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The International Treaty ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

INTERNATIONAL TREATY ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

ELEVENTH MEETING OF THE *AD HOC* ADVISORY COMMITTEE ON THE FUNDING STRATEGY AND RESOURCE MOBILIZATION

Rome, Italy, 8 − 10 May 2019

GLOBAL PLAN OF ACTION FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE – PRIORITIES, IMPLEMENTATION AND MONITORING

This document provides: a summary of the priorities of the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA); a 2016 report on the assessment of its implementation; and the full Second GPA.

The GPA is a supporting component of the International Treaty (Art. 14) and should be taken into account by the Governing Body in establishing a target the Funding Strategy of the International Treaty (Art.18).

The Second GPA is a strategic framework for the conservation and sustainable use of the plant genetic diversity on which food and agriculture depends. It was prepared under the aegis of the Commission on Genetic Resources for Food and Agriculture and adopted by FAO Council at its 143rd Session in November 2011. It agrees a set of Priority Activities that directly address the new developments, opportunities and challenges facing plant conservation and use in the 21st century. The priority activities of the Second GPA addresses these developments to ensure that PGRFA continue to be available for current and future use for food security and sustainable agriculture.

There are linkages with the updating of the Funding Strategy and the Second GPA: the Commission recommended that the Second GPA be focused, so as to assist priority setting, including identifying priorities for the Funding Strategy of the International Treaty (para. 17 Second GPA).

PART I: SUMMARY OF PRIORITY ACTIVITIES OF THE SECOND GLOBAL PLAN OF ACTION FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

In Situ Conservation and Management

1. Surveying and inventorying plant genetic resources for food and agriculture
2. Supporting on-farm management and improvement of plant genetic resources for food and agriculture
3. Assisting farmers in disaster situations to restore crop systems
4. Promoting in situ conservation and management of crop wild relatives and wild food plants

Ex Situ Conservation

5. Supporting targeted collecting of plant genetic resources for food and agriculture
6. Sustaining and expanding ex situ conservation of germplasm
7. Regenerating and multiplying ex situ accessions

Sustainable Use

8. Expanding the characterization, evaluation and further development of specific subsets of collections to facilitate use
9. Supporting plant breeding, genetic enhancement and base-broadening efforts
10. Promoting diversification of crop production and broadening crop diversity for sustainable agriculture
11. Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species
12. Supporting seed production and distribution

Building Sustainable Institutional and Human Capacities

13. Building and strengthening national programmes
14. Promoting and strengthening networks for plant genetic resources for food and agriculture
15. Constructing and strengthening comprehensive information systems for plant genetic resources for food and agriculture
16. Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of plant genetic resources for food and agriculture
17. Building and strengthening human resource capacity
18. Promoting and strengthening public awareness of the importance of plant genetic resources for food and agriculture

PART II: ASSESSMENT OF THE IMPLEMENTATION OF THE SECOND GLOBAL PLAN OF ACTION FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE 2012-2014

联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Alimentación y la Agricultura | منظمة الأغذية والزراعة للأمم المتحدة

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 5.2 of the Provisional Agenda

Sixteenth Regular Session

30 January - 03 February 2017

ASSESSMENT OF THE IMPLEMENTATION OF THE SECOND GLOBAL PLAN OF ACTION FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE 2012-2014

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EXECUTIVE SUMMARY

As agreed under the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA) governments and other FAO Members monitor and guide its implementation and the related follow-up processes through the Commission on Genetic Resources for Food and Agriculture (Commission).

Accordingly, the Commission adopted a monitoring framework for the Second GPA, which is based on a set of 63 indicators for monitoring the implementation of its 18 priority activities (PAs). A Reporting Format for Monitoring the Implementation of the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture[1] (Reporting Format) was developed to collect the information from government-appointed National Focal Points (NFPs).

The aim of this report is to assess progress in the implementation of the Second GPA between 1 January 2012 and 30 June 2014. The assessment is based on information provided by:

- 35 countries that responded, on average to 67 percent of the questions of the online Reporting Format reflecting the 63 indicators,
- 8 countries that responded to about 16 percent of the questions of the Reporting Format;
- other sources of information on the *ex situ* collections of 71 countries and 12 international agricultural research centres (31 countries reported directly to FAO on 1.17 million accessions and data for the remaining 40 countries were sourced from EURISCO and Genesys).

As agreed by the Commission, NFPs were also asked to provide a qualitative expert judgement or rating on the level of achievement for each of the 63 indicators adopted by the Commission. NFP ratings from 33 countries were used to elaborate rating values for indicators and PAs of the Second GPA, as well as to elaborate the Higher-order Composite Indices (HCIs) for PGRFA. NFP ratings range from 1 to 8, with 1 representing the lowest and 8 representing the highest level of achievement. HCIs were elaborated for each of the three PGRFA targets adopted by the Commission:

> **Target 1 - PGRFA Conservation**
> By 2020, an increasing proportion of the genetic diversity of cultivated plants and their wild relatives, as well as of wild food plant species is maintained *in situ*, on farm and *ex situ* in a complementary manner;
>
> **Target 2 - PGRFA Sustainable Use**
> By 2020, there has been an increased use of plant genetic resources for food and agriculture to improve sustainable crop production intensification and livelihoods while reducing genetic vulnerability of crops and cropping systems; and
>
> **Target 3 - PGRFA Institutional and Human Capacities**
> By 2020, many more people are aware of the values of plant genetic resources for food and agriculture and institutional and human capacities are strengthened to conserve and use them sustainably while minimizing genetic erosion and safeguarding their genetic diversity.

Whenever possible, reported information was followed up with the relevant countries and international agricultural research centres. Experience gained during the reporting process indicates that countries and centres collecting and reporting data on the implementation of an action plan as complex as the Second GPA require assistance and guidance from a specialist. A subsequent "quality check" of the information reported is also a prerequisite for clear, comprehensive and comparable results.

The implementation of the Second GPA as a whole contributes to the achievement of the adopted PGRFA targets, and each PA covers a particular dimension of, and contributes to one of the three targets. PAs 1 to 7 of the Second GPA contribute to Target 1, PAs 8 to 12 to Target 2, and PAs 13 to 18 to Target 3. Progress in the implementation of each PA is assessed through a set of indicators adopted by

[1] http://www.fao.org/3/a-mm294e.pdf

the Commission. More information on the construction of the HCIs is contained in the document *Targets and indicators for plant genetic resources for food and agriculture*.[2]

With the above-mentioned limitations, this document provides an assessment of progress and gaps in implementation in terms of the 63 indicators, the 18 PAs and the three PGRFA targets. The main outcomes of the analysis are presented below.

Conservation of plant genetic resources for food and agriculture

Overall progress on PGRA conservation was weaker than progress towards the other two targets during the reporting period, as shown by the corresponding HCIs in Figure 1. However, a clear distinction can be observed between the *in situ* and *ex situ* components of the HCI on conservation when these are considered separately. Progress in *ex situ* conservation was rated considerably higher than in *in situ* conservation. *In situ* conservation was, overall, the area of the Second GPA with the lowest level of achievement.

***In situ* conservation and on-farm management**

In situ conservation and on-farm management appeared to be area of the Second GPA that countries had the most difficulty implementing. This was evidenced by the fact that the average rating for the corresponding 12 indicators and HCI subcomponent was lower than for *ex situ* conservation, sustainable use and institutional and human capacities. Notwithstanding this overall picture, some good progress was reported on specific PAs, in particular surveying and inventorying of PGRFA and on-farm management of farmers' varieties and landraces. The results of the assessments of the corresponding PAs can be summarized as follows.

> *PA1, Surveying and inventorying PGRFA.* More than 5 200 *in situ* and on-farm surveys and inventories for over 1 800 distinct and predominantly wild taxa were reported. Although representing significant progress with regard to the collection and documentation of data and assessment of these resources, more than 55 percent of the surveyed species and approximately 11 percent of the surveyed varieties were reported to be threatened. This implies that interventions beyond merely inventorying the existence of these PGRFA are required in order to safeguard the materials.
>
> *PA2, Supporting on-farm management and improvement of PGRFA.* Significant efforts to support on-farm management and improvement of PGRFA were reported in countries where on-farm crop genetic diversity was particularly broad and important for food systems, nutrition and the livelihoods of farming communities. More than 240 on-farm management projects involving over 172 thousand farmers belonging to 677 farming communities were reported in 29 countries across all continents. About 136 of the projects also assessed either local varieties or farmers' knowledge. Furthermore, in specific areas of 15 reporting countries, where crops of traditional importance and of high diversity predominated, farmers' varieties and landraces were reportedly grown on more than 45 percent of the cultivated land. A number of countries also reported the redistribution of local cultivars or landraces to farmers or farming communities, either directly from local genebanks or through community seed banks.
>
> *PA3, Assisting farmers in disaster situations to restore crop systems.* The distribution of quality seeds and planting materials as part of the emergency aid to restart agricultural production after natural disasters and conflicts was reported frequently in vulnerable countries. Seeds and planting materials of 25 crops, which were in most cases produced locally, were distributed during the reporting period. Eleven countries reported having risk management policies, including seed security assessments and other provisions, for restoring crop systems after significant disruptions.

[2] CGRFA-15/15/4.1; cf. also Background Study Paper No. 67.

PA4, Promoting in situ *conservation and management of crop wild relatives and wild food plants.* Increased attention to crop wild relatives (CWRs) in the *in situ* conservation and management of PGRFA was reported. Overall, 14.2 percent of the over 15 000 *in situ* conservation sites that were reported in 20 countries had management plans addressing CWRs and wild food plants. A total of 78 activities on *in situ* conservation and management of CWRs and wild food plants were implemented with institutional support in 19 countries. More than 2 000 species, predominantly CWRs, were reported to be conserved *in situ*. These encouraging developments were, however, rather limited in scope. The reporting countries rated their achievements with respect to this PA as the lowest across all the 18 PAs of the Second GPA. This indicates that, given the importance of these PGRFA, more effort needs to be invested in their conservation and management.

Ex situ conservation

The group of 12 indicators pertaining to the PAs associated with the *ex situ* conservation of PGRFA received the second highest average rating, indicating countries' relatively high satisfaction with progress made on *ex situ* conservation.

PA5, Supporting targeted collecting of PGRFA. Reflecting the high level of attention given to the PA, 31 countries implemented a total of 890 collecting missions. These led to the collection of more than 20 000 samples of 800 crops or groups of crops. Cereals, vegetables and pulses were the crop groups with the most collected materials. The 12 international agricultural research centres also reported collection of more than 8 100 samples of 18 crops or crop groups. Twenty-nine countries identified gaps in their collections and reported that mitigating targeted collecting strategies had been developed for a large majority of the crops conserved. Based on gap analyses, targeted collecting was required by countries for almost 350 crops or crop groups. In the case of the international centres, gaps in the holdings of over 65 crops or crop groups required targeted collecting.

PA6, Sustaining and expanding ex situ *conservation of germplasm.* Although an overall increase in human, financial and infrastructural capacity was observed, there was nonetheless a significant reduction in capacity in these areas in the majority of the countries of sub-Saharan Africa and Latin America. About 3.6 million accessions are conserved by the 71 assessed countries and 12 international centres (approximately 20 percent of the total). About half the total holdings belong to the nine major food crops. Compared to 2009, *ex situ* PGRFA conservation efforts had been strengthened significantly overall, as shown by the increases of 16 and 28 percent, respectively, in the number of genera and species conserved, and the increased level of safety duplication of individual accessions (on average 50 percent of the national collections and 62 percent of the collections held by the international centres). The 13 percent decrease in the number of accessions conserved was mainly the result of rationalization of conservation programmes in countries and more consistent reporting, in which data on duplicated working collections were removed. No major irreplaceable losses were reported by countries. The conservation activities of the international agricultural research centres remained significant and continued to complement the efforts of countries, especially with regard to their regional and global coverage.

PA7, Regenerating and multiplying ex situ accessions. Of the three PAs on *ex situ* conservation, this is the one with the least encouraging results. Information gathered on almost 900 000 accessions showed that 18 percent had been regenerated, whereas 38 percent were in need of regeneration. For about 40 percent of those that were due for regeneration, adequate budget was not available. The collections of the international agricultural research centres have a better, though not ideal, status: about 10 percent had been regenerated during the reporting period; 13 percent were in need of regeneration; and for 12 percent of those due for regeneration the required budget was not available.

Sustainable use of plant genetic resources for food and agriculture

The sustainable use of PGRFA had the second highest HCI score (Figure 1). Activities reported on included the characterization and evaluation of accessions, the management and distribution of collections, pre-breeding and breeding, seed systems and promotion of the diversification of crop production and increase of crop diversity on-farm. There were variations in the ratings provided for the different PAs: supporting seed production and promoting diversification actions received the highest and lowest average ratings, respectively.

PA8, Expanding the characterization, evaluation and further development of specific collection subsets to facilitate use. More than 50 percent of the accessions held in national genebanks have been morphologically characterized and, impressively, almost 1 000 trait-specific subsets of collections have been developed. More than 175 000 accessions (and more than 350 000 samples) of about 280 different crops were distributed by national genebanks. Similar figures were reported by the international agricultural research centres for the accessions held in their genebanks.

PA9, Supporting plant breeding, genetic enhancement and base-broadening efforts. There were almost 500 breeding and pre-breeding programmes or projects for more than 300 crops, the majority of which were major crops. More than half of the germplasm used in these breeding activities was obtained from regional or international networks or the genebanks of international centres, thus demonstrating clear interdependency. About one-third of the activities aimed to address constraints relevant to the production systems of small-scale farmers or local communities. About 200 genetic enhancement and pre-breeding activities were implemented in 20 countries for almost 100 crops. Local cultivars and landraces were by a wide margin the types of materials that were most used. About 2 000 active plant breeders were working in public-sector institutions in 30 countries; their work focused mostly on fruits, cereals and vegetables. Almost 500 plant breeders were working in the private sector, with a significant majority working on cereals. The international centres reported 56 breeding programmes or activities on 36 crops and employed 150 plant breeders.

PA10, Promoting diversification of crop production and broadening crop diversity for sustainable agriculture. There were crop diversification programmes and activities in 24 countries for 145 different crops, with almost 70 new crops or wild species introduced into cultivation. More than 160 underutilized species with potential for commercialization were identified. In addition, 25 projects or programmes related to the improvement of plant genetic diversity in the cropping systems of 12 different crops or crop groups were implemented by the international centres.

PA11, Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species. Across most of the 20 countries that provided data for this PA there were 53 different national laws, policies, etc. for promoting the development and/or commercialization of farmers' varieties and/or landraces. In addition, there were more than 530 programmes or projects for more than 200 different crops. In all, 1 443 landraces of almost 200 crops, as well as 168 underutilized species with potential for commercialization were identified. Eight of the international centres reported 19 programmes or projects promoting the development and commercialization of varieties. They also identified 633 landraces and 16 underutilized species with potential for commercialization.

PA12, Supporting seed production and distribution. About 6 400 varieties were released in 29 countries. Vegetables and cereals constituted the majority of the crop groups. More than 9 000 registered seed enterprises operated in 26 countries. On average 14.5 varieties were cultivated on 80 percent or more of the total cropping area for the five most widely spread crops of the reporting countries. Although difficult to judge without comparisons, this latter aspect could be a reliable indicator for assessing within-crop diversity and vulnerability of monocropping systems.

Building sustainable institutional and human capacities

Progress towards the PGRFA target on Institutional and Human Capacities was greater than that towards the other targets. The corresponding HCI indicated the highest average of country ratings (Figure 1). PA 13 Building and Strengthening National Programmes had the highest score of all the 18 PAs. It might therefore be inferred that this PA was the highest priority for most countries. It might also be expected that this heightened national-level coordination of activities should improve national priority setting and promote the efficient use of human and material resources. It is also plausible to expect this trend to translate into greater national awareness of the importance of PGRFA. The lowest reported progress among the PAs of this group was on the development and strengthening of systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion (PA 16). This showed that significant work still needed to be done with respect to this important aspect of the Commission's PGRFA target. Details of countries' performances for the different PAs are presented below.

PA13, Building and strengthening national programmes. The achievements made in strengthening capacity for the conservation and sustainable use of PGRFA were quite impressive for most of the countries and can be considered a positive signal for the future. In all, 29 countries reported on the existence of entities or mechanisms that coordinated PGRFA activities at the national level and rated this indicator relatively highly. In half of the reporting countries, these entities oversaw not only PGRFA but also genetic resources in other sectors. The appointment of a national PGRFA coordinator was also positively rated by countries. Another encouraging development was the existence of legal instruments for governmental policy frameworks for the conservation and use of PGRFA in most countries. Countries also reported progress on the use of one or more information-sharing mechanisms for PGRFA and other information management tools; 56 percent reported using the National Information Sharing Mechanism (NISM). While acknowledging its inclusive, positive role, they also recognized that ensuring its sustainability required continuous effort.

PA14, Promoting and strengthening networks for PGRFA. A total of 56 countries across all continents reported being members of one or more regional or international networks. A total of 124 networks were listed, including PGRFA regional and global networks, as well as crop networks. In addition, the international agricultural research centres played an active role in at least 29 PGRFA conservation and use networks. Only a relatively small number of countries reported on the production of publications and they negatively rated their achievements in this regard.

PA15, Constructing and strengthening comprehensive information systems for PGRFA. Only a very small number of countries reported maintaining information on CWRs and farmers' varieties and landraces in publicly available information systems. The corresponding indicator for CWRs was rated the lowest of all. However, countries reported more than 1.375 million *ex situ* conserved accessions documented in such information systems. The international centres, on average, updated their data in Genesys rather irregularly. Characterization and evaluation data were available, respectively, for a little over 40 percent and less than 2 percent of conserved accessions. Characterization and evaluation data were available for more than 56 percent of the accessions in the genebanks of international centres. In addition, 19 countries recorded almost 16 500 released varieties in publicly available information systems.

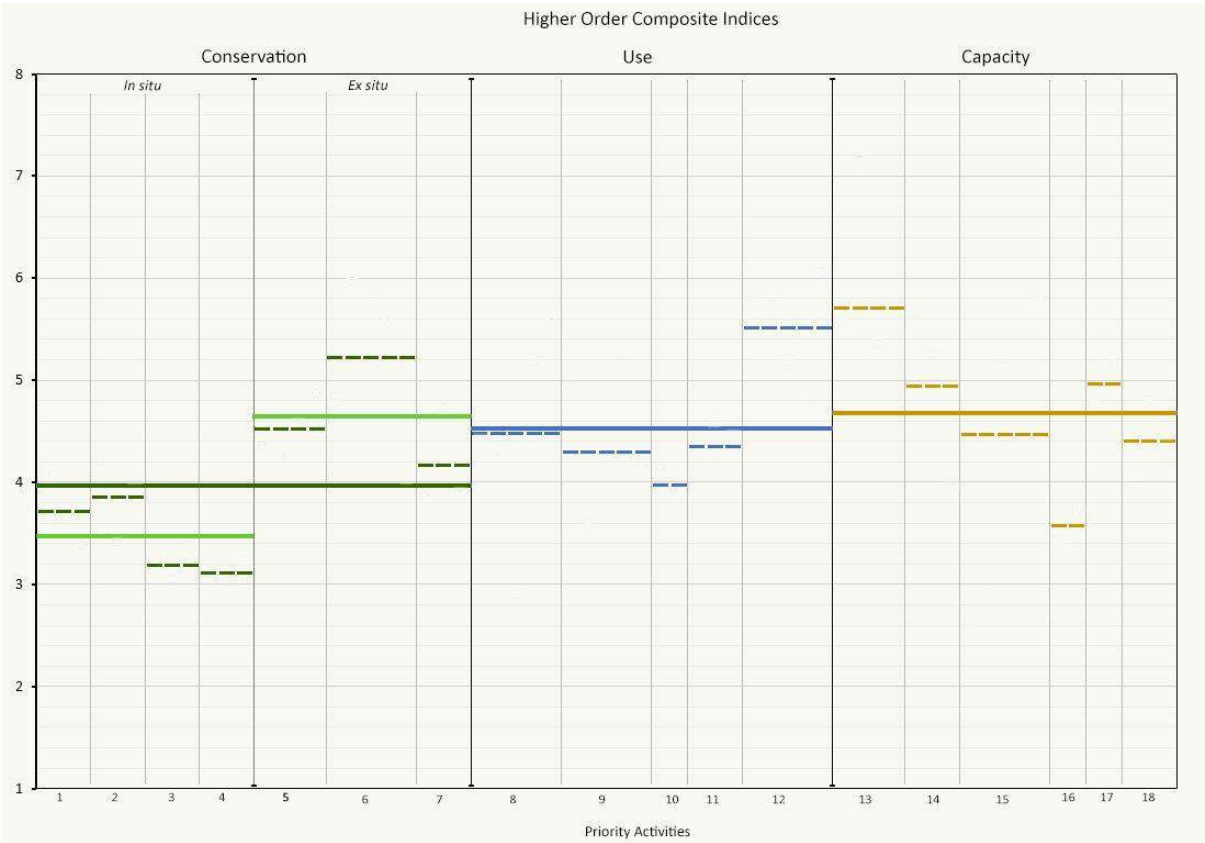
PA16, Developing and strengthening of systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of PGRFA. Fourteen countries had one or more systems in place to monitor and safeguard genetic diversity and minimize genetic erosion. Less than half of the international centres had variable approaches for monitoring genetic diversity and minimizing genetic erosion for their mandate crops. Sixteen countries had undertaken a number of remedial measures that resulted from these monitoring systems. However, compared with the other PAs, countries' ratings were among the lowest, reflecting their disappointment with achievements in this PA.

