependent; and
   - no risk.

Additionally, either a **consequence** or **scenario analysis**, or both, can be prepared to complement the threat analysis. While a consequence analysis will measure the effects or consequences of a particular threat, a scenario analysis will consider alternative outcomes and analyse possible future situations. Both analyses are closely related to the threat assessment and can help decision-making by considering outcomes and their implications.

Validation of the threat assessment

It is necessary to validate the assessment before it is finalized and made available. For validation, it is best to include both farmers and scientific experts. It is particularly important to validate the assessment for those farmers' varieties/landraces thought to be lost or close to extinction bearing in mind the characteristics of farmers' varieties/landraces.

B. Gap analysis

What is a conservation gap analysis?

A conservation gap analysis for farmers' varieties/landraces should assess both the diversity existing in farmers' fields (on-farm) and the diversity stored in genebanks (*ex situ*). The result of a farmer's variety/landrace conservation gap analysis is a list of farmers' variety/landrace populations that require active conservation, through enhanced on-farm management initiatives, in community seedbanks, or in *ex situ* collections.

Why is a conservation gap analysis of priority farmers' varieties/ landraces useful?

Conservation gap analyses are aimed at evaluating the effectiveness of current conservation actions and identifying potential gaps. This information helps to identify priorities for the development of an integrated conservation strategy for farmers' varieties/landraces.

Methodology for assessing conservation gaps

Conservation gaps can be assessed at different levels, including at individual farmers' variety/landrace, ecogeographical, trait or genetic variability levels. Examples of the application of identifying gaps in germplasm collections is described below (Box 5).

Box 5. Identification of gaps in international genebank collections

GIS-based tools in combination with passport data can accurately predict sites for further collecting of germplasm accessions to fill gaps in genebanks. For instance, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) assessed the geographical distribution, diversity and gaps in sorghum accessions conserved in its genebank that had been collected from East Africa,[5] Central and Western Africa[6] and from South Asia[7] using passport data and the GIS software FloraMap[8] and DIVA-GIS[9] (see also Box 4). The same approach was used to identify gaps in pigeon pea accessions from East and Southern Africa.[10] These have allowed targeted collection missions to be undertaken for addressing geographical, trait-specific and taxonomical gaps in their germplasm collections.

5 Upadhyaya, H.D., Narsimha Reddy, K., Vetriventhan, M., Gumma, M.K., Irshad Ahmed, M., Manyasa, E.O., Thimma Reddy, M. & Singh, S. 2017. Geographical distribution, diversity and gap analysis of East African sorghum collection conserved at the ICRISAT genebank. *Australian Journal of Crop Science*, 11(4):424-437.

6 Upadhyaya, H.D., Reddy, K.N., Vetriventhan, M., Ahmed, M.I., Krishna, G.M., Reddy, M.T. & Singh, S.K. 2017. Sorghum germplasm from West and Central Africa maintained in the ICRISAT genebank: Status, gaps, and diversity. *The Crop Journal*, 5(6):518-532.

7 Upadhyaya, H.D., Reddy, K.N., Vetriventhan, M., Gumma, M.K., Ahmed, M.I., Reddy, M.T. & Singh, S.K. 2017. Status, genetic diversity and gaps in sorghum germplasm from South Asia conserved at ICRISAT genebank. *Plant Genetic Resources*, 15(6):527-538.

8 Jones, P.G. & Gladkov, A. 1999. FloraMap: a Computer tool for predicting the distribution of plants and other organisms in the wild. Version 1. Edited by Annie L. Jones, CIAT, CD-ROM series, Cali, Colombia; Centro Internacional de Agricultura Tropical.

9 Hijmans, R.J., Guarino, L. & Mathur, P. 2012. *DIVA-GIS Version 7.5 Manual*. International Potato Center, Lima, Peru. https://www.diva-gis.org/docs/DIVA-GIS_manual_7.pdf

10 Upadhyaya, H.D., Reddy, K.N., Ahmed, M.I., Gowda, C.L.L., Reddy, M.T. & Ramachandran, S. 2015. Identification of gaps in pigeonpea germplasm from East and Southern Africa conserved at the ICRISAT genebank. *Indian Journal of Plant Genetic Resources*, 28(2):180-188.

Individual farmers' varieties/landraces level

A farmers' variety/landrace gap analysis is undertaken to identify particular farmers' varieties/landraces that are neither adequately conserved *ex situ* nor managed on-farm.

- On-farm: Review on-farm activities and seed systems that favour or maintain particular farmers' varieties/landraces. Comparison with the full landrace inventory should identify priority farmers' varieties/landraces that are not actively managed in farmer fields (on-farm).
- *Ex situ*: Review the *ex situ* accessions in genebanks by direct contact with genebank curators or by querying online databases. Based on the national inventory or checklist, determine farmers' varieties/landraces not conserved *ex situ* versus those where accessions are appropriately stored in genebanks. This analysis will identify farmers' varieties/landraces that are not actively conserved in genebanks.

Ecogeographical level

At the ecogeographical level, the gap analysis is undertaken to ascertain whether the whole ecogeographical range of a farmer's variety/landrace is represented on-farm and *ex situ*.

- On-farm: A review of the total ecogeographical range of the farmers' variety/landrace, as well as where in that range the farmer's variety/landrace is actively managed on-farm, will identify areas or environmental conditions where it is not actively managed on-farm, and thus help target new on-farm sites.
- *Ex situ*: A review of the total ecogeographical range of the farmers' variety/landrace, which has been sampled and conserved *ex situ,* will identify areas or environmental conditions where sampling has not yet occurred and/or where germplasm collection is required to complement existing *ex situ* collections and/or community seedbanks.

Trait level

Gap analysis for traits is undertaken to ascertain whether specific farmers' variety/landrace populations with a particular trait of interest (e.g. gluten content) are managed and conserved on-farm and *ex situ*.

- On-farm: A farmer's variety/landrace with a specific trait of interest actively managed on-farm may be compared to its total ecogeographical range, thus identifying additional sites where the farmer's variety/landrace could be managed on-farm.

- *Ex situ*: A farmer's variety/landrace with a specific trait of interest that has been collected and conserved *ex situ* may be compared to its total ecogeographical range, thus identifying sites to target for further collecting and *ex situ* conservation (see also Box 6).

Box 6. Focused Identification of Germplasm Strategy (FIGS)

GIS-based predictive characterization can be used to identify populations that are likely to contain desirable traits (e.g. insect resistance). Focused Identification of Germplasm Strategy (FIGS) is a predictive characterization technique that can be used in this context. The basic steps of a FIGS analysis for farmers' varieties/landraces are:

- Compile the geographical distribution of farmers' varieties/landraces.
- Gather characterization and evaluation data regarding the trait of interest from *ex situ* collection databases and georeference the samples that contain the trait of interest.
- Gather environmental information (e.g. climate, soil, elevation, topography) and extract environmental data for each farmers' variety/landrace accession or population using GIS software (e.g. DIVA-GIS) (Box 4).
- Use the existing characterization and evaluation data to identify sites where the target variation likely exists.
- Produce profiles of the sites identified above in terms of environment, ecology and any other relevant data.
- Look for similar environmental profiles among other sites and develop a sampling strategy using clustering, principal component analysis, etc.
- Identify whether *ex situ* accessions are available or if active on-farm management is carried out, and whether it is necessary to collect *de novo* from the identified sites in order to complete the *ex situ* collection or to target populations for *in situ* conservation.

Further information can be found in Bari *et al*. (2012)[11] and references therein. Other approaches to predictive characterization can be found as a pdf file[12] at the following Web site:
https://www.bioversityinternational.org/index.php?id=244&tx_news_pi1%5Bnews%5D=5681&cHash=387f3adec800cf957324f79a5c413770

[11] Bari, A., Street, K., Mackay, M., Endresen, D.T.E., De Pauw, E. & Amri, A. 2012. Focused identification of germplasm strategy (FIGS) detects wheat stem rust resistance linked to environmental variables. *Genetic Resources and Crop Evolution*, 59(7): 1465–1481. (See doi: http://www.dx.doi.org/10.1007/s10722-011-9775-5)

[12] Thormann, I., Endresen, D.T.F., Rubio-Teso, M.L., Iriondo, M.J., Maxted, N. & Parra-Quijano, M. 2014. *Predictive characterization of crop wild relatives and landraces: Technical guidelines version 1*. Bioversity International, Rome (Italy). https://www.bioversityinternational.org/index.php?id=244&tx_news_pi1%5Bnews%5D=5681&cHash=387f3adec800cf957324f79a5c413770

Genetic variability

Looking at the genetic variability of a farmer's variety/landrace or of a specific trait, a gap analysis can be undertaken to ascertain whether adequate genetic variability is represented on-farm and *ex situ* for each farmers' variety/landrace.

- On-farm: A review of the genetic diversity of the farmers' variety/landrace populations actively managed on-farm and the genetic diversity within the total ecogeographical range of the farmers' variety/landrace, will show whether or not adequate genetic diversity is conserved on-farm.
- *Ex situ*: A review of the genetic diversity of the farmers' variety/landrace populations collected and conserved in genebanks and the genetic diversity within the total ecogeographical range of the farmers' variety/landrace, will show whether or not adequate genetic diversity is conserved *ex situ*.

Chickpeas and lentils diversity
©ICRISAT

C. Setting conservation priorities

What is farmer's variety/landrace conservation prioritization?

Farmer's variety/landrace conservation prioritization is the process of ascribing a relative value to farmers' varieties/landraces and ranking them in order of importance.

Why is it useful to set farmers' variety/landrace conservation priorities?

In most cases, a national inventory of farmers' varieties/landraces will identify a greater number of farmers' varieties/landraces than can be conserved with the financial resources and expertise available in the country. Therefore, farmers' varieties/landraces must be prioritized in order to select those for which active conservation measures should start immediately, versus those for which conservation actions could be delayed. This will directly aid governmental agencies and other groups in determining conservation priorities and is helpful in developing a conservation plan.

Methodology for prioritizing farmers' varieties/landraces

Farmer's variety/landrace conservation prioritization depends on a number of factors, including the number of farmers' varieties/landraces grown in the country, the resources available for their conservation, the differing needs of farmers and the local communities, as well as the existing policy framework and interests of the authorities. The process of setting priorities for farmers' variety/landrace conservation may, therefore, vary according to the needs of the country. A generic methodology is described below addressing common criteria.

