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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 3 of the Provisional Agenda

INTERGOVERNMENTAL TECHNICAL WORKING GROUP ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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NATIONAL LEVEL CONSERVATION AND USE OF LANDRACES DRAFT TECHNICAL GUIDELINES

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I. BACKGROUND

1. The Commission on Genetic Resources for Food and Agriculture (the Commission), at its Fifteenth Session, invited its Working Group to review and revise the Draft Technical Guidelines, *National level conservation and use of landraces*[1].

2. This document contains the Draft Technical Guidelines, as revised following peer review.

II. FOREWORD

3. Plant genetic resources for food and agriculture (PGRFA) are any material of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity, of actual or potential value for food and agriculture[2], and comprise the diversity contained in landraces or traditional varieties, modern cultivars, crop wild relatives (CWR) and other wild plants that can be used for food and agriculture now and in the future. Farmers throughout the world rely on PGRFA in their production systems, and thus substantially contribute to the conservation and use of global crop diversity. These resources represent a source of food 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 receive information and support in relation to sustainably managing 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 is needed at both the country and local levels.

4. This need has been recognized by international conventions and agreements, including the *Convention on Biological Diversity* (CBD)[3], *the International Treaty on Plant Genetic Resources for Food and Agriculture* (International Treaty)[4] *and the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture* (Second GPA)[5]. They each underline the commitment of governments to ensuring that 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.

5. These technical guidelines outline the process for preparing a *National Plan for Conservation and Use of Crop Landraces*, with the aim to help national authorities in developing a systematic approach to the management of these genetic resources. 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, as well as the resources available for its implementation. Even so, the process will require a series of decisions and actions that essentially follow the same pattern in all countries. Through a step-by-step approach, these guidelines focus on the common elements that are necessary to ensure a systematic, national approach to conservation and use of crop landraces.

[1] CGRFA-15/15/Report, paragraph 51
[2] International Treaty on Plant Genetic Resources for Food and Agriculture, Part I - Introduction, Article 2. Use of terms. http://www.planttreaty.org/content/texts-treaty-official-versions
[3] http://www.cbd.int/convention/text/
[4] http://www.planttreaty.org/content/texts-treaty-official-versions
[5] http://www.fao.org/docrep/015/i2624e/i2624e00.htm

III. ACRONYMS AND ABBREVIATIONS

CBD	Convention on Biological Diversity
CSO	civil society organization
CWR	Crop Wild Relative(s)
ELC	ecogeographical land characterization
ESA	environmentally sensitive area
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
International Treaty	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	International Union for Conservation of Nature
MSB	Millennium Seed Bank
National Plan	National Plan for the Conservation and Use of Crop Landraces
NGO	non-governmental organization
PA	protected area
PES	Payment for Environmental Services
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources (for Food and Agriculture)
Resource Book	Resource Book for Preparation of National Conservation Plans for Crop Wild Relatives and Landraces
SIS	Species Information Service [of IUCN]
SNP	single nucleotide polymorphism
SSR	single sequence repeat(s)
TDGW	Taxonomic Databases Working Group – developing Biodiversity Information Standards

IV. INTRODUCTION

6. 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, 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. Unfortunately, the world's rich and highly adapted plant diversity is threatened by urban encroachment on farmland, unsustainable use of natural resources, introduction of invasive species, changing pattern of human consumption, and climate and other environmental changes.

A. Landraces[6]

1. The role of landrace diversity for sustainable agriculture, food security and economic development

7. 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 posing a challenge to producing more food sustainably with fewer inputs. In such a scenario it is an imperative to conserve PGRFA more broadly than in the past.

8. A significant amount of local crop diversity is only maintained in farmer's fields. This diversity is adapted to specific ecosystems, climatic conditions and farming practices. 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 number and status of crop landraces on-farm, and their use in crop improvement is also limited (FAO, 2010)[7].

9. Recognizing the need for increased efforts in conservation and use of local crop diversity, these guidelines focus specifically on crop landraces. Crop landraces are often genetically diverse 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. Landraces have often developed their unique characteristics through adaptation to local agro-environments and repeated *in situ* grower selection in traditional farming systems. They are a dynamic, constantly evolving component of farming systems. Landraces may grow mixed with other landraces and/or in proximity to close wild relatives with which gene exchange can occur. Local communities experiment with, share and exchange crop 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.

10. In order to be able to continually adapt modern agriculture to ever changing conditions, both farmers and plant breeders need to have access to a genetically diverse portfolio, suited to a range of agro-ecosystems and farming practices, allowing them to meet and address the challenges facing agriculture. The importance of 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 on the other hand landraces constitute a potential source of basic genetic material for developing better

[6] See Resource Book section B1. In addition to the Resource Book a large body of information on crop landraces and conservation, with particular reference to Europe, can be found at the helpdesk of PGRSecure http://www.pgrsecure.org/helpdesk_lr

[7] http://www.fao.org/docrep/013/i1500e/i1500e00.htm

adapted varieties. Further, landrace production associated with niche marketing may increasingly be a means of sustaining traditional farming systems within otherwise intensive production systems.

11. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. 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, crop 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.

2. The causes and consequences of landrace erosion

12. Vast numbers of landraces have been replaced by modern cultivars in recent decades. When landraces are replaced by modern cultivars, the unique combination of genetic diversity 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. As many landraces are not conserved systematically, the genetic diversity and unique traits they contain might therefore be permanently lost. The main factors contributing to the genetic erosion of landraces are:

- changes in agricultural practices and land use, including mechanization, use of pesticides, herbicides and irrigation – all of which favour the cultivation of modern cultivated varieties rather than landraces;
- changes in consumption habits, favouring introduced crops and varieties;
- subsidies, incentives, national registration and certification systems that promote the use of uniform 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 consequently loss of traditional knowledge of landraces and farming systems due to ageing of farmers;
- lack of awareness of the unique value of plant genetic resources as a local, national and global resource, and limited research on the useful traits of 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 landraces are often grown near their cultivation limits.

13. The loss of landrace diversity can also be seen as a form of ‘local cultural erosion’. This relates to the fact that the loss of particular landraces can lead to the loss of crop-related cultural activities which underpin local selection and breeding activities, use and traditions.

3. Conservation and management of crop landraces

14. The principal efforts to counter genetic erosion have concentrated on conservation of seeds in genebanks (*ex situ*), and considerable progress has been made in this area. However, despite the improved systematic conservation of PGRFA in *ex situ* genebanks, there are still large gaps in the collections, and 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 and natural disasters.

15. Still, today landrace diversity is largely found in farmers' fields. Landraces actively managed on-farm are serving as a repository of this diversity and a proportion of them is backed-up within *ex situ* collections worldwide. Crops and varieties that grow in their natural habitats facilitate the continued adaptation and evolution of diversity, which may increase the creation of variants that are better suited to address global environmental changes.

16. Agrobiodiversity conservation strategies combine both *in situ* and *ex situ* conservation practices. On-farm management of landraces is referred to as all practices for the conservation and sustainable use of these genetic resources within the agricultural systems in which they have evolved.

17. Central to the concept of on-farm management of landraces is the continuing use of these resources by farmers, often resource poor with limited livelihood options. Farmers keep 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 farmer's capacity to adapt to change. In some cases, however, farmers keep growing landraces because they lack alternatives. 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 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. *A fundamental principle for successful on-farm management is that it is beneficial both for the farmers and for their communities*.

B. The global response to crop genetic erosion and national obligations

18. 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:

19. **The Convention on Biological Diversity (CBD)** that was established in 1992 as a global and legally-binding framework on biodiversity conservation and use. 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[8]. Several of the Aichi Targets are relevant to crop diversity, in particular Target 1[9], 7[10] and 13[11]. In 2010, the Conference of the Parties to the CBD also adopted the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity[12], a legal framework for the implementation of the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, and established a Global Strategy for Plant Conservation (GSPC)[13] with 16 global targets set for 2020, where Target 9[14] refers specifically to the conservation and management of crop diversity. The CBD requires that each Contracting Party "shall develop national strategies, plans or

[8] http://www.cbd.int/sp/targets.

[9] 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.

[10] Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

[11] 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.

[12] http://www.cbd.int/abs/

[13] http://www.cbd.int/gspc/

[14] 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.

programmes for the conservation and sustainable use of biological diversity", explicitly including its agrobiodiversity.

20. **The International Treaty on Plant Genetic Resources for Food and Agriculture** (International Treaty)[15] was adopted by FAO's Member Countries in 2001. The International Treaty is legally binding for the Contracting Parties, and its objectives are 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. As the International Treaty relates to PGRFA, all provisions are relevant for the conservation and management of crop diversity, and Articles 5, 6 and 7 of the International Treaty contain clauses that mandate contracting parties not only to conserve and use crop diversity sustainably but also to develop policy instruments to underpin such activities.