PA17, Building and strengthening human resource capacity. Educational and training programmes on PGRFA were reported by 30 countries. The international centres trained more

than 1 000 persons on various research and routine operations related to the conservation and sustainable use of PGRFA. The employment of almost 1 500 PGRFA professionals was reported by 33 countries, and 28 national PGRFA programmes reported a staff strength that included 508 professionals. Countries also reported encouraging figures on the upgrading of the skills of their scientific staff, both through formal education (PhD and MSc levels) and through ad hoc in-service training. More than 50 percent of staff received further training in one or more disciplines relevant to the conservation and sustainable use of PGRFA.

PA18, Promoting and strengthening public awareness of the importance of PGRFA. Countries carried out more than 130 public-awareness programmes or activities with the participation of a broad spectrum of stakeholders. The development of a wide range of advocacy and information-dissemination products was also reported and relevant media were used to reach the target groups.

Figure 1. HCIs and global averages for PAs based on the NFP ratings provided on the indicators for monitoring the implementation of the Second GPA



Continuous lines represent the average rating values (ranging from 1 for the lowest achievement to 8 for the highest achievement) for the three HCIs. Light green lines represent the average rating values for the two sub-HCIs on conservation. Dashed lines represent the average rating values for the 18 PAs.

I. INTRODUCTION

The FAO Council, in adopting the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA), agreed that progress in its implementation and the related follow-up processes would be monitored and guided by governments and other FAO Members through the Commission on Genetic Resources for Food and Agriculture (Commission). In order to discharge this function, the Commission, at its Fourteenth Regular Session, adopted 63 indicators for monitoring the implementation of the 18 priority activities (PAs) of the Second GPA. Countries report on the implementation of the Second GPA through the online WIEWS Reporting System, which allows National Focal Points (NFPs) appointed by governments for this purpose to provide information on the different indicators and to rate the level of their achievement.

The Commission also agreed on three targets for plant genetic resources for food and agriculture (PGRFA), a conservation target, a sustainable use target and an institutional and human capacities target, and three corresponding Higher-order Composite Indices (HCIs) in order to measure progress towards the targets. The HCIs are based on ratings or expert judgements on the level of achievement of the 63 indicators.[3] The PGRFA targets are:

> **Target 1 - PGRFA Conservation**
> By 2020, an increasing proportion of the genetic diversity of cultivated plants and their wild relatives, as well as of wild food plant species is maintained *in situ*, on farm and *ex situ* in a complementary manner;
>
> **Target 2 - PGRFA Sustainable Use**
> By 2020, there has been an increased use of plant genetic resources for food and agriculture to improve sustainable crop production intensification and livelihoods while reducing genetic vulnerability of crops and cropping systems; and
>
> **Target 3 - PGRFA Institutional and Human Capacities**
> By 2020, many more people are aware of the values of plant genetic resources for food and agriculture and institutional and human capacities are strengthened to conserve and use them sustainably while minimizing genetic erosion and safeguarding their genetic diversity.

This document contains a first assessment of the implementation of the Second GPA, based on the monitoring framework adopted by the Commission. As agreed by the Commission, the document has been prepared for the Eighth Session of the Commission's Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture (Working Group) in 2016 and the Sixteenth Regular Session of the Commission, which will be held in 2017.

II. THE PREPARATORY PROCESS

On 1 October 2015, NFPs were invited to report on activities undertaken by their countries to implement the Second GPA between 1 January 2012 and 30 June 2014. Information was also sought from countries with regard to various matters relevant to the status of conservation and sustainable use of PGRFA at the end of June 2014.

As agreed by the Commission, NFPs were also asked to provide a qualitative expert judgement on the level of progress achieved for each of the 63 indicators adopted by the Commission. These NFP expert judgements were used to elaborate the HCIs for each of the three PGRFA targets adopted by the Commission.

The WIEWS Reporting System was made available on the FAO web site in five official languages to facilitate country reporting and data analysis. NFPs were provided with credentials for accessing the Reporting System together with sign-in instructions and a user manual in three official languages.

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[3] More information on the construction of the HCIs is contained in document CGRFA-15/15/4.1 *Targets and indicators for plant genetic resources for food and agriculture*; cf. also Background Study Paper No. 67.

FAO also invited regional and international agricultural research centres holding PGRFA *ex situ* collections to provide information, mainly on those collections. The CGIAR centres, AfricaRice, Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Maize and Wheat Improvement Center (CIMMYT), the International Potato Center (CIP), the International Center for Agricultural Research in the Dry Areas (ICARDA), the World Agroforestry Centre ICRAF, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Institute of Tropical Agriculture (IITA), the International Livestock Research Institute (ILRI) and the International Rice Research Institute (IRRI), and the World Vegetable Center (AVRDC) provided information to FAO on the basis of an adapted version of the Reporting Format used by countries.

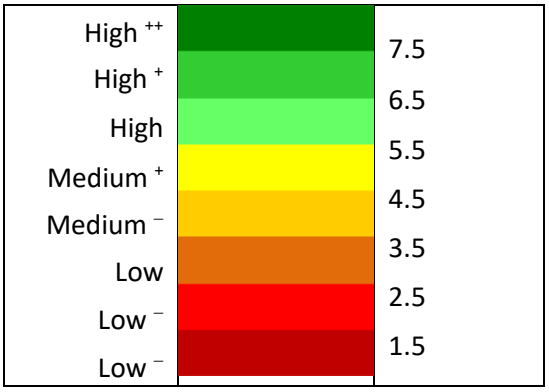
As of March 2016, 35 countries had completed the online Reporting Format (answering on average 67 percent of the questions). An additional eight countries reported only partially (about 16 percent of the questions answered). For one specific question and its three indicators associated with *ex situ* collection holdings, data on about 3.6 million accessions were gathered from 71 countries and 12 international centres. Thirty-one countries reported directly to FAO on about 1.17 million accessions. Data for the remaining 40 countries were sourced from EURISCO and Genesys.

Overall, it should be noted that a greater number of country reports is needed to be able to draw conclusions as to the global state of implementation of the Second GPA. It is therefore important to consider how country reporting might be improved. Based on experiences gained during the first assessment, it can be concluded that NFPs and other reporting entities require, at least initially, assistance and guidance in providing data on the implementation of the Second GPA. Subsequent "quality checks" of the information provided requires considerable human resources from FAO's side.

III. MAIN FINDINGS

The information provided by countries has been analysed for each of the indicators and the corresponding questions using basic statistics. Throughout the document, NFP ratings (on the scale of 1 to 8) are presented both as numeric values and in graphic form based on the colour scheme shown in Figure 1.

Figure 1. NFP rating and colour categories



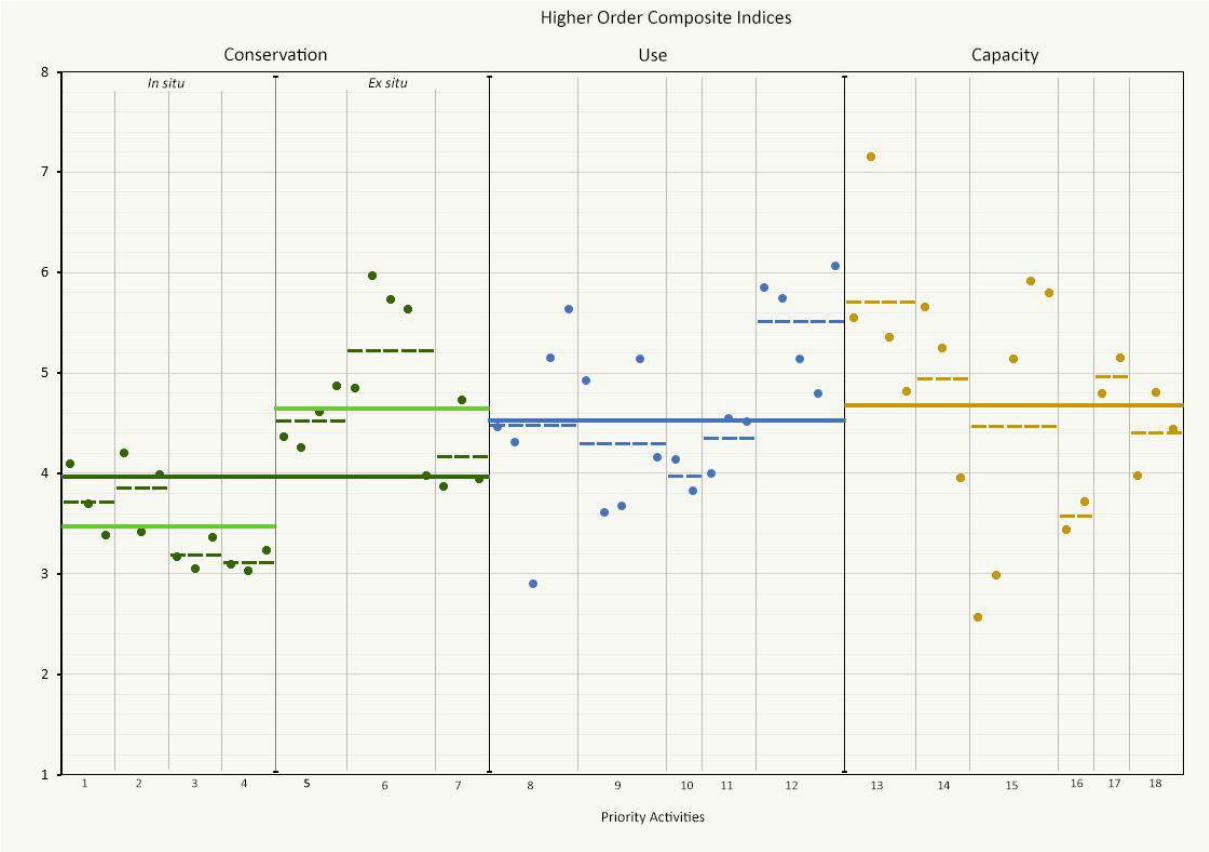
The main findings of the assessment based on HCIs are summarized in Figure 2. The HCIs were calculated based on information provided by NFPs from 33 countries, who rated the level of achievement in their countries for 91 percent of the indicators on average. The purpose of HCIs is to assess progress towards the three PGRFA targets.

The implementation of the Second GPA as a whole contributes to the achievement of the adopted PGRFA targets, and each PA covers a particular dimension of, and contributes, to one of the three targets. PAs 1 to 7 of the Second GPA contribute to Target 1, PAs 8 to 12 to Target 2, and PAs 13 to 18 to Target 3. Progress in the implementation of each PA is assessed through the set of indicators adopted by the Commission.

Conservation of plant genetic resources for food and agriculture

Overall progress on PGRFA conservation was weaker than progress towards the other two targets during the reporting period, as shown by the corresponding HCIs in Figure 2. However, a clear distinction can be observed between the *in situ* and *ex situ* components of the HCI on conservation when these are considered separately. Progress in *ex situ* conservation was rated considerably higher than in *in situ* conservation. *In situ* conservation was, overall, the area of the Second GPA with the lowest level of achievement.

Figure 2. HCIs, global averages for the priority activities and the 63 indicators of the Second GPA based on NFP ratings



Dots represent the average rating values (ranging from 1 for the lowest achievement to 8 for the highest achievement) for the 63 indicators. Dashed lines represent the average rating values for the 18 PAs. Continuous lines represent the average rating values for the three HCIs. Light-green lines represent the average rating values for the two sub-HCIs on conservation.

In situ *conservation and on-farm management*

In situ conservation and on-farm management appeared to be area of the Second GPA that countries had the most difficulty implementing. This was evidenced by the fact that the average rating for the corresponding 12 indicators and HCI subcomponent was lower than for *ex situ* conservation, sustainable use and institutional and human capacities. Notwithstanding this overall picture, some good progress was reported on specific activities, in particular surveying and inventorying of PGRFA and on-farm management of farmers' varieties and landraces.

Ex situ *conservation*

The group of 12 indicators pertaining to the PAs associated with the *ex situ* conservation of PGRFA received the second highest average rating, indicating countries' relatively high satisfaction with progress made on *ex situ* conservation.

Sustainable use of plant genetic resources for food and agriculture

The sustainable use of PGRFA had the second highest HCI score (Figure 2). Activities reported on included the characterization and evaluation of accessions, the management and distribution of collections, pre-breeding and breeding, seed systems and promotion of the diversification of crop production and increase of crop diversity on-farm. There were variations in the ratings provided for the different PAs: supporting seed production and promoting diversification actions received the highest and lowest average ratings, respectively.

Building sustainable institutional and human capacities

Progress towards the PGRFA target on Institutional and Human Capacities was greater than that towards the other targets. The corresponding HCI indicated the highest average of country ratings (Figure 2). PA 13 Building and Strengthening National Programmes had the highest score of all the 18 PAs. It might therefore be inferred that this PA was the highest priority for most countries. It might also be expected that this heightened national-level coordination of activities should improve national priority setting and promote the efficient use of human and material resources. It is also plausible to expect this trend to translate into greater national awareness of the importance of PGRFA. The lowest reported progress among the PAs of this group was on the development and strengthening of systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion (PA 16). This showed that significant work still needed to be done with respect to this important aspect of the Commission's PGRFA target. Details of countries' performances for the different PAs are presented below.

IV. CONSERVATION

In situ *conservation*

With steadily increasing changes in land use in both cultivated and non-cultivated areas, continuously expanding opportunities to use genetic resources in general, agro-ecosystem changes caused by climate change, and other factors that threaten biological diversity at large, the importance of conserving genetic resources *in situ*, including on-farm, is increasing being recognized. In particular, recognition of the potential of crop wild relatives (CWRs) and to some extent wild harvested food plants, as sources of new and important traits or variants and genes that can be used to adapt cultivated crops to changing conditions, increase or stabilizing yield and improve nutritional value, and thus contribute to food and nutritional security, have convinced a growing number of countries to pay due attention to activities that contribute to the conservation and sustainable use of these resources. More attention is being paid to landraces of local crops or those introduced in the distant past, as well as to so-called underutilized local and traditional crops, as these resources are increasingly being eroded or even threatened with extinction. In particular, the increasing number of on-farm conservation efforts, which many countries indicate form part of their national PGRFA programmes, is encouraging.

Newly developed tools and methodologies to study the distribution of CWRs, to monitor their threat status, to identify gaps in terms of species that are not or not adequately included in existing protected conservation areas and/or in *ex situ* collections, and the development of approaches and methods to increase the ease with which genes and traits can be incorporated into existing crops (e.g. pre-breeding activities supported by the Global Crop Diversity Trust) contribute positively to these developments.

Priority Activity		NFP Rating
1	**Surveying and inventorying PGRFA**	3.7

Rational conservation of PGRFA, including *in situ* (in nature as well as on-farm) and *ex situ* activities, begins with surveys and inventories. In order to elaborate policies and strategies for conservation and use of PGRFA and to allow effective planning of identified actions, national programmes need to know what resources exist in their countries, their distribution and extent to which they are already being conserved, as well as their threat status.

CWRs and wild food plants occur predominantly in natural habitats or in disturbed but non-cultivated areas, and thus their conservation can be best achieved through *in situ* approaches. Knowledge on the presence and distribution of these species in the territory of a given country is mainly obtained by conducting surveys and preparing inventories.

The objectives of this PA are to facilitate the development, implementation and monitoring of complementary conservation strategies and national policies related to the conservation and sustainable use of PGRFA, to strengthen linkages between ministries of agriculture and ministries of the environment, and to promote monitoring of the status and trends in PGRFA and thereby ensure their adequate conservation. The three indicators related to this PA are treated together.

More than 5 200 *in situ* and on-farm surveys and inventories for over 1 800 distinct and predominantly wild taxa were reported. Although representing significant progress with regard to the collection and documentation of data and assessment of these resources, more than 55 percent of the surveyed species and approximately 11 percent of the surveyed varieties were reported to be threatened. This implies that interventions beyond merely inventorying the existence of these PGRFA are required in order to safeguard them.

With an average rating of 3.7, PA 1 is the fourth lowest rated among the 18 PAs of the Second GPA. From additional comments provided by several of the countries on achievements made with respect to the three indicators related to this PA, it can be concluded that the low rating indicates that efforts dedicated to surveying and inventorying PGRFA inadequately address the urgency and importance of the work needed and that a higher priority should be accorded to future activities in this area.

Indicator 1: Number of *in situ* (including on-farm) surveys/inventories of PGRFA carried out		
Number of reporting countries: 32 Number of countries with NFP rating: 33	NFP Rating	4.1

Thirty-two countries reported that they have conducted a total of more than 5 230 surveys and inventories (on average more than 160 per country, a maximum per country of 2 679 and a minimum of 1), covering more than 138 unique crops or crop groups. Fruit trees were among the most targeted crop groups, with almost 800 surveys, followed by vegetables, sugar crops, cereals, pulses, spices and roots and tubers (for details see Table 1). Sugarcane was reportedly the most surveyed crop (770 times), followed by maize (272), potatoes (239), beans (184), bananas/plantains (163) and faba beans (121). Thirty-nine more crops were surveyed 10 or more times. Bananas (in 4 countries), mangoes (in 4 countries) and citruses (in 8 countries) were the most surveyed fruit trees. *Prunus* and *Triticum* were among the genera surveyed by the largest number of countries, 11 and 9, respectively. Only 29 surveys explicitly targeted CWRs.

Table 1. Number of surveys per crop group

Crop group	Number of surveys		Crop group (continued)	Number of surveys
Fruits	796		Stimulant crops	160
Vegetables	780		Medicinal species	75
Sugar crops	773		Agroforestry species	16
Cereals	636		Oil crops	15
Pulses	551		Fibre crops	7
Spices	510		Flowers	4
Roots and tubers	471		Beverages	1
Forages	382		Others	8

Thirty-three countries rated their achievements for this indicator, with an average score of 4.1: a rating below the overall average of 4.5 on the scale of 1 to 8, indicating some degree of satisfaction with the work done, but also awareness that more work is needed.

Indicator 2: Number of PGRFA surveyed/inventoried		
Number of reporting countries: 32 Number of countries with NFP rating: 33	NFP Rating	3.7

A total of 1 823 distinct taxa were surveyed and inventoried in 32 countries. About 10 percent of these taxa (185) were surveyed/inventoried in more than one country. The total numbers of taxa surveyed per country are shown in Table 2. CWRs and wild food plants accounted for 85.9 percent of the surveyed taxa and crop species for 16.0 percent, with about 36 taxa surveyed both on-farm and in the wild. Of the crop species, approximately 17 400 varieties were surveyed.

Thirty-three countries rated their achievements for this indicator and scored an average of 3.7, a relatively low score indicating the urgency and amount of work still needed in this field.

Table 2. Number of surveyed taxa per country

Country	Taxa (no.)		Country (continued)	Taxa (no.)
Iran (Islamic Rep. of)	458		Malawi	8
Bulgaria	424		Mali	6
Germany	260		Ethiopia	5
Egypt	239		Togo	4
Cuba	207		Tanzania (United Rep. of)	3
Mongolia	130		Ecuador	3
Armenia	77		Senegal	3
Azerbaijan	67		Costa Rica	2
France	41		Brazil	2
Albania	38		Zambia	2
United Kingdom	23		Bangladesh	2
Turkey	21		Croatia	2
Guyana	17		Morocco	1
Estonia	16		Switzerland	1
Lebanon	11		Latvia	1
Panama	9		Sweden	-

Indicator 3: Percentage of PGRFA threatened out of those surveyed/ inventoried		
Number of reporting countries: 32 Number of countries with NFP rating: 31	NFP Rating	3.4

Overall 56.3 percent of the 1 823 surveyed species were reported to be threatened, i.e. they were found no longer to be cultivated or no longer to occur *in situ* in most of their previous areas of cultivation or occurrence. About 11.5 percent of varieties surveyed (2 006 out of 17 427) were reported to be threatened. Figures for the wild species surveyed were more alarming: 61.5 percent of them were found to be threatened.

It is encouraging to note that approximately 51 percent of the countries that reported on the implementation of the indicators of PA 1 are located in the so-called Vavilovian centres of diversity and thus that the fact that some of them do have high numbers of reported surveys is probably because of the high diversity they have, in particular for CWRs.

As surveys and inventories of CWRs, wild food plants and landraces provide an obvious opportunity to collect threatened resources, especially in remote areas, a positive correlation between these two indicators might be expected. However, the 23 countries that reported that they had conducted surveys/inventories for one or more taxa reported a similar number of collected samples to those that reported no surveys or inventories. This probably reflects the difficulty some countries have in reporting on surveying and inventorying activities.

The large number of very diverse (wild) species in several of the biodiverse countries certainly provides big challenges to these countries, as their staff capacity is in general limited. Some countries listed wild species, possibly with an internationally recognized threat status, that do not strictly fall in either the CWR or wild food plant categories. This problem is difficult to check and resolve, in particular for wild food plants, as this is an extremely variable category and use as foodstuff is typically localized.

Given the importance of assessing the threat status of (in particular) CWRs, wild food plants and farmers' varieties/landraces, simple but adequate tools for conducting such assessments are needed. The International Union for Conservation of Nature (IUCN) preliminary threat assessment tool on the CWR species, which was reported by one of the international centres, could possibly serve this purpose.[4]

Thirty-one countries gave their performance for indicator 3 an average rating of 3.4. This is one of the lower ratings among the 63 indicators and show that there is concern and recognition of the need for much more work on this important topic.

Priority Activity		NFP Rating
2	**Supporting on-farm management and improvement of PGRFA**	3.9

Whereas research and plant breeding have helped to raise crop yields, improve resistance to pests and diseases and enhance quality of food products, especially in favourable environments, many farmers have made conscious decisions to continue to maintain significant crop genetic diversity in their fields. This diversity constitutes an important element in the livelihood strategies of farmers because of its ability to adapt to marginal, heterogeneous and/or steadily changing environments, to meet changes in market demands, labour availability and other socio-economic factors, as well as for cultural and religious reasons. Consequently, there is a need to integrate CWR and landrace conservation into existing conservation strategies, as well as to pay more attention to underutilized crops/species, many of which are "hidden" in local production systems.