Identify prioritization criteria

To determine which farmers' varieties/landraces to conserve, an agreed set of prioritization criteria needs to be defined (Drucker, 2011). To prevent these criteria from being subjective, it is essential that this be done in a participatory way, involving all relevant stakeholders, including farmers. It is best to use a combination of criteria from various categories in the process of prioritizing farmers' varieties/landraces or specific farmers' variety/landrace populations. Some criteria that are commonly used include:

- *Economic value*: Farmers' varieties/landraces are of direct use, particularly in subsistence or marginal agriculture and they constitute a potential source of novel genetic diversity for breeding and other uses. Two sub-criteria may be used:

  - *National economic value of the crop*: For example, crop production quantity and area and the number of known crop varieties (including farmers' varieties/ landraces) grown at the national level; and
  - *Economic value of the farmer's variety/landrace*: Farmer's variety/landrace production quantity, area and uses (whether the farmers' variety/landrace is grown for food, fodder, forage, etc.).

- *Farmers' variety/landrace diversity*: Whether a particular farmer's variety/landrace occurs together with other farmers' varieties/landraces. It is more cost effective to conserve sites with a high number of farmers' varieties/landraces rather than sites with a single farmer's variety/landrace.
- *Cultural value*: The cultural importance that a particular farmer's variety/landrace has in a community.
- *Farmers' priorities*: The priority given to a particular farmer's variety/landrace by the farmers, e.g. based on importance in their diet, or special cooking qualities. An indication of the importance of the farmers' variety/landrace may be estimated by the number of farmers that grow a particular variety/landrace, which could often be linked to culinary or other quality traits. It is important to note that members of a community may value crops and traits differently, which needs to be taken into consideration when assessing priorities.
- *Threat status*: The more threatened (i.e. increased likelihood of genetic erosion or actual extinction of the crop or farmers' variety/landrace), the greater the conservation priority.
- *Native status*: Whether the farmers' variety/landrace originated in the country, or whether it has been introduced and when.
- *National rarity*: A farmer's variety/landrace with limited range within the country is considered rarer than a farmer's variety/landrace occurring throughout the country; therefore, the number of provinces in which each farmers' variety/ landrace occurs (or other indicator of restricted distribution) can be considered.
- *Conservation status*: Before a farmer's variety/landrace can be given high priority for conservation, related current conservation activities should be reviewed. If sufficient genetic diversity is already being conserved *ex situ* or managed on-farm, additional conservation efforts may not be justified and resources should focus on those farmer's varieties/ landraces that are not being actively conserved. The information obtained from *ex situ* holdings should be evaluated carefully, while keeping in mind potential issues such as duplication of accessions, lack of population representation and low sample viability.

- *Agronomic information as noted by the farmer:* Beneficial farmers' variety/landrace characteristics such as adaptation to high altitude, tolerance of water stress, resistance to pests or diseases, yield, size, taste or colour;
- *Historical evidence:* A farmer's variety/landrace that has been cultivated for a longer time may have higher priority, assuming that the length of cultivation is an indication of perceived value by farmers, relative adaptability to the local environment and consumer preferences.
- *Other:* Other criteria that might be useful or considered important include threats to a small niche market, or declining use of particular farmers' varieties/landraces in religious ceremonies, changing dietary habits, etc.

Agree on type of prioritization assessment

Priority to a range of farmers' varieties/landraces can be assigned in a variety of ways, from subjective, expert-led assessments, to prioritization schemes. Quantitative methods for prioritizing species range from simple indices depending on a few relatively easily measured variables, to more complex, rule-based scoring systems, where points are assigned for various biological, phenological and management variables. The complexity of the scheme or methodology adopted will depend on the available time, financial resources and data, as well as the genetic diversity of the crop.

Whatever scoring system is used for farmers' variety/landrace conservation priority, it must be agreed. These can be modified from the IUCN categories of threats, or developed specifically for the intervention. A simple list of categories indicating priority is provided as Table 2.

Farmer's field, Rwanda
©FAO/L. Borgen Nilsen

Table 2. Example of prioritization categories

Prioritization category	Description	Explanations and notes
1a	Urgent need for on-farm management and *ex situ* conservation	Highest priority
1b	Urgent need for on-farm management	
1c	Urgent need for *ex situ* conservation	
2a	Need for on-farm management and *ex situ* conservation	Priority
2b	Need for on-farm management	
2c	Need for *ex situ* conservation	
3a	Moderate to little need for on-farm management and *ex situ* conservation	Less priority, but monitoring and evaluation schemes recommended
3b	Moderate to little need for on-farm management	
3c	Moderate to little need for *ex situ* conservation	
4a	No need for on-farm management and *ex situ* conservation	No priority
4b	No need for on-farm management	
4c	No need for *ex situ* conservation	
5	Need for re-assessment	Insufficient data

Produce the list of prioritized farmers' varieties/landraces

Based on the criteria, assessment method and collected information, the prioritization scheme can be applied to the national inventory (or checklist), and the priority farmers' varieties/landraces identified. The prioritization assessment should include the following parts:

- Identification of the prioritization criteria on which the threat assessment is based, e.g.
  - *economic value;*
  - *cultural value;*
  - *farmer priorities; and*
  - *threat status.*

- A **prioritization assessment** where the list of farmers' varieties/landraces (as available in the checklist or inventory) are evaluated against each of the selected criteria.

- An **impact assessment**, indicating the final "conservation category" of the farmers' variety/landrace, e.g.
  - Highest priority: Urgent need for on-farm management and *ex situ* conservation;
  - Priority: Need for on-farm management.
  - Priority: Need for *ex situ* conservation.
  - Less priority: Moderate-to-little need for *ex situ* conservation.
  - No priority.

Environmental and agronomic situations can change quickly, and have unforeseen consequences for crops and varieties. In addition, the chosen criteria may not cover all elements that may have an effect on the priority status of a particular farmer's variety/landrace. Therefore, it is necessary to monitor farmers' varieties/landraces on a regular basis, regardless of the prioritization category.

Validation and finalization of the conservation priority assessment

As with other assessments, it is necessary to validate the outcomes of the conservation priority assessment among stakeholders, including relevant indigenous peoples and local communities and farmers, before it is finalized. The final list of the prioritized farmers' varieties/landraces should be subject to specific *ex situ* conservation and on-farm management measurements, and addressed specifically in the National Plan. It is therefore important that the total number of prioritized farmers' varieties/landraces is adjusted to a number that can be actively conserved or managed using the available resources.

6. PREPARING THE NATIONAL PLAN

Rice terraces, China
©FAO/A. Noorani

A National Plan is a blueprint for the management of the farmers' varieties/landraces found in the country. It should identify the country's vision, goals and objectives, as well as the corresponding action plan, describing how each objective will be accomplished. Although the National Plan itself can be structured in a variety of ways, it is recommended to include some common elements, which are described below.

A. Vision statement

A vision statement is an inspirational declaration reflecting the long-term vision the country has for conserving farmers' varieties/landraces. It should relate to overall national strategies. The vision should illustrate where the country wishes to be with regards to conservation and sustainable use of farmers' varieties/landraces in the future. A simple approach to developing a vision statement may be to:

1) Discuss the country's aspirations and long-term expectations for the conservation and sustainable use of farmers' varieties/landraces. The country context, scope and state of farmers' variety/landrace conservation and sustainable use should be taken into account.

2) Envision a "best scenario" for the state of farmers' variety/landrace conservation and sustainable use at the end of an agreed period. The scenario should be inspirational, but at the same time realistic.

3) Formulate the vision statement, based on the outcome of (1) and (2). This exercise can be done by using a series of participatory approaches, such as focus group discussions with illustrations of scenarios. An example of a vision statement could be: "By 2025, Country X has a national system in place for the active conservation of the country's diversity of farmers' varieties/landraces, while simultaneously promoting their use".

4) Seek stakeholder inputs and agreement.

B. Goals and objectives

A National Plan will have clearly defined goals and objectives, covering the prioritized crops and farmers' varieties/landraces, and addressing the most pressing issues. The goals and objectives should be guided by the long-term vision for the state of farmers' varieties/landraces in the country.

The **goals** of the National Plan should be stated as general intentions, describing the overall purpose and desired result. The goals of the National Plan should focus on promoting farmers' variety/landrace management in farmers' fields, their collection and conservation in genebanks, their sustainable use, as well as the strengthening of institutional and human capacities, including awareness creation and information management. The goals should be based on the country context and policy framework and agreed among all stakeholders, while also complementing other PGR initiatives. The goals should be in harmony with national programmes, in particular the National Strategy for PGRFA.

National programmes within the Ministry of Agriculture need to be consulted, so that appropriate information and linkages are ensured. Where necessary, the National Plan can set goals to align existing laws to enabling policies for the use and conservation of farmer varieties/landraces. Goals of a National Plan might include:

- establishing a systematic and coordinated national approach in support of on-farm management of farmers' varieties/landraces;
- formulating and implementing a collection programme for complementary *ex situ* conservation of farmers' varieties/landraces in the country; and
- ensuring the sustainable use of farmers' varieties/landraces in the country.

The **objectives** of the National Plan should be more specific and define the concrete targets that the National Plan intends to accomplish for the priority farmers' varieties/landraces. The objectives should be based on the threat assessment, gap analysis and elaborated conservation priorities. Five suggested objectives within a specified time frame might be to:

- identify [number] areas where farmers' varieties/landraces are managed on-farm;
- establish a network of [number] on-farm management sites, actively managing the full genetic range of the [number] highest priority farmers' varieties/landraces;

- conduct a minimum of [number] collection missions in Provinces X, Y, Z, and ensure *ex situ* back-up of the [number] highest priority farmers' varieties/landraces in the country;
- initiate pre-breeding and breeding activities at a minimum of [number] sites, focusing on farmer-preferred varieties; and
- ensure commercialization and marketing of a minimum of [number] farmers' varieties/landraces or derived products.

C. Action plan and timeline

The main content of the National Plan should be in the form of an action plan, where goals, objectives and planned activities are described, along with the responsible unit(s), success criteria or indicators, a time frame and a budget. The roles and tasks of stakeholders should be clearly outlined, including the responsibilities in management and coordination. The action plan can include both strategic activities, aimed at providing enabling conditions and necessary incentives to achieve the objectives of the plan (often at political, institutional, legislative or economic levels), as well as concrete activities describing practical measures to be implemented on the ground by stakeholders, programmes and projects.