21. **The Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture** (Second GPA)[16] was adopted by the FAO Commission on Genetic Resources in 2011. Based on the findings of the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture[17], the Second GPA is an agreed set of priority activities that directly address the new developments, opportunities and challenges facing plant conservation and use in the 21st century. It includes 18 priority activities guiding action and progress at the community, national, regional and international levels, and is a supporting component to the International Treaty. Throughout the Second GPA, there are specific references to crop landraces, highlighting the need to strengthen their management and improvement 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.

C. The need for a National Plan for the Conservation and Use of Crop Landraces (National Plan)

22. Agrobiodiversity strategies and specifically the management of 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 use of 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) demonstrate the benefits of local PGRFA retention and (b) promote retention by providing policy incentives that support farming communities and farm-related institutions to sustain their PGRFA. 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. On this basis it is necessary to explore how national authorities can support the conservation and use of landraces, and farmers and their communities that grow traditional landraces. The following points are highlighted:

- 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. Without a National Plan, activities and interventions related to the conservation and sustainable use of landraces will continue to happen in an *ad hoc* manner, without 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.

[15] See footnote 4
[16] See footnote 5
[17] See footnote 7

- A National Plan will 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 use.

23. The development of a National Plan for Conservation and Use of Crop Landraces is a clear message from the authorities regarding the importance and priority of conservation and sustainable use of landraces at the national level. It will also be a catalyst for attracting greater funding and support to these areas of endeavour.

D. The purpose of these technical guidelines

24. Some countries, such as the UK and Italy, have already developed strategic national plans for conservation and sustainable use of crop landraces[18]. However, most countries lack a national plan for crop landraces. Hence these *Technical Guidelines* are specifically aimed to serve as a reference for national authorities developing and strengthening the conservation and use of crop landraces. They are primarily intended for staff associated with National PGRFA programmes, but may also be of use for universities and research organizations, NGOs and other partnering institutions of national authorities. To promote systematic, coordinated and integrated *ex situ* conservation and on-farm management of landraces, the guidelines consist of a simple set of steps and methods to guide the formulation of a *National Plan for Conservation and Use of Crop Landraces (National Plan).* The following sections are included in the guideline:

- **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 and contacted and 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 for the process will be needed.
- **Understanding the country context.** To formulate any strategic plan it is necessary to analyse the policy context in the country where it will be implemented, and the current status of local crop diversity conservation and use. This will provide the basis for priorities and issues to be addressed, and guide the formulation process of the National Plan.
- **Strengthening the crop 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 crop landraces in the country. As part of strengthening the knowledge base in the country, this section 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 for Conservation and Use of Crop Landraces is a document that describes what the country wants to do to ensure appropriate handling of crop 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.** To implement a National Plan means turning it into reality, 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:

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(1) Promoting and establishing on-farm management of local crops and varieties;
(2) Formulating and implementing a collecting programme for complementary *ex situ* conservation of crop landraces; and (3) Promoting sustainable use of local crops and varieties.

- **Monitoring crop landrace diversity.** Monitoring of crop diversity means 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, aimed at providing data for modelling trends in agriculture, crops and farming systems. Based on the monitoring data, changes in management plans, including new goals and objectives and alternatives for achieving them, can be introduced as appropriate.

V. STAKEHOLDERS AND TIMELINE

A. Stakeholders

25. Once it has been decided at a high level that a National Plan for Conservation and Use of Crop Landraces is required, a National Focal Point or Coordinator for developing and implementation of the National Plan should be appointed. Most of the stakeholders that are likely to be involved directly or indirectly with crop 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.

26. The National Focal Point and support team will need to identify who the stakeholders across the country are that will be needed to help in the development and implementation of the National Plan.

27. The usefulness of a National Plan 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 use of 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. Particular attention should be paid to farmer and farming community involvement, as conservation and use of landraces directly involves their knowledge and livelihood. The stakeholders may include:

- government, including ministries and authorities relevant to the agriculture sectors, particularly agricultural extension workers;
- farmers and local communities;
- local authorities;
- national research institutions, including genebank curators and plant breeders;
- universities and other educational institutions;
- civil society organizations (CSOs), such as farmer- or community-based organizations;
- non-governmental organizations (NGOs), such as professional development and conservation organizations;
- private sector;
- regional and international organizations, research centres and networks; and
- UN agencies and bilateral technical cooperation or funding agencies, especially those involved in PGRFA conservation, use and management.

28. It is recommended to arrange a stakeholder meeting, involving all stakeholders with knowledge or interest in landrace conservation and use, at an early stage in developing the National Plan. The aim of this meeting will be to discuss and to inform participants about the planned preparation of the National Plan, to share existing knowledge and strengthen the existing network.

29. The objectives of such an initial meeting can include:

- providing an introduction to the project, preparation of a National Plan, and to discuss the proposed project strategy and objectives;
- sharing knowledge of previous and ongoing interventions related to inventorying, conservation and use of landraces;
- discussing how to achieve the project objectives, including gathering of 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 landraces for *ex situ* conservation, which can be used for reference purposes when formulating recommendations for the National Plan; and
- providing examples of the use of landrace germplasm in formal crop improvement programmes that can be used for reference purposes.

30. The National Focal Point and their support team might need to consider at the first stakeholders' meeting how to organize participating stakeholder involvement. For example, a core group of stakeholders might be people with 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.

31. In addition, the wider stakeholder list will include, to the extent possible, all those that may be impacted by the National Plan, and 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 a commitment to helping successfully implement the National Plan to which they have contributed. At key stages in the National Plan development, open meetings with all stakeholders should be arranged for inputs and support.

B. Timeline

32. In the sections that follow a logical series of steps are outlined 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 and guide 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 regarding a timeline to achieve specific objectives so that momentum can be built up to achieve implementation of the National Plan.

VI. UNDERSTANDING THE COUNTRY CONTEXT

33. A National Plan for Conservation and Use of Crop Landraces 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 use of landraces, and the range and commitment of farmers, agricultural-related workers and other stakeholders. Before any specific landrace assessments are conducted, a country assessment related to plant genetic resources for food and agriculture (PGRFA) will be helpful to guide the development of the National Plan. This section will provide guidance for such preparatory work.

A. Constitutional, legal and institutional framework

34. A National Plan needs to be in line with national goals and priorities, and based on the environmental and agricultural policy context of the country. An assessment of the constitutional, legal and institutional framework should include:

- identifying which international agreements, relevant to conservation and use of PGRFA, the country has signed, e.g. the CBD and the International Treaty;
- preparing an overview of the key programmes, networks and other PGRFA-related activities national stakeholders that are active at the regional and sub-regional levels;
- 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;
- laws and strategies governing the conservation and use of PGRFA at the national level, including sector-specific strategies and national programmes; and
- priorities, programmes and activities within the National PGRFA Programme.

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

B. State of conservation and use of landraces

36. An assessment of the current status of conservation and use of 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[19] or as an independent research project targeting crop diversity. If these types of assessments are lacking, no longer valid, or includes little information about landraces, it is recommended to conduct a brief review of the status of 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 landraces in farmer's fields;
- the current conservation status of 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 crop landraces, and their use in pre-breeding and breeding activities.

[19] 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

37. 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.

Agree on what constitutes a landrace[20]

38. Often, landraces have developed unique characteristics through repeated farmer selection and have never been subjected to formal plant breeding. In other cases, a particular variety may have been developed in the formal plant breeding sector but has later been maintained through repeated farmer selection and seed saving schemes. The definition of what constitutes a landrace is of crucial importance when formulating a National Plan. Since the common understanding of what a crop landrace is may vary among stakeholders, it is necessary to develop a common definition for the purpose of developing a coherent National Plan. Common elements of a working definition of a landrace for a National Plan may include some or all of the following:

- recognizable, distinct crop variety;
- dynamic population character;
- lacks formal crop improvement;
- genetically diverse;
- long grown in an area and locally adapted;
- associated with local cultural, historic or religious values; and
- associated with traditional farming systems.

39. Since it should not be expected that a 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.

40. Once the definition is agreed, the stakeholders should decide whether to recognize a 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 distinction is required. A distinction based on nomenclature relies on the assumption that actual genetic 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 correctly distinguish and identify varieties.

Crops and landraces

41. In determining which crops and landraces for which the National Plan should be relevant, countries can choose to focus on all landraces, or a specific set of prioritized crops×landraces. Two distinct approaches are: (i) focusing on priority 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 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. To the extent possible, the National Plan will want to cover the largest possible range of landraces. To further maximize the conservation and use of landraces, a combination of both approaches could be considered, e.g. to prepare a National Plan encompassing all landraces in the country, and in addition develop specific strategies for the highest priority crop×landrace combinations.

[20] See Section B.1 in *Resource Book.*

Geographical Coverage

42. 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 is 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 use of 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

43. A National Plan should be in harmony within 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 Use of Crop Landraces

44. The Second GPA, with its 18 Priority Activities[21] serves as a guide for elaborating the content of the National Plan. It is not a requirement that the National Plan should 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.

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

45. Management of 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 use

46. The concept of use is fundamental to the management of PGRFA, and acts as a bridge between conservation of genetic resources and delivery of improved varieties to farmers. Sustainable use encompasses a wide range of actions, *inter alia* characterization; 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 local varieties and products. The National Plan should encourage and promote sustainable use of landraces, by strengthening the links between stakeholders working with *ex situ* conservation, on-farm management and those involved in research, plant breeding, crop production, seed production, etc.