Significant efforts to support on-farm management and improvement of PGRFA were reported in countries where on-farm crop genetic diversity was particularly broad and important for food systems, nutrition and the livelihoods of farming communities. More than 240 on-farm management projects involving over 172 thousand farmers belonging to 677 farming communities were reported in 29 countries across all continents. About 136 of the projects also assessed either local varieties or farmers' knowledge. Furthermore, in specific areas of 15 reporting countries, where crops of traditional importance and of high diversity predominated, farmers' varieties and landraces were reportedly grown on more than 45 percent of the cultivated land. A number of countries also reported the redistribution to farmers or farming communities of local cultivars or landraces, either directly from local genebanks or through community seed banks.

The overall average rating for PA 2 is 3.9. This rating is well below the average of 4.5 and thus indicates a relatively low level of satisfaction and recognition that much more work is required.

Indicator 4: Number of farming communities involved in on-farm PGRFA management and improvement activities		
Number of reporting countries: 29 Number of countries with NFP rating: 31	NFP Rating	4.2

Twenty-nine countries across all continents reported a total of 243 active on-farm PGRFA management and improvement projects during the reporting period. More than 172 000 farmers belonging to 677 farming communities were involved, with a maximum of 50 000 farmers from 8 farming communities

[4] http://www.iucnredlist.org/about/overview#assessment_process

in the surroundings of 12 protected areas in Panama. Guyana and Azerbaijan reported the largest numbers (35 and 31, respectively) of on-farm management and improvement projects implemented during the reporting period. The projects reported included one activity or a combination of two or more activities, ranging from *assessment of improved varieties utilization and management* (featuring in 98 projects), *characterization* and *evaluation of local varieties* (80 projects), *assessment of local varieties utilization and management* (in 75 projects), *assessment of farmers' knowledge* (in 70 projects), *seed multiplication and distribution of bred varieties* (in 66 projects), *on-farm breeding* (in 59 projects), *studies on local varieties population structure and dynamics* (in 46 projects), and *environmental assessment of PGRFA on-farm management and improvement* (in 42 projects). Activities including the establishment of *pilot sites in high-risk areas* or *in areas of high diversity* and the *socio-economic assessment of PGRFA on-farm management and improvement* were reported in 36 and 28 projects, respectively.

The average rating of 4.2 from 31 countries seems to indicate that the countries are relatively active in this area and modestly satisfied with their performance. The fact that in most cases the activities are carried out on a project basis, raises the question of how sustainable and durable such initiatives are. A significant number of activities are development oriented and might not have a direct impact on the conservation of genetic diversity in the production system. However, the apparent linkages between development and conservation activities within countries are encouraging and important.

Indicator 5: Percentage of cultivated land under farmers' varieties/landraces in areas of high diversity and/or risk		
Number of reporting countries: 29 Number of countries with NFP rating: 31	NFP Rating	3.4

This is an important indicator, reflecting the degree of replacement of landraces and traditional varieties by modern varieties in specified areas of high diversity (and potential risk of genetic erosion, as replacement is possibly one of the most important drivers of genetic erosion).

In the reported areas of high diversity and/or risk, the average percentage of crop area still sown with landraces or farmers' varieties is 46.1. These data refer to crops of traditional importance and of high diversity in the 15 countries that reported on this. Countries known for a significant level of traditional agriculture in specific areas reported the highest values (80 to 94.4 percent), whereas countries with hardly any traditional agriculture reported very low percentages (lowest 1.6 percent). This is of particular relevance as most countries reported on crops or crop groups that either originated, or are represented by a high degree of diversity, within their respective territories.

Considering the above, it should be noted that only 15 countries provided detailed information on this indicator. Other countries commented on the importance of the existence and distribution of farmers' varieties/landraces, but lack the information to report on them. It has also been noted that knowledge of risks to such material in areas of high diversity is lacking. The fact that 29 countries rated their achievements for this indicator relatively low (3.4, the sixth-lowest rating) indicates that countries are not satisfied with the level of achievement in this particular field and confirms concern about the level of erosion of farmers' varieties/landraces in high-diversity areas and the lack of information with which to assess it.

Indicator 6: Number of farmers' varieties/landraces delivered from national or local gene banks to farmers (either directly or through intermediaries)		
Number of reporting countries: 25 Number of countries with NFP rating: 28	NFP Rating	4.0

A total of over 4 660 distinct farmers' varieties or landraces from more than 80 crops and 10 crop groups were distributed directly to farmers in 22 countries. In some cases, the distribution occurred via researchers and projects. The highest rates of distribution were reported by Spain and Bulgaria for farmers' varieties/landraces of vegetables, with 935 and 269 samples distributed per year, respectively.

This indicator received a relatively low average rating (4.0 – based on data from 28 countries). Several countries reported either that their germplasm distribution policy does not allow direct distribution to farmers or that they distributed germplasm samples only through intermediaries or projects. In one country, the distribution was done through scientists. One country noted the importance of this activity, but reported that it had so far only managed to conduct a pilot project.

If it is accepted that assistance to farmers in conserving genetic resources is important, arrangements for access by farmers to genetic resources conserved in (largely publicly funded) genebanks needs to be foreseen. Therefore, it seems to be essential that national PGR programmes carefully consider how the distribution of landrace and traditional variety germplasm to farmers can best be organized and anchored within the responsibilities of the programme. Indeed, as noted in the Second GPA, addressing this issue requires effective and strategic linkage between *in situ* and *ex situ* conservation to ensure their complementarity and thus create beneficial links between the production, conservation and use communities.

Priority Activity		NFP Rating
3	**Assisting farmers in disaster situations to restore crop systems**	3.2

Natural disasters and civil strife often challenge the resilience of crop systems, in particular affecting small-scale and subsistence farmers in developing countries. Seed security is a key component of such resilience. Whereas immediate seed assistance can help the farmers affected by an acute disaster, a more systematic approach to re-establishing seed security and crop systems is needed in the case of chronic stresses. Easy access by affected farming communities to well-adapted planting materials is essential.

The distribution of quality seeds and planting materials as part of the emergency aid to restart agricultural production after natural disasters and conflicts was reported frequently in vulnerable countries. Seeds and planting materials of 25 crops, in most cases produced locally, were distributed during the reporting period. Eleven countries reported having risk-management policies, including seed-security assessments and other provisions, for restoring crop systems after significant disruptions.

The average rating of achievement for PA 3 was 3.2, the second lowest rating of all PAs. This indicates particular concern about the level of progress and the overall capacity to restore crop systems in areas affected by disasters through the current intervention plans and institutional set ups. More work is required to satisfy country expectations and to adequately address needs.

Indicator 7: Number of households that received seeds for planting as aid after disaster situations		
Number of reporting countries: 6 Number of countries with NFP rating: 24	NFP Rating	3.2

Six countries out of the seven that at least once during the reporting period were reportedly affected by natural disasters (drought, flood, hail) provided information on this indicator. Seeds of 10 staple crops and various vegetables were distributed to more than 12 200 households, which received on average 16 kg of seed each.

An average rating of 3.2 by 24 countries indicates concern about the level of achievement in this field and confirms that the re-establishment of seed security and crop systems requires a systematic approach in case of increasingly chronic stresses. Much more attention and coordination within and among countries is needed in order to properly address this indicator.

Indicator 8: Percentage of seed produced at the local level out of that made available through disaster response interventions		
Number of reporting countries: 14 Number of countries with NFP rating: 23	NFP Rating	3.0

Seven countries provided information on 16 disaster events for this indicator, of which five were related to hail, ten to floods and two to droughts. Among seed crops, cereals were distributed after 15 events, pulses and vegetables after 5. The amount of seeds distributed after the reported disasters varied from 100 kg to 164 tonnes, and more than 95 percent of it was reportedly produced locally. In ten cases the seed aid was provided through direct seed distribution; in two cases it was provided indirectly through a market-based approach (such as seed vouchers or seed fairs); and in 4 cases the seeds came from a community-based seed multiplication scheme. In 25 percent of the reported events a combination of two or three ways of delivering seed aid were reported. For quantities up to 200 kg, the seeds were sourced from community seed banks (in five cases), the national genebank (twice) and farmers (once). For larger quantities, seed was sourced from commercial agencies (in four cases), NGOs and FAO (three cases) and an institutional seed farm. In seven disaster events where seed interventions had occurred, an assessment was carried out to evaluate the impact of the disaster on farmers' seed systems, and in one case to characterize the functioning of seed systems at the farm level.

Despite the relatively good results reported by some countries, this indicator received a very low rating overall: 3.0 (the third lowest) based on ratings from 23 countries. This indicates great concern with overall performance and the need to increase focus and efforts and to continue monitoring this important field.

Indicator 9: Existence of disaster risk management policies for restoring crop systems that include seed security provisions		
Number of reporting countries: 14 Number of countries with NFP rating: 27	NFP Rating	3.4

Eleven countries reported having risk-management policies that include seed-security provisions in place for restoring crop systems. The reported policies are in most countries rather broad in scope and only in a few countries do they include specific crop system restoration measures.

Twenty-seven countries rated the achievement level for this indicator on average at 3.4, a low rating, in line with the ratings assigned to the other indicators from this PA. However, the reporting countries are clearly split into two groups, with six countries indicating a relatively high level of achievement and rest, the majority, reporting a low level of achievement.

Priority Activity		
4	**Promoting *in situ* conservation and management of crop wild relatives and wild food plants**	NFP Rating 3.1

Natural ecosystems contain important PGRFA, including rare, endemic and threatened CWRs and wild food plants. With the development of new molecular techniques, these species are becoming increasingly important as providers of new traits for plant breeding. CWRs and wild food species are ideally conserved *in situ*, where they can evolve under natural conditions. Unique and particularly diverse populations of these species must be protected *in situ* when under threat. Many of these species occur in protected areas. However, many of these areas were established with little specific concern for the conservation of genetic diversity of any plants, let alone specifically CWRs and wild food plants. Thus, the planning and management practices in important *in situ* conservation areas for CWRs and wild food plants have to promoted and improved.

Increased attention to CWRs in the *in situ* conservation and use of PGRFA was reported. Overall, 14.2 percent of the over 15 000 *in situ* conservation sites that were reported in 20 countries had management plans addressing CWRs and wild food plants. A total of 78 activities on *in situ* conservation and management of CWRs and wild food plants were implemented with institutional support in 19 countries. More than 2 000 entries, predominantly CWRs, were reported to be conserved *in situ*. These encouraging developments were, however, rather limited in scope.

The overall average rating for all indicators of PA 4 is 3.1. This is the lowest average rating for all PAs. It stresses the weakness of the achievements in this area and the importance and urgent need of assigning adequate priority by national programmes to the *in situ* conservation and management of CWRs and wild food plants.

Indicator 10: Percentage of national *in situ* conservation sites with management plans addressing crop wild relatives and wild food plants		
Number of reporting countries: 20 Number of countries with NFP rating: 31	NFP Rating	3.1

Twenty countries reported managing over 15 000 *in situ* conservation sites, with an average of 751 sites per country. The minimum reported was one site and the maximum 8 444 sites. Most countries reported the current protected areas in their respective countries, including all the IUCN categories. Of the total reported *in situ* conservation sites, 14.2 percent reportedly have management plans addressing CWRs and wild food species. In one country only one site out of thousands explicitly included a management plan for CWRs. These figures are not very encouraging, as CWRs and wild food species worldwide are seriously affected by genetic erosion and climate changes and their conservation very much depends on local/national initiatives. The coordination and integration of *in situ* and *ex situ* institutions and efforts is paramount to success in preserving these two categories of germplasm.

The average rating of 3.1, based on ratings from 31 countries, demonstrates great concern about this subject, together with a rather modest level of satisfaction with the progress achieved. One reason for this could be that the importance of, in particular, CWRs has been stressed and demonstrated only relatively recently and in most countries activities started with surveys and the establishment of inventories. A few international projects had or still have activities in several countries.

Growing attention to the importance of wild food species is a relatively recent development and this may not yet have been translated into action as part of national *in situ* conservation efforts. This category of species is also extremely diverse and their inclusion in conservation programmes depends on the way they are used/eaten by local people and not on how they might potentially contribute to crop improvement and plant breeding. Knowledge about them is typically localized and very limited overall.

Indicator 11: Number of crop wild relatives and wild food plants *in situ* conservation and management actions with institutional support		
Number of reporting countries: 20 Number of countries with NFP rating: 29	NFP Rating	3.0

Twenty countries reported having one or more programmatic, project-related or activity-supported initiatives that provide institutional support to the conservation of one or more CWRs and/or wild food plants. A total of 52 projects/activities were reported, out of which 20 targeted CWRs only, 17 wild food plants and 15 both groups. A total of 125 species or species genepools, evenly divided between CWRs and wild food plants, were listed as targets of the *in situ* conservation actions, 18 times in protected areas, 9 in restoration areas and 9 in both protected and restoration areas.

Out of the 52 *in situ* conservation projects/activities reported, 25 were implemented with support from a national institute alone, 2 with the participation of the private sector, 14 with the participation of an institution from a foreign country, 5 with the participation of an international research centre, 3 with the participation of a United Nations agency and 9 with the participation of NGOs. Countries reported that 39 of the *in situ* conservation projects aimed to maintain high levels of CWR and/or wild food plant genetic diversity, 28 targeted the involvement of local communities, 14 promoted public participation and 19 had provisions for *ex situ* conservation of threatened and endangered CWRs or wild food plants. In most cases, two or more objectives were combined.

The average rating for this indicator, based on ratings from 29 countries rated was 3.0. This rather low rating indicates unsatisfactory progress. The reasons for this may be similar to those noted for the

previous indicator. *In situ* conservation actions with institutional support are important, as institutional support may increase sustainability. Local communities are reported to be involved in a number of projects/activities, another indication of a more stable approach. For the majority of the projects/activities, the countries reported maintenance of high levels of genetic diversity for both CWRs and wild food plants.

Indicator 12: Number of crop wild relatives and wild food plants species actively conserved *in situ*		
Number of reporting countries: 16 Number of countries with NFP rating: 31	NFP Rating	3.2

Sixteen countries reported an estimated total of 2 141 CWRs, including species from primary and secondary genepools, as well species previously used for breeding but belonging to the tertiary genepools, and wild food plants, actively conserved in *in situ* areas. The average per country was 134 species, with a maximum of 840 species in one country. CWRs and wild food plants combined were reported 1 301 times, CWRs 694 times and wild food plants 146 times.

The average rating of 3.2 from 31 countries is still very low, but nonetheless encouraging as six countries concretely reported on active conservation of genepools of CWRs, three on wild food plant species and seven on both categories.

Ex situ *conservation*

Ex situ conservation of germplasm is a widely applied approach to the preservation of PGRFA. Whereas *in situ* conservation has the advantage of allowing genetic resources to evolve in response to direct exposure to ever more rapidly changing environments and allowing the direct involvement of stakeholders in management activities, *ex situ* conservation has the advantage of providing a better controlled conservation environment, facilitating better targeted access to requested material and providing a safety back-up of *in situ* material.

Depending on the biological nature of the species, *ex situ* conservation can be done by: (i) storing dried orthodox seeds at low temperature (by far the most routine methodology, especially for long-term storage); (ii) maintaining field genebanks for plant species vegetatively propagated and with recalcitrant seeds; (iii) maintaining tissue under slow growth conditions in *in vitro* genebanks (for the category of germplasm mentioned under previous point); (iv) storing material in liquid nitrogen (cryopreservation); and (v) (increasingly) storing DNA obtained from valuable material.

Typically, material kept in field genebanks is increasingly also being maintained *in vitro* and, when possible, cryopreserved. This combination of two or more methods is referred to as "complementary conservation". In addition to plants, seeds and tissue (e.g. embryo cells, callus and differentiated tissue, cell suspensions), pollen is used for conservation purposes. Information management is a critically important activity for any genebank or germplasm collection, allowing access to the conserved material and showcasing knowledge about the individual accessions, as well as providing a precondition for effective management of the collections.

Although a lot of experience and knowledge has been accumulated in the field of *ex situ* conservation, internationally agreed standards for quality management of *ex situ* collections are not consistently applied by all genebanks. There is an urgent need to assist those genebanks that do not yet have adequate operational procedures in place. Furthermore, activities such as regeneration, characterization and evaluation of conserved genetic resources remain a challenge, including because knowledge about the biology of many of the CWRs and wild food plants is still very limited compared to crops and because these operations are costly. Characterization and evaluation deserve due attention, as they are a prerequisite for wider and more effective use of germplasm. The management of germplasm accessions

and their associated information to attract the interest of molecular geneticists, advanced plant breeders and researchers is a key challenge for traditional genebanks.

The rapid development of new biotechnological and information management tools and techniques is providing increasing opportunities to improve the quality of conservation activities, as knowledge of the distribution and patterns of genetic diversity increases, the costs of applying new techniques decrease and more people are trained in their use.

Despite the existence of legal frameworks for the conservation and sustainable use of genetic resources, more work is needed to resolve issues that fall at the interface between these frameworks. Awareness among conservation staff about recent developments in the legal and policy field also need to be improved in order to limit misunderstandings, generate confidence in applying policies and legal agreements and promote equitable distribution of the benefits that the compliance with such frameworks produces.

Priority Activity		NFP Rating
5	**Supporting targeted collecting of plant genetic resources for food and agriculture**	4.5

The prime motivating forces behind most germplasm collection efforts are gap-filling, imminent risk of loss of diversity *in situ* and opportunities for use. For a large number of crops, the germplasm currently conserved in genebanks worldwide does not represent the total existing variation in their genepools. Most of the major crops have, in general terms, been well collected, but geographical or genetic diversity gaps may still need to be addressed.

Germplasm collections of most of the regionally important, minor and/or underutilized crops are much less complete. CWRs, including those of the major food crops, have received little attention relative to their potential importance in breeding. This “gap” is partially being filled through concerted collecting actions in the diversity hot spots of the world, in particular for the species under the Multilateral System of Access and Benefit Sharing of the International Treaty (Annex I), through a number of global projects, including those supported through the Benefit Sharing Fund of the International Treaty as well as those coordinated by the Global Crop Diversity Trust, Kew Gardens and the University of Birmingham. Unfortunately, systematic collection of wild food plants is much more demanding and difficult, due to their much less well-defined biological status and gaps in knowledge. Consequently, these species, which fit within traditional local food and production systems, are doomed if no particular efforts are made at the global level.

Due to the distribution patterns of, in particular, non-domesticated species, cooperation at the regional level is a logical step towards achieving effective and efficient results. Existing regional and/or global crop networks provide an obvious entry point for such collaboration.

Reflecting the high level of attention given to this PA, 31 countries implemented a total of 890 collecting missions. These led to the collection of more than 20 000 samples of 800 crops or groups of crops. Cereals, vegetables and pulses were the crop groups with the most collected materials. The 12 international agricultural research centres reported collection of more than 8 100 samples of 18 crops or crop groups. Twenty-nine countries identified gaps in their collections and reported that mitigating targeted collecting strategies had been developed for a large majority of the crops conserved. Based on gap analyses, targeted collecting was required by countries for almost 350 crops or crop groups. In the case of the international centres, gaps in the holdings of over 65 crops or crop groups required addressing through targeted collecting.

The overall average rating for PA 5 is 4.5. This confirms that countries believe that they have done an adequate job in this field and should continue to dedicate effort and resources to targeted collecting.

Indicator 13: Existence of a strategy for identification of gaps in national genebank holdings and for targeted collecting missions to fill identified gaps		
Number of reporting countries: 33 Number of countries with NFP rating: 33	NFP Rating	4.4

Indicator 14: Number of crops conserved in the national genebank(s) that require targeted collecting		
Number of reporting countries: 33 Number of countries with NFP rating: 33	NFP Rating	4.3

As indicators 13 and 14 are closely related, they are treated together.

Thirty-three countries reported that strategies for gap identification in national *ex situ* collections existed at the end of the reporting period. In twenty-nine of them, the strategies also addressed targeted collecting for filling the identified gaps. These countries reported a total of 217 crops and 23 groups of crops for which targeted collecting would be required. About five countries reported the lack of a strategy for a limited number of crops (14), mainly fruit trees, many of which from tropical latitudes, and stimulant plants.

An analysis of the gaps detected showed that *incomplete geographical coverage* is the most frequently mentioned gap (261 times or 60 percent of the cases), followed by *incomplete coverage of targeted taxa* (49 percent), *missing known farmers' varieties/landraces* (45 percent), *missing CWRs* (41 percent), *missing historical varieties* and *incomplete biotic and abiotic stress resistance coverage* (21 percent each).

Comparing the stored material with the organization mandate was the most frequent method (69 percent) of detecting gaps in the collections, followed by the use of geographical references (63 percent) and the use of historical references (43 percent). Some research on gap analysis was based on collecting activities in 15 countries or region. For 21 crops or crop groups, other methods to detect gaps were reported, ranging from farmer baseline surveys to interviews and expert consultations, as well as genetic diversity assessments, including the use of molecular tools to verify varieties within collections.

The 12 international agricultural research centres of the CGIAR and AVRDC reported on 66 crops or crop groups for which targeted collecting would be required on the basis of gap analyses and reported threats to the taxa. Incomplete coverage of the targeted taxa or geographic area was by far the most important detected "gap" in the collections (83.3 percent), followed by missing CWRs (22.7 percent), incomplete coverage of biotic and abiotic stress tolerances (10.6 percent), missing known farmers' varieties/landraces (4.5 percent) and missing historical varieties (3.0 percent).