The action plan should define activities precisely, referring to specific farmers' varieties/landraces, locations, institutions and methods. However, the National Plan can also include indicative activities, acknowledging that specific approaches will need to be adapted in light of experience in implementation. The National Plan should also include elements that will allow an efficient monitoring of progress, including implementing agency, success criteria or indicators, time frame and financial resources, as well as a plan for updating/revision. An example of a simple action plan is shown in Table 3.

Table 3. Example of an action plan

Objective	Activities	Implementing agency	Success criteria	Time frame	Budget
What are the overall, broader impacts to which the activity will contribute?	What should be done to achieve the country objectives?	Who is the responsible unit (or person) for each task?	What are the indicators to measure whether and to what extent the activities have achieved the expected results?	By when should the task have been achieved?	What are the costs of each activity?

D. Monitoring the implementation of the National Plan

Monitoring the National Plan is part of the overall responsibility of the National Focal Point and implementing authority, and is quite distinct from the monitoring of individual populations of farmers' varieties/landraces. There are several reasons why monitoring the National Plan is an essential part of any strategic plan, including:

- to measure efficiency and effectiveness of the activities;
- to detect potential or emerging problems and make adjustments if necessary; and
- to record changes over time.

To enable efficient monitoring of deliverables and progress, the action plan should specify implementation and review cycles, clearly indicating the time period in which the activity should take place, when key deliverables should be produced, how they should be measured, and by whom. To allow an efficient monitoring process, it is recommended that the National Plan include a specific monitoring plan, where these details are elaborated for all the activities. The monitoring plan should at a minimum include a defined set of indicators, each with an associated baseline,

target, time frame and responsible unit. Additional information, including the tools and methods to observe and collect data to measure the indicators, should also be incorporated. The following questions can be useful when developing indicators and preparing a monitoring plan:

- What are the key objectives of monitoring the activity?
- What is your target?
- What should be monitored and how can it be measured?
- When and how often should activities and indicators be measured?
- Who should measure them?
- How should the monitoring data be used?

An example of a simple monitoring plan is shown as Table 4.

Table 4. An example of a monitoring plan.

Goal/ objective	Activities	Performance indicator	Baseline	Target	Time frame	Responsibility
What are the overall, broader impacts to which the activity will contribute? (Same as in the action plan).	What should be done to achieve the country objectives? (Same as in the action plan).	What quantifiable measures can be used to determine performance in relation to the goals and objectives?	What are the starting conditions against which progress can be measured?	What is the specific, measurable goal, linked to the indicator?	By when should the monitoring exercise have been done?	Who is the responsible unit (or person) for monitoring each task?

E. Resource mobilization

Implementing a National Plan will require financial resources. Realistic and detailed cost estimates for the individual elements of the action plan will facilitate the mobilization of resources and funding for the implementation of the strategy. These funds should primarily come from the implementing stakeholders, but can also be obtained from other sources, including the domestic budget, external partners, donor assistance or other innovative financial mechanisms. If the financial resources in the country are limited or not secure, the scope of the plan and the activities it describes might need to be adjusted accordingly.

Similar considerations should be applied if the country has limited human resources or few committed stakeholders to drive the implementation of the National Plan. To prevent lack of resources at a later stage, it is recommended that a resource mobilization scheme be agreed upon between stakeholders and included in the National Plan. The resources mobilization scheme should be a simple plan that outlines how the financial resources needed to implement the National Plan should be secured. This can include activities to:

- ensure predictable, adequate and stable growth of stakeholder core resources to implement activities;
- supplement core resources with non-core funding, specifically aimed at implementing the National Plan;
- expand the donor base;
- increase the amount of resources currently provided by the government to implement activities; and
- initiate joint activities (e.g. task forces).

F. Communication, consultation and validation

Communication and consultations are part of the vertical process that supports the development of the National Plan. The fully participatory approach to developing the National Plan in harmony with concepts at regional and international levels can yield many benefits, including increased ownership of the strategy, a broadened knowledge base; and better general understanding of how the National Plan will achieve its objectives. Collaboration between stakeholders will also increase the sustainability of the work in the implementation phase, reduce costs (through sharing of tasks), increase effectiveness and ensure more political and practical support. Through regular consultation processes, the relevant stakeholders can participate in the preparation of the vision statement, goals and objectives; identify priority activities to form the main elements of the strategy; and help serve as communication channels for creating awareness and building support for the National Plan.

Before implementation can take place, the National Plan needs to be validated by all relevant stakeholders and approved by the national authorities. It is therefore necessary to conduct a consultation process to verify and validate the document. The aim of the consultation process is to capture the perspectives of the stakeholders so that inputs from a broad spectrum of interest groups contribute to shaping the final version of the National Plan, and ultimately agree on timelines, management responsibilities, and key deliverables. A combination of electronic consultations and in-person meetings is recommended in order to have the best

Cashews
©FAO

possible consultation process, allowing all stakeholders an equal opportunity to provide feedback and contribute to discussions. Encourage feedback from all stakeholders; allowances should be made for different stakeholders that may, for example, need translations of documents.

To validate the final document of the National Plan, a large meeting should be arranged, where all stakeholders participate, including the relevant authorities. This will allow for the presentation of the final product, sensitizing stakeholders and agreeing on how the document should be presented and promoted in the country. The finalization and validation of the draft strategy should always be followed by stakeholder commitment to implement it. Therefore, the validation meeting can be an occasion to agree on specific "next steps" that can help initiate the implementation phase.

Following the validation of the National Plan, it is recommended that the final document be made available in printed and/or electronic form and disseminated widely, including to all stakeholders involved. The organization of events, as well as the timely use of mass media – social media, newspapers, TV, leaflets, radio, etc. – should also be considered for creating public awareness about the National Plan.

7. IMPLEMENTATION

Local sorghum variety, India
©ICRISAT/S. Sridharan

To implement a National Plan means to realize the objectives and activities it describes, following the process, budget and timeline envisioned. This chapter provides guidance for the implementation of three suggested goals: on-farm management of farmers' varieties/landraces; *ex situ* conservation of farmers' varieties/landraces; and sustainable use of farmers' varieties/landraces.

A. Establish a systematic and coordinated national approach in support of on-farm management of farmers' varieties/ landraces

It is highly recommended that the National Plan include a goal specifically for promoting on-farm management of farmers' varieties/landraces. Potential objectives that may contribute to a more systematic and better coordinated national approach to on-farm management are discussed below.

Establish or strengthen the national PGRFA network

The national PGRFA network is conceived here as the organization of interconnected stakeholders contributing to the management of PGRFA within the country. Such networks exist in many countries, often in the form of a National PGRFA Programme. Some countries have an efficient network and coordination of stakeholders in place; in others these are completely lacking or exist only in informal structures.

National PGRFA networks are invaluable in coordinating activities related to PGRFA at the country level, providing advice to authorities and others on PGRFA issues, and providing a practical mechanism for fostering synergies among stakeholders. The key to an effective national PGRFA network is to ensure that it is fully participatory and includes all relevant stakeholders, especially farmers and their organizations. The implementation of activities supporting on-farm management of farmers' varieties/landraces can be complicated in many countries, especially where farmers are not involved in the national PGRFA network. Farmers therefore need to be fully acknowledged by the conservation and policy communities at the national level.

In order to establish or strengthen the national network, the authorities (or the entity leading PGRFA initiatives) could:

- identify and recognize key stakeholders in the country working with PGRFA-related issues;
- communicate, connect and share information;
- offer support to stakeholders and create "win-win" situations;
- initiate meetings and collaborative activities, ensuring full participation; and

- create awareness, upstream and downstream, of the importance of PGRFA and their on-farm management.

The preparation of a National Plan is an example of an activity that demands the involvement and collaboration of a broad range of stakeholders, and that would directly benefit from a well-coordinated, operational network at the country level. Ensure that on-farm management is recognized as a priority at the country level.

Ensure that on-farm management is recognized as a priority at the country level

Despite on-farm management being considered a priority activity[28] it has not been regarded as a priority in a number of countries. To establish a systematic and coordinated approach for on-farm management at the country level, it is necessary to ensure that on-farm management is a priority for all involved: the authorities; stakeholders working with issues related to PGRFA; and, most importantly, farmers and farming communities. To promote on-farm management as a national priority, the following need to be addressed:

- build *awareness* and explain the importance of farmers' varieties/landraces (both among policy-makers and practitioners);
- ensure that on-farm management is addressed in the national *policy framework*;
- mobilize *funds and support* for on-farm management;
- support the value chains and markets for the products of farmers' varieties/landraces; and
- ensure that *farmers benefit* from the initiatives that are proposed and implemented.

Recognize and involve local communities in the sustainable use of farmers' varieties/landraces

Maintenance of farmers' varieties/landraces cannot be successful without the support and involvement of indigenous peoples and local communities. In order to promote their continuing management and use, farmers' varieties/landraces must be demonstrated as beneficial to the individual farmer. In addition, indigenous peoples' and local communities' use of farmers' varieties/landraces should not be

28 Second GPA priority area 2 states "Supporting on-farm management and improvement of plant genetic resources for food and agriculture". http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/gpa/priority-areas/en

restricted or infringed by active conservation and management of certain farmers' varieties/landraces.

The following points can help recognize and involve indigenous peoples and local communities:

- recognize, document and promote traditional knowledge and traditional cultivation practices with the active involvement and prior informed consent of the holders of that knowledge or in keeping with established norms (FAO, 2010);
- promote participatory action and involve farming communities in information gathering and planning of interventions;
- promote participatory approaches to crop improvement, including the improvement of farmers' varieties/landraces, (e.g. through the adoption of participatory variety selection, participatory plant breeding, etc.) and effective seed delivery systems, including the production of quality seeds;
- raise the profile of farmers' varieties/landraces in the agricultural community;
- foster short- and long-term farmer benefits, including innovative market niches and commercial opportunities; and
- promote linkages and collaboration among stakeholders, to support local initiatives, e.g. marketing and commercialization of farmers' varieties/landraces.