Financial and human resources for implementation

47. 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 not secure, 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.

[21] http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/gpa/priority-areas/en/ and see Box 7 in Section 7.

VII. STRENGTHENING THE CROP LANDRACE KNOWLEDGE BASE

48. To determine how to conserve and use landraces most effectively, it is necessary to know which landraces exists in the country, where they are and what management measures should be adopted to most efficiently protect and use them. A National Plan for Conservation and Use of Crop Landraces should therefore be as specific as possible, targeting priority crop species×landraces and locations. This chapter provides a guide for developing a knowledge base of the diversity of landraces in the country. Four approaches to developing a knowledge base are discussed: checklist; inventory; ecogeographical diversity data; and genetic data (Table 1). These four approaches provide increasingly greater resolution of information on crop landraces. Checklist is simply a list of landrace names while genetic data may involve studies at the molecular level. In addition, the greater the resolution of information available on landraces is the greater potential there is to analyse the data meaningfully.

49. There are a number of features common to the four databases:

- Each database may be developed **independently but in parallel**. Thus, for example, while making a checklist, much landrace data to include in the inventory may be gathered.
- **Prior to developing** each database the scope of the database should be determined, keeping in mind human capacity and financial resources, and be agreed 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 easy 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 done in a large meeting, where all the relevant stakeholders are present. The purpose of the validation meeting 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. The validation meetings are also an occasion to update stakeholders on the National Plan, allowing exchange of information, and raising awareness.

Table 1. Databases for strengthening knowledge of crop landraces

Database name	Focus data
Checklist	Landrace names
Inventory(1)	Landrace names, landrace maintainer data, site data, crop data, socio-economic data
Ecogeographical survey(1)	Environmental and ecological data that affects distribution of landraces
Genetic	DNA fragments or sequences in genic or non-genic regions, neutral or adaptive genes

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

A. National checklist of landraces[22]

What is a national checklist of landraces?

50. A national checklist of landraces is a list of names of the landraces present in the country. A checklist of 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 (see Section 4.2).

[22] See Section B.3 in *Resource Book*.

Why develop a national checklist of landraces?

51. By knowing what landraces exist and where, effective conservation and use strategies can be determined. Preparing a checklist of 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 landraces. The checklist should be easy to access and exchange among stakeholders.

Methodology for creating a national checklist of landraces

52. The preparation of a national checklist of landraces is outlined below as a three-stage process.

Agree on a working definition of landraces, and determine the scope

53. The scope of the crop landrace checklist in terms of crops, landraces and geographical coverage should be agreed among stakeholders. A checklist will naturally have the greatest use when it has a broad geographical and crop scope. However, whether the checklist should include all landraces within a geographically defined area, or focus on particular crops or landraces, depend on the goals and priorities of the National Plan. If a partial checklist of landraces is developed, at a later stage it can contribute to the compilation of a full national checklist.

Survey and elaboration of a draft checklist of landraces

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

54. 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.

Consultations and checklist validation

55. Once a draft checklist of landraces has been generated, it should be validated through broad consultation with stakeholders in order to resolve any potential errors or confusion.

56. A final validation of the checklist is particularly important because the validated checklist is the starting point for elaborating an inventory of landraces, and may therefore be useful for a wide community of users and researchers. Having made a validated checklist, a process of updating at regular intervals should be agreed.

57. An example of developing a regional checklist for Sorghum varieties in Ethiopia is described in Box 1.

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 collections from 31 locally named Sorghum varieties were collected and are stored at Mekelle University. The socio-economic factors that affect varietal diversity as well as conservation and incentives strategies were discussed.

Source: Tsehaye, *et al.* (2009).
http://www.ajol.info/index.php/mejs/article/viewFile/46049/32457

B. National inventory of landraces[23]

1. What is an inventory of landraces?

58. An inventory of landraces is the checklist plus associated information, such as management, cultivation, uses, characterization, evaluation, farmer-based knowledge data, threats and conservation. In practice this means that, whereas each landrace name has only one entry in the checklist, in the inventory one landrace name may cover several landraces if landraces with the same name have different information or traits associated with them.

2. What is the value of a national inventory of landraces?

59. An inventory of 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 policy-makers, conservation practitioners, plant breeders and other user groups.

3. Methodology for creating a national inventory of landraces

60. This methodology assumes that a checklist is already available (see Section 4.1). If this is not the case, the compilation of the checklist and the inventory can proceed in parallel.

Scope of the inventory

61. For the National Plan, it is recommended that the inventory consider the broadest possible crop scope, and covers the whole 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 crop landraces, and that it therefore may be possible to limit the number of crops or taxa to be assessed.

62. Prioritization of landraces to be included in the inventory may be recognized. Some common criteria that are often used in prioritization of landraces include: their importance to food security; livelihood development; poverty reduction; sustainable agriculture; environmental resilience; and socio-economic importance at the national and local levels. In prioritizing which crops and 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:

[23] See Section B.4 in *Resource Book*.

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

Identification of resource persons and expertise

- Farmers and farm communities play a key role in the management of many 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 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 are usually familiar with documenting, interpreting and using genetic diversity at the infra-specific level; as well as identifying gaps in existing collections; regions known or suspected to harbour interesting landrace germplasm; and what 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.

63. It is recommended to arrange an expert meeting before the activities of inventorying landraces begin, in order to inform and involve stakeholders, to discuss where and how to make contact with landrace maintainers, to agree on possible collaborative activities among stakeholders, and to 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

64. An absolute minimum for data to be included in an inventory would be the **name of the landrace**, the **growing site** and the **crop maintainer** (farmer). However, it is recommended that traditional and local knowledge associated with the specific landrace maintenance and use are also collected and documented. Data that are commonly included in inventories are:

- *Crop maintainer details*: Name, address, contact details, year of birth, gender, family structure, education, main source of income, owned or rented land, etc.
- *Crop maintainer data*: How long the maintainer has cultivated the landrace, how long the maintainer will continue cultivation or conservation, whether someone (from younger generations, other relatives or neighbour) will continue to cultivate the 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 data*: 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 or for sale in markets, how marketed, current and past values, member of grower or marketing cooperative), maintainer-perceived value, source, country or region of origin, history of cultivation, crop qualities, local or national incentives to grow the landrace.
- *Crop 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 status, crop resistance as noted by maintainer, propagation method, selection criteria for propagation, variation displayed by the landrace with regard to characterization and evaluation traits, major agronomic problems faced by the crop (pest, diseases, drought, etc.), relationship to other landraces.

- *Relative uniqueness of the landrace*, i.e. grown on a single farm or with a more widespread, genetic distinction.
- *Crop conservation status*: Whether the crop is stored *ex situ*, method of selection of seed saved, method of seed storage, maintainer 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.
- *Evaluation data*: e.g. pest and disease resistance, abiotic stress resistance, maintainer's comparison with modern varieties.
- *Photographs.*

65. 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 landraces to be traced if desirable traits are found. An example of a questionnaire used to compile data for an inventory can be found at:
http://www.grfa.org.uk/media_files/publications_plant/veg_lr_inventory_england_and_wales.pdf

Choose or agree on an inventory database structure (see Section 3.5)

66. It is highly recommended that the inventory be organized and made available 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 Microsoft Access, OpenOffice Base and MySQL. The database structure should be aligned with the data collection form (Section 3.3 below), 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 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 (Section 3.5, Box 4).
- 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 landraces included), as well as addition of relevant information.

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.
- *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 and maintainers of landraces. It can also be useful to contact taxon or crop experts and people with specialist knowledge of the crops in the target area. The agreed data collection form should be used in the field survey.

67. It should be noted that landraces may consist of several populations or *ex situ* accessions, as different farmers or maintainers can grow the same landraces. It is therefore important to link landrace populations to specific sites or farmers and maintainers to ensure that the local intra-landrace diversity is recognizable. Passport data[24] should be available for every 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 landrace.

Ensure validation and dissemination

68. Once a draft inventory of landraces has been generated it should be validated through broad consultation with stakeholders. Once the inventory is validated, 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.

C. Ecogeographical analysis[25]

69. The inventory of 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?

70. Ecogeography is the study of environmental and ecological effects on the distribution of living things. The process of collating geographical, agro-ecological, 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?

71. Analysis of ecogeographical data is an integral part of formulating, and implementing conservation priorities, e.g. by helping to identify priority 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

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

Determine the scope

73. Before ecogeographical analysis is conducted, the scope of the study, especially related to crops, landraces and geographical coverage, must be discussed and agreed upon (see Section 2.3).

74. The selection of target crops and landraces should be done in collaboration with farmers and other experts. Conduct an ecogeographical survey using, to the extent possible, existing information, including floras, crop monographs, crop studies and crop databases. Some criteria for prioritization of landraces to be included in the study are important for national and local food security, livelihood

[24] 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 the FAO/Bioversity Multi-Crop Passport Descriptors V.2 at: http://www.bioversityinternational.org/uploads/tx_news/FAO_Bioversity_Multi-Crop_Passport_Descriptors_V.2__MCPD_V.2_._1526_02.pdf

[25] See Section B.4 in *Resource Book*.

development and poverty reduction (see Section 4.3 for more details on setting conservation priorities).