Thirty-three countries provided an average rating of 4.4 for indicator 13. Thirty-one countries rated their achievements for indicator 14 at 4.3 on average, thus indicating moderate satisfaction with their achievements with respect to this indicator. This can be interpreted as an encouraging sign as the establishment of a strategy for the identification of gaps in collections seems to be one of the main arguments in defining collecting priority targets in the respective countries. Based on this and the various reported gaps, countries seem to base their collecting work plans largely on well-founded priorities and thus have more rational and effective ways of conducting their routine conservation efforts than in the past.

Indicator 15: Number of targeted collecting missions in the country		
Number of reporting countries: 33 Number of countries with NFP rating: 32	NFP Rating	4.6

Indicator 16: Number of accessions resulting from targeted collecting missions in the country		
Number of reporting countries: 33 Number of countries with NFP rating: 32	NFP Rating	4.9

As indicators 15 and 16 are closely related and reported in the same question of the Reporting Format they are treated together.

Thirty-three countries reported a total of 890 collecting missions, during which 868 taxa belonging to 399 genera were collected. The total number of samples collected during these missions was 20 771. The largest number of collected samples were reported by Ecuador (2 332: maize, sweet potatoes, *Chenopodium*, *Prunus*, etc.), followed by Germany (2 032: CWRs), Spain (1 919: mainly date palm, beans, apple trees, etc.), Peru (1 647: potatoes, maize, oca, mashua, etc.), Bangladesh (1 562: peppers, cucurbits, pulses, etc.) and the Islamic Republic of Iran (1 290: forages, oilseeds, etc.).

Table 3. Number of distinct taxa and samples collected in countries

Country	Number of distinct collected		Country	Number of distinct collected	
	Taxa	Samples		Taxa	Samples
Iran (Islamic Rep. of)	210	1 290	Panama	11	419
Turkey	146	1 101	Ethiopia	8	100
Spain	136	1 919	France	8	1 265
Bulgaria	110	624	Latvia	8	128
Bangladesh	69	1 562	Pakistan	6	343
Jordan	65	470	Peru	6	1 647
Kenya	62	144	Lebanon	5	190
Armenia	56	501	Senegal	3	814
Cuba	56	287	Finland	2	100
Egypt	35	222	Guyana	2	23
Albania	29	149	Malawi	2	135
Azerbaijan	27	607	Togo	2	236
Morocco	22	302	Costa Rica	1	64
Estonia	16	68	Tanzania (United Rep. of)	1	564
Zambia	13	342	Germany	*	2 032
Chile	12	753	Sweden	*	38
Ecuador	12	2 332			

* Unspecified crop wild relatives.

The most widely collected crop was maize (14 countries), followed by onion (9 countries), faba beans, common beans and cucumbers (6 countries), and sweet pepper, bread wheat and cowpeas (6 countries). The maximum number of reported taxa for one country was 210, and 3 other countries reported more than 100 taxa collected (see Table 3). Maize was the most collected crop (1 413 samples), followed by

Capsicum (847 samples), *Solanum*-potato (816), *Oryza* (845), *Lolium* (571 samples in France only), *Prunus* (530) and *Pennisetum* (500) (see Table 4).

Table 4. Number of samples and number of countries of collection for the most collected genera

Genus	Number of		Genus	Number of	
	Samples	Countries		Samples	Countries
Zea	1413	14	*Oryza*	748	5
Allium	282	11	*Manihot*	467	5
Lycopersicon	416	10	*Ipomoea*	380	5
Cucumis	379	10	*Cucurbita*	286	5
Vicia	184	10	*Lactuca*	282	5
Phaseolus	474	9	*Amaranthus*	212	5
Triticum	380	9	*Sesamum*	263	4
Brassica	417	8	*Helianthus*	174	4
Hordeum	367	8	*Digitaria*	315	2
Malus	347	7	*Melilotus*	209	2
Vigna	219	7	*Ricinus*	184	2
Solanum (eggplant)	154	7	*Tropaeolum*	130	2
Capsicum	847	6	*Lolium*	571	1
Solanum (potato)	816	6	*Pennisetum*	500	1
Prunus	530	6	*Aristotelia*	437	1
Vitis	428	6	*Phoenix*	372	1
Chenopodium	283	6	*Oxalis*	228	1
Medicago	249	6	*Ilex*	157	1

It should be noted that the period during which the collecting missions took place did not in all cases fully coincide with the reporting period.

The above-reported numbers are encouraging as concerns have been expressed that discussions on the implementation of the Nagoya Protocol, as well as on how best to proceed and allow collecting in " third countries" (by international organizations and individual countries) would have had a negative effect on the collection of PGRFA in general.

Information about the amount of samples secured in long-term conservation after collecting was provided only for 70.6 percent of the total samples collected (20 771). At the time of reporting, 78.2 percent of the 14 671 samples with information on this subject had been secured, which accounts for about 55.2 percent of the total collected, processed and stored.

The 11 CGIAR centres and AVRDC reported a total of 8 118 samples of 18 crops/crop groups collected in 25 countries, largely by NARS and subsequently shared with the centres. Rice (*Oryza* spp.) was the crop genepool with the most reported samples (1 539) or 19 percent of the total reported material, followed by yam species (1 449 accessions or 17.8 percent). Three centres did not undertake any collecting, in part due to the uncertain policy situation (e.g. forage species are largely excluded from Annex I). Only a relatively small number of the collected samples (1 482 or 18.3 percent) had been included in long-term storage, most of the collected material was reported still to be under processing.

Specific collecting guidelines were made available to some countries through a global CWR project coordinated by the Global Crop Diversity Trust. According to several countries, these guidelines will be of use even after the project comes to an end. This shows the value of these efforts in terms of sustainability.

Thirty-two countries rated their achievements for indicator 15, on average, at 4.6. This looks like a fair rating and confirms that countries collectively have been able to pay due attention to collection efforts

and that they were able to implement a satisfactory number of targeted collecting missions, while realizing that more work needs to be done. The slightly higher average rating for indicator 16 (4.9) indicates that countries were content with the number of samples that they were able to collect.

Priority Activity		NFP Rating
6	**Sustaining and expanding *ex situ* conservation of germplasm**	5.2

It is widely recognized that there is a pressing need to improve conservation techniques and protocols by expanding biological and agronomic knowledge on individual species, even on some major crops. This is particularly the case for species that do not produce orthodox seed (e.g. recalcitrant seeded plants, crops that are reproduced vegetatively, big-seeded species, etc.). Furthermore, advances with new technologies create new challenges and opportunities that need to be adequately reflected in genebank's approaches to conservation and distribution. Currently, PGRFA are predominantly conserved in seed, field and *in vitro* genebanks. In *The Second Report on the State of the World's PGRFA*, global holdings were estimated to be above 7 million accessions and about 25 percent of these were considered to be distinct.

As part of this assessment, it has been possible to document more than 3.6 million accessions from 488 genebanks and germplasm collections. About 94 percent of these holdings are conserved, not exclusively, as seed in medium/long-term conditions; 6 percent are in field collections; almost 1 percent are *in vitro*; 0.2 percent are cryopreserved; and 1 458 accessions are conserved as DNA. The so-called "biological status" of the accessions conserved (i.e. whether they are wild materials, farmers' varieties/landraces, advanced/improved cultivars, breeding/research material, etc.) is known for about 66.2 percent of the material conserved *ex situ*. Of these, about 15.4 percent are advanced cultivars, 26.6 percent breeding/research material, 38.4 percent farmers' varieties/landraces and 19.3 percent wild materials.

Genebank holdings are complemented by an estimated 2 500 botanical gardens worldwide. These botanic gardens grow over one-third of all known plant species and maintain important herbaria and other botanic collections.

Because of an increasing interest in establishing and maintaining collections of underutilized crops, wild food species and, in particular, CWRs, and given that such species tend to be more difficult to conserve *ex situ* than the much better known major food crops, there is an increasing need to build the capacity needed to allow for safe and efficient conservation. Increasingly, communities are establishing so-called community seed or genebanks to facilitate the management and enhance availability of genetic diversity in their local production system. Typically these have limited access to limited external inputs and simple infrastructures. Capacity-building is essential. New technologies that allow better conservation practices are being developed and many are already available to genebanks. However, in many cases capacity to make use of them is lacking.

Whereas overall there was an increase in human, financial and infrastructural capacity, there was nonetheless a significant reduction in capacity in these fields in the majority of the countries of sub-Saharan Africa and Latin America. About 3.6 million accessions are conserved by the 71 assessed countries and 12 international centres (approximately 20 percent of the total), about half the total holdings belong to the nine major food crops. Compared to 2009, *ex situ* PGRFA conservation efforts have been strengthened significantly overall, as shown by the increases of 16 percent and 28 percent, respectively, in the number of genera and species conserved, and the increased level of safety duplication of individual accessions (on average 50 percent of the national collections and 62 percent of the collections held by the international centres). The 13 percent decrease in the number of accessions

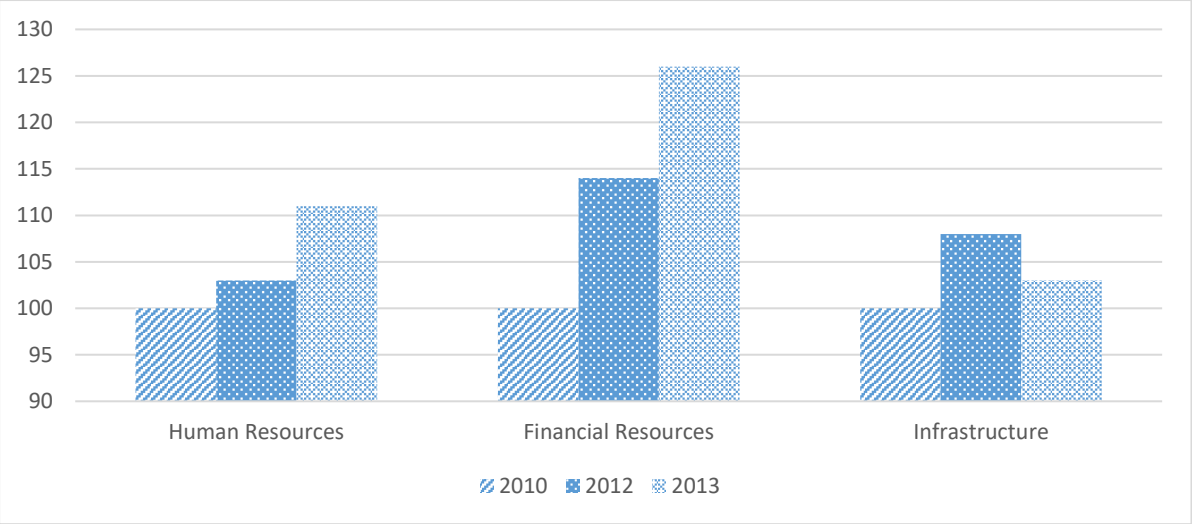
conserved was mainly the result of rationalization of conservation programmes in countries and more consistent reporting in which data on duplicated working collections were removed. No major irreplaceable losses were reported by countries. The conservation activities of the international agricultural research centres remained significant and continued to complement the efforts of countries, especially with regard to their regional and global coverage.

The overall rating 5.2 for PA 6 represents a good score in this important area. However, the relatively poor performance with respect to safety duplication by most countries lowered the average score and underlines the need to give due attention to this important aspect of *ex situ* conservation.

Indicator 17: Trend in annual capacity for sustaining *ex situ* collections		
Number of reporting countries: 33 Number of countries with NFP rating: 32	NFP Rating	4.8

Given that collections are steadily growing, that the availability of properly trained genebank staff is limited and that countries do not always regard conservation as a high priority, and possibly for other reasons as well, it is important to ensure adequate capacity to manage collections and projects efficiently and effectively. To this end, countries were asked to indicate the capacity of their national PGRFA programmes compared to that of 2010 with respect to three essential assets needed to support *ex situ* conservation activities. Responses are summarized in Figure 2. Overall, a clear increase in capacity with respect to human resources, financial resources and infrastructure can be observed.

Figure 2. Capacity developments for sustaining *ex situ* collections (expressed as percentage of capacity in 2010)



Despite the overall improvements, individual countries reported significant decreases. Particularly notable is that six out of eight sub-Saharan African countries reported an average drop of 50 percent in capacity in the three areas under consideration between 2010 and 2014. In three out of six Latin American countries, the decrease was 30 percent. This is cause of concern as it represents a factor of high risk to the germplasm collections in the affected countries that should be assessed in more detail and monitored over the years.

The rather polarized situation in which there are countries with large improvements and others with decreasing capacities is not evident from the average rating of 4.8 for this indicator, calculated from the scores of 32 countries.

About half of the international agricultural research centres reported a slight increase in capacity, especially for infrastructure (doubled by AVRDC, Bioversity and CIP). However, two centres reported decreases: ICARDA, in order to continue to operate, had to move out of a war-affected country and find temporary storage solutions for collections held in trust; CIAT reported nearly 40 year old facilities that need replacement.

Indicator 20:[5] Number of accessions conserved *ex situ* under medium or long-term conditions		
Number of reporting countries: 71 Number of countries with NFP rating: 33	NFP Rating	5.6

Data on about 3.595 million accessions held in *ex situ* collections under medium- and long-term conditions were gathered and analysed. They relate to the germplasm holdings of over 470 genebanks in 71 countries, plus the genebanks of 12 international agricultural research centres (i.e. CGIAR and AVRDC), as of 30 June 2014[6]. Thirty-one of these countries and one regional agricultural research centre, the *Centro Agronómico Tropical de Investigación y Enseñanza* (CATIE),[7] reported more than 1.171 million accessions directly to FAO; the remainder were sourced through the Genesys and EURISCO portals.[8] Number of genera, species and accessions in collections maintained in selected national genebanks are presented in Table 5.

Nine crops, namely wheat, rice, barley, maize, beans, sorghum, oats, chickpea and soybean, accounted for more than 50 percent of the total reported *ex situ* accessions. The 12 international agricultural research centres reported a total of 783 717 accessions for their mandate crops (see Tables 6).

[5] For discussion purposes indicators 18, 19 and 20 are presented in the following order: 20, 19 and 18.
[6] Accessions with acquisition date later than 30 June 2014 were not considered.
[7] CATIE reported through Costa Rica.
[8] https://www.genesys-pgr.org and http://eurisco.ipk-gatersleben.de/

Table 5. Numbers of genera, species and accessions in collections maintained by selected national genebanks in 1995, 2008 and 2014 and comparisons among years[9]

		1995 (no.)			2008 (no.)			2014 (no.)			1995-2008 change (percent)			2008-2014 change (percent)		
Country	**Genebank**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**
Brazil	EMBRAPA[10]	136	312	40 514	213	651	107 067	28	162	51 959	57	109	164	-87	-75	-51
Canada	PGRC	237	1 028	100 522	257	1 017	106 442	255	963	106 943	8	-1	6	-1	-5	0
China	ICGR-CAAS	-	-	358 963	-	-	391 919	-	-	-	-	-	9	-	-	-
Czech Republic	CRI	34	96	14 495	30	175	15 421	28	138	16 470	-12	82	6	-7	-21	7
Ecuador	INIAP/DENAREF	207	499	10 835	269	658	17 775	349	806	20 583	30	32	64	30	22	16
Ethiopia	EBI	71	74	46 322	151	321	67 554	192	380	71 705	113	334	46	27	18	6
Germany	IPK Gatersleben	633	2 513	147 436	766	2 887	145 190	761	3 151	149 554	21	15	-2	-1	9	3
Hungary	RCA	238	742	37 969	312	979	46750	312	979	46 750	31	32	23	0	0	0
India	NBPGR	73	177	154 533	723	1 662	354 303	788	1 789	396 783	890	839	129	9	8	12
Japan	NIAS[11]	-	-	202 581	336	1 256	240 819	339	1 343	220 396	-	-	19	1	7	-8
Kenya	KALRO-GeRRI	140	291	35 017	854	2 349	48 777	1 021	2 908	50 323	510	707	39	20	24	3
Nordic Countries	NORDGEN	88	188	24 241	164	368	29 312	207	409	33 807	86	96	21	26	11	15
Russian Federation	VIR	262	1 840	328 727	376	2 169	322 238	126	1 024	123 430	44	18	-2	-66	-53	-62
Netherlands	CGN	30	147	17 349	37	338	24 258	42	330	22 765	23	130	40	14	-2	-6
Turkey	AARI	317	1 941	32 122	535	2 692	54 523	111	192	14 099	69	39	70	-79	-93	-74
United States of America	NPGS	1 582	8 474	411 246	2 118	11 873	509 071	2 357	13 131	565 847	34	40	24	11	11	11
Average		**289**	**1 309**	**122 680**	**476**	**1 960**	**155 089**	**461**	**1 847**	**126 094**	**65**	**50**	**26**	**-3**	**-6**	**-19**

[9] Update of Table 1.2 in the Second Report on the State of the World's PGRFA. Data sources: **A.** direct reporting to FAO WIEWS for Empresa Basileira de Pesquisa Agropecuaria (EMBRAPA); Plant Gene Resources of Canada (PGRC); Instituto Nacional de Investigaciones Agropecuarias (INIAP), Ecuador; Ethiopian Biodiversity Institute (EBI); National Bureau of Plant Genetic Resources (NBPGR), India; National Institute of Agrobiological Sciences (NIAS), Japan; Kenya Agricultural and Livestock Research Organization, Genetic Resources Research Institute (KALRO-GeRRI); Nordic Genetic Resource Center (NORDGEN), in 2008; Centre for Genetic Resources, the Netherlands Plant Research International (CGN), in 2008; Aegean Agricultural Research Institute (AARI), Turkey, in 2014; National Plant Germplasm System (NPGS), United States of America, in 2008; **B.** EURISCO for Crop Research Institute (CRI), Czech Republic in 2008; Genebank, Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany; Institute for Agrobotany (RCA), Hungary; NORDGEN in 2014; N.I. Vavilov Research Institute of Plant Industry (VIR), Russian Federation, in 2014; CGN in 2014; **C.** Country reports for the Second Report on the State of the World's PGRFA for Institute of Crop Germplasm Resources of the Chinese Academy of Agricultural Sciences (ICGR-CAAS), China; VIR in 2008; AARI in 2008; **D.** Direct communication for CRI in 2014; **E.** Genesys for NPGS in 2014.

[10] Incomplete reporting for 2014.

[11] Incomplete reporting for 2014.

Table 6. Numbers of genera, species and accessions in collections maintained by AVRDC and CGIAR centres in 1995, 2008 and 2014 and comparisons among years[12]

	1995 (no.)			2008 (no.)			2014 (no.)			1995-2008 change (percent)			2008-2014 change (percent)		
Centre[13]	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**	**Genera**	**Species**	**Accessions**
AVRDC	63	209	43 205	160	403	56 522	170	429	60 883	154	93	31	6	6	8
CIAT[14]	161	906	58 667	129	872	64 446	-	-	67 770	-20	-4	10	-	-	5
CIMMYT	12	47	136 259	12	48	173 571	14	63	164 320	0	2	27	17	31	-5
CIP[15]	9	175	13 418	11	250	15 046	-	-	17 536	22	43	12	-	-	17
ICARDA	34	444	109 223	86	570	132 793	109	614	146 892	153	28	22	27	8	11
ICRAF	3	4	1 005	3	6	1 785	78	158	4 301	0	50	78	2 500	2 533	141
ICRISAT	16	164	113 143	16	180	118 882	15	187	123 021	0	10	5	-6	4	3
IITA	72	155	36 947	72	158	27 596	15	87	30 445	0	2	-25	-79	-45	10
ILRI	358	1 359	13 470	388	1 746	18 763	426	1 880	20 231	8	28	39	10	8	8
INIBAP	2	21	1 050	2	23	1 207	2	43	1 529	0	10	15	0	87	27
IRRI	11	37	83 485	11	39	109 161	7	34	127 168	0	5	31	-36	-13	16
WARDA	1	5	17 440	1	6	21 527	1	6	19 621	0	20	23	0	0	-9
TOTAL	**494**	**2 813**	**627 312**	**612**	**3 446**	**741 299**	**627**	**3 331**	**783 717**	**24**	**23**	**18**	**2**	**-2**	**3**

[12] Update of Table 1.1 in *The Second Report of the State of the World's PGRFA*. 2014 data sources as follows: Genesys portal 2016 (data filtered for field Acquisition date (ACQDATE) older than 1 July 2014).
[13] The World Vegetable Centre (former Asian Vegetable Research and Development Centre, AVRDC); Centro Internacional de Agricultura Tropical (CIAT); Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT); Centro Internacional de la Papa (CIP); International Centre for Agricultural Research in the Dry Areas (ICARDA); International Centre for Research in Agroforestry [now the World Agroforestry Centre] (ICRAF); International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); International Institute of Tropical Agriculture (IITA); International Livestock Research Institute (ILRI); International Network for the Improvement of Banana and Plantain [now Bioversity International] (INIBAP); International Rice Research Institute (IRRI); AfricaRice (former West African Rice Development Association, WARDA).
[14] 2014 data from direct reporting. As no accession level information could be retrieved from the internet, genera and species counting, as well as other statistics, could not be performed.
[15] 2014 data from direct reporting. As no accession level information could be retrieved from the internet, genera and species counting, as well as other statistics, could not be performed.