Identify locations where on-farm management initiatives can best be supported

In order to identify sites or farms where targeted on-farm management activities should be supported, the following points might be considered:

1) **Agree on prioritized farmers' varieties/landraces**

   A list of farmers' varieties/landraces should be developed to rank them in order of importance for on-farm management initiatives. If farmers' variety/landrace conservation and sustainable use priorities have already been established, it is important to evaluate the assessment and verify it among the local stakeholders. The environmental, social or agronomic situations may have changed since the assessment was done. If a new prioritization assessment is needed, the methodology provided in Chapter V, Section C can be applied.

2) Select a single- or multi-farmer's variety/landrace approach

Whether to focus on-farm management initiatives for one or several farmers' varieties/landraces (and how many) will ultimately depend on the goals of the National Plan, the priorities and capacity of the executing stakeholder(s), and on farmers' willingness to maintain the farmers' varieties/landraces in their production system. Often, an approach targeting multiple farmers' varieties/landraces is more viable and realistic because the management unit costs will be reduced. In addition, multi-landrace sites may support entire farming systems, whereas single-farmers' variety/landrace sites are focused on the value (economic, nutritional, cultural, etc.) of an individual farmers' variety/landrace and on its particular adaptive diversity. However, if a particular farmers' variety/landrace is of sufficient national priority, even if found in isolation from other farmers' varieties/landraces, measures should be taken to manage it.

3) Preliminary selection of sites

Selected sites should offer potential for efficient, long-term management of prioritized farmers' varieties/landraces:

- If a single farmers' variety/landrace approach is taken, the sites targeted for on-farm management activities should be selected throughout the distribution area of that particular farmer's variety/ landrace. Sites can be based on geographical location or other parameters, such as intraspecific genetic variability, cultural value, or threat status (see criteria for prioritization, Chapter V, Section C).

- If a multi-farmers' variety/landrace approach is taken, the sites should be established based on the minimum number of farm areas that contain the optimal number of farmers' varieties/landraces. Such site selection can be based on either a 'hotspot analysis', which identifies one or more areas with high farmer's variety/landrace richness ('hotspots'), or a 'complementarity analysis', which can be used to identify the minimum number of sites needed to manage all the diversity of target farmers' varieties/landraces within the minimum number of sites. Both analyses can be carried out using the computer program DIVA-GIS (see Box 4). Using hotspot analysis, common farmers' varieties/landraces are likely to be duplicated if multiple on-farm sites are planned, which can be avoided using complementarity analysis. However, it might be worthwhile to focus management activities on multiple sites with a similar array of farmers' varieties/landraces if the genetic diversity contained at one site complements rather than duplicates the diversity at other sites. If time and resources for carrying out a complementarity analysis are not available, a general guide is to choose five farmers' variety/landrace

populations from the most ecogeographically diverse sites for active management that have farming communities willing to participate in on-farm conservation and sustainable use of the selected farmers' variety/landrace populations.

- In the selection of sites, collaboration with managers of protected areas should be explored, as some protected areas contain a considerable amount of agricultural land where farmers' varieties/landraces are maintained by farmers. It is therefore relevant to consider and assess protected areas in the preliminary selection of sites. If prioritized farmers' varieties/landraces exist within the boundaries of protected areas, it is logical that they be included in the conservation and management plan for the area.

4) **Consider threats and sustainability of the preliminary selected sites and agree on a final selection**

   The final selection of sites where on-farm management should be supported will be based on an assessment of threats and sustainability of these sites, including the willingness and ability of the farmers in the area to be involved on a long-term basis. Threats, such as vulnerability to disasters, and demographic fluctuations, will make the agricultural production in an area less sustainable. Such factors should be taken into account when selecting areas for on-farm management. Priority should be given to areas not known to be severely affected by threats. Areas where farmers' varieties/landraces are more likely to suffer genetic erosion due to threats may be more appropriately targeted for *ex situ* conservation. Particularly vulnerable areas should also be closely monitored, as the farmers' varieties/landraces remaining in these areas may be evolving in response to the changing environmental conditions, thus making them of potential value to breeders.

Promote on-farm management activities

Farmers' variety/landrace diversity of major staple crops and minor crops remains important to the livelihoods of small-scale farmers. The reasons for maintenance of traditional farmers' varieties/landraces are complex and often associated with adaptation to low input agriculture, stable performance, cultural value and food preference, socio-economic conditions of small-scale farmers, and existence of niche markets whose requirements cannot be met by modern cultivars.

When priority sites have been identified, the promotion and implementation of on-farm management activities can broadly be separated into three stages:

1) Develop an appropriate understanding of the extent and distribution of the farmers' variety/landrace diversity at the site and those cultivating the farmers'

varieties/landraces. If comprehensive national or regional inventories have been developed, most of the needed information will already be available. For each farmers' variety/landrace being assessed, collect relevant data such as name and characteristics, names and locations of farmers growing them, use, association with local cultural values, seed access, seed distribution, and whether used by researchers, breeders or seed companies.

2) Assess how this farmers' variety/landrace diversity is maintained and used, as well as the constraints affecting its sustainable management. Of the factors influencing the use of the farmers' varieties/landraces, it is pertinent to identify the mechanisms that allow farmers to keep growing particular crops. This may include access to seeds, preferred taste, suitability to the local farming systems, and traditional and ceremonial significance.

3) Analyse the interaction between the farmers' variety/landrace diversity and farming practices to identify complementary and/or supporting actions. The success of any actions will depend on local knowledge, and the involvement and leadership of farmers, indigenous peoples and local communities and local institutions.

The common constraints farmers face in the maintenance and use of farmers' varieties/landraces are related to the *availability* of on-farm diversity, farmers' access to farmers' variety/landrace diversity and related information, the *worth* and *significance* given to the farmers' varieties/landraces, and the *benefits* obtained from their use. In many countries, legislative issues around seed certification and national registration of varieties may cause serious constraints for maintenance of farmers' varieties/landraces (Visser, 2017). In order to be able to plan and promote on-farm management activities, these constraints will need to be considered carefully. It has been suggested that the following must be ensured in order to promote on-farm management successfully (Jarvis *et al.*, 2011):

- local crop diversity exists in sufficient abundance within the production systems;
- local crop diversity is accessible to farmers;
- farmers are aware of the value (environmental, nutritional, socio-economical, etc.) of the farmers' varieties/landraces; and
- farmers derive benefit from the management of farmers' varieties/landraces.

Interventions and activities supporting on-farm management normally address one (or more) of the points above. An overview of many such interventions is provided as Table 5.

Promote and support linkages between farmers, community seed banks and national genebanks

In many cases, farmers store and safeguard the seed or planting material they are planning to use in the next planting season. Farmers may also save more than they need for their own use, in order to distribute and sell to other farmers. In some cases, storage and distribution or exchange mechanisms are operating at the local level. These may be formalized as community seed banks (CSB). The goals of these community seed banks are to provide a safe and controlled storage facility for seeds and easy access to seed for farmers, as well as act as a buffer against seasonal crop failure and loss of seed. A CSB can also play a role in extending access to particular crops and varieties (e.g. a particular farmers' variety/landrace) for more farming communities. As such, community seed banks have an important role in ensuring food security, especially in areas affected by environmental changes, and increased awareness and promotion of farmers' variety/landrace diversity. Community seed banks are in most cases administered locally by a selected group or a specific person.

As a community seed bank cannot be regarded as long-term conservation facility, it is highly recommended that farmers' varieties/landraces stored there are also conserved in a national genebank as a safety back-up. This will enable reintroduction in case of local loss of a farmers' variety/landrace. Good linkages between farmers, community seed banks and genebanks (whether at local, regional or national level) will help farmers to have access to the planting material they need in a timely manner and ensure that the plant diversity they use is safely stored in genebanks.

Production of specific management plans

Action plans developed for specific farmers' varieties/landraces and/or specific sites depend on which approach is being used. A farmers' variety/landrace action plan is typically produced when a single-farmers' variety/landrace approach is used. It should focus on the current on-farm conservation and sustainable use status of the targeted farmers' variety/landrace, threat assessment, and describe any additional management and monitoring requirements, including the incorporation in existing national or local conservation initiatives, and farmers' knowledge of the production systems.

An **on-farm management plan** is produced to include information on all the farmers' varieties/ landraces within the site, including to the extent possible the information listed above for the *farmers' variety/landrace action plans*, as well as information about the management of the specific site as a whole.

Propose and establish a long-term funding mechanism in support of on-farm management

Realistic and detailed cost estimates for all proposed activities supporting on-farm management will help to facilitate the mobilization of resources and funding. Financial mechanisms need to be set up and articulated in ways that will survive change in people, policies and governments. To establish a long-term funding mechanism in support of on-farm management of farmers' varieties/landraces it will be necessary to have a clear statement from the government and stakeholders of the importance and commitment to this activity.

Vegetable diversity in a local market, Papua New Guinea
©Bioversity International/P. Mathur

Table 5. Examples of actions that promote on-farm management

General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the production systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Improving availability of material	Reintroduction of materials from *ex situ* collections (national or community genebanks)	X	X		
	Reintroduction of materials collected from farmers from similar environments into local informal seed systems	X	X		
	Seed cooperatives for collection, distribution and multiplication of seeds	X	X		X
	Community seed banks and genebanks	X	X	X	X
	Community-managed nurseries	X	X	X	X
	Diversity field fora (where farmers experiment in and discuss crop analysis, management and improvement)	X	X	X	X
	Diversity kit (diverse farmers' varieties/landraces made available to farmers to allow them to select those that suit their conditions and need)	X	X	X	X
	Diversity fairs	X	X	X	X
	Seed vouchers	X	X	X	
	Reduced transport costs of traditional variety as material is already closer to farm communities		X		
	Cross-site visits for farmers and local extension workers	X	X	X	
	Microfinance or credit schemes to enable purchase of local materials		X		

Table 5. Examples of actions that promote on-farm management

General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the production systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Improving information and availability of information	On-farm experimental diversity blocks	X	X	X	X
	Field or lab trials comparing traditional and modern varieties	X	X	X	
	Community Biodiversity Register			X	X
	Literacy training, particularly for poor and vulnerable groups			X	X
	Variety information databases made in farmer friendly formats			X	X
	Setting up information systems and Internet connections for farmers' access to information		X	X	X
	Small weather stations that can be linked to Internet sites			X	X
	Rural radio programmes that includes talks on the importance of crop diversity			X	X
	Drama, music and poetry travelling shows that have crop diversity as a theme			X	X
	Painting and art competitions that reward farmer groups for knowledge and descriptions of agricultural diversity			X	X