Identification of taxon and crop expertise

75. The resource persons would be the same as listed in Section 3.2.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

76. 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 landrace, its habitat and ecology. It is essential that this information is 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, crop species, taxonomic rank, synonyms, vernacular name(s).
- *Landrace biology:* Descriptive information, phenology[26], pollination, autecology[27], synecology[28].
- *Landrace distribution:* Known distribution of the landrace.
- *Habitats and ecology:* Altitude, aspect, slope, soil texture, soil drainage, soil pH, temperature, rainfall, habitat, vegetation type, associated species, human pressures.
- Landrace threat status: Threat status of crop using IUCN Red List categories[29], where applicable, and threats facing crop, e.g. urbanization, intensification of agriculture, competition from alien species.
- Landrace conservation status: Legislation, on-farm and *ex situ* conservation status, method of selecting seeds for conservation and storage, maintainer exchange frequency, management on-farm.
- Landrace utilization potential: Previous use as trait donor, potential use as trait donor, other known uses (including characterization, evaluation, pre-breeding and breeding activities.

Population- and Accession-level information

- *Accession identification*: Accepted identification for accession.
- *Accession occurrence*: Geo-referenced location, coordinates, geographical range, altitudinal range.
- *Accession characteristics*: Size, age structure, genetic diversity.
- *Accession 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.
- *Accession characterization and evaluation data:* Leaf shape, flower colour, plant habit, seed colour, chromosome number, plant height, days to maturity, etc.

[26] 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.
[27] 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.
[28] Synecology is the study of groups of organisms associated as a community.
[29] http://www.iucnredlist.org/technical-documents. See also Hammer, K. and Khoshbakht, K. 2005. Towards a ‘‘red list’’ for crop plant species. *Genetic Resources and Crop Evolution*, 52(3): 249–265.

- *Accession image*: Photographs, illustrations or links to digital images.

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

77. The database structure should follow the process described in Section 3.2.d. The database containing ecogeographical information may be directly linked to the national inventory of landraces through a unique identifier number (name of landrace or 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 specialist 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 and landrace maintainers 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, landrace populations should be geo-referenced by using, for example, global positioning systems, maps or Google Earth.

Verification and finalization of the ecogeographical survey

78. 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.

79. 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

80. The data collected in the ecogeographical survey enable detailed ecogeographical profiles of the landraces to be prepared (Box 2). The types of ecogeographical analysis that are useful for establishing conservation priorities include:

- the distribution of landraces in a country or region;
- the variation and distribution displayed by the landrace with regard to characterization and evaluation traits, e.g. pest resistance, frost tolerance, yield characteristics;
- analysis of major agronomic problems faced by the crop or landrace (pest, diseases, drought, etc.);
- the mapping and detection of ecogeographical patterns (e.g. phenology of the crop in different areas, whether a particular 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 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) (Box 3).

Data synthesis, validation and dissemination

81. 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 landrace.
- A report of the ecogeographical data analysis, containing the analysis and interpretation of the data.

82. Once the desired products have been produced, they should be validated through broad consultation with stakeholders. Once the products are validated, it is necessary to ensure that the information is easily available to all, such as through the Internet.

Box 2. 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 errors in the input tables that will be used in the other tools;
2) GEOQUAL: assesses the quality of the geo-referencing information of passport data;
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 that help detecting 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 the crop improvement without this trait being evaluated, partially or completely, in the original collection.

More information is available at www.planttreaty.org/content/tools-capfitogen.

Box 3. 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 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 landraces, or other 'point-distributions'. It reads standard data formats such as 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

D. Genetic data analysis[30]

What is genetic data analysis?

83. Here 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, although there are many other approaches, such as use of morphological or biochemical data.

Why it is useful to undertake genetic studies of landraces?

84. To effectively conserve and use landraces, the conservationist must be able to distinguish and identify them correctly. Studies of genetic diversity are commonly used to:

- *Identify germplasm and produce a classification*. Poorly known crop genetic resources can be accurately identified, described, and classified, and the relationship between landraces and their genetic distinction can be revealed. This includes clarifying situations in which farmers use the same name for landraces that are genetically distinct or use different names for the same landrace.
- *Provide genetic baseline information*. An understanding of the pattern of allelic richness and evenness across the geographical breadth of the crop or 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 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 can be identified.

Planning genetic data analyses

85. 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 human capacity available for such studies.

Review existing studies

86. 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 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

87. 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. Funding to undertake the study, as well as availability of skilled researchers, need to be secured before any data collection or analysis starts. When personnel have been identified, appropriate research objectives for the molecular study need to be determined with them. If the necessary facilities

[30] See Section B.7 in *Resource Book*.

or personnel are not available, plant samples can be sent away to an organization or institute willing to conduct the research.

Define the scope and plan acquisition of material

88. Material from the 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 objective germplasm.

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

90. Based on the agreed scope of the genetic analysis, the following points can help in planning the acquisition of material:

- Which 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 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?
- 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?

91. Further details related to collection of germplasm are included in Section 6.2.

92. DNA can be extracted from both fresh and dried plant material. However, the protocol for extracting DNA varies from species to species. As part of the preparation, it is recommended to assess the short- and long-term storage options for the collection of germplasm to be analysed, as well as the alternatives for DNA extraction. This information can be obtained from the researchers working at the laboratory where the analysis will take place.

Determine the type of assessment and tools

93. The type of molecular markers to use should be determined based on the needs and expectations of the study. 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.

94. With regard to conservation and use of landraces, it can be relevant to assess both neutral and adaptive variation. Neutral genetic variation refers to gene variants which do not necessarily have any direct effect on fitness. 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 that should be taken depends on the objectives, the resources (staff, budget and facilities) and genetic markers available.

Consider alternatives to genetic analyses

95. If resources or the availability of skilled staff, or both, are limited and it is not possible to undertake a molecular genetic study, it is possible to use farmer's perceived diversity and ecogeographical information as a proxy for genetic data. When using farmer's 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.

96. The main categories of descriptors that can be used to document the diversity perceived by farmers are:

- distinguishing traits (e.g. colour, shape or size of fruits and/or leaves);
- agronomic traits (e.g. days to maturity, yield);
- abiotic stresses (e.g. response to drought, high or low temperature);
- 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).

E. Information systems and data management[31]

1. Why is data accessibility critical to landrace conservation and use?

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

2. Strengthen the information and data management system for landraces

Challenges for retrieving information on landraces

98. Information about 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 different understandings of what constitutes a landrace, and therefore classify the same variety differently (Section 2.3).
- In many existing databases, landrace accessions are not distinguished from modern varieties. However, the FAO/Bioversity Multi-crop Passport Descriptors (Box 4) allows for distinction between landrace and other types of collection samples, to minimize this occurring.
- Information related to the nomenclature of a landrace may not always be correct. Common mistakes are to assume that landraces with the same name come from the same genetic unit, and that landraces with different local names are in fact different. In some cases, modern varieties have also been given similar names to existing landraces. To avoid such types of confusion, it is necessary to gather all relevant information, and in some cases to also do a genetic analysis.
- Collecting information about landraces grown for private companies can be hindered by issues of commercial sensitivity, concerns about the potential legal repercussions associated with

[31] See Section B.14 in *Resource Book*.

national listing of unregistered varieties, and insufficient time and resources available for the private company to respond.

Assess the current information and data management systems

99. In many countries there are information and management systems in place, such as partial checklists and inventories of 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 landraces

100. 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 data (passport);
- ecogeographical data (taxonomic, ecological and geographical);
- conservation management data (curatorial); and
- characterization and evaluation data (descriptive)

101. 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 (Box 4).

102. A meeting involving all relevant stakeholders can be arranged to review, discuss and verify the data.

Box 4. Development and use of standardized descriptors

A descriptor may be defined as "any attribute referring to a population, accession or taxon which the conservationist uses for the purpose of describing, conserving and using this material". The use of well-defined, tested and rigorously implemented descriptor lists considerably simplifies all operations concerned with data recording, such as updating and modifying data, information retrieval, data exchange, data analysis and transformation. When data are recorded, they should therefore be classified and interpreted with a pre-defined list of descriptors and descriptor states. The use of lists ensures uniformity, while reducing errors and problems associated with text synonyms.

In recent years the adoption of data collection and information management standards has improved, due to the use of standard data descriptors such as the FAO/Bioversity Multi-Crop Passport Descriptors V.2[32]. Descriptors specifically developed for Web-enabled national *in situ* landrace inventories have also been developed by independent projects, such as the EC-funded PGR Secure project, and Bioversity – The Christensen Fund, USA, project[33]. These descriptors have been designed to record the landrace(s) present on-farm, as well as to describe aspects of farm management practices (e.g. agricultural system, cropping management and farm labour division by gender). Descriptors to describe the seed supply system, farmer criteria for distinguishing landraces, selection criteria, seed storage practices, and crop uses, amongst others, are included.