Table 7. Numbers of genebanks, genera, species and accessions in the collections of 71 countries in 2008 and in June 2014 and comparisons between years

Country	2008 (no.)*				2014 (no.)				2008-2014 change (percent)		
	Gene-banks	Genera	Species	Accessions	Gene-banks	Genera	Species	Accessions	Genera	Species	Accessions
United States of America	32	2 118	11 873	509 071	**29**	**2 357**	**13 131**	**565 847**	11	11	11
India	60	762	1 842	572 737	**1**	**788**	**1 789**	**396 783**	3	-3	-31
Japan	1	336	1 256	240 819	**1**	**339**	**10343**	**220 396**	1	7	-8
Germany	11	779	3 015	153 547	**45**	**815**	**3 656**	**174 266**	5	21	13
Russian Fed.	1	134	974	217 206	**1**	**126**	**1 024**	**123 430**	-6	5	-43
United Kingdom	8	4 412	22 815	107 833	**8**	**5 288**	**30 724**	**121 946**	20	35	13
Canada	1	257	1 017	106 442	**3**	**258**	**1 032**	**110 363**	0	1	4
Ukraine	54	313	1 034	62 257	**60**	**484**	**1 717**	**94 025**	55	66	51
Spain	33	979	3 625	59 624	**37**	**1 008**	**3 873**	**76 970**	3	7	29
Ethiopia	1	151	321	67 554	**1**	**192**	**380**	**71 705**	27	18	6
Poland	2	294	839	60 054	**11**	**334**	**933**	**69 741**	14	11	16
Bulgaria	3	502	1 827	62 131	**3**	**514**	**1 875**	**63 608**	2	3	2
Brazil	56	329	865	325 273	**4**	**41**	**194**	**54 868**	-88	-78	-83
Morocco	1	87	316	24 197	**1**	**128**	**412**	**53 728**	47	30	122
Czech Republic	15	358	1 109	49 464	**11**	**339**	**1 049**	**52 947**	-5	-5	7
Kenya	2	854	2 355	50 562	**1**	**1 021**	**2 908**	**50 323**	20	23	0
Hungary	1	312	979	46 750	**1**	**312**	**979**	**46 750**	0	0	0
Italy	51	134	648	38 939	**31**	**199**	**200**	**44 547**	49	-69	14
Romania	45	293	745	43 837	**36**	**291**	**748**	**42 837**	-1	0	-2
Switzerland	10	35	110	23 978	**23**	**84**	**216**	**39 906**	140	96	66
Chile	4	142	199	30 094	**8**	**66**	**142**	**36 563**	-54	-29	21
New Zealand	2	20	52	26 752	**1**	**394**	**1 510**	**34 240**	1 870	2 804	28
Slovakia	2	152	296	17 902	**1**	**152**	**297**	**34 032**	0	0	90
Nordic countries[1]	1	164	368	29 312	**1**	**207**	**409**	**33 807**	26	11	15
Pakistan	10	99	150	42 315	**1**	**243**	**476**	**30 500**	145	217	-28
Israel	2	9	47	20 914	**2**	**581**	**1 279**	**26 464**	6 356	2 621	27
Netherlands	1	37	338	24 258	**2**	**92**	**892**	**25 736**	149	164	6
Ecuador	12	363	870	24 285	**5**	**355**	**819**	**21 294**	-2	-6	-12
Cuba	14	340	732	17 988	**17**	**343**	**805**	**18 433**	1	10	2
Turkey	1	535	604	47 282	**2**	**111**	**194**	**14 129**	-79	-68	-70
Mongolia	4	56	76	20 369	**1**	**24**	**50**	**13 992**	-57	-34	-31
Portugal	6	158	265	39 695	**8**	**42**	**157**	**12 193**	-73	-41	-69
Bangladesh	9	105	146	33 875	**7**	**99**	**136**	**11 980**	-6	-7	-65
Azerbaijan	12	98	187	13 927	**8**	**449**	**1 117**	**11 837**	358	497	-15
Country	**2008 (no.)***				**2014 (no.)**				**2008-2014 change (percent)**		

[1] Denmark, Finland, Norway, Sweden.

	Gene-banks	Genera	Species	Accessions	Gene-banks	Genera	Species	Accessions	Genera	Species	Accessions
Austria	13	308	525	10 754	**14**	**366**	**661**	**11 722**	19	26	9
Egypt	1	-	-	11 167	**1**	**22**	**38**	**11 654**	-	-	4
Costa Rica	11	271	470	17 654	**7**	**79**	**207**	**11 588**	-71	-56	-34
Bolivia (Plur. State of)	12	52	107	16 843	**1**	**22**	**61**	**11 506**	-58	-43	-32
Belgium	1	26	154	1 741	**12**	**822**	**2 237**	**9 306**	3 062	1 353	435
Sri Lanka	14	111	189	13 910	**1**	**21**	**40**	**8 808**	-81	-79	-37
Zambia	1	44	85	6 191	**1**	**47**	**98**	**7 252**	7	15	17
Armenia	8	116	382	12 262	**5**	**123**	**395**	**6 747**	6	3	-45
Greece	1	65	168	6 084	**4**	**64**	**166**	**6 265**	-2	-1	3
Tanzania (Un. Rep. of)	1	53	90	4 327	**1**	**78**	**153**	**5 825**	47	70	35
Serbia	1	1	1	5 475	**1**	**1**	**1**	**5 475**	0	0	0
Albania	1	33	52	2 058	**2**	**95**	**145**	**4 105**	188	179	99
Jordan	2	291	511	3 270	**2**	**432**	**842**	**3 985**	48	65	22
France	3	15	66	14 217	**3**	**14**	**34**	**3 589**	-7	-48	-75
Croatia[2]	7	247	346	2 826	**8**	**255**	**358**	**3 264**	3	3	15
Malawi	1	53	67	2 814	**1**	**51**	**72**	**3 253**	-4	7	16
Estonia	3	40	47	2 716	**3**	**43**	**71**	**2 768**	8	51	2
Latvia	3	40	83	1 651	**4**	**54**	**86**	**2 555**	35	4	55
Macedonia (TFYR of)	1	21	27	887	**1**	**57**	**84**	**2 158**	171	211	143
Cyprus[3]	1	23	28	12 199	**1**	**-**	**-**	**2 028**	-	-	-83
Senegal	3	77	100	1 757	**3**	**7**	**10**	**1 890**	-91	-90	8
Slovenia	2	55	92	1 776	**2**	**55**	**92**	**1 776**	0	0	0
Lithuania	3	174	350	3 193	**1**	**55**	**96**	**1 681**	-68	-73	-47
Lebanon	7	54	101	657	**1**	**450**	**925**	**1 547**	733	816	135
Ireland	3	9	12	1 117	**3**	**21**	**29**	**1 421**	133	142	27
Moldova (Rep. of)[17]	3	8	15	1 211	**3**	**8**	**15**	**1 211**	0	0	0
Guyana	5	22	28	2 270	**1**	**94**	**137**	**1 210**	327	389	-47
Mali	10	20	23	7 154	**2**	**5**	**6**	**838**	-75	-74	-88
Panama[17]	3	29	38	361	**5**	**68**	**80**	**824**	134	111	128
Georgia	4	19	30	654	**4**	**41**	**78**	**440**	116	160	-33
Bosnia and Herzegovina[17]	2	31	32	129	**2**	**40**	**50**	**434**	29	56	236
Montenegro[17]	2	7	7	166	**2**	**17**	**17**	**356**	143	143	114
Togo	3	32	32	1 267	**1**	**2**	**2**	**220**	-94	-94	-83
Belarus[17]	-	-	-	-	**1**	**1**	**21**	**203**	-	-	-
TOTAL	**604**	**5 840**	**37 951**	**3 382 001**	**476**	**6 788**	**48 636**	**2 938 090**	**16**	**28**	**-13**

*Source: FAO WIEWS 2008

[2] Estimates based on the date of acquisition of the accessions reported in 2014.
[3] 2014 data are based on Cyprus' country report. No details available as per genera and species.

A summary of the germplasm material conserved by countries can be found in Table 7. The 2014 data have been obtained from the 71 countries that reported through the WIEWS Reporting Format as well as from the data available in EURISCO and Genesys. 2008 data were sourced from the WIEWS dataset used to prepare *The Second Report on the State of the World's PGRFA*. Whereas the data are not comprehensive for some of the countries and time did not allow for proper cross-checking with all countries, it can be stated that there have been some positive developments. For many countries the data look consistent over the two periods and some growth as well as rationalization of the holdings can be observed.

The number of accessions in *ex situ* genebanks shows a drop between 2008 and 2014 (see Table 7). This drop may be the result of: (i) more selective reporting in which active collections that are duplicated in base collections have not been reported (e.g. Armenia, Ecuador, India, Pakistan, Sri Lanka); (ii) limited coverage of existing collections for this interim reporting (e.g. Brazil, France, Japan, Russian Federation, Turkey); (iii) a combination of the above.

There has been overall progress in the management of *ex situ* collections by countries that benefitted from attempts to rationalize the conservation approach with the support of improved documentation.

Thirty-three countries rated their achievements 5.6 on average for indicator 20, a relatively high score, albeit slightly lower than the two other indicators (18 and 19) on medium- or long-term *ex situ* conservation. Therefore, countries are relatively satisfied with their performance, but more work remains.

Indicator 19:[4] Number of species conserved *ex situ* under medium- or long-term conditions		
Number of reporting countries: 71 Number of countries with NFP rating: 33	NFP Rating	5.7

As reported by 71 countries, in 2014, there are 6 788 genera and 48 636 species conserved *ex situ* under medium- or long-term conditions. The overall increase in the number of genera (16 percent) and species (28 percent) reported in 2014 compared to 2008, as shown in Table 7, confirms the trend reported in *The Second Report on the State of the World's PGRFA*, although the trend is less pronounced. The greater diversity coverage of non-staple crops and CWRs, particularly in national genebanks, as a result of increased recognition of ongoing genetic erosion and of the potential for using these resources, partly explains these changes. Documentation and reporting has also improved in some cases, leading to more detailed taxonomic reporting (e.g. Israel, New Zealand).

The number of genebanks or germplasm collections dropped by 21 percent over the period from 2008 to 2014. This drop seems caused by a reduced double reporting of germplasm held both in base and working collections and by the limit imposed on the 2014 reporting, which excluded collections conserved *ex situ* in short-term conditions, as well as by the less comprehensive coverage of the data compared to those used for the Second Report.

The 33 countries that rated their achievements for indicator 19 had an average score of 5.7 – a relatively high score, as with the previous indicator.

[4] For discussion purposes indicators 18, 19 and 20 are presented in the following order: 20, 19 and 18.

Indicator 18:[5] **Number of crops conserved *ex situ* under medium or long-term conditions**		
Number of reporting countries: 71 Number of countries with NFP rating: 33	NFP Rating	6.0

The analysis for this indicator is affected by improper use of the descriptor *Name of crop* in genebank documentation systems. In many cases, vernacular names of plants and not always crops are reported under this descriptor. Furthermore, distinct vernacular names of plants cannot easily be counted, due to different reporting languages and synonyms within languages.

Notwithstanding the above problem, the five countries with the highest numbers of "crops" are the United States of America (7 347), followed by New Zealand (1 423), the United Kingdom (1 392), India (940) and Austria (824).

The number of crops conserved in genebanks is, in general, highly correlated with the number of species and accessions conserved (indicators 19 and 20), except in the case of specialized genebanks such as some of the international agricultural research institutes of the CGIAR (e.g. IRRI and CIMMYT). At country level, there are specialized genebanks (e.g. the C.M. Rick Tomato Genetic Resources Center – USA176; the Instituto Madrileño de Investigación y Desarrollo Rural – ESP080 with their grape collection; and the Canadian Clonal Genebank, Harrow Research and Development Centre – CAN025, with strawberry and other fruit collections), as well as genebanks that are very widely focused in terms of numbers of crops (e.g. the National Bureau of Plant Genetic Resources in India – IND001, with 939 distinct occurrences under crop name; the Lebanese Agricultural Research Institute – LBN020, with 802; the Genetic Resources Unit, Institute of Biological, Environmental and Rural Sciences, Aberystwyth University in the United Kingdom – GBR016, with 799; and the Genebank of the Japanese National Institute of Agrobiological Sciences – JPN183, with 534).

Thirty-three countries, on average, rated their performance for this indicator at 6.0, a comparatively high average score, reflecting the overall good compliance of the collections with the crop mandates of the genebanks.

Indicator 21: Percentage of *ex situ* accessions safety duplicated		
Number of reporting countries: 52 Number of countries with NFP rating: 33	NFP Rating	4.0

Data from 52 countries and 9 international agricultural research centres were gathered for this indicator. The total number of country accessions for which information on safety duplication of the collections was obtained was 1.82 million. 40.9 percent of these were reported to be safety duplicated.

The percentage of safety duplicates of the collections held by the international research centres was 82.5 percent. Furthermore, most of the centres reported that the majority of the germplasm material in their genebanks is also stored in the Svalbard Global Seed Vault (SGSV). Considering data for national and international genebanks combined, the overall percentage of *ex situ* accessions safety duplicated is 53.4 percent.

The average rating for the 33 countries that provided a score for this indicator was 4.0. This is considerably lower than the previous three indicators and shows that safety duplication is still "below

[5] For discussion purposes indicators 18, 19 and 20 are presented in the following order: 20, 19 and 18.

average". This coincides with the overall data reported (i.e. 40.9 percent, well below the agreed technical genebank standard) and illustrates that this area of work requires a much higher priority.

Whereas safety duplication is an essential part of the *ex situ* conservation concept, it is also an area in which there is significant confusion regarding terminology and definitions. Unfortunately, this confusion has increased with the operation of the Svalbard Global Seed Vault, which is intended to provide an additional duplication backup of accessions that have been stored at another genebank.

Priority Activity		NFP Rating
7	**Regenerating and multiplying *ex situ* accessions**	4.2

Even under optimal *ex situ* storage conditions, all accessions stored as seed will eventually lose their viability and thus require regeneration. As capacity for regenerating germplasm was often not adequately considered when assembling collections, a large backlog of materials has been accumulated and needs to be cleared. Low initial sample size, low viability and frequent demand for samples from long-term storage facilities can shorten the regeneration–multiplication cycle. The increased collection and storage of CWRs and wild food plants also contributes to the backlog, as for many of these species there is no regeneration protocol. Many countries lack facilities for handling cross-pollinated species and inadequate funds and human resources are reported to be major problems.

Good germplasm management practices, proper planning and efficient coordination within the country, but also at the regional and global levels, will either minimize the amount of material to be regenerated or enable more efficient use of the regeneration capacity and infrastructure that exists for given crops. In addition, the development and/or application of scientifically robust protocols is needed in order to ensure that the genetic integrity of the accessions is maintained and that sufficient quantities of seed can be produced at an affordable price.

Of the three PAs on *ex situ* conservation, this is the one with the least encouraging results. Information gathered on almost 900 000 accessions showed that 18 percent had been regenerated, whereas 38 percent were in need of regeneration. For about 40 percent of those that were due for regeneration, adequate budget was not available. The collections of the international agricultural research centres have a better, though not ideal, status: about 10 percent had been regenerated during the reporting period; 13 percent were in need of regeneration; and for 12 percent of those due for regeneration, the required budget was not available.

The overall average rating for PA 7 is 4.2, clearly below average. This indicates that countries see the need for further improvements, including in capacity development.

Indicator 22: Percentage of *ex situ* accessions in need of regeneration for which a budget for regeneration does not exist		
Number of reporting countries: 34 Number of countries with NFP rating: 33	NFP Rating	3.9

Indicator 23: Number of *ex situ* accessions regenerated and/or multiplied		
Number of reporting countries: 34 Number of countries with NFP rating: 33	NFP Rating	4.7

Indicator 24: Percentage of *ex situ* accessions in need of regeneration		
Number of reporting countries: 34 Number of countries with NFP rating: 33	NFP Rating	3.9

Indicators 22, 23 and 24 are reported jointly as they are closely related and all were addressed under one question.

Thirty-four countries reported a total number of 899 145 accessions stored in 108 genebanks of national programmes; 18.2 percent (164 008 accessions) of these had been regenerated during the reporting period and 38.2 percent were identified as being in need of regeneration. Among the collections in need of regeneration, six have more than 10 000 accessions each to be regenerated (totalling 122 982 accessions or 35.8 percent of the total holdings needing regeneration), six collections have 5 000 to 10 000 accessions to be regenerated, and 45 collections have 1 000 to 5 000 accessions to be regenerated.

Importantly, 139 005 accessions, or 15.6 percent of the total and 40.4 percent of all accessions in need of regeneration, have been reported as being in need of regeneration but without a budget for this to be done. Of this last category of collections, two collections contained more than 10 000 accessions, one between 5 000 and 10 000; five between 2 000 and 5 000; and 15 between 1 000 and 2 000 accessions. Out these 23 collections, which represent 67 percent of the total number of collections at risk, ten, including the three largest ones, are held in Africa (69 599 accessions), six in Latin America (14 359 accessions), four in Europe (6 004 accessions); and three in the Near East (3 521 accessions). The backlogs, especially in Africa and Latin America, are a cause of particular concern, as the number of accessions in need of regeneration goes well beyond the capacity to undertake the task soon enough to avoid losses of genetic diversity.

The 12 international centres reported a total of about 780 000 accessions. Of these, 10.2 percent were regenerated during the reporting period and 13.1 percent were reported to be in need of regeneration. One of the constraints mentioned is that (as for many national collections) the number of accessions to be regenerated is well above the physical capacity of the centre. Another constraint is that most of the material at one centre consists of clonally propagated material, while another centre deals largely with perennial crops. The centres reported that for over 12 267 accessions they do not have the required budget.

From the data it can be concluded that regeneration/multiplication (largely of seed propagated crops and species) remains a problem for many genebanks. Based on the total number of accessions reported under this assessment (i.e. about 1.7 million accessions, including those of the international centres) it can be stated that these 34 countries represent about 20 percent of the Commission members and that their holdings, together with those of the international centres, constitute about one quarter of global *ex situ* holdings. These findings are thus certainly indicative of the overall worldwide situation with respect to regeneration.

As mentioned above, 18.2 percent of the accessions that are included in the holdings of the 34 countries (and 9.9 percent of those of the international centres) were reported to have been regenerated during the reporting period. This would coincide with approximately 5.7 percent of the reported holdings being regenerated annually. Converting this performance into the number of years required to regenerate each accession at least once, it would require slightly over 17.5 years on average to regenerate all accessions, which would be acceptable assuming that most of the accessions are stored under medium- or long-term storage conditions. However, as noted above, this average situation does not apply to all countries and regions.

At the same time, 38.2 percent of all the reported accessions (13.1 percent of all accessions in international centres) are in need of regeneration and for more than 40 percent of them (and 12 percent of the accessions in international centres) genebanks have no budget to regenerate them. This situation needs careful monitoring to make sure that it does not lead to dramatic losses over the years to come. The analysis of germplasm collection trends and the composition of *ex situ* collections (PAs 5 and 6) showed that CWRs and wild food plants are increasingly included in many collections. Considering that the reproductive behaviours and seed physiology of these two groups are, in general, not well known and that their regeneration is therefore more difficult and demanding, it can be expected that CWRs and wild food plants will increasingly constitute the germplasm in need of, and without an adequate budget for, regeneration. The loss of CWR material would even be more serious, given their probable unique status, the cost of collecting them and the potential such resources have for plant breeding. Careful monitoring of the situation is therefore recommendable as a basis for drawing up the best possible strategies to address regeneration gaps, at country, regional or international levels.

Thirty-three countries rated their performances for indicators 22, 23 and 24, on average, at 3.9, 4.7 and 3.9, respectively. This seems to be in accordance with the actual state of this important genebanking task, the best rating being for indicator 23 *Number of* ex situ *accessions regenerated and/or multiplied*, a recognition of the work done, in many cases, under difficult circumstances. The ratings for the other two indicators are both somewhat below average and clearly indicate that countries see the need for further improvements, including in capacity development.

V. SUSTAINABLE USE

The conservation of PGRFA is ultimately aimed at using the genetic diversity conserved. Such use can consist of a number of different activities, including research, plant breeding or making the resources available to farmers for selection and adaptation processes. In all cases, the holding genebank or *in situ* conservation programme should be able to assist the user in identifying and selecting the best possible material. This will require solid knowledge of the germplasm conserved and that steps are taken to ensure that the material has good viability and that it can be readily used without legal restrictions. Curators will need to ensure that material is managed so as to maintain its availability and that adequate characterization and evaluation of the conserved accessions are conducted and published. In some cases, it may also be necessary to conduct pre-breeding activities in order to allow the user to have easier access to the traits required and/or place them in a more conducive genetic background. This section deals with the different aspects of the use of conserved resources.

Priority Activity

8

Expanding the characterization, evaluation and further development of specific collection subsets to facilitate use

NFP Rating

4.5

Genebank collections are intended to help users to respond to new challenges and opportunities, to improve productivity, enhance sustainability and respond to change, particularly climate change. Crop germplasm collections house much of the diversity that will be needed to meet these challenges. In order for plant breeders, researchers and other users of PGRFA to make effective use of collections, they need to be able to quickly identify a manageable number of genotypes that possess, or are likely to possess, the traits needed in their programmes. Thus, systematic and improved characterization and evaluation of these collections is a prerequisite for greater and more efficient use of collections. Better understanding of genetic variability and phenotypic expression is also important for improving the management of the collections and the use of plant genetic resources. Furthermore, evaluation can aid the identification of germplasm with the potential for more direct use by farmers.

The development of limited sets of material based either on capturing total diversity in a small number of accessions or on representing the variation for particular traits in subsets has been found to improve use significantly. The formation of small and manageable subsets requires close collaboration between germplasm curators and plant breeders.