Table 5. Examples of actions that promote on-farm management					
General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the pro-duction systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Improving and management of traditional varieties materials	Participatory crop improvement (Participatory Plant Breeding, Participatory Varietal Selection)		X	X	X
	Using genomics to improve *in situ* crop populations		X	X	X
	Changing the formal breeding institutions to increase the use of farmer selected materials and traditional varieties in their programmes		X	X	X
	Planting of intra-specific mixtures to reduce pests and diseases		X	X	X
	Improve seed storage facilities and methods			X	X
	Seed cleaning and treatment			X	X
Improved processing	Shift retailers to use different processing equipment that can use diversified materials			X	X
	Training of producers in improved processing techniques and providing credit to acquire processing equipment			X	X

Table 5. Examples of actions that promote on-farm management

General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the production systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Alternatives and modifications to seed certification systems	Plant varieties common knowledge (VCK)		X	X	X
	Registration and release of farmer varieties with acceptance of enhanced bulk varieties		X	X	X
	Geographical indications		X	X	X
	Quality declared seed (QDS) (that certify the vendor rather than the seed)		X	X	X
	Laws that focus on seed quality rather than seed purity (truthfully-labelled seed)		X	X	X
	Registries of native crops		X	X	X
	Links between intellectual property rights protection and benefit-sharing				X
	Plant variety protection systems adapted to farmer varieties			X	

Table 5. Examples of actions that promote on-farm management

General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the pro-duction systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Market creation and promotion	Market promotion through taxes and subsidies				X
	Market creation for traditional varieties or products from traditional varieties, including niche markets		X	X	X
	Education and financial support to farmer groups and other stakeholders to develop a marketing strategy			X	X
	Micro-credit facilities to set up small businesses, particularly for rural men and women				X
	Advertising campaigns to improve consumer and retailer awareness of important traits (nutritional, adaptive, etc.)			X	X
	Cook books with traditional recipes; gardening books that promote traditional varieties for particular management practices			X	X
	Fair trade price premiums – Eco-labelling (paying the full production value through price premiums)		X	X	X

Table 5. Examples of actions that promote on-farm management

General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the pro-duction systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Building partnerships and trusts	Organization of meetings involving market-chain actors to discuss how to enhance market potential			X	X
	Private and public partnership for the construction of small infrastructure for the production of a better quality product			X	X
	Strengthened and cooperative extension services that include farmers are more demand driven, or establish new farmer-governed local institutions	X	X	X	X
Changing norms	Advertising and social campaigns that promote better adapted varieties that reduce the need for chemical inputs, or to change social norms such as nutritional cultural values of food			X	X
	School biology curriculum includes traditional crop varieties as agricultural resource and ecosystem service	X		X	X
	Gender-sensitive response policy	X	X	X	X

Table 5. Examples of actions that promote on-farm management

General category	Actions	Steps			
		Ensure local crop diversity exists in sufficient quantities within the pro-duction systems	Ensure local crop diversity is accessible to farmers	Ensure local crop diversity is valued among farmers	Ensure farmers benefit from the use of local crop diversity
Promoting ecological land management practices	Environmentally sensitive areas include high agrobiodiversity areas			X	X
	Agrobiodiversity Zones			X	X
	Agrobiodiversity Ecotourism			X	X
	Organic farming and organic seed breeding with traditional variety used as planting materials		X	X	X
	Investment in agricultural research that includes the use of agricultural biodiversity within the production system	X	X	X	X
	Biodiversity included in Environmental Impact Assessment of individual projects, policies and programmes	X	X	X	X
Payment schemes for ecosystem services	Payment for Environmental Services		X	X	X
	Linking upstream and downstream communities		X	X	X
	Sharing of monetary benefits				X

B. Formulate and implement a collecting programme for *ex situ* conservation of farmers' varieties/landraces

What is *ex situ* conservation?

Ex situ conservation means the conservation of plant genetic resources for food and agriculture outside of their natural habitat.[29,30] This involves locating, sampling, transferring and storing samples of the target taxon away from its native habitat, most often in genebanks. Farmers' varieties/landraces can be stored *ex situ* as seeds, as ex-plants maintained *in vitro* or cryopreserved, or as living collections in field genebanks. However, for farmers' varieties/landraces that produce orthodox seeds (i.e. seeds that can be dried and stored at low temperatures), seed storage in genebanks predominates. The most important components of managing germplasm *ex situ* include well established procedures for collection, characterization, evaluation, preservation and use of conserved material.

What is a collecting programme for *ex situ* conservation of farmers' varieties/landraces?

A collecting programme for *ex situ* conservation here refers to an agreed plan to collect farmers' varieties/landraces for long-term storage with existing *ex situ* collections, from specific areas (ecogeographical regions).

Why is a collecting programme for *ex situ* conservation of farmers' varieties/landraces necessary?

Ex situ conservation provides an efficient long-term safeguard of plant genetic resources, at the same time allowing easy access for characterization, evaluation and use. To ensure that the genetic diversity of priority farmers' varieties/landraces is represented in national collections, programmes to target and collect them systematically need to be implemented, preferably in parallel with on-farm management initiatives.

Methodology for formulation and implementation of a collecting programme for complementary *ex situ* conservation of farmers' varieties/landraces

In the methodology referred to below, the focus is on filling in gaps in an *ex situ* collection to complement ongoing on-farm management initiatives.

29 http://www.fao.org/plant-treaty/overview/texts-treaty/en

30 http://www.cbd.int/convention/text

Define the type of collection mission

The most common reasons why farmers' variety/landrace germplasm is collected include:

- rescue collection (where there is a danger of genetic erosion or extinction of target farmers' varieties/landraces);
- need for immediate use (e.g. for breeding purposes, immediate planting, land management);
- "gap filling" (diversity is missing from *ex situ* collections);
- research purposes (more needs to be known about a particular farmers' variety/landrace); and
- collected on an opportunistic basis, for instance during other activities or studies.

When formulating an *ex situ* collecting programme it is necessary to consider short- and long-term user needs for the collected material. A short-term demand could be to allow for re-introduction of lost material and to meet immediate needs for specific traits in breeding programmes (e.g. to combat a new, virulent form of a pest or disease). Long-term demands might be to have a pool of variation (e.g. to improve yield or quality) on which to draw. Preparatory work should be carried out to help the germplasm curators in anticipating these demands, so that germplasm meeting those demands can be included or specifically targeted during the collecting programme.

There remain challenges with existing *ex situ* storage, including deterioration of seed stocks or inadequate facilities; lack of surveys, inventories, studies and evaluation of existing collections; and vulnerability to damage and loss due to civil strife and natural disasters. Also, even under optimal *ex situ* storage conditions, seed viability will naturally decline, which makes it necessary to regenerate seed samples and carry out safety duplication of samples.[31] It is therefore not recommended to plan a large collecting programme for *ex situ* storage if the existing genebank facilities are not optimally equipped, financed or staffed to handle new collections, and to regenerate as needed.

31 A safety duplicate sample for every original accession should be stored in a geographically distant area, under the same or better conditions than those in the original genebank.

Prioritization of farmers' varieties/landraces and sites for targeted collecting

Generally, well-documented *ex situ* collections that have captured as much genetic diversity of farmers' varieties/landraces as possible will have the greatest conservation value. For collecting farmers' varieties/landraces, priority should be given to those that are identified as threatened, those not adequately represented in existing genebank collections, or those that are not sustainably maintained in farmers' fields. If priority farmers' varieties/landraces have not yet been identified, a review of the conservation gaps is recommended.

Preparation for the collecting programme

The most important information to be included in a collecting programme is a list of the prioritized farmers' varieties/landraces, the sites or areas from where they should be collected, when the sampling should take place, and by whom. In order to determine this information, it is recommended to discuss and agree on a set of basic field sampling factors:

- *Distribution and number of sites* - the collecting sites should be chosen with a view to maximizing the genetic diversity of the samples.
- *Total number of sites* - farmers' varieties/landraces can be collected from a variety of possible sites, ideally from farmer fields, gardens and orchards, but also from farm stores, markets and shops. Samples should be collected from the maximum number of sites, depending on the resources available. It is worth noting that if samples are collected from farm stores, markets or shops, the sample of the variation is not necessarily representative and certain passport data cannot be recorded, such as data related to habitat.
- *Total number of visits* - sites can be visited one or multiple times, depending on the need, resources, and other practicalities, such as maturation phenology.
- *Distribution of plants sampled at a site* - collecting should be done randomly throughout the farmer's field. Particularly interesting material and off-types can be collected selectively.
- *Number of plants sampled per site* - a pragmatic approach should be taken, bearing in mind that the minimum number of plants from which seeds should be collected is between 30 and 60 plants, depending on the breeding system of the target species. If germplasm and resources allow, collect 5 000 seeds from a total of 100 individuals.

- *Farmer knowledge* - field collectors should note and acknowledge information provided by the farmers who maintain particular farmers' varieties/landraces. This may relate to field locations, threats, cropping system, seed acquisition and exchange, as well as use.
- *Passport data* - a unique passport number must be associated with each sample collected. Other passport data collected in the field should be as comprehensive as possible, organized and made available to the user's community. It is recommended that a minimum of associated data, as detailed in the FAO/Bioversity multi-crop passport descriptors (Alercia *et al*., 2015), accompany each collection.
- *Collection teams* - agree if the collection mission is best done centralized (by a designated entity) or decentralized (involving several groups/stakeholders). Species-specific collecting missions are less complicated than collection of multiple species, if several stakeholders are involved.
- *Documentation of indigenous knowledge* should be considered.

Finalize, validate and implement the collecting programme

Once a draft collecting programme has been developed, it should be validated through consultation with stakeholders in order to resolve any potential errors. As with other plans of this type, this is also an important step in engaging stakeholders and an opportunity to promote collaboration. It is helpful to involve, electronically or through face-to-face meetings, as many relevant local and national stakeholders as possible.