[32] The "FAO /Bioversity Multi-Crop Passport Descriptors V.2 (June 2012)" is available at http://www.bioversityinternational.org/index.php?id=19&user_bioversitypublications_pi1[showUid]=6901

[33] 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

Designing the landrace database: descriptors and structure

103. 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 or establish a new system. 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.

VIII. ESTABLISHING CONSERVATION PRIORITIES

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

A. Threat assessment[34]

What is a threat assessment of landrace diversity

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

Why conduct a threat assessment?

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

Methodology for landrace threat assessment

107. A threat assessment of landrace diversity can either be conducted at the landrace level (i.e. extinction of the landrace), or genetic level (i.e. allelic loss within a landrace). The threat assessment is below described as a three-stage process, with a focus on the landrace level only. A threat assessment can be done at the same time as the landrace inventory is being prepared.

Identify criteria that indicate threats

108. It is recommended to use a combination of criteria from various categories to estimate the relative threat to specific landraces 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.

109. Some commonly used criteria indicating threats to a landrace or landrace population include:

- *Total growing area*: A landrace can be considered less threatened if the area dedicated to growing the landrace (often as a percentage of total regional area of the crop) is large, or if the trend in area of cultivation of the landrace is increasing.
- *Relative uniqueness of the landrace*: A landrace can be considered less threatened if it is widespread rather than growing at a single site.
- *Cultivation system*: A landrace can be considered less threatened if it is grown in sustainable farming systems, which are less likely to be changed or altered. 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, for instance, commercial farming systems.
- *Socio-economic indicators*: Landraces can be considered less threatened if they contribute significantly to the income and nutrition of farmers, if the maintainer-perceived value is high, or if there are market prospects to commercialize the landrace or landrace products.
- *Access to seed planting materials*: Landraces can be considered less threatened if many farmers produce or maintain seed of the landraces (easy to access), than if few farmers maintain the seeds (difficult to access).
- *Level of plant use*: A landrace can be considered less threatened if it has more than one types of use, this may be reflected in the number of plant parts of the landrace that are used.

[34] See Section B.5 in *Resource Book*.

- *Value to breeders and seed companies*: A landrace can be considered less threatened if it is known to have traits of interest to breeders and seed companies (e.g. resistance to biotic stresses), if it is currently used in breeding programmes, or referred to in catalogues of seed companies or nurseries.
- *Landrace conservation status*: A 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 re-introduction).
- *Historical indicators*: A 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*: Landraces can be considered less threatened if they produce abundant seeds or are easily propagated vegetatively, than if they produce few seeds or are difficult to propagate vegetatively.

Agree on type of threat assessment and category of threat

110. Assessing the severity of threats facing a particular 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 landrace should be the starting point. If a scoring system is developed, it can be a simple point-based system or a more complex rule-based scoring system, where the chosen criteria (or a combination of criteria) are weighed according to the priorities of stakeholders.

111. The most commonly used rule-based system for classifying threats to species is the IUCN system. Based on the pre-2001 IUCN Red List Categories[35], a set of threat categories have been proposed as follows[36]:

- 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).

Identify sources and collect information

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

Produce the threat assessment

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

1) **Identification of criteria** on which threat assessment is based, e.g.

   - growth area;
   - socio-economic importance;

[35] http://www.iucnredlist.org/technical-documents. See also Hammer, K. and Khoshbakht, K. 2005. Towards a ‘‘red list’’ for crop plant species. *Genetic Resources and Crop Evolution*, 52(3): 249–265

[36] Antofie, M., Sand, M., Ciotea, G. & Iagraru, P. 2010. Data sheet model for developing a red list regarding crop landraces in Romania. *Annals. Food Science and Technology*, 11(1): 45–49. Available at http://www.postdoctorat.ro/articole/4AR01.pdf Accessed 2016-03-09.

- conservation status; 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 landrace.
3) **An impact assessment**, indicating the final "threat category" of the landrace, e.g.

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

114. Additionally, a **consequence analysis** or a **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 providing consideration of outcomes or consequences and their implications.

Validation of the threat assessment

115. It is necessary to validate the assessment before it is finalized and made available. For validation, it is best to include both scientific experts and the maintainers of the landrace. It is particularly important to validate the assessment for those landraces thought to be lost or close to extinction bearing in mind the characteristics of landraces (Section 2.2).

B. Gap analysis[37]

What is a conservation gap analysis?

116. Gap analysis is an evaluation technique that can identify missing elements in the conservation of particular landraces or landrace populations. Essentially, a conservation gap analysis for landraces should assess both the diversity existing in farmers' fields (on-farm) and the diversity stored in genebanks (*ex situ*). The result of a landrace conservation gap analysis is a list of landrace populations that require active conservation, either through enhanced on-farm management initiatives or in *ex situ* collections.

Why is a conservation gap analysis of priority landraces useful?

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

Methodology for assessing conservation gaps

118. Conservation gaps can be assessed at different levels, including at individual landrace, ecogeographical, trait or genetic variability levels. A systematic approach for identifying gaps at each of these levels is described below (see also Box 5).

[37] See Section B.8 in *Resource Book*.

Box 5. Identification of gaps in international genebank collections

An approach has been developed to identify which areas around the world, traits and taxa are still unrepresented among international genebank collections managed by CGIAR-supported centres. The initiative has been a collaborative project, involving several of the CGIAR centres, and supported by the Global Crop Diversity Trust, the Global Public Goods Programme, the World Bank and Grains, Research and Development Corporation.

A number of gap analyses of key crops, including landraces, are available at the following link: http://gisweb.ciat.cgiar.org/GapAnalysis

Individual landraces level

119. A landrace gap analysis is undertaken to identify particular 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 landraces. Comparison with the full landrace inventory should identify priority landraces that are not actively managed in farmer's fields (on-farm).
- *Ex situ*: Review the *ex situ* accessions in genebanks and field genebanks, by direct contact with genebank curators or by interrogating on-line databases. Based on the national inventory or checklist, determine landrace taxa not conserved *ex situ* versus the landrace taxa where accessions are appropriately stored in genebanks. This analysis will identify landraces that are not actively conserved in genebanks.

Ecogeographical level

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

- On-farm: A review of the total ecogeographical range of the landrace and where in that range the landrace is actively managed on-farm will identify areas or environmental conditions where landraces are not managed on-farm, and thus help target new on-farm sites.
- *Ex situ*: A review of the total ecogeographical range of the landrace and the elements of that range that have been sampled and are conserved *ex situ* will identify areas or environmental conditions where sampling has not occurred and/or where germplasm collection is required to supplement existing *ex situ* collections.

Trait level (see Box 6)

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

- On-farm: A review of the landrace populations with a specific trait of interest actively managed on-farm, compared with the total ecogeographical range of the landrace (with the trait of interest), will identify populations with the desired genetic characteristics that are not actively managed on-farm.
- *Ex situ*: A review of the landrace populations with a specific trait of interest that have been collected and are conserved *ex situ*, compared with the total ecogeographical range of the landrace (with the trait of interest) will identify specific populations with the desired genetic characteristics that are not conserved *ex situ*.

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 one predictive characterization technique, and can be used in this context. The basic steps of a FIGS analysis for landraces are:

Compile the geographical distribution of 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 landrace accession or population using GIS software (e.g. DIVA-GIS) (Box 3).

Use the existing characterization and evaluation data to identify sites where the target variation probably 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) and references therein (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 [online]. See doi: http://www.dx.doi.org/10.1007/s10722-011-9775-5 Accessed 2016-03-26.)

Other approaches to predictive characterization can be found at the following Web site: http://www.bioversityinternational.org/e-library/publications/detail/predictive-characterization-of-crop-wild-relatives-and-landraces/

Genetic variability

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

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

C. Setting conservation priorities[38]

What is landrace conservation prioritization?

123. Landrace conservation prioritization is the process of ascribing a relative value to landraces and ranking them in order of importance.

[38] See Section B.6 in *Resource Book*.

Why is it useful to set landrace conservation priorities?

124. In most cases, a national inventory of landraces will identify a greater number of landraces than can be conserved with the financial resources and expertise available in the country. Landraces must therefore be prioritized as a means of selecting 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 landraces

125. Landrace conservation prioritization depends on a number of factors, including the number of 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 landrace conservation may therefore vary according to the needs of countries or those that are undertaking the work, but a general methodology is described below.