In the recent past, significant progress has been made in the characterization and evaluation of crop germplasm collections. Many countries and genebanks have acquired the capacity to use molecular techniques in germplasm characterization, a development that is leading to the generation of more comprehensive and reliable data. Significant advances have also been made in the development of high-throughput genotyping and phenotyping techniques, together with the related infrastructure. In order to characterize germplasm accessions and breeding materials efficiently for traits associated with adaptation to, and mitigation of, the effects of climate change, it is equally important to continue developing phenotyping capacity.

Unfortunately, despite these advances there are still large data gaps and much of the existing data are not easily accessible. Lack of adequate and comprehensive characterization and evaluation data, lack of capacity to generate and manage them and lack of access to these data remain serious constraints to the use of many germplasm collections. This situation applies in particular to minor crop and underutilized species and CWRs. With improved access to molecular and computational biology techniques, information technology and geographic information systems (GIS), the utility of PGRFA collections could be greatly enhanced. The development of standard descriptors and uniform characterization methodologies for more crops and species is another high priority.

More than 50 percent of the accessions held in national genebanks have been morphologically characterized and, impressively, almost 1 000 trait-specific subsets of collections developed. More than 175 000 accessions (and more than 350 000 samples) of about 280 different crops were distributed by national genebanks. Similar figures were reported by the international agricultural research centres for the accessions held in their genebanks.

The overall rating for PA 8 was 4.5. This may reflect a situation in which progress has been made, but also recognition that there is still plenty of room for improvement.

Indicator 25: Average number of morphological traits characterized per accession for the *ex situ* collections		
Number of reporting countries: 27 Number of countries with NFP rating: 31	NFP Rating	4.5

Twenty-seven countries reported on the level of morphological characterization of their collections, by crop and accession. The total number of accessions conserved by these countries was 725 165 and about 52.6 percent of these materials had been characterized using 22.3 morphological traits on average. As no characterization was undertaken for the remaining 47.4 percent of the collections in these countries, the overall average number of morphological traits per accession was approximately half, i.e. 11.7.

Figure 3 shows the frequency distribution of the number of traits used to characterize the germplasm collections in the 27 countries. The highest frequencies, ranging from 4 to 11 percent of the characterized accessions, are between 14 and 24 traits.

Figure 3. Frequency of the percentage of characterized accessions against the number of traits used

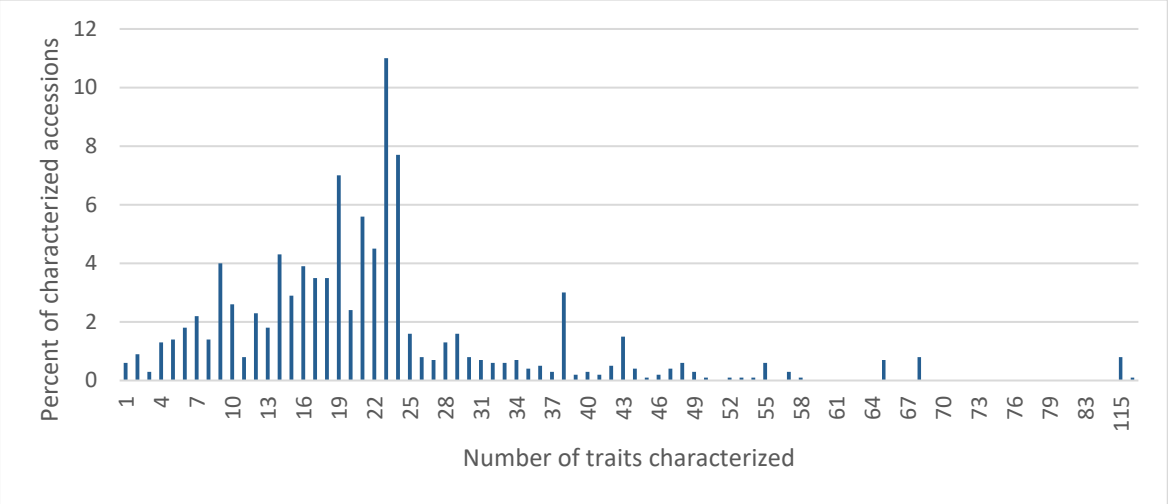


Table 8 summarizes for the five largest crop collections conserved by the reporting countries, the percentage of accessions characterized for at least one morphological trait and the average number of morphological traits used to characterize the collections. Highest levels of characterization are reported in barley, sorghum and rice collections, both in terms of the number of traits and the coverage of the collection.

Table 8. Degree of characterization for the five largest crop collections conserved by 27 reporting countries

Crop	Number of accessions conserved	Accessions characterized, percent	Average number of traits per conserved accession
Wheat	138 873	53	9.9
Barley	67 591	81	16.6
Rice	31 871	73	18.1
Sorghum	16 293	80	16.1
Beans	21 105	55	12.2

The level of characterization of respective collections varies greatly among the individual genebanks, as shown in Table 9.

Whereas in absolute terms these numbers of characterized accessions and the number of traits used look good at face value, it should be noted that for many important crops these numbers are still well below the agreed technical genebank standard level and thus countries still have work to do. In addition, this quantitative assessment does not shed light on another very important issue related to the characterization of the collections: the quality of the data and their level of compliance with international standards. Therefore, great care is required with the management and reporting of these data.

Thirty-one countries rated their achievements for this indicator, on average, at 4.5, thus indicating a certain satisfaction with the achievement but also a clear recognition of the need for further improvements.

The international centres provided detailed information on their total holdings (781 052 accessions from 66 crops or crop groups) and the weighted average number of morphological traits used to characterize these collections (20.2). The *Brassica* complex had the highest number of traits (85), followed by *Cucurbita* (74) and *Cucumis* (69).

Table 9. Level of characterization for collections in selected genebanks holding more than 10,000 accessions

Country	Genebank	Number of accessions conserved	Percentage of accessions characterized	Average number of traits per conserved accession
Germany	IPK Gatersleben	129 191	100	21.6
Japan	NIAS	93 569	76	16.0
Ethiopia	EBI	71 705	82	15.0
Morocco	INRA CRRAS	53 728	12	0.7
Netherlands	CGN	22 765	80	12.8
Ecuador	INIAP/DENAREF	20 583	11	3.4
Chile	INIA Carillanca	14 899	29	2.1
Germany	IPK Malchow	14 269	100	32.1
Egypt	NGB	11 654	100	13.3
Bolivia (Plur. State of)	Toralapa INIAF	11 506	68	20.3

Indicator 26: Number of publications on germplasm evaluation and molecular characterization

Number of reporting countries: 29

Number of countries with NFP rating: 32

NFP Rating **4.3**

Twenty-nine countries reported that a total of 1 038 publications on germplasm evaluation and molecular characterization had been produced by 99 national genebanks and/or their partner stakeholder institutes. This coincides with an annual average of about 15 publications per country during the reporting period. The maximum number of publications reported by one country was 282 and one more country reported more than 250 publications. In addition, 175 publications were reported to have been produced by recipients of the germplasm and, as such, reported back to the national programme. Eighteen countries also provided reference information on the characterization and evaluation work, in a descriptive manner.

The international centres reported a total of 217 publications in peer reviewed journals, an annual average of 7.2 publications per centre over the reporting period. ICRISAT was the most productive centre, with 86 publications in refereed journals, followed by CIP (67) and Bioversity (31). A total of 116 publications/reports in non-refereed journals were reported, an annual average of 3.9

publications per centre. ICRISAT reported 56 publications, CIP 33 and Bioversity and CIMMYT 6 each. It should be noted that two centres did not report any publications (one due to time constraints) and one centre reported one publication. Four centres provided a full list of publications.

The total number of publications produced and reported by recipients of germplasm from the international centres was 30, an average of 3.3 per centre. However, it has been reported that it is difficult to obtain information on publications produced by recipients of germplasm material made available to them. This is also an issue with respect to characterization and evaluation data generated by recipients of germplasm. This is unfortunate as it could be an important additional source of very pertinent information on individual germplasm accessions that would further strengthen their use and value.

Thirty-two countries assessed their level of achievement with respect to this indicator and scored an average rating of 4.3, thus indicating an insufficient level of achievement and progress in this area.

Indicator 27: Number of trait-specific collection subset published		
Number of reporting countries: 13 Number of countries with NFP rating: 33	NFP Rating	2.9

Thirty-one stakeholders from 13 countries and 79 germplasm collections reported the identification and publication of a total of 1 429 trait-specific subsets during the reporting period. References to the publications were provided for 1 103 subsets. Trait-specific subsets were reportedly produced and published for a total of 56 crops/crop groups. Forty-three of these crops were mentioned only once. Five trait-specific subsets were reportedly published for grapes, four for wheat and tomatoes, three for chickpeas and two for the remaining crops. Altogether, three stakeholders published more than 100 subsets.

Five of the international centres that reported for seven crops/crop groups published one core collection subset each for specified traits. ICARDA reported 48 subsets on pests and diseases and abiotic stress traits for five crops developed through the Focused Identification of Germplasm Strategy (FIGS) tool. CIMMYT produced a number of subsets for its mandate crops, but these were not formally published.

Thirty-three countries rated achievements under this indicator, at 2.9 on average. This is a very low but not surprising figure, as the creation of subsets or core collections is not a simple operation. It requires well-trained specialized staff and very good genetic diversity data on the entire collection, including on individual traits. Furthermore, there needs to be a clear request from the user of the collection with precise indications on what subsets are needed and for what purpose.

Indicator 28: Number of accessions distributed by genebanks to users of germplasm		
Number of reporting countries: 33 Number of countries with NFP rating: 32	NFP Rating	5.2

Indicator 29: Number of samples distributed by genebanks to users of germplasm		
Number of reporting countries: 33 Number of countries with NFP rating: 32	NFP Rating	5.6

The two indicators are treated together as information on them was reported under the same question and as there seems to be a degree of overlap between them.

Information on the distribution of germplasm belonging to more than 280 crops/crop groups was provided by 89 stakeholders from 33 countries: 178 314 germplasm accessions were reportedly distributed by 32 countries and 373 774 samples by 26 countries (see Table 10). On average, 1 080.7 accessions and 2 300.1 samples per country and stakeholder were distributed annually.

Table 10. Number of accessions and samples distributed by national genebanks to different categories of recipients during the reporting period*

	Recipient categories						
Distributed germplasm (no.)	NARCs	Private sector	Farmers or NGOs	Others (national)	Foreign stakeholders	Unknown	Total
Accessions	77 384	4 478	4 924	26 010	14 167	3 957	178 314
Samples	94 212	37 238	23 519	15 561	8 839	1 436	373 774

* 32 countries reported on accessions, 26 on samples.

It is noticeable that most of the germplasm was distributed within the respective countries and that on average 7.9 percent of the accessions were sent to foreign recipients. Most of the germplasm (43.4 percent) was sent to national agricultural research centres within the respective country, followed by other national institutions (14.6 percent). Twenty-five countries reported that they had distributed germplasm to farmers and/or local NGOs (5.2 percent). This is an interesting and important figure, albeit relatively low, as in many countries the genebanks are expected to share germplasm with farmers. Nonetheless, it should be noted that distribution policies of several genebanks prevent the direct distribution of materials to farmers.

The largest distribution figures reported by countries for individual crops or crop groups refer to wheat (24 523 accessions), vegetables (12 906 accessions), "oilseed" (9 134 accessions), pulses (8 216 accessions), sorghum (5 422 accessions), rice (5 754 accessions) and potatoes (5 091 accessions). Furthermore, five genebanks reported a distribution between 15 000 and 40 000 accessions during the reporting period, namely the genebanks of the Leibniz Institute of Plant Genetics and Crop Plant Research (Germany), the Plant Genetic Resources Institute of Pakistan, the Nordic Genetic Resource Center, the Ethiopian Biodiversity Institute and the National Plant Gene Bank of Iran. Four genebanks distributed between 4 000 and 7 000 accessions and eight genebanks distributed between 1 000 and 3 500 accessions. Twenty-five genebanks reportedly distributed over 1 000 germplasm samples each, three of these more than 64 000 samples.

During the reporting period, the international centres distributed a total of 151 237 accessions and 248 788 samples to users for 51 crops or crop groups (e.g. vegetables are recorded as one although they represent 53 species).[6] These figures correspond to an average of 12 603 accessions per centre over the reporting period and 5 041 accessions per year and per centre. For a single crop and centre, IRRI had the biggest distribution (34 244 rice accessions and 105 315 samples), followed by CIMMYT for wheat (10 003 accessions and 12 109 samples), CIAT for beans (9 369 and 9 862 samples), Africa Rice for rice (7 614 accessions and 14 821 samples) and CIP for potatoes (7 474 accessions and 9 875 samples). AVRDC distributed a total of 21 484 accessions and 32 902 samples from 53 vegetable crops.

A total of 33 and 32 countries, respectively, rated their progress with respect to indicators 28 and 29, with scores of 5.2 and 5.6, respectively. These are relatively high scores and indicate that on average the countries are satisfied with the progress made regarding the distribution of germplasm, but recognize that there is room for further improvement.

[6] One centre provided data for two years only; others for three full years.

Priority Activity

9

Supporting plant breeding, genetic enhancement and base-broadening efforts

NFP Rating

4.3

Germplasm collections maintained in genebanks can be used both to identify specific traits and, where possible, specific alleles useful for developing new varieties adapted to new conditions, and to broaden the overall genetic base of breeding programmes for a given crop. While some of the conserved material can be used directly by breeders for either of these purposes, pre-breeding or genetic enhancement to produce material that can be easily used by breeding programmes is often indispensable.

Unfortunately, the use of PGRFA is hampered in many countries by stagnant or dwindling capacity at all stages of the plant breeding process. This applies to the major food crops. For many minor or underutilized crops, no breeding capacity exists, in many instances not even internationally. There is a shortage of plant breeders in the public sector, and enrolment in conventional plant breeding courses in universities is declining. Students tend to opt for disciplines that offer career paths in what are regarded as more modern sciences, such as molecular biology. There is a compelling need to redress this situation.

Currently, the challenge of climate change (in particular) is placing increasing demands on breeding programmes, and this is likely to intensify. Breeding programmes are being expected to deliver varieties with enhanced tolerance to biotic and abiotic stresses that are needed for adaptation to climate change. Such capacity enhancements must go together with a rethinking of strategies, including those of traditional plant-breeding activities. Pre-breeding and genetic enhancement activities must be encouraged. Greater emphasis must be paid to improving the less studied crops that constitute important staples in many parts of the world. CWRs must be used more systematically to identify the genes needed for generating the resilient crop varieties needed to safeguard food security in the face of changing climatic conditions.

It should be noted that improvement of the sustainability, resilience and adaptability of crop production will require increased amounts of diversity in terms of both the crops and the varieties available to farmers. An important contribution can be made through base-broadening strategies that seek to widen the genetic diversity in plant breeding programmes and in the products of such programmes.

One of the objectives of this PA is to reduce vulnerabilities in cropping systems by increasing genetic diversity in the production systems themselves, as well as in crop-breeding programmes, in particular through the utilization of (more) CWRs and landraces. Where and when applicable, introductions of appropriate germplasm from elsewhere also need to be considered.

There were almost 500 breeding and pre-breeding programmes or projects for more than 300 crops, the majority of which were major crops. More than half of the germplasm used in these breeding activities was obtained from regional or international networks or the genebanks of international centres, thus demonstrating clear interdependency. About one-third of the activities aimed to address constraints relevant to the production systems of small-scale farmers or local communities. About 200 genetic enhancement and pre-breeding activities were implemented in 20 countries for almost 100 crops. Local cultivars and landraces were by a wide margin the types of materials that were most used. About 2 000 active plant breeders were working in public-sector institutions in 30 countries; their work focused mostly on fruits, cereals and vegetables. Almost 500 plant breeders were working in the private sector, with a significant majority of them working on cereals. The international centres reported 56 breeding programmes or activities on 36 crops and employed 150 plant breeders.

The overall rating for PA 9 is 4.3, possibly a fair rating that shows that countries are engaged in breeding efforts but that much more work is needed to meet expectations for these key activities.

Indicator 30: Number of crops with active public pre-breeding and breeding programmes		
Number of reporting countries: 28 Number of countries with NFP rating: 29	NFP Rating	4.9

Indicator 31: Number of crops with active private pre-breeding and breeding programmes		
Number of reporting countries: 20 Number of countries with NFP rating: 26	NFP Rating	3.6

Indicators 30 and 31 are reported together as the data were difficult to separate.

Twenty-eight countries reported a total of 306 crops with active pre-breeding and breeding programmes. Out of these, 300 crops were supported with public progammes, 14 with private and about 40 with joint public and private support. The maximum number of crops with genetic improvement activities reported by one country was above 200 (Bangladesh – though not all reported activities were strictly related to breeding). This was followed by 36 crops (Cuba), 32 crops (Azerbaijan), 26 crops (Chile) and 25 crops (Estonia). Wheat programmes are reportedly active in 15 out of the 28 reporting countries, maize in 12, barley in 11, common beans and potato in 10. Croatia reported 11 private breeding/pre-breeding activities. Armenia reported five and Chile two. Chile reported the highest number of joint public and private sector breeding activities (ten), followed by Azerbaijan (eight). It should be noted that most breeding activities carried out by the private sector alone (21 projects on 14 unique crops) were on cereals (barley, wheat and maize – mentioned each three times – and oats) and fruit trees; 70 combined public and private activities addressed 42 unique crops, including fruit trees, cereals, legumes and grapes. Barley and apple were mentioned three times and grapes twice.

For about 425 of the breeding activities (80.3 percent), the improvement targets in terms of trait(s) or characteristic(s) were reported (an optional open-ended question). As might be expected, the large majority had a clear focus on yield (67.3 percent of those reporting on traits), in many instances combined with resistances and quality aspects; 21.4 percent of the breeding activities mentioned biotic or abiotic resistance or tolerance as an objective; quality aspects were reported as a breeding objective in 9.6 percent of the activities. Adaptation to changed climatic conditions (e.g. early or late maturing traits), conservation and several other objectives were also reported.

The source of the material used in the breeding programme is important to know, as it relates to countries' interdependency with respect to PGRFA. Information on the source of the material was given for 433 out of the 529 reported breeding activities. Most frequently, germplasm was obtained from a national genebank (73.4 percent of the breeding activities); materials were sourced from a regional/international network for 61.9 percent of the reported activities, from a CGIAR genebank for 60.5 percent, from a local genebank for 16.7 percent, from the private sector for 7.8 percent, and from a public organization from developed country for 2.5 percent.

The use of germplasm sourced from outside the country occurred in almost 70 percent of the reported breeding activities, proving once again the great dependency of breeding programme on germplasm from abroad.

With respect to participatory plant breeding, farmers were involved in setting breeding priorities in 322 out of 355 cases; in 97 breeding activities this was the only kind of involvement. In 255 cases farmers participated in the selection from fixed lines or finished varieties (i.e. participatory varietal selection); in 29 cases this was the only involvement. Farmers have also reportedly been involved in selection from segregating populations (129 cases). Only in four breeding activities did farmers participate in the selection of parents and/or making crosses.

Almost half of the countries reported improved or released varieties as outputs obtained through the breeding efforts. Other outputs resulting from the reported breeding activities included selected lines.

For 201 breeding activities only, countries reported on the number of professional staff involved. For 155 activities, between one and five individuals were employed; for 31 activities, between six and ten professionals, and for 15 activities more than ten professionals were employed.

Nine out of the twelve international centres reported 56 breeding projects/programmes that were active during the reporting period, on a total of 36 crops and in most cases with a global or regional perspective. Rice was the crop with highest number of breeding projects (13), followed by potato and wheat (four each) and barley with three projects/programmes. The majority of the projects reported involved breeding or applied breeding aspects. In a number of instances the aim was to identify and include specific traits. Pre-breeding was mentioned a few times.

Twenty countries provided information about 270 genetic-enhancement and base-broadening programmes during the reporting period; 220 were undertaken by public institutions, 4 by private ones and 46 by institutions from both sectors. Altogether, 91 crops and six crop groups from 74 genera were targeted. Wheat, maize, potatoes, rice and barley were the crops most frequently targeted by pre-breeding programmes (Table11).

Table 11. Number of countries and programmes for genera with pre-breeding programmes reported in more than one country

Genus	Crop	Countries (no.)	Programmes (no.)		Genus	Crop	Countries (no.)	Programmes (no.)
Triticum	Wheat	8	15		*Malus*	Apples	3	4
Zea	Maize	8	11		*Prunus*	Prunus	3	4
Solanum	Potatoes	6	19		*Coffea*	Coffee	3	3
Oryza	Rice	6	7		*Ipomoea*	Sweet potatoes	3	3
Hordeum	Barley	5	23		*Lens*	Lentils	3	3
Phaseolus	Beans	4	10		*Capsicum*	Chillies/peppers	2	3
Cicer	Chickpea	4	6		*Daucus*	Carrots	2	3
Arachis	Groundnut	4	5		*Lolium*	Ryegrass	2	3
Glycine	Soybean	4	5		*Allium*	Onions	2	2
Sorghum	Sorghum	4	5		*Beta*	Beet	2	2
Vigna	Cowpeas	4	5		*Helianthus*	Sunflower	2	2
Sesamum	Sesame	4	4		*Pisum*	Peas	2	2
Lupinus	Lupins	3	10		*Psidium*	Guavas	2	2
Lycopersicon	Tomatoes	3	10		*Saccharum*	Sugarcane	2	2
Brassica	Rapeseed	3	6		*Vicia*	Faba bean	2	2
Avena	Oats	3	4					

The genetic enhancement and base-broadening activities used introgression of specific traits into a desirable genetic background as the enhancement approach in 96 programmes. Population improvement through incorporation or base-broadening was reported in 102. A combination of the two approaches was applied in 36 programmes.