National collecting missions and acquisition of germplasm

All collecting of farmers' varieties/landraces needs to be undertaken legally and in line with the applicable international conventions and national legislations. Also, permissions must be obtained from the appropriate national authorities and activities implemented in consultation with and with the prior informed consent[32] of the indigenous peoples and local communities and farmers, as applicable, from whom the materials are being collected. The *Genebank Standards for Plant Genetic Resources for Food and Agriculture* (Genebank Standards) contains standards for acquisition of germplasm (FAO, 2014). Many other organizations have also developed specific protocols to guide the collection of plant material, including Bioversity International[33] and the Millennium Seed Bank.[34]

32 http://www.fao.org/docrep/013/i1500e/i1500e07.pdf

33 http://cropgenebank.sgrp.cgiar.org/index.php/procedures-mainmenu-242/collecting

34 http://brahmsonline.kew.org/Content/Projects/msbp/resources/Training/English_kppcont_035653_A-field-manual-for-seed-collectors.pdf

Careful planning is required so that the collecting team is in the right area at the right time, finds the desired germplasm (ripe seeds, tubers, vegetative propagules, etc.) and is able to study variability in the field. In addition to the field sampling factors, other technical, practical and logistical aspects need to be discussed and agreed upon in advance of a collection mission taking place, including:

- *knowledge of agroecology and plant distribution* in the area, including crops grown, varietal diversity available, harvesting time, etc.;
- *knowledge of the area*, its people (culture, ethnic groups), socio-religious customs, etc.;
- *local contacts*;
- *time requirement* (the expected duration will vary according to the mission);
- *transport arrangements*, including transport, routes to be followed, layovers;
- *equipment required*, including equipment for storage and transportation of material;
- *team composition*, leader, members, additional help, etc.; and
- *special requirements* when planning a collection mission include permission letter(s), permits to visit area(s), letters of contact and an archive of previous correspondence.

Handling of material in *ex situ* collections

Collected material should be conserved in facilities with the capacity to manage it; usually this would be the national genebank. A duplicate sample should be deposited elsewhere for safety purposes. After the collection of material, the samples should be processed in a standard manner at the genebank, which should include seed cleaning, seed health evaluation, seed viability testing, characterization, evaluation, dehydration, packaging, registration and storage. Standards for how germplasm should be appropriately handled in *ex situ* storage can be found in the Genebank Standards.

Assess the complementarity between *ex situ* conservation and on-farm management

Collecting samples of farmers' varieties/landraces for *ex situ* storage is an excellent occasion to assess the complementarity between *ex situ* conservation and on-farm management. In order to adopt a holistic conservation approach, the authorities need to look at the characteristics and specificities of the particular farmers' variety/landrace and assess which combination of techniques offers the most appropriate option for conserving the diversity. To identify the most appropriate approach, the following points should be considered:

- abundance of farmers' varieties/landraces in the farmer's field;
- the active maintenance of farmers' varieties/landraces in farmer fields and support provided for on-farm management;
- crop species' breeding system and *ex situ* storage characteristics;
- type of storage facilities available;
- location of farmers' varieties/landraces and location of *ex situ* storage facilities;
- accessibility of germplasm and possible implications of laws and agreements;
- human capacity to manage and conserve resources sustainably (both on-farm and *ex situ*);
- already existing diversity in collections, including international collections, to avoid redundancy and attempt to fill already identified gaps; and
- financial resources ear-marked for on-farm management and *ex situ* conservation.

C. Promote sustainable use of conserved farmers' variety/ landrace diversity

What is meant by use of farmers' varieties/landraces?

The "use" of farmers' varieties/landraces can be understood at two levels. On the one hand, it may refer to direct use by farmers in meeting their food security, economic and cultural requirements. On the other hand, use may refer to farmers' varieties/landraces as a source of germplasm for developing better adapted and improved varieties in the future. This second way of using germplasm involves users such as researchers, pre-breeders and breeders, who characterize and evaluate germplasm prior to incorporating it in a crop breeding programme; and ultimately agricultural extension workers and farmers, who use the products from crop breeding programmes.

Why link conservation with use?

Only by conserving farmers' variety/landrace diversity, can countries take advantage of the potential implicit in farmers' varieties/landraces, whether by direct or indirect use. By conserving farmers' varieties/landraces, the end goal is not the diversity itself, but the direct or potential use of that diversity. For sustainable conservation, there needs to be a strong link between stakeholders conserving germplasm (*ex situ, in situ* and on-farm) and stakeholders using germplasm. This would imply the need for recognition that indigenous peoples and local communities and farmers contribute to the conservation and development of plant genetic resources, in particular farmers' varieties/landraces diversity.

Steps to promote wider utilization of farmer's variety/landrace diversity

This section will highlight some key steps to help promote the sustainable use of farmers' varieties/landraces among farmers and researchers or breeders.

Establish a knowledge base of farmers' varieties/landraces and make the information available

Establishing a checklist and inventory of farmers' varieties/landraces is the start of a farmers' variety/landrace knowledge base that can be enhanced with additional analyses of ecogeographical and characterization data. The information gathered on farmers' varieties/landraces may show which ones are suitable for wider use either directly or indirectly. Farming communities are likely to have extensive knowledge of specific crops and farmers' varieties/landraces. This should form

part of the knowledge base. Many of the same practices that promote on-farm management (see Table 5) can support local communities in documenting their knowledge, including:

- drama, music and poetry presented in communities, as well as social media, rural radio programmes or other type of media.
- use of smart phones and setting up information systems and Internet connections for farmer access to information, ensuring that variety information databases are made in farmer-friendly formats; and
- supporting the distribution of information about farmers' varieties/landraces and their specific characteristics.

Increase access to material

1) **Farmer and community access**

   Farmers access seeds and planting material from a variety of different sources, including within their own and neighbouring communities, local seed enterprises, genebanks, the governmental extension service and NGOs. The private sector has less incentive to provide seed for small-scale farmers because of high transaction costs and poorly developed systems for certification and distribution of seeds. As they have done for centuries, a large proportion of small-scale farmers are saving seeds from their own harvest to sow the following year, while subjecting their varieties/landraces to various selection pressure, testing, selecting and evaluating variants to create new crop diversity. In order for farmers to maintain access to a varied portfolio of seeds and planting materials, including those of farmers' varieties/landraces, information about and access to these resources need to be strengthened.

   Support is needed to provide farmers with the seeds and planting materials they prefer. These would include not only certified seeds of improved varieties, but also community-level produced quality seeds and planting materials of farmers' varieties/landraces. There is a significant community of researchers, agronomists and the institutions in which they work, which aims to promote income generating prospects for traditional subsistence crops. Establishment of sustainable and effective seed industries to serve the needs of growers will lead to improvements in the efficiency of food production. As a part of strategic on-farm management, a number of initiatives have also been implemented to increase farmer access to farmers' variety/landrace germplasm (Jarvis *et al*., 2000; Maxted *et al*., 2013).

2) **Researcher and breeder access**

The community of researchers and breeders also needs easy access to farmers' variety/landrace material. Normally, researchers and breeders get the germplasm they use directly from genebanks. Therefore, it is a requisite that farmers' variety/landrace germplasm be available from - and well documented in - *ex situ* collections. Farmers' varieties/landraces can also be collected directly from farmer fields, which requires direct interaction between researchers and farmers, especially to obtain farmers' consent, and facilitates the collection of relevant information by the researcher while respecting the rights of the farmers and communities involved. To improve the accessibility of farmer material for researchers, farmers and researchers need to agree on the benefits of their collaboration. Local organizations, including farmer organizations and NGOs working directly with farmers, may be essential links in establishing contact between farmers and researchers. Contact can also be established by:

- involving farmers in collecting, documentation and breeding activities, such as participatory plant breeding and participatory varietal selection;
- researchers helping in the development of market opportunities and strategies, involving farmer-selected farmers' varieties/landraces;
- supporting the introduction of farmers' varieties/landraces into formal breeding programmes; and
- involving farmers in dissemination activities.

Raise public awareness about the importance of farmers' varieties/landraces

Public awareness is an important factor in stimulating political and practical action. Interventions that result in the value of farmers' varieties/landraces being better understood by more people should be a priority. There are a number of ways to promote public awareness of farmers' varieties/landraces, including through:

- media (mass media such as newspapers, radio, TV, etc.) and modern social media;
- farmers' markets, "fair trade" initiatives, and marketing of products;
- formal and informal educational material;
- ecotourism focusing on agrobiodiversity; and
- art, literature, etc.

Review and address the PGRFA conservation and sustainable use capacity needs in the country

Many countries lack, or are experiencing a deficit in, capacity and skills in plant genetic resources management, which may hinder optimal use of farmers' varieties/landraces. To strengthen the country's PGRFA system, it might be appropriate to:

- review the country's capacity needs;
- encourage the inclusion of plant genetic resources management in the education system;
- provide a wider spectrum of training opportunities and workshops on conservation and sustainable use of PGRFA, targeting professionals and including researchers, technicians, development workers and agricultural extension workers;
- arrange information seminars, workshops and training sessions for rural communities;
- upgrade and strengthen research stations, their facilities and plant breeding programmes; and
- develop a national portfolio of expertise.

Increase the characterization and evaluation of farmers' varieties/landraces

One of the most significant obstacles to greater use of farmers' varieties/landraces is the lack of adequate characterization[35] and evaluation[36] data, and limited capacity to generate and manage such data. In order for breeders to use farmers' varieties/landraces in their work effectively, the existing diversity needs to be comprehensively characterized and evaluated for novel traits. Various characterization techniques can be used to record a plant variety's distinct and heritable features and identify useful traits. To support the characterization and evaluation of farmers' varieties/landraces, the following points should be considered:

- establish or enhance existing characterization and evaluation activities for farmers' varieties/landraces, and ensure the information can be widely accessed;
- develop capacities of and involve farmers in characterization and evaluation on-farm;

35 Characterization refers to descriptive characters of germplasm, such as height, days to maturity and flower colour.

36 Evaluation refers to the agronomic performance of germplasm.

- promote the access and exchange of farmers' variety/landrace accessions and breeding material;
- improve the characterization and evaluation of farmers' varieties/landraces on-farm, particularly in areas known to be hotspots for environmental stresses;
- ensure that priority farmers' varieties/landraces are collected, documented and stored in genebanks;
- expand the collection and conservation (both *ex situ* and on-farm) of farmers' varieties/landraces, if necessary;
- establish trait-specific collections of farmers' varieties/landraces in genebanks;
- publish characterization and evaluation data;
- establish a web-enabled "Trait Information Portal" of characterization and evaluation data;
- develop and adapt molecular techniques for a wider range of crops, including those of local importance;
- incorporate new biotechnological tools within plant breeding programmes;
- provide adequate financial support to characterization and evaluation programmes involving farmers' varieties/landraces; and
- monitor progress in the characterization, evaluation and use of farmers' varieties/landraces.