Identify prioritization criteria

126. To determine which landraces to conserve, an agreed set of prioritization criteria needs to be defined. To prevent these criteria from being subjective, it is essential that this is 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 landraces or specific landrace populations. Some criteria that are commonly used include:

- *Economic value*: 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 landraces) grown at the national level; and
    - *Economic value of the landrace*: Landrace production quantity, area and uses (whether the landrace is grown for food, fodder, forage, etc.).
- *Landrace diversity*: Whether a particular landrace occurs together with other landraces. It is more cost effective to conserve sites with a high number of landraces rather than sites with a single landrace.
- *Cultural value*: The cultural importance that a particular landrace has in a community.
- *Farmers' priorities*: The priority given to a particular landrace by the farmers, e.g. based on importance in their diet, or special cooking qualities. An indication of the importance of the landrace may be estimated by the number of farmers that grow a particular landrace. 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 landrace), the greater the conservation priority.
- *Native status*: Whether the landrace has originated in the country, or whether it has been introduced.
- *National rarity*: A landrace with limited range within the country is considered rarer than a landrace occurring throughout the country; therefore, the number of provinces in which each landrace occurs (or other indicator of restricted distribution) can be considered.
  Conservation status: Before a 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 landrace that are not being actively conserved.

The information obtained from *ex situ* holdings should be evaluated carefully, considering the following:

- researchers often identify landraces using merely the name given to the landrace by the farmer (assuming that two differently named landraces are in fact different), but not only might farmers use the same name for landraces that are genetically distinct, they might also use different names for the same landrace;
- the material held in genebanks might be incorrectly determined, dead, in poor condition or unavailable to potential users;
- the number of accessions might be misleading because of duplicates; and
- *ex situ* accessions might not be representative of the overall genetic diversity of a landrace.

- *Agronomic information as noted by the maintainer:* Beneficial 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 landrace that has been cultivated for a longer time may have higher priority, assuming that the length of cultivation indicates 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 landraces in religious ceremonies.

Agree on type of prioritization assessment

127. To assign priority to a range of landraces can be done in a variety of ways, ranging from subjective, expert-led assessments, to prioritization schemes. Quantitative methods for prioritizing species range from simple indexes 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 time available, financial resources and data availability.

128. Whatever scoring system is used for landrace conservation priority, it must be agreed. These can be modified from the IUCN categories of threats (outlined in Section 4.1), or developed specifically for the intervention. A simple list of categories indicating priority is provided as Table 2.

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	

3b	Moderate to little need for on-farm management	Less priority, but monitoring and evaluation schemes recommended
3c	Moderate to little need for *ex situ* conservation	
4a	No need for on-farm management and *ex situ* conservation	
4b	No need for on-farm management	No priority
4c	No need for *ex situ* conservation	
5	Need for re-assessment	Insufficient data

Produce the list of prioritized landraces

129. Based on the criteria, assessment method and collected information, the prioritization scheme can be applied to the national inventory (or checklist), and the priority 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 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 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.

130. 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 landrace. Therefore, it is necessary to monitor landraces on a regular basis (see Section 7.1), regardless of the prioritization category.

Validation and finalization of the conservation priority assessment

131. As with other assessments, it is necessary to validate it among stakeholders before it is finalized. The final list of the prioritized 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 landraces is adjusted to a number that can be actively conserved or managed using the available resources.

IX. PREPARING THE NATIONAL PLAN

132. A National Plan for Conservation and Use of Crop Landraces is a blueprint for the management of the 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

133. A vision statement is an inspirational declaration reflecting the long-term vision the country has for conserving crop landraces. It should relate to overall national strategies. The vision should illustrate where the country wishes to be with regards to conservation and use of 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 use of landraces. The country context, scope and state of landrace conservation and use should be taken into account.
2) Envision a "best scenario" for the state of landrace conservation and 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 landraces, while simultaneously promoting their use".
4) Seek stakeholder inputs and agreement. Goals and objectives

B. Goals and objectives

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

135. The **goals** of the National Plan should be stated as general intentions, describing the overall purpose and desired result of the National Plan. The goals of the National Plan should focus on promoting 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. Goals of a National Plan for Conservation and Use of Crop Landraces might include:

- establish a systematic and coordinated national approach in support of on-farm management of landraces;
- formulate and implement a collection programme for complementary *ex situ* conservation of landraces in the country; and
- promote the sustainable use of landraces in the country.

136. 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 landraces. The objectives should be based on the threat assessment, gap analysis and elaborated conservation priorities (see Section 4). Four suggested objectives within a specified time frame might be:

- establish a network of [number] on-farm management sites, actively managing the full genetic range of the [number] highest priority landraces;
- conduct a minimum of [number] collection missions in Provinces X, Y, Z, and ensure *ex situ* back-up of the [number] highest priority 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] landraces or landrace products

C. Action plan and timeline

137. The main content of the National Plan should be in the form of an action plan, where planned activities, fulfilling the goals and objectives, are described, along with the responsible unit(s), success criteria or indicator, time frame and budget. The roles and tasks of stakeholders should be clearly outlined, including the responsibilities in managing and coordinating. 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 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 of implementation. The National Plan should also include provisions that will allow an efficient monitoring of the progress, including implementing agency, success criteria or indicators, time frame and financial resources. 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

138. 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 landraces (discussed in Section 7.1). 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.

139. 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 included. 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 it?
- How should the monitoring data be used?

140. 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

141. 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.

142. 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 is agreed 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; and
- increase the amount of resources currently provided by the Government to implement activities.

F. Communication, consultation and validation

143. 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 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 a 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 build support for the National Plan.

144. 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. For the best possible consultation process, allowing all stakeholder an equal opportunity to provide feedback and contribute to discussions, a combination of electronic consultations and personal meetings is best. Encourage feedback from all stakeholders; allowances should be made for different stakeholders that may, for example, need translations of documents.

145. To validate the final document of the National Plan, it is recommended to arrange a large meeting, where all relevant stakeholders participate, including the relevant authorities. This will allow presentation of the final product, sensitization of stakeholders and agreement 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. The validation meeting can therefore be an occasion to agree on specific “next steps” that can help initiate the implementation phase.

146. Following the validation of the National Plan, it is recommended that the final document is 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 – newspapers, TV, leaflets, radio, etc. – should also be considered for creating public awareness about the National Plan for Conservation and Use of Crop Landraces.

X. Implementation

147. To implement a National Plan for Conservation and Use of Crop Landraces means to realize the objectives and activities it describes, following the process, budget and timeline envisioned. This section provides guidance for the implementation of three suggested goals: on-farm management of landraces; *ex situ* conservation of landraces; and sustainable use of landraces (See Section 5.2).

A. Establish a systematic and coordinated national approach in support of on-farm management of landraces[39]

148. It is highly recommended that the National Plan includes a goal specifically for promoting on-farm management of crop 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

149. 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, while in other countries this is completely lacking.

150. 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 landraces can be complicated in many countries, especially where farmers are not involved in the national PGRFA network. Farmers or maintainers of landraces therefore need to be fully acknowledged by the conservation and policy communities at the national level.

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

- 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.

152. 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

153. Despite on-farm management being considered a priority activity[40] 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,

[39] See Section B.10 in *Resource Book*.
[40] 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

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 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; and
- ensure that *farmers benefit* from the initiatives that are proposed and implemented.

Recognize and involve local communities in the sustainable use of landraces

154. Maintenance of landraces cannot be successful without the support and involvement of local communities. To promote the continuing management and use of landraces, it must also be proven that it is beneficial to the individual farmer. In addition, traditional or local community use of landraces should not be restricted or infringed by active conservation and management of certain landraces.

155. The following points can help the recognition and involvement of local communities:

- recognize, document and promote traditional knowledge and traditional cultivation practices;
- promote participatory action and involve farming communities in information gathering and planning of interventions;
- raise the profile of landraces in the agricultural community;
- stimulate 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 landraces.

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

156. 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 landraces

In order to identify the landraces for which on-farm management measures should start immediately, a list of prioritized landraces should be identified (see Section 4.3). If landrace conservation and 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 Section 4.3 can be applied.

2) Select a single- or multi-landrace approach

Whether to focus on-farm management initiatives for one or several 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 farmer's willingness to maintain the landraces in their production system. Often, an approach targeting multiple 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-landrace sites are focused on the value (economic, nutritional, cultural, etc.) of an individual landrace and on its particular adaptive diversity. However, if a particular landrace is of sufficient national priority, even if found in isolation from other 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 landraces:

- If a single-landrace approach is taken, the sites targeted for on-farm management activities should be selected throughout the distribution area of a particular landrace. Sites can be based

on geographical location or other parameters, such as intra-landrace genetic variability, cultural value, or threat status (see criteria for prioritization, Section 4.3).

- Multi-landrace sites should be established based on the minimum number of farm areas that contain the optimal number of landraces. Such site selection can be based on either a 'hotspot analysis', which identifies one or more areas with high landrace richness (landrace 'hotspots'), or a 'complementarity analysis' that can be used to identify the minimum number of sites needed to manage all the diversity of target landraces within the minimum number of sites. Both analyses can be carried out using the computer program DIVA-GIS (see Box 3 and Section 3.3). Using hotspot analysis, common landraces are likely to be duplicated if multiple on-farm sites are planned, which can be avoided using complementarity analysis. However, if the genetic diversity within landraces should be taken into consideration, it might be worthwhile to focus management activities on multiple sites with a similar array of landraces if the genetic diversity contained at one site complements rather than duplicates the diversity at other sites. If time and resources for doing a complementarity analysis are not available, a general guide is to choose five landrace populations from the most ecogeographically diverse sites for active management that have farming communities willing to participate in on-farm conservation and use of the selected landrace populations.
- In the selection of sites, collaboration with managers of protected areas (PAs) should be explored, as some PAs contain a considerable amount of agricultural land where landraces are maintained by farmers. It is therefore relevant to consider and assess PAs in the preliminary selection of sites. If prioritized landraces exist within the boundaries of PAs, it is logical that they are 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 landraces are more likely to suffer genetic erosion due to threats may be more appropriately targeted for *ex situ* conservation (see Section 6.2). Particularly vulnerable areas should also be closely monitored, as the 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

157. Landrace diversity of major staple crops and minor crops remain important to the livelihoods of small-scale farmers. The reasons for maintenance of traditional crop landraces are complex and often associated with adaptation to low input agriculture, and 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.