The lack of specific traits in breeding materials was the most common rationale for the pre-breeding activities (110 reported programmes; in 74 it was the only reason). Evidence of a narrow genetic base was the second most frequent driver, which to a degree overlaps with the previous one. It was reported 53 times as the only reason, plus 29 in combination with others. The third most frequently

reported rationale was observed poor gain in breeding programmes (in 20 programmes in combination with others and in 44 alone).

Although it is difficult to judge the rationales given for the reported genetic enhancement or population improvement activities, it is encouraging to note that genetic resources are used in a targeted manner to overcome constraints in breeding programmes.

A specific question was asked about the approach used to assess genetic diversity. For 91 activities, pedigree studies were reported either alone (71) or in combination with other approaches; for 82 activities, molecular markers were reported (in 44 this was the only approach); in 83 activities other methods were used; for 14 activities no assessment was made. It is encouraging that molecular marker technology was used in 38 percent of the activities for which information was reported on this issue and that in less than 2 percent was there no assessment of the genetic diversity of the collection.

The likelihood of success with genetic enhancement and/or base-broadening activities depends to a large extent on the material that is used at the start. Thus, it is interesting to see what kind of starting material was used for the 270 reported activities. Local varieties/landraces were by far the most frequently used starting materials (122 times, including 47 activities for which some other material was also used in combination). Exotic materials were the second most used type of material (83 times, of which 49 were in combination with one or more other categories). Improved varieties that were already in use in the respective country were reported 81 times, 63 of which combined with other material. Wild relatives were used in 48 activities, 28 in combination with other material. Given that CWRs are possibly the most difficult sources to use, this is an encouraging development. CWRs were used in pre-breeding activities that targeted several crops, the most frequent being barley, potatoes, geraniums, wheat and rapeseed (Table 12).

Table 12. Genera targeted by pre-breeding programmes that made use of crop wild relatives and the number of pre-breeding programmes

Genus	Programmes (no.)		Genus	Programmes (no.)
Hordeum	12		*Hydrangea*	1
*Solanum**	8		*Lactuca*	1
Pelargonium	4		*Lens*	1
Triticum	3		*Lolium*	1
Brassica	3		*Malus*	1
Avena	2		*Phaseolus*	1
Allium	2		*Prunus*	1
Cicer	1		*Saccharum*	1
Daucus	1		*Ugni*	1
Glycine	1		*Vascocellea*	1
Gossypium	1			

* Potatoes in 7 programmes and cocona (*S. sessiliflorum*) in one programme.

The large reported use of the more diverse and still adapted traditional varieties or landraces is interesting and logical, as ultimately plant breeding has to strike a balance between adaptation and diversity.

The involvement of farmers in genetic enhancement or population improvement efforts is not considered an easy undertaking technically. Consequently, it is not surprising that there is no reporting for 53 percent of the activities. In 91 activities farmers were reported to have been involved in priority setting (including 27 times in both priority setting and implementation) and in 63 activities in the implementation of the activity (including 27 times in both priority setting and implementation).

Seven of the 12 international research centres reported a total of 27 genetic enhancement projects/programmes for 17 different crops. Rice was reported 11 times, common bean 3 times, wheat twice and 14 additional crops once. The reported activities entailed a wide array of different aspects of research and development, including wide crosses, gene discovery, identification of specific traits, a number of advanced molecular techniques, increasing the sustainability of the crop and yield stability.

Thirty-one countries rated their performance for indicator 30 at 4.9, a relatively high score. In fact, reported figures and information on the many subquestions demonstrate good record keeping on the part of genebanks for this important responsibility, which, *inter alia*, helps the genebanks demonstrate their relevance and importance for development-oriented activities in their respective countries. It should be noted that the rating for indicator 31, *Number of crops with active private pre-breeding and breeding programmes*, by 29 countries is much lower than the one referring to the public sector (i.e. 3.6). This can in part be explained by the fact that collaboration with the private sector on this type of activity is more complex and reporting on such activities by the private sector only sporadic. On the other hand, the low rating suggests the need for greater involvement of the private sector in breeding activities, particularly for locally important crops.

Indicator 32: Number of breeding activities oriented to small-scale farmers, villages or traditional communities		
Number of reporting countries: 28 Number of countries with NFP rating: 26	NFP Rating	3.7

As they to a large extent addressed major staple food crops, most of the reported improvement activities (69.3 percent) were reported to be of high importance to food security in the respective agro-ecological zone and/or farming system; 11.9 percent of activities were reported to have medium importance and 3.2 percent to have limited importance. About 44 percent of the reported breeding activities were orientated to small-scale farmers, villages or traditional communities. Out of these, 3 percent were exclusively focused on villages or communities that use traditional varieties or landraces.

The average rating (from 26 countries) of the progress for this indicator was 3.7, and thus a relatively low figure. Given the complexity of the issues related to the deployment of germplasm to small farmers, villages or traditional communities, this is not surprising. The fact that the countries see "room for improvement" is an indication of the need to put more emphasis on this type of activity given that interventions of this kind may have direct effects on the food security and nutrition of these vulnerable groups.

Indicator 33: Number of active public crop breeders		
Number of reporting countries: 30 Number of countries with NFP rating: 28	NFP Rating	5.1

Indicator 34 Number of active private crop breeders		
Number of reporting countries: 30 Number of countries with NFP rating: 28	NFP Rating	4.2

As these indicators are closely related to each other they have been assessed jointly.

Thirty countries reported on numbers of public and/or private crop breeders for nine crop groups using the latest available statistics. Overall, these data are rather incomplete and the year to which they refer varies from 2007 to 2015 depending on the reporting country. Data groupings shown in this section are therefore only indicative and should be treated with caution. A second round of reporting in a few years time will likely increase their value as it should be possible to calculate trends.

The total number of public breeders reported was 1 918. The number of private breeders was 481. These figures correspond to an average of 64 public and 16 private breeders per country. Numbers of public and private breeders per country and per crop group are shown in Tables 13 and 14, respectively. The country with the largest number of breeders reported is Brazil, with 641 public breeders, followed by Bangladesh with 249 public and 44 private breeders, and Azerbaijan with 189 (156 public and 33 private) breeders.

Table 13. Number of public and private breeders per crop group

Crop group	Countries with public breeders (no.)	Public breeders (no.)	Private breeders (no.)	IARCs* breeders (no.)
Cereals	19	182	117	89
Oil plants	13	54	30	na
Grain legumes	12	78	17	16
Roots and tubers	11	37	11	22
Vegetables	10	116	16	13
Forages	9	103	32	2
Fruits	8	246	31	na
Sugar plants	6	33	15	na
Fibre plants	5	24	4	na
Above groups, combined	14	548	204	-
Others	6	497	9	8

* Data from AVRDC, CIAT, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IITA, ILRI, IRRI.

According to the data reported, there are approximately four times more public than private breeders. This is not a surprise as data from the private breeding sector were not available in 13 out of 23 countries that reported on the private-sector indicator. Cereals were the crop group with the highest number of breeders (182 public and 117 private breeders). Fruits were the group with the second largest number of breeders, although the total number of public breeders reported in Table 13 is somewhat biased as one country (Brazil) alone reported 128 public breeders. Vegetables, with 116 public and 16 private breeders, ranked third, followed by forages and grain legumes.

Ten of the twelve international centres reported a total of 150 plant breeders, in some cases including support research staff and molecular breeders. Eighty-nine breeders were reported for cereal crops, 22 for roots and tubers, 16 for grain legumes, 13 for vegetables, eight for agroforestry trees, and two for forages.

Thirty and twenty-eight countries, respectively, rated their performances with respect to indicators 33 and 34, for which the average ratings were 5.1 and 4.2, respectively. This indicates satisfaction with the number of public crop breeders and much less satisfaction with respect to the number of private crop breeders. As noted above, this is not entirely surprising as information from the private sector was apparently much less accessible than that from the public sector. In order to overcome this limitation, some countries used registers or other reference material on plant breeders in their country. If applied more systematically, this could well be a way to fill the information gap on this matter. Whatever the precise situation, it seems appropriate to target collaboration with private-sector

breeders on "all fronts" and wherever possible to enlarge possibilities for synergies between the public and private sectors. Representation of the private breeding sector in the national programme advisory committee (or similar entity) would be a very good starting point and would facilitate and strengthen the exchange of information.

Both indicators 33 and 34 address, *inter alia*, the important issue of creating more competition in the plant-breeding community. One way of achieving this is to have, in any given country, more breeding companies active and producing varieties that are well adapted to local production conditions. This could function as a counter to the increasing globalization that is ongoing in the commercial private breeding sector.

Priority Activity		NFP Rating
10	**Promoting diversification of crop production and broadening crop diversity for sustainable agriculture**	4.0

Diversification of crop production is an important task, as monoculture and genetically uniform crops increasingly dominate our agricultural systems. A number of challenges have been recognized in the past decade or so that will require strengthening of diversification efforts. These include: the need for long-term sustainability in agricultural practices; increasing competition from biofuel crops; increasing rural poverty in some parts of the world with declines in food security and quality nutrition undermining health; outbreaks of pests and diseases that are difficult to control; and, last but not least, climate change.

To cope with coming challenges, agricultural systems will need to incorporate a broader range of crop varieties and new crops, including crops that produce raw materials for agro-industry and energy, crops that are now underutilized and wild food plants. Similarly, plant breeders will need to incorporate more diversity into their improvement programmes and thus allow the production and marketing of more diverse varieties. Diversification at the species and genetic levels should be complemented with diversification of production systems. Diverse production systems will both provide enhanced ecosystem services and be better able to benefit from the services provided by surrounding landscapes. Together with solutions such as better crop rotations, varietal mixtures and multilines, these practices, in combination with functional formal and informal seed systems, will improve the resilience and stability of agricultural systems and thus help ensure food and income security and quality nutrition.

Genetic resources can play an important role in meeting these challenges. As described in some of the earlier sections, efforts at the national and certainly at the local level are increasing and spreading, including participatory breeding and variety selection approaches with farmers, genetic enhancement of local and traditional crops and population improvement.

There were over 180 crop diversification programmes and activities in 24 countries for 145 different crops, with almost 70 new crops or wild species introduced into cultivation. More than 160 underutilized species with potential for commercialization were identified. In addition, 25 projects or programmes related to the improvement of plant genetic diversity in the cropping systems of 12 different crops or crop groups were implemented by the international centres.

The overall rating for PA 10 is 4.0, which seems to indicate that countries want to achieve more than they have so far managed.

Indicator 35: Number of programmes/projects/activities to increase genetic heterogeneity of crop species and diversity within the agro-ecosystem		
Number of reporting countries: 24 Number of countries with NFP rating: 28	NFP Rating	4.1

Twenty-four countries reported on a total of 181 programmes/projects/activities related to the improvement of plant genetic diversity within agro-ecosystems and their crops. These projects focused on about 145 crops. Cuba was the country reporting the largest number of projects (71). In 25 cases, countries reported a combination of different crops in relation to one project. *Increasing intra-specific diversity in crops* was one the most frequently implemented activities under these projects (it was reported alone 51 times and in combination with other options 49 times). *Assessing/monitoring intra-specific diversity in crops* was the second most frequent activity (reported 39 times alone and 88 times in combination with other listed options). Twenty-two activities aimed to increase the overall crop diversity in agricultural systems and 21 included this objective among others. Nine activities were reported to address assessing/monitoring crop diversity in agricultural systems and 15 included this objective.

Eight out of the twelve international centres reported a total of 25 projects/programmes related to the improvement of plant genetic diversity within the agro-ecosystems on 12 different crops or crop groups. Potato was mentioned five times, followed by bread and durum wheat (four times) and maize, banana/plantain and sweet potato (twice each). Seven more crops/groups were mentioned, as well as a wide array of activities, including conventional breeding, monitoring diversity in hot spots, intensification and enhancing production systems, increasing diversity, landrace introgression and evaluation (including 22 activities applying FIGS to mandate crops).

Twenty-eight countries rated their performance for this indicator, scoring an average of 4.1. This moderate rating seems to show a keen interest in the topic and that there is more work to be done in order to increase the heterogeneity of crop species and diversity within the production system.

Indicator 36: Number of new crops and/or wild species introduced into cultivation		
Number of reporting countries: 24 Number of countries with NFP rating: 31	NFP Rating	3.8

Twenty-four countries provided information on this indicator and reported a total of 68 new crops and/or wild species that had been introduced into cultivation. The highest level of new introductions (18 new crops) was reported in specific areas of Mongolia. Nine new crops were introduced in Jordan, seven in Cuba, six in Pakistan and five new crops/species in areas of Albania, Bulgaria and Lebanon. Introduction of quinoa was reported by eight countries, which confirms the recognized potential of this traditional Andean crop. Soybean was reported three times and five other crops were reported twice each. For 66 of the new crops or wild introduced species, countries also provided the name(s) of the main cultivation area(s).

Ratings of achievements with respect to this indicator were provided by 31 countries, with an average score of 3.8. This relatively low score shows a certain satisfaction with achievements, but also the need to do (much) more in this potentially important area of activity, especially in the light of climate change. The interest in quinoa is remarkable and shows that minor crops remain relevant. The exploitation of its potential has been boosted by the great attention this crop has received in the public media over the past five years or so.

Priority Activity

11 Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species

NFP Rating

4.4

In most parts of the world, high-input production of crops is increasingly dominating agricultural systems. Such systems, and a limited number of varieties of a few major crops grown within them, provide for a large proportion of global demand. However, a large number of species and farmers' varieties of both major and minor crops are being used by local communities to meet local demand for food, fibre, energy and medicine. Knowledge concerning the uses and management of these varieties and species is often localized and specialized. Increasingly, this diversity at both the species and variety levels is being replaced by uniformity in the agricultural marketplace. To support commercial production systems, varieties are bred to meet the strict needs of high-input production, industrial processing and demanding market standards.

Farmers' varieties and underutilized species are not part of this trend towards the modernization of agriculture and are thus being marginalized and lost, along with the knowledge associated with them. Although there has been a modest increase in efforts to conserve such species *ex situ*, overall, their diversity is not yet adequately represented in collections. Moreover, many underutilized crops are not included in Annex I of the International Treaty and thus cannot benefit from its Multilateral System of Access and Benefit Sharing. Nonetheless, many of these species and varieties have great potential for wider use and could contribute significantly to sustainable livelihoods through improved food security and nutrition, income generation and risk mitigation.

There is growing global recognition of the value of farmers' varieties and underutilized species in the face of uncertain climates, malnutrition and rural poverty. For example, there is evidence of growing awareness on the part of both the public and policy-makers of the importance of traditional vegetables and fruits and of potential new energy crops. So-called niche or high-value markets are also expanding, as consumers are increasingly willing to pay higher prices for better quality, novel foods from known sources. New legal mechanisms are enabling farmers to market "lost" heritage crops and farmers' varieties, and legislation supporting the marketing of geographically identified products are available, providing incentives for farmers to conserve and use local crop genetic diversity.

In order to capture the potential market value of farmers' varieties and underutilized species, there is a need for greater integration of the efforts of individuals and institutions with stakes in different parts of the production chain. In particular, the involvement of local communities is essential, as is taking traditional knowledge systems and practices fully into account.

In order to promote the cultivation and commercialization of farmers' varieties and underutilized species, stronger demand and more reliable markets for these materials and their products are needed. There is also a need to promote local processing, commercialization and distribution of the products of farmers' varieties and underutilized species. Finally, increased public awareness of the value of farmers' varieties and underutilized species is needed in order to enlarge the consumer community for such products.

Across most of the 20 countries that provided data for this PA there were 53 different national laws, policies, etc. supporting the development and/or commercialization of farmers' varieties and/or landraces. In addition, more than 530 programmes or projects for more than 200 different crops were reported. In all, 1 443 landraces of almost 200 crops, as well as 168 underutilized species with potential for commercialization, were identified. Eight of the international centres reported 19 programmes or projects promoting the development and commercialization of varieties. They also identified 633 landraces and 16 underutilized species with potential for commercialization.

For all the indicators under PA 11, the overall rating is 4.4, an average that seems to indicate some satisfaction with the achievements, but also recognition that more work is needed.

Indicator 37: Existence of national policies that promote development and commercialization of farmers' varieties/landraces and underutilized species		
Number of reporting countries: 20 Number of countries with NFP rating: 29	NFP Rating	4.0

Twenty countries reported the existence, at the end of the reporting period, of a total of 53 different national laws, policies, directives or legal framework instruments promoting the development and commercialization of farmers' varieties/landraces and underutilized species. About 37.7 percent of these had been published between 2000 and 2011. Only three of these instruments exclusively addressed the promotion of the development and commercialization of underutilized species (a further 17 did so in combination with addressing farmers' varieties/landraces). Spain was the country that reported the highest number of relevant instruments (twelve), followed by Cuba (ten), Germany (five) and Lebanon (three). Seven countries reported two instruments and the remainder one instrument each.

Twenty-nine countries rated their performance for this indicator with an average score of 4.0, thus indicating progress but certainly not that the "job is completed".

Indicator 38: Number of programmes/projects/activities promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species		
Number of reporting countries: 24 Number of countries with NFP rating: 30	NFP Rating	4.5

Twenty-four countries reported a total of 534 activities promoting the development and commercialization of crop varieties, in particular farmers' varieties/landraces and underutilized species. Guyana reported the largest number of projects (189), followed by Bangladesh (105), Cuba (51), Estonia (35) and Armenia (28). While the large majority of activities (65.9 percent) focused, as might be expected, on all varieties, in 56 activities the focus was exclusively on farmers' varieties/landraces and in 24 on underutilized crops or species. Farmers' varieties/landraces and underutilized crops or species were also the focus, although not the exclusive focus, of an additional 82 activities, and underutilized crops or species of an additional 74. A total of 217 unique crops and 13 crop groups and 116 unique taxa were reported under these projects.

The topics most frequently listed as being covered by the reported activities were "market development" (53 times, plus 82 times in combination with another topic), followed by "research", "seed distribution", "crop improvement" and others.

Seven of the international centres reported 19 projects promoting the development and commercialization of varieties (primarily farmers' varieties/landraces) and underutilized species of eight crops. Potato was addressed by the highest number of projects (six), followed by wheat (five), forages (two), sweet potatoes (two), food legumes (two) and maize, tepary bean and banana (one each). In ten projects, all varieties were targeted; three targeted farmers' varieties/landraces, four targeted underutilized crops, and two both groups. The majority of the projects covered crop improvement as the main topic, followed by public awareness (four), seed distribution (two), research and characterization and evaluation (one each).

Thirty countries rated their performance, scoring an average of 4.5, a figure that shows that the countries feel somewhat satisfied with the achievements, but also agree that more work is needed.

Indicator 39: Number of farmers' varieties/landraces and underutilized species with potential for commercialization identified		
Number of reporting countries: 23 Number of countries with NFP rating: 31	NFP Rating	4.5

Twenty-three countries reported a total of 1 415 farmers' varieties/landraces that they had identified as having potential for commercialization from a total of 192 crops. This is on average 7.4 farmers' varieties/landraces with market potential per reported crop. Out of the total, 176 crops were reported to have between one and ten farmers' varieties and 16 crops had between 11 and 20 varieties. *Chenopodium quinoa*, with 125 varieties, *Ensete ventricosum*, with 88 varieties, *Solanum andigenum*, with 50 varieties, *Pouteria sapota*, with 40 varieties, and *Manihot esculenta*, with 31 varieties, were among the underutilized crops with the highest number of varieties with potential for commercialization identified. All but cassava were reported by a single country. Thirty-seven bibliographical references were also reported for 59 of the listed crops with their respective number of promising varieties.

Twenty countries reported that they had identified a total of 149 underutilized species with a potential for commercialization, an average of 7.6 species per country. Many of the reported species are vegetables, fruits, cereals, roots and tubers, pulses, forages and spices, with some ornamentals. The country with the highest number was Cuba, with 34 species, followed by Egypt with 33, Albania with 25, Mongolia with 17 and Zambia with 13.

Table 14 below includes an overview of the reported status of a number of activity areas related to underutilized species.

Table 14. Status of various activities related to the 149 different underutilized species identified for their potential for commercialization

Activities	No activities planned	Activities planned but not initiated	Some ongoing activities	Activities well advanced	Activities completed
Species distribution mapping	16	15	74	4	4
Characterization/evaluation	25	23	54	28	1
Crop improvement	53	30	35	10	-
Post-harvest processing	65	11	41	13	-
Marketing	49	8	59	13	-
Seed/planting material multiplication	36	12	65	18	-
Documentation	10	37	69	11	3
Total	253	136	397	97	8

For 56.3 percent of the reported underutilized crops, one or more activities were ongoing, well advanced or completed. For 15.3 percent, activities had been planned but not yet initiated. For 28.4 percent, no activities were planned.

Eight of the international research centres reported a total of 633 farmers' varieties/ landraces of 19 crops that have a potential for commercialization. One centre did not report on the number of varieties with a potential for commercialization, as the releases are done through the national programmes. Of those varieties reported, 294 were potato varieties (related to a project on the management of potato diversity in the field), 198 were wheat, 50 maize, 24 chickpea, 21 lentil, 19 barley, 17 minor millets,

eight faba bean and two *Phaseolus lunatus*. Some of the varieties reported were germplasm accessions identified for release in three countries, others were to be released by NARS, and yet other materials were part of a project.

Eight of the international centres reported the identification of underutilized species with a potential for commercialization for a total of 16 crop species or crop groups. In six cases they reported an economic perspective; in another six cases the species fit well into an existing production system; and in another four cases the species were suited to a particular ecological niche.

Thirty-one countries rated their performance for this indicator with an average score of 4.5, an indication of satisfaction, as well as a recognition that more work needs to be done.