Establish partnerships and linkages among groups of stakeholders

The work of professional users, the general public and local communities can be linked through partnerships, contributing to sustainable rural development or natural resources use. All partners should share a common goal, related to the conservation and sustainable use of farmers' varieties/landraces.

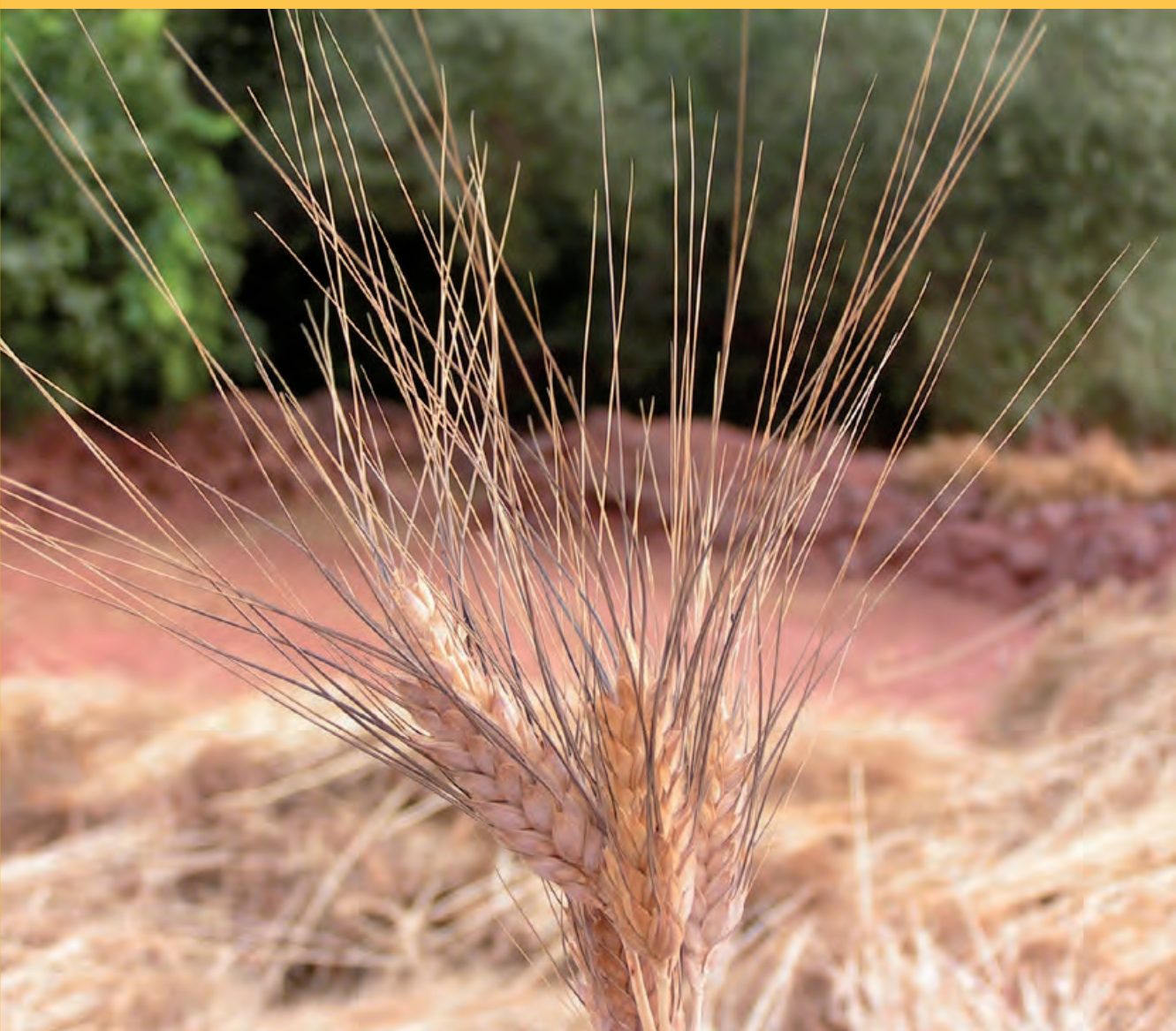
In order to ensure improved access and more efficient use of farmers' varieties/landraces, it helps to establish strong linkages between those conserving and managing these resources, and those wishing to utilize them. Since many farmers' varieties/landraces are only found in farmer fields, certain farming communities and farmers could be approached and consulted to provide research platforms for field experimentation, characterization and evaluation, as well as pre-breeding and breeding activities. Promotion of such participatory activities may stimulate the use of farmers' varieties/landraces.

The spectrum of activities managed by local and national projects and networks related to conservation and sustainable use of PGRFA should be fully understood. There are many ways to support and strengthen linkages within and among networks and partnerships, including to:

- promote and prioritize collaborative activities;
- promote complementarity by aligning and streamlining strategic plans, priorities and project outcomes;
- mobilize resources to sustain these activities, as well as the networks and partnerships involved;
- promote concerted awareness creation;
- increase information and knowledge sharing;
- encourage and engage broad participation (both across sectors and stakeholder groups); and
- ensure that the aims of networks support the national and thematic goals and priorities for the conservation and sustainable use of PGRFA.

8. MONITORING FARMER'S VARIETY/ LANDRACE DIVERSITY AND REPORTING

Wheat landrace, Morocco
©FAO/B. Furman



A. Monitoring farmers' variety/landrace diversity

What is monitoring of farmers' varieties/landraces on-farm?

Monitoring of farmers' varieties/landraces on-farm means to collect data systematically, including from and in collaboration with farmers and other stakeholders, about farmers' varieties/landraces grown and maintained in farmer fields over time. Farmers' variety/landrace monitoring can be carried out at the individual farmers' variety/landrace level, or at the level of overall farmers' variety/landrace diversity. Farmers' varieties/landraces can also be monitored for evolution and adaptation to specific environmental conditions.

Why is it useful to monitor farmers' variety/landrace diversity on-farm?

Monitoring of farmers' variety/landrace diversity on-farm provides an early warning mechanism for detecting genetic erosion and threats to farmers' variety/landrace diversity. It also allows results, methods and experiences to be documented and used as a basis to steer decision-making and learning processes. Monitoring populations of farmers' varieties/landraces and their habitats aims to:

- record changes in varietal diversity and habitats;
- assess trends in population size and structure;
- detect changes in the genetic diversity of farmers' varieties/landraces; and
- determine the outcomes of management or farming practices on populations, and guide management decisions.

Methodology for developing a monitoring plan for farmers' varieties/landraces growing on-farm

Agree on the scope of the monitoring plan

It is necessary to develop a realistic monitoring plan according to the scope of the particular intervention, area or farmers' varieties/landraces to be assessed. In some cases, it is relevant to develop a monitoring plan to assess the outcomes of a specific project. In this case, the scope of the monitoring plan should be equal to that of the project, in terms of locations and farmers' varieties/landraces monitored. In other cases, it might be relevant to monitor farmers' variety/landrace diversity in only a specific area, or target specific farmers' varieties/landraces.

Agree on the level at which the farmers' variety/landrace(s) should be monitored

It is helpful to agree on the level(s) of the monitoring in order to identify the appropriate indicators and parameters to measure and to apply a suitable methodology for data collection. In many cases, it may be relevant to assess the farmers' variety/landrace diversity on several levels. Farmers' variety/landrace monitoring can be carried out at the level of:

- individual farmers' varieties/landraces;
- genetic diversity; or
- evolution and adaptation to specific environmental conditions.

The key objectives of monitoring farmers' varieties/landraces could be to detect:

- changes in farmers' varieties/landraces maintained;
- changes in the environments of each farmers' variety/landrace;
- farming practices;
- changes in farmers' perceptions and reasons for any changes in farmers' varieties/landraces grown;

Potato diversity, Bolivia
©PROINPA

- changes in specific field plots; and
- reasons for varietal change and loss of farmers' variety/landrace diversity.

The key objectives when monitoring farmers' variety/landrace genetic diversity are to:

- detect changes in the genetic composition within a population of a farmers' variety/landrace;
- detect changes in the genetic composition among different populations of the same farmers' variety/landrace;
- identify individuals, species or populations;
- assess population differentiation within farmers' varieties/landraces and introgression in farmers' varieties/landraces; and
- detect or assess genetic erosion.

The key objectives in monitoring the evolution and adaptation to specific environmental conditions are to:

- assess changes in genetic composition in relation to the environmental parameters recorded;
- identify specific farmers' varieties/landraces and populations that exhibit adaptive capacity in relation to environmental changes; and
- detect gene flow among varieties and with sympatric wild relatives.

Agree on indicators and parameters to measure

Depending on the agreed level of monitoring, indicators must be developed. Examples of indicators that can be used to assess farmers' variety/landrace diversity – both morphological and genetic – as well as the related data that should be collected during monitoring missions are shown in Table 6.

Table 6. Examples of indicators and data relevant for the three levels of monitoring

Monitoring Level	Indicators	Data collected
Individual farmers' varieties/landraces	Decrease or increase in the numbers of farmers growing each farmers' variety/landrace. Decrease or increase in the area covered by a farmers' variety/landrace. Decrease or increase in the total number of farmers' varieties/landraces grown. Decrease or increase in richness indexes. Decrease or increase in annual replacement of farmers' varieties/landraces by modern varieties.	Number of farmers' variety/landrace grown. Area allocated to each farmers' variety/landrace. Richness indexes e.g. Shannon Weaver Index (H') and Simpson Index (D). Management practices. Threats.
Genetic erosion within a farmers' variety/landrace	Decrease or increase in richness of diversity. Decrease or increase in evenness of diversity. Significant population differentiation between samples collected in different years. Changes in the genetic composition of farmers' varieties/landraces.	Genetic diversity (richness of diversity). Average number of alleles per locus (evenness of diversity). Linear regression of the above variables against the fixed variables of the year (of collection) surveyed and population size (where population size varied). Analysis of molecular variance (AMOVA) (to compare variances among populations) A comparison between *ex situ* accessions (collected in previous years) and/or between *ex situ* accessions and extant on-farm populations (of the same farmers' variety/landrace and from the same farm).
Evolution and adaptation	Decrease or increase in 'ecotypes' (genetically distinct population adapted to specific environmental conditions). Decrease or increase of measurable fitness traits. Changes in agronomic practices used by farmers. Decrease or increase of susceptibility to pests and diseases. Decrease or increase in area grown under changing environmental conditions.	Responses to climatic changes. Responses to variation in agronomic practices. Responses to pathogen incidences. Responses to planting in disease nurseries, etc.