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

- Develop an appropriate understanding of the extent and distribution of the landrace diversity at the site and those cultivating the landraces. If comprehensive national or regional inventories have been developed most of the needed information will already be available (see Section 3.2). For each landrace that is being assessed, collect relevant data such as name and characteristics, names of farmers growing them, use, association with local cultural values, seed access, seed distribution, and whether used by researchers, breeders or seed companies.
- Assess how this landrace diversity is maintained and used, as well as the constraints affecting its sustainable management. Of the factors influencing the use of the landraces, it is relevant 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.
- Analyse the interaction between the 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, communities and local institutions.

159. The common constraints farmers face in their maintenance and use of landraces are related to the *availability* of on-farm diversity, farmers' *access* to landrace diversity and related information, the *worth* and *significance* given to the 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 landraces. 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[41] that to successfully promote on-farm management, it must be ensured that:

- local crop diversity exists in sufficient abundance within the production systems;
- local crop diversity is accessible to farmers;
- farmers are aware of the values of the landraces; and
- farmers derive benefit from the management of landraces

160. 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

161. 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. The goals of these community seed banks are to provide a safe and controlled storage facility for seeds and provide easy access to seed for farmers, and act as a buffer against seasonal crop failure and loss of seed. It can also play a role in extending access to particular crops and varieties (e.g. a particular 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 landrace diversity. Community seed banks are in most cases administered locally, by a selected group or a specific person.

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

Production of specific management plans

163. Action plans developed for specific landraces and/or specific sites depend on which approach is being used. A *landrace action plan* is typically produced when a single-landrace approach is used. It should focus on the current on-farm conservation and use status of the targeted landrace, threat

[41] Jarvis, D.I., Hodgkin, T., Sthapit, B.R., Fadda, C. & Lopez-Noriega, I. 2011. A heuristic framework for identifying multiple ways of supporting the conservation and use of traditional crop varieties within the agricultural production system. Critical Reviews in Plant Science, 30(1-2; Special Issue): 125–176. Article No. PII 937009149.

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 if a multi-landrace site is designated; it should contain information on all the landraces within the site, including to the extent possible the information listed above for the *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

164. Realistic and detailed cost estimates for all proposed activities supporting on-farm management will help to facilitate the mobilization of resources and funding (see Section 5.5). Financial mechanisms need to be set up and articulated in ways that will survive changes in individuals, policies and governments. To establish a long-term funding mechanism in support of on-farm management of landraces it will be necessary to have a clear statement from the government and stakeholders of the importance and commitment to this activity.

Table 5. Actions that promote on-farm management[42]

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	Re-introduction 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 discuss and experiment in crop analysis, management and improvement)	X	X	X	X

[42] Adapted from Jarvis, D.I., Hodgkin, T., Sthapit, B.R., Fadda, C. & Lopez-Noriega, I. 2011. A heuristic framework for identifying multiple ways of supporting the conservation and use of traditional crop varieties within the agricultural production system. Critical Reviews in Plant Science, 30(1-2; Special Issue): 125-176. Article No. PII 937009149

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**
	Diversity kit (diverse 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 for traditional variety as material is already closer to farmer 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		
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 farmer 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

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**
	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
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
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

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**
	Quality declared seed (QDS) (that certify the vendor rather than the seed)		X	X	X
	Truthfully labelled seed laws that focus on seed quality rather than seed purity		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	
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's groups 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

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**
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
Promoting ecological land management practices	Environmentally sensitive areas (ESA) include high agro-biodiversity areas			X	X
	Agro-biodiversity Zones			X	X
	Agro-biodiversity 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

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**
	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 (PES)		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 landraces[43]

What is ex situ *conservation?*

165. *Ex situ* conservation is the preservation of components of biological diversity outside their natural habitats (CBD, 1992)[44]. This involves locating, sampling, transferring and storing samples of the target taxon away from its native habitat, most often in genebanks. 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 landraces having orthodox seeds (i.e. seeds that can be dried and stored at -18°C), 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 landraces?*

166. A collecting programme for *ex situ* conservation here refers to an agreed plan to collect 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 landraces necessary?*

167. *Ex situ* conservation provides efficient long-term safeguarding of plant genetic resources, at the same time allowing easy access for characterization, evaluation and use. To ensure that the genetic diversity of priority landraces is represented in national collections, programmes to systematically

[43] See Section B.11 in *Resource Book.*
[44] http://www.cbd.int/convention/text

target and collect them 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 landraces*

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

Define the type of collection mission

169. he most common reasons why landrace germplasm is collected include:

- rescue collection (where there is a danger of genetic erosion or extinction of target 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 landrace); and
- collected on an opportunistic basis, for instance during other activities or studies.

170. 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 done 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.

171. 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. 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 and staffed to handle new collections, and to re-generate as needed.

Prioritization of landraces and sites for targeted collecting

172. Generally, well-documented *ex situ* collections that have captured as much genetic diversity of landraces as possible will have the greatest conservation value. For collecting 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 landraces have not yet been identified, a review of the conservation gaps is recommended (see Section 4.2).

Preparation for the collecting programme

173. The most important information to be included in a collecting programme is a list of the prioritized landraces, the sites or areas from where they should be collected, when the sampling should take place, and by whom.

174. 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*: Landraces can be collected from a variety of possible sites, ideally from farmer's 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 remembering that in theory 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 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[45] 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 planned and prepared for.

Finalize, validate and implement the collecting programme

175. 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 by face-to-face meetings, as many relevant local and national stakeholders as possible.

National collecting missions and acquisition of germplasm

176. All collecting of landraces needs to be undertaken legally, with the appropriate national permission and be in line with international conventions and legislation. The *Genebank Standards for Plant Genetic Resources for Food and Agriculture* (2013)[46] includes standards for acquisition of germplasm. Many other organizations have also developed specific protocols to guide the collection of plant material, including the Global Crop Diversity Trust, Bioversity International[47] and the Millennium Seed Bank (MSB)[48].

177. 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 (see Sections 6.2 and 6.3), other

[45] FAO/Bioversity Multi-Crop Passport Descriptors V.2 [MCPD V.2]. June 2012 Available at http://www.bioversityinternational.org/e-library/publications/detail/faobioversity-multi-crop-passport-descriptors-v2-mcpd-v2/ Accessed 2016-03-09
[46] http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/gbs/en
[47] http://cropgenebank.sgrp.cgiar.org/index.php/procedures-mainmenu-242/collecting
[48] http://www.kew.org/science-conservation/millennium-seed-bank/collecting

technical, practical and logistical aspects need to be discussed and agreed in advance of a collection mission taking place, including:

- *knowledge of agro-ecology 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, places to halt at night;
- *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

178. Collected material should be conserved in facilities with the capacity to manage it; usually this will be the national genebank. A duplicate sample should be deposited elsewhere for safety purposes.

179. 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 for Plant Genetic Resources for Food and Agriculture*[49].

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

180. Collecting samples of 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 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 landraces in the farmer's field;
- the active maintenance of landraces in farmer's fields, and support provided for on-farm management;
- crop species' breeding system and *ex situ* storage characteristics;
- type of storage facilities available;
- location of 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*); and
- financial resources ear-marked for on-farm management and *ex situ* conservation.

C. Promote use of conserved landrace diversity[50]

What is understood by use of landraces?

181. The "use" of landraces can be understood at two levels. On the one hand, use may refer to direct use by farmers in meeting their economic, food security and cultural requirements. On the other

[49] http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/gbs/en
[50] See Section B.13 in *Resource Book.*

hand, use may refer to 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?

182. Only by conserving landrace diversity, can countries take advantage of the potential implicit in landraces, whether by direct or indirect use. By conserving 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.

Steps to promote wider utilization of landrace diversity

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

Establish a knowledge base of landraces and make the information available

184. Establishing a checklist and inventory of landraces is the start of a landrace knowledge base that can be enhanced with additional analyses of ecogeographical and genetic data (see Section 3). The information gathered on landraces may show which landraces are suitable for wider use either directly or indirectly. Farming communities are likely to have extensive knowledge of specific crops and 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 rural radio programmes or other type of media;
- setting up information systems and Internet connections for farmer access to information, and ensure that variety information databases are made in farmer-friendly formats; and
- supporting the distribution of information about landraces and their specific characteristics.

Increase access to material

(i) Farmer and community access

185. Farmers access seeds and planting material from a variety of different sources, including within their own and neighbouring communities, local seed enterprises, 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. A large proportion of small-scale farmers are therefore saving seeds from their own harvest to sow the following year. In order for farmers to have access to a varied portfolio of seeds and planting material, including landraces, information about and access to these resources needs to be strengthened. Support is needed to provide farmers with the planting material they prefer, not only improved or certified material, but also landraces. There is a significant community of researchers, agronomists and the institutions in which they work, that are aiming 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 landrace germplasm[51].

[51] See footnote 41 and references therein.

(ii) Researcher and breeder access

186. The community of researchers and breeders also needs easy access to crop landrace material, if they are to use them in their work. Normally, researchers and breeders get the germplasm they use directly from genebanks. It is therefore a requisite that landrace germplasm is available from - and well documented in - *ex situ* collections. Landraces can also be collected directly from farmer's fields, which allows direct interaction between researchers and farmers, and facilitates collection of relevant information by the researcher. To improve the accessibility of farmer material for researchers, farmers and researchers need to agree on the benefits to be expected from 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;
- researchers helping in developing market opportunities and strategies, involving farmer-selected landraces; and
- supporting the introduction of landraces into formal breeding programmes

Raise public awareness about the importance of landraces

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

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

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

188. Many countries lack, or are experiencing a deficit in, capacity and skills in plant genetic resources management, which may hinder optimal use of landraces. To strengthen the country PGRFA system, it might be relevant 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 use of PGRFA, targeting professionals and including researchers, technicians, development workers and agricultural extension workers;
- arrange information seminars, workshops and trainings for rural communities;
- upgrade and strengthen research stations, their facilities and plant breeding programmes; and
- develop a national portfolio of expertise.

Increase the characterization[52] and evaluation[53] of landraces

189. One of the most significant obstacles to greater use of landraces is the lack of adequate characterization and evaluation data, and limited capacity to generate and manage such data. In order for breeders to effectively use landraces in their work, the existing diversity needs to be

[52] Characterization refers to descriptive characters of germplasm, such as height, days to maturity and flower colour.
[53] Evaluation refers to the response of germplasm to biotic and abiotic stresses.

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 landraces, the following points should be considered:

- establish or enhance existing characterization and evaluation activities for landraces, and ensure the information can be widely accessed;
- promote the access and exchange of landrace accessions and breeding material;
- improve the characterization and evaluation of landraces on-farm, particularly in areas known to be hotspots for environmental stresses;
- ensure that priority landraces are collected, documented and stored in genebanks;
- expand the collection and conservation (both *ex situ* and on-farm) of landraces, if necessary;
- establish trait-specific collections of crop 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 landraces; and
- monitor progress in the characterization, evaluation and use of landraces.

Establish partnerships and linkages among groups of stakeholders

190. 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 use of landraces.

191. In order to ensure improved access and more efficient use of landraces, it helps to establish strong linkages between those conserving and managing these resources, and those wishing to utilize the genetic resources. Since many landraces are only found in farmers' fields, certain farms can be valuable as research platforms for field experimentation, characterization and evaluation, as well as pre-breeding and breeding activities. Promotion of such activities may stimulate the use of landraces.

192. 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 and 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.

XI. Monitoring crop landrace diversity and reporting

A. Monitoring landrace diversity[54]

What is monitoring of landraces on-farm?

193. Monitoring of landraces on-farm means to systematically collect data concerning landraces grown and maintained in farmers' fields over time. Landrace monitoring can be carried out at the individual landrace level, or at the level of overall landrace diversity. Landraces can also be monitored for evolution and adaptation to specific environmental conditions.

Why is it useful to monitor landrace diversity on-farm?

194. Monitoring of landrace diversity on-farm provides an early warning mechanism for detecting genetic erosion and threats to landrace diversity. It also allows results, processes and experiences to be documented and used as a basis to steer decision-making and learning processes. Monitoring populations of 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 landraces; and
- determine the outcomes of management or farming practices on populations, and to guide management decisions.

Methodology for developing a monitoring plan for landraces growing on-farm

Agree on the scope of the monitoring plan

195. It is necessary to develop a realistic monitoring plan according to the scope of the particular intervention, area or 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 landraces monitored. In other cases, it might be relevant to monitor landrace diversity in only a specific area, or target specific landraces.

Agree on the level at which the landrace(s) should be monitored

(i) Landrace monitoring can be carried out at the level of:

- individual landraces;
- genetic diversity; or
- evolution and adaptation to specific environmental conditions.

196. 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 landrace diversity on several levels.

197. The key objectives of monitoring landraces are:

- to monitor changes in landraces maintained;
- to monitor changes in the environments of each landrace;
- to monitor farming practices;
- to record farmers' perceptions and reasons for any changes in landraces grown;
- to record changes in specific field plots; and

[54] See Section B.12 in .

- to determine the reasons for varietal change and loss of landrace diversity.

198. The key objectives when monitoring landrace genetic diversity are:

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

199. 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;
- to identify specific landraces and populations that exhibit adaptive capacity in relation to environmental changes; and
- to detect gene flow among varieties and with sympatric wild relatives.

Agree on indicators and parameters to measure

200. Depending on the agreed level of monitoring, indicators must be developed. Examples of indicators that can be used to assess 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 landraces	Decrease or increase in the numbers of farmers growing each landrace. Decrease or increase in the area covered by a landrace. Decrease or increase in the total number of landraces grown. Decrease or increase in richness indexes. Decrease or increase in annual replacement of landraces by modern varieties.	Number of landrace grown. Area allocated to each landrace. Richness indexes e.g. Shannon Weaver Index (H') and Simpson Index (D). Management practices. Threats.

Genetic erosion within a 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 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 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 variation in agronomic practices. Responses to climatic changes. Responses to pathogen incidences. Responses to planting in disease nurseries, etc.

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

201. In line with the scope of the monitoring plan, specific sites should be selected where the 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.

202. The time interval between the surveys can vary and should be adjusted in the light of experience. If the site or the landraces on the site are threatened (see list of threats under Section 4.1), it is recommended to monitor the site frequently (e.g. every 2 to 4 crop generations). Regular interaction between the maintainer and conservationist can also have additional benefits, such as better communication and collaboration, and possible follow-up regarding emerging issues (e.g. a disease outbreak). If the site or landraces on the site are not especially prone to threats, a longer interval between monitoring visits is acceptable.

Data collection methodology

(i) Monitoring of individual landraces

203. Monitoring is done by comparing 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.

(ii) Monitoring of genetic diversity

204. Monitoring of genetic diversity within landraces can be done through a genetic analysis of diversity. In most of these analyses, 'neutral' genetic markers are used, meaning the genetic variation measured is not known to change the fitness of an individual. Reference to genetic data analysis and to collection of material is included in Sections 3.4 and 6.2, respectively.

(iii) Monitoring evolution and adaptation

205. Monitoring of the evolution of landraces under specific environmental conditions and noting the adaptation of landraces to specific environmental conditions can be done through a genetic analysis of adaptive diversity and recording, and analysing changes in the growing environment of the landrace. Genetic markers that have known variations in a particular gene with an effect on the adaptive fitness of the individual are analysed (see Section 3.4).

Reporting and disseminating information

206. Results from the monitoring of landrace diversity on-farm are of interest to a large number of stakeholders. Therefore the results of the monitoring should available to all relevant stakeholders.

B. International reporting requirements and global linkages

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

208. In particular the indicators[55] and reporting format[56] 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 landraces (Box 7). 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. Below is a small selection of the Second GPA indicators that are relevant to the monitoring of landraces.

[55] A draft list of Indicators can be found in Appendix I of the FAO Commission document, available at http://www.fao.org/docrep/meeting/027/mf557e.pdf Accessed 2016-03-09.
[56] A draft reporting format for the implementation of the Second GPA can be found in an Information document to the 14th Session of the Commission, available at http://www.fao.org/docrep/meeting/027/mg015e.pdf Accessed 2016-03-09.

Box 7. A selection of the Second GPA indicators in different priority areas relevant to monitoring of crop landraces

In situ conservation and management:

- Number of *in situ* (including on-farm) surveys or inventories of PGRFA carried out.
- Number of PGRFA surveyed or inventoried.
- Percentage of PGRFA threatened out of those surveyed or inventoried.
- Number of farming communities involved in on-farm PGRFA management and improvement activities.
- Percentage of cultivated land under farmer varieties or landraces in areas of high diversity or risk, or both.
- Number of farmer varieties or landraces delivered from national or local genebanks to farmers (either direct or through intermediaries).

Ex situ conservation

- Existence of a strategy for identification of gaps in national genebank holdings and for targeted collecting missions to fill identified gaps.
- Number of targeted collecting missions in the country.

Sustainable use

- Number of programmes, projects or activities promoting development and commercialization of all varieties, primarily farmer varieties, landraces and underutilized species.
- Number of farmer varieties and landraces and underutilized species identified with potential for commercialization.
- 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

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