Select or establish on-farm monitoring sites and plan data collection

In line with the scope of the monitoring plan, specific sites should be selected in close collaboration with the farming communities, where the farmers' variety/landrace diversity can be assessed regularly. The data collection should take place several times, over a set time frame, and it is therefore important that the relevant farmers agree with the proposed data collecting activities.

The time interval between the surveys can vary and should be adjusted in the light of experience. If the site or the farmers' varieties/landraces on the site are threatened (see list of threats under Chapter V, Section A), it is recommended to monitor the site frequently (e.g. every two to four crop generations). If the site or farmers' varieties/landraces on the site are not especially prone to threats, a longer interval between monitoring visits is acceptable.

Data collection methodology

1) **Monitoring of individual farmers' varieties/landraces**
   Monitoring is done by comparing farmers' variety/landrace inventories from the same farms in different years. This is normally done through:

   - direct observation, including participatory field observations;
   - farmer interviews and focus group discussions; and
   - Community Biodiversity Registers.

2) **Monitoring of genetic diversity**
   Monitoring of genetic diversity within farmers' varieties/landraces can be accomplished through a morphological or molecular analysis of diversity. Most of the molecular assessments utilize 'neutral' genetic markers (Hayward *et al.*, 2015).

3) **Monitoring evolution and adaptation**
   Monitoring of the evolution of farmers' varieties/landraces under specific environmental conditions and noting the adaptation of farmers' varieties/landraces to specific environmental conditions can be achieved through a genetic analysis of adaptive diversity and recording, as well as analysing changes in the growing environment of the farmer's variety/landrace. Genetic markers that have known variations in a particular gene with an effect on the adaptive fitness of the individual are analysed.

Reporting and disseminating information

Results from the monitoring of farmers' variety/landrace diversity on-farm are of interest to a large number of stakeholders. Therefore, the results should be available to all relevant stakeholders, while recognizing and respecting the rights and interests of the farmers and indigenous peoples and local communities from whom the information is derived.

B. International reporting requirements and global linkages

National monitoring of PGRFA conservation and sustainable use is fundamental to any global assessment or status analysis. All countries that are a contracting party to the CBD or the Treaty, or a Member of the Commission on Genetic Resources for Food and Agriculture have certain monitoring and reporting requirements related to conservation and sustainable use of PGRFA, including for farmers' varieties/landraces. Specific targets and indicators have been developed to facilitate country reporting (see Chapter 1 – Introduction).

In particular the indicators[37] and reporting format[38] for monitoring the implementation of the Second GPA have been prepared to monitor its 18 priority activity areas, of which several are critical for the monitoring of farmers' varieties/landraces. As all countries that are members of the Commission are required to report on these indicators regularly, it is strongly recommended to ensure that indicators developed to monitor specific programmes and projects at the local level are compatible with the indicators that will be used to report on national progress. A small selection of the Second GPA indicators that are relevant to the monitoring of farmers' varieties/landraces (Box 7) is reproduced below.

37 The list of indicators adopted by the Commission can be found in Appendix C of CGRFA-14/13/Report, available at http://www.fao.org/docrep/meeting/028/mg538e.pdf.

38 A draft reporting format for monitoring the implementation of the Second GPA can be found in the information document CGRFA-17/19/9.2/Inf.6, available at http://www.fao.org/3/my818en/my818en.pdf.

Box 7. A selection of the Second GPA indicators in different priority areas relevant to monitoring of farmers' varieties/landraces

In situ conservation and management

1) Number of *in situ* (including on-farm) surveys or inventories of PGRFA carried out.

2) Number of PGRFA surveyed or inventoried.

3) Percentage of PGRFA threatened out of those surveyed or inventoried.

4) Number of farming communities involved in on-farm PGRFA management and improvement activities.

5) Percentage of cultivated land under farmer varieties or landraces in areas of high diversity or risk, or both.

6) Number of farmer varieties or landraces delivered from national or local genebanks to farmers (either direct or through intermediaries).

Ex situ conservation

7) Existence of a strategy for identification of gaps in national genebank holdings and for targeted collecting missions to fill identified gaps.

8) Number of targeted collecting missions in the country.

Sustainable use

9) Number of programmes, projects or activities promoting development and commercialization of all varieties, primarily farmer varieties, landraces and underutilized species.

10) Number of farmer varieties and landraces and underutilized species identified with potential for commercialization.

11) Existence of national policies that promote development and commercialization of all varieties, primarily farmer varieties and landraces and underutilized species.

Building institutional and human capacities

12) Number of farmer varieties and landraces cultivated on-farm and documented in a publicly available information system.

9. CAPACITY BUILDING

Capacity development in the field
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The Second GPA recognized the critical importance of training and capacity building for scientists, breeders and extension specialists, as well as for seed producers, farmers, indigenous peoples and local communities (with a particular emphasis on women) on themes that enable the promotion of the development and commercialization of all crop varieties, primarily farmers' varieties, landraces and underutilized species. The Second GPA identifies the relevant topics for such training and capacity building activities to include establishing, running and advising local small-scale enterprises. To promote the increased on-farm management of these PGRFA, the Second GPA also recommended the identification of all suitable materials and the development and implementation of sustainable management practices, postharvest processing and marketing methods and the documentation of relevant local and traditional knowledge. It also called for raising public awareness on this subject.

The guidelines provided in this volume would contribute to the efforts aimed at actualizing these recommendations. A complementary capacity building tool, structured to address both these provisions of the Second GPA and the more theoretical and applied subjects provided in this set of guidelines, would also be extremely useful. Its development, through a broad stakeholder participatory engagement, would therefore be the next logical intervention for the enhanced utility of the guidelines. Such a tool might build upon existing resources such as the *Training Guide for* In situ *Conservation On-farm* (Jarvis *et al.*, 2000), which contains the following modules:

- Social, cultural and economic factors and crop genetic diversity;
- Agroecosystem factors: natural and farmer-managed;
- Agro-morphological characters, farmer selection and maintenance;
- Crop population genetics and breeding (mating) systems;
- Seed systems;
- Building an on-farm conservation initiative;
- Getting started: preparation, site selection and participatory approaches;
- Sampling, structuring, documenting and presenting information for action plans; and
- Enhancing the benefits for farmers from local crop diversity.

The aforementioned *Training Guide for* In Situ *Conservation On-farm* also contains recommendations on additional reading materials, provided at the end of each chapter. Other resources that help strengthen capacities for the on-farm management of farmers' varieties and landraces can be found in the annexes to this guide.

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ANNEXES

Common bean varieties, Ecuador
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ANNEX 1: Examples of internet resources for farmers' varieties/ landraces

Name	Description	URL
Coconut Genetic Resources for Enhanced Livelihoods (GOGENT)	An international coconut genetic resources network	http://www.cogentnetwork.org/home
Crop Genebank Knowledge Base	An initiative of the System-wide Genetic Resources Programme (SGRP) of the Consultative Group on International Agricultural Research (CGIAR).	https://cropgenebank.sgrp.cgiar.org/
Diversifood	An international project funded under the European Union's Horizon 2020 Programme integrating existing networks across Europe.	http://www.diversifood.eu/
European Cooperative Programme for Plant Genetic Resources (EPCGR) On-farm Conservation and Management Working Group	A collaborative programme among most European countries aimed at ensuring the long-term conservation and facilitating the increased utilization of plant genetic resources in Europe	http://www.ecpgr.cgiar.org/working-groups/on-farm-conservation/
FAOSTAT	Agricultural statistics and data	http://faostat.fao.org/
Farmer's Pride	Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources	http://www.farmerspride.eu/
Focused Identification of Germplasm Strategy (FIGS)	Technique for searching agricultural genebanks	http://www.icarda.org/figs/teaser
GENESYS	Global database of major *ex situ* genebank holdings	http://www.genesys-pgr.org/

Name	Description	URL
Global Musa Genetic Resources Network (MusaNet)	Global collaborative framework for Musa genetic resources	http://www.musanet.org/
Plant list	Working list of all known plant species	http://www.theplantlist.org/
PGR Secure	Resources and tools on all aspects the CWR and landrace conservation strategy planning, with particular reference to Europe	http://www.pgrsecure.org
US Genetic Resources Information Network (GRIN)	Database of United States Department of Agriculture *ex situ* genebank holdings	https://www.ars-grin.gov/
IUCN Red List	Database of red list (extinction threat) assessments	http://www.iucnredlist.org/
Wheat Landraces Project	Project to improve food security by enhancing wheat production and its resilience to climate change through maintaining the diversity of currently grown landraces.	https://wheatlandraces.org/
World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS)	WIEWS is the information system used by FAO for the preparation of periodic, country-driven global assessments of the status of conservation and use of PGRFA.	http://www.fao.org/wiews/en/

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The cultivation of diverse farmers' varieties/landraces, which tend to be well-adapted and suited to local production systems, confers increased resilience for crop production. Farmers' varieties/landraces are also potential sources of traits for crop improvement, especially for developing varieties tolerant to biotic and abiotic stresses and for incorporating farmer-preferred traits. Unfortunately, many of these genetic resources have been replaced by modern cultivars in recent decades, resulting in a reduction in the total number of different varieties grown and/or loss of heterogeneity. Such losses make farming systems less resilient, especially to shocks from abiotic and biotic stresses. These guidelines, intended as reference materials for preparing a National Plan for the Conservation and Sustainable Use of Farmers' Varieties/Landraces, will contribute to addressing this continuing loss of diversity. The guidelines are therefore a useful tool for development practitioners, researchers, students and policy-makers who work on the conservation and sustainable use of these valuable resources.

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