Priority Activity		NFP Rating
12	**Supporting seed production and distribution**	5.5

Effective and functional seed systems need to be in place to ensure that farmers have access to planting material in sufficient quantity and of sufficient quality in a timely manner and at reasonable cost. Only in this way will farmers benefit from the potential of both local and improved varieties to increase food production and adapt to climate change. In the past 25 years or so, there has been a significant growth of the private seed sector in developed and developing countries; however, the main focus of its interest has been high-value products, such as hybrid, genetically modified and vegetable seed. This expansion has been accompanied by the development of increasingly sophisticated seed regulatory frameworks. Investment by the public sector in seed production has decreased significantly in developed and in many developing countries. In developing countries, access to improved varieties and quality seed remains limited and a real concern. Formal and informal seed systems often operate side by side, but with different levels of success depending on the crop, the agro-ecological zone and output market opportunities.

The availability of high-quality seed of a wider range of plant varieties, including improved and farmers' varieties remains the main objective. The combination of maximizing diversity in the production system and productivity in farmers' fields is key to sustainable and productive agriculture. Optimization of the complementarity in seed production and seed distribution between public and private sectors, as well as between formal and farmers' seed systems, is a major challenge. This includes the need to develop viable local-level seed production and distribution mechanisms in formal and informal systems for varieties and crops important to small-scale farmers. In addition to making new crop varieties available to farmers, suitable germplasm materials stored in genebanks should also be made available for multiplication and distribution to farmers to fulfil their needs for sustainable crop production.

About 6 400 varieties were released in 29 countries during the reporting period. Vegetables and cereals constituted the majority of the crop groups. More than 9 000 registered seed enterprises operated in 26 countries. On average, 14.5 varieties were cultivated on 80 percent or more of the total cropping area for the five most widespread crops of the reporting countries. Although difficult to judge without comparisons, this latter measure could be a reliable indicator for assessing within-crop diversity and the vulnerability of monocropping systems.

The overall rating for PA 12 on seed production and distribution was 5.5, a relatively high score reflecting the satisfaction of countries with the progress on this subject and the recognition that more work is needed.

Indicator 40: Number of new varieties released		
Number of reporting countries: 29 Number of countries with NFP rating: 31	NFP Rating	5.8

A total of 29 countries reported on the production and release of varieties during the reporting period. They reported that they had released 6 395 varieties, an average of 220.5 varieties per country during the reporting period. The maximum number reported by one country was 1 912 varieties released (France), followed by Germany (687 varieties), Spain (639), Morocco (447) and Brazil (405).[7] Five countries reported less than ten varieties.

Over 98 percent of the varieties for which information was provided on this topic were reported to be improved varieties and 58 were landraces/farmers' varieties. The latter were released in eight countries, namely in Azerbaijan (one barley variety), Bangladesh (two fruit tree varieties), Germany (six tomato varieties; five bread wheat; three sweet corn, spelt wheat and curly kale, two winter rye, and one each of other 11 crops), Guyana (one cassava variety), Croatia (three varieties of chillies, two of tomatoes and garlic, and one each of eight other vegetable crops), Jordan (one durum wheat variety), Malawi (two tomato varieties) and Panama (three rice varieties).

Information on the origin of the released varieties, which was not a mandatory requirement, was provided for 58.3 percent of the varieties. Out of the released varieties for which information was provided on their origin, for each variety produced within the country, two were introduced from abroad. The countries collectively released varieties of 148 crops, belonging to 125 genera. Maize was the crop for which most varieties were released (526 varieties), followed by tomato (379), wheat (357), beet (352), cabbage (236), chilli pepper (222), melon (216) and potatoes (191).

An overview of the number of varieties released by crop groups is presented in Table 15. Vegetable crops make up more than one-third of all the varieties, followed by cereal crops. Thereafter there is a big drop to the third most important crop group, the oil crops, followed by sugar-producing plants and fruits.

Target agro-ecological environments, an optional item of information, was reported for 12.2 percent of all varieties, for some in very general terms and for others describing the region(s) where the varieties can be grown. Countries provided information (in response to a non-mandatory question) on the main varietal characteristics of 6.7 percent of all reported varieties. These ranged from earliness to plant height, oil content and kernel type, yield and other productivity related characteristics, as well as tolerance and/or resistance to biotic and abiotic stresses.

Thirty-one countries provided a score of their performance. The average rating was 5.8. This is fourth highest rating overall and reflects positive developments in a crucial area for the sustainable use of PGRFA.

[7] Further updates from Brazil on this topic were received too late to be incorporated in this assessment. They will be taken into consideration in subsequent assessments.

Table 15. Number of varieties per crop group and their percent of the total

Crop group	Number of varieties	Percent
Vegetables	2 165	33.9
Cereals	1 792	28.0
Oil crops	446	7.0
Sugar producing plants	408	6.4
Fruits and berries	365	5.7
Forages	334	5.2
Pulses	253	4.0
Roots and tubers	252	3.9
Flowers	128	2.0
Fibre plants	91	1.4
Spices and condiments	85	1.3
Stimulants	44	0.7
Nuts	24	0.4
Multipurpose trees	6	0.1
Pseudo cereals	2	0.0
Total	6 395	100

Indicator 41: Number of formal/registered seed enterprises		
Number of reporting countries: 26 Number of countries with NFP rating: 27	NFP Rating	5.7

For this indicator, 26 countries reported a total of 9 015 formal and/or registered seed enterprises, corresponding to an average of 346.7 enterprises per country. Spain reported the highest number (4 149 enterprises included in the National Register of Seed Producers and Nursery Plants), followed by the United Kingdom (1 145), Pakistan (755), Panama (364) and Germany (263). Sixteen countries provided a reference for the source of these data, which included the Plant Variety Office, formal registers and ministerial websites.

Twenty-seven countries reported their ratings of the achievements made for this indicator, scoring an average per country of 5.7. This is a relatively high score and possibly reflects the fact that in most countries (61.5 percent) reliable sources of information were available and that the numbers of formal/registered seed enterprises appear rather high.

Indicator 42: The least number of varieties that together account for 80 percent of the total area for each of the five most widely cultivated crops		
Number of reporting countries: 24 Number of countries with NFP rating: 28	NFP Rating	5.1

For this indicator, 24 countries reported a total of 2 531 varieties, with an average of 35.0 varieties per country and crop, which together account for 80 percent of the total crop area for the most widely cultivated crops. On average 4.5 crops per country were reported, as only 18 countries out of 24 reported data on the five requested crops (see Table 16). The number of crops reported ranged from

one (two countries) to seven. With an average of 193.2 varieties for the 80 percent of the total area for the five most cultivated crops, Turkey was the country reporting the highest level of diversity in terms of number of varieties in the vast majority of the crop cultivated areas (Table 16). Specifically, the corresponding numbers of varieties for the individual crops occurring in 80 percent of the total crop area were the following in 2014: wheat (251 varieties), maize (222), sunflower (111), barley (81) and alfalfa (35).

Table 16. Average number of varieties accounting for 80 percent of the total crop area for the most widely cultivated crops per reporting country, number of crops reported, minimum and maximum number of varieties for the reported crops and year

Country	Varieties, average (no.)	Min. (no.)	Max. (no.)	Crops (no.)	Year	Country	Varieties, average (no.)	Min. (no.)	Max. (no.)	Crops (no.)	Year
Turkey	193.2	35	251	5	2014	Brazil	10.0	10	10	1	2012
Armenia	60.3	8	110	5	2013	Estonia	10.0	5	12	5	2014
United Kingdom	41.0	41	41	1	2015	Malawi	8.3	2	11	5	2013
Spain	25.5	10	48	5	2014	Jordan	7.2	4	24	5	*
Guyana	24.7	3	600	5	2013	Mongolia	6.6	2	8	5	2014
Sweden	24.3	5	38	6	2014	Morocco	6.4	3	9	3	2014
Germany	23.3	8	29	4	2014	Azerbaijan	5.7	5	6	5	2014
Bangladesh	17.9	5	20	5	2014	Iran (Islamic Rep. of)	5.3	1	11	7	2014
Cuba	12.8	3	17	5	2014	Panama	5.1	4	6	5	2014
Bulgaria	11.7	5	15	5	2014	Albania	4.7	4	7	5	2012
Ethiopia	11.7	5	16	5	2014	Egypt	4.0	3	5	5	2013
Pakistan	11.5	3	25	5	2014	Lebanon	3.5	2	5	5	2011

* Data for three crops referred to 2012 and for two crops to 2013.

Twenty-eight countries rated their achievements for this indicator on average with a score of 5.1, which is a relatively high score. This might have been triggered by the fact that most countries were able to provide apparently statistical data for the five most important crops. Only one country reported one crop only.

Indicator 43: Percentage of area supplied with seed meeting the quality standard of the formal seed sector for the five most widely cultivated crops

Number of reporting countries: 21

Number of countries with NFP rating: 26

NFP Rating **4.8**

Twenty-one countries reported on this indicator. Among these, three countries reported on three crops only, and one on four crops. The percentage of area supplied with seed meeting the quality standard of the formal seed sector for the most widely cultivated crops was on average 32.6 percent for all countries. At country level, the average percentage of supplied quality seed for the top five crops ranged between 77 percent and 87 percent in Lebanon, Jordan and the United Kingdom, between 62 and 73 percent in Senegal, Cuba and Armenia, between 46 and 60 percent in Chile, Estonia, Azerbaijan and Panama, between 34 and 36 percent in Turkey, Pakistan and Spain, between 14 and 26 percent in Mongolia, Egypt, Albania and Morocco. The figure was 7 percent in Guyana, Togo, Ethiopia and Malawi.

Information on 25 crops was reported by the 21 countries. Table 17 summarizes the data reported on the 25 crops into eight crop groups. Vegetables (i.e. tomatoes, eggplants and peppers) and oil crops (i.e. groundnuts, sunflower, canola and soybeans) were the two groups showing the highest

percentage of area sown with standard-quality seed – 64 percent and 58 percent, respectively. As might be expected, pulses (i.e. common beans and faba beans) were the crop group with the lowest percentage.

Table 17. Average percentage of area sown with seed meeting the quality standard of the formal seed sector for eight crop groups representing the most widely cultivated crops reported by 21 countries

Crop/Crop group	Crops (no.)	Countries (no.)	Total sown area (ha)	Area sown with quality seed (percent)
Self-pollinated cereals	6	21	4 7690 956	30.1
Cross-pollinated cereals	2	13	10 251 774	32.7
Oil crops	4	12	4 050 856	58.3
Fibre crops (cotton)	1	2	3 273 842	49.0
Pulses	3	8	1 986 504	4.1
Forages	2	3	655 584	46.3
Roots and tubers	3	8	252 270	30.9
Vegetables	4	4	54 754	64.3
Total	25	21	67 813 440	32.6

It should noted that for 14 crops belonging to all the above crop groups the percentage of area sown with standard quality seed was equal or below 5 percent at least once. These low percentages occurred in 11 countries and not only in the four countries with the overall lowest averages mentioned above.

Although countries seem to have had some difficulties reporting on this indicator and no data are available to compare results over years, it could nonetheless be a possible indicator for the within crop genetic diversity in the respective production system.

Twenty-six countries reported an average rating of 4.8 for this indicator, a score slightly above average. This means that overall countries are satisfied with the status and performance achieved but also realize that more work is needed.

Indicator 44: Existence of a national seed policy and seed laws		
Number of reporting countries: 29 Number of countries with NFP rating: 33	NFP Rating	6.1

A total of 29 countries reported on this indicator and shared 82 references to national seed policies and/or to national seed laws, including regulations to implement them. Some responses were provided in the national language and/or in the form of codes or numbers of the laws but with no indication of their content. References to seed laws were provided by 26 countries and to seed policies by six countries. Furthermore, some countries also provided references to plant variety protection legislation and to procedures for seed testing or the organization of such tests.

The oldest law stemmed from 1966 and the newest one was the draft Seed Act of Pakistan, which was subsequently approved in 2015.

Thirty-three countries provided their ratings on this indicator, scoring 6.1 on average, a relatively high score indicating good satisfaction with the current status of the subject covered by the indicator.

VI. BUILDING SUSTAINABLE INSTITUTIONAL AND HUMAN CAPACITY

This section addresses the state of human capacity in institutions and programmes related to the conservation and use of PGRFA, the institutional and strategic framework for planning, implementation and coordination of routine operations in these fields, and the policy framework needed to provide a supportive environment for multiple stakeholders and interests at country level. It also addresses organizational matters at regional and global levels that ensure that national activities take into account higher order requirements. It also deals with the critically important fields of information management and systems at national, regional and global levels, technology development and availability, and activities related to the creation of public awareness of, and support for, the importance of PGRFA, the need for its conservation and the benefits that such activities create for society at large.

Priority Activity		NFP Rating
13	**Building and strengthening national programmes**	5.7

National PGRFA programmes are the basis for well-functioning activities at national level and thus provide the foundation for regional and global PGRFA efforts. They contribute directly to the objectives of international instruments such as the Second GPA, the International Treaty, the CBD, and other intellectual property rights (IPR) and trade agreements. Especially in the context of climate change, national programmes are the key to maximizing the contribution of PGRFA to food security, rural development, poverty alleviation and sustainable development. Strong national programmes are needed to fully and effectively contribute to, and take full advantage of, international cooperation on access to PGRFA and the fair and equitable sharing of the benefits arising from their use. They provide the enabling policies, supportive strategies and concrete action plans that are necessary for setting well-defined goals and clear priorities, allocating resources, distributing roles and responsibilities and identifying and strengthening linkages between stakeholders. The success of national programmes requires commitment from governments to provide adequate funding and the design of appropriate national policies and legal and institutional frameworks.

National PGRFA activities are carried out by public entities, private companies, NGOs, botanic gardens, communities and individuals from the agriculture, environment and development sectors. The integration of such different PGRFA activities in the framework of a unified national programme provides the opportunity to add value to these diverse efforts and ensure that the whole is bigger than the sum of its parts.

During the last decade, there has been considerable progress in establishing national programmes and enhancing stakeholder participation in national strategies and action plans, especially as regards the private sector, NGOs, farmer organizations and research and educational bodies. The commitment that this suggests is also seen in the fact that several important agreements relating to PGRFA have been negotiated, adopted or revised at international level. National legislation has also been enacted in many countries on phytosanitary regulations, biosafety, seed regulations and IPRs, including plant breeders' rights and Farmers' Rights.

However, many countries still lack adequate policies, strategies and/or action plans for PGRFA. Many existing national programmes suffer from inadequate and unreliable funding and isolation from related activities at national level. Areas that require particular attention include priority setting, enhancing collaboration between the public and private sectors, national and international cooperation, strengthening the links between PGRFA conservation and use, developing effective information systems and publicly accessible databases (e.g. the NISM on the implementation of the

GPA), identifying gaps in the conservation and use of PGRFA, increasing public awareness, and implementing national policies and legislation and international treaties and conventions.

National *ex situ* collections are an integral part of national PGRFA programmes. Genebanks work best as dynamic centres that foster integration of conservation, documentation and use. Overemphasis on conservation can detract from sustainable use, which has supported progress in agriculture together with conservation of PGRFA. The increasing impacts of climate change make it essential to support activities related to crop adaptation, including genetics, genomics and breeding. Capacity for such adaptation is an essential part of efficient and effective PGRFA management.

To achieve the above it is critical to establish and strengthen the essential elements of an integrated national programme: (i) recognized national status; (ii) appropriate policy, legal and institutional frameworks including mechanisms for coordinated planning and action; and (iii) a programme strategy, including well-defined goals, clear priorities, and adequate and sustainable funding. Improvement of institutional and sectoral linkages, enhancement of synergies among all stakeholders involved in the conservation, development and use of PGRFA, and strengthening the integration of institutional and community efforts are important.

The achievements made in strengthening capacity for the conservation and sustainable use of PGRFA were quite impressive for most of the countries and can be considered a positive signal for the future. In all, 29 countries reported on the existence of entities or mechanisms that coordinated PGRFA activities at the national level and rated this indicator relatively highly. In half of the reporting countries, these entities oversaw not only PGRFA but also genetic resources in other sectors. The appointment of a national PGRFA coordinator was also positively rated by countries. Another encouraging development was the existence of legal instruments for governmental policy frameworks for the conservation and use of PGRFA in most countries. Countries also reported progress on the use of one or more information-sharing mechanisms for PGRFA and other information management tools; 56 percent reported using the National Information Sharing Mechanism (NISM). While acknowledging its inclusive, positive role, they also recognized that ensuring its sustainability required continuous effort.

The overall rating of this PA 13 was 5.7, a relatively high score that indicates satisfaction with what has been achieved and recognition that more work needs to be done.

Indicator 45: Existence of national entity (agency, committee, etc.) functioning as a coordination mechanism for PGRFA activities and/or strategies		
Number of reporting countries: 28 Number of countries with NFP rating: 32	NFP Rating	5.5

Twenty-eight countries reported on the existence of national entities that coordinate PGRFA activities and/or strategies. In some countries more than one entity was reported. In such cases, the mandate of one entity was reported to cover specific aspects of PGRFA management such as seed and property rights, while the other addressed issues associated with genetic diversity conservation and management.

The reported entities most frequently consisted of a national multistakeholder committee, council, commission or agency. In some cases, the national agricultural research institute, a department within it or the national genebank were reported to be the national coordinating structure.

The years of establishment of the various national multistakeholder committees, councils, commissions or agencies reported by 17 countries varied from 1988 for the Costa Rican National Commission on PGR, whose last meeting took place very recently, to 2014 for the Lebanese National PGRFA Committee and the Chilean Public–Private Group on Genetic Resources.

Besides PGRFA, the mandate of more than 50 percent of the reported national entities also covered other genetic resources subsectors: the mandates of 34.3 percent of the entities reportedly included forest genetic resources; the same percentage covered animal genetic resources; 28.6 percent covered micro-organisms; 17.1 percent covered aquatic genetic resources. The mandate of 28.6 percent of the reported national coordinating entities covered more than two of the above-mentioned genetic resources subsectors.

Information on the stakeholder composition of the national coordination entities was provided for 28 entities. On average, seven stakeholder groups were reported to be members of the national coordination entity. Table 18 summarizes the frequency of participation in the national entities coordinating PGRFA activities and/or strategies for selected groups of stakeholders, as reported by 16 countries.

Table 18. Frequency of participation in the composition of the national entities coordinating PGRFA activities and/or strategies for selected groups of stakeholders, as reported by 16 countries

Stakeholder group	Entities (no.)
National genebanks	16
Universities	16
Ministries of Agriculture	14
Breeders	14
NGOs	13
Ministries of Environment	12
Private sector	8
Farmers	6
Community organizations	6
Ministries of Fisheries	2

As indicated above, the situation with respect to the existence of national entities for the coordination and/or facilitation of PGRFA activities can be regarded as positive overall. It should be underlined that half of the reported entities also include other genetic resources sectors as part of their mandate. From an agricultural biodiversity perspective in particular, this can be regarded as a desirable development. At the same time, it is evident that many of the national entities suffer from limited and sometime irregular annual budgets. One of the reasons for this is that the budget of the coordinating mechanisms depends on allocations from other institutes or organizations. Another less encouraging point is that four entities have not had a meeting since 2010 or earlier, which raises some uncertainty as to whether these entities can be regarded as functional.

Thirty-two countries rated their performance on this indicator on average with a score of 5.5, a relatively high rating. This confirms the apparent positive developments and shows that a governance entity has been accepted as important.

Indicator 46: Existence of a formally appointed national focal point or coordinator for PGRFA		
Number of reporting countries: 35 Number of countries with NFP rating: 32	NFP Rating	7.2

Thirty-five countries reported having official procedures for the appointment of the NFP or national coordinator for PGRFA in place. Ten of these NFPs were directors, seven are chiefs or heads of departments, four were coordinators, three were principle scientists or researchers, two were senior advisors or officers and six more had miscellaneous positions.

Thirty-two countries rated this indicator on average 7.2, a high score, which stresses the importance of coordination among stakeholders and the responsibility implied by this task.

Indicator 47: Existence of a governmental policy framework and strategies for PGRFA conservation and use		
Number of reporting countries: 35 Number of countries with NFP rating: 31	NFP Rating	5.3

Thirty-five countries provided information on 92 instruments that provide a governmental policy framework for the conservation and use of PGRFA. Bulgaria reported 14 instruments, followed by Albania with 12, Ecuador with nine, and Egypt and Zambia each with seven. The most frequently reported governmental policy instrument were laws, decrees, acts and the like (34), followed by strategies (23), action plans (11) and programmes (six). The remainder was a mix of very different policies. Nineteen of the policy framework instruments were published before 2000, 39 between 2001 and 2010 and 33 between 2011 and 2015.

Thirty-one countries rated this indicator with an average score of 5.3. This score is above the average of 4.5 and thus shows satisfaction but with a clear understanding that there is further room for improvement.

Indicator 48: Existence of a national information sharing mechanism for PGRFA		
Number of reporting countries: 23 Number of countries with NFP rating: 31	NFP Rating	4.8

Twenty-three countries reported the existence of mechanisms for sharing PGRFA information and other national information management tools. Thirteen countries (56.5 percent) reported the use of the NISM; national information databases were reported seven times; GRIN-Global was mentioned once, whereas a national inventory and a webpage were each reported twice., References were provided for most mechanisms. Eighteen of them were published prior to 2009 and ten after 2012. For 26 mechanisms, the involvement of a total of 394 stakeholders was reported, an average of 15.2 per mechanism. Ten mechanisms involved between one and ten stakeholders, eight between 11 and 20, and seven between 21 and 50.

Only 23 countries reported on this key aspect of coordinating and managing the conservation and use of PGRFA at national level. However, it is encouraging that 13 countries reported the NISM as their principle mechanism. It is evident that more work and apparently more assistance are required to ensure that all countries reporting on the implementation of the Second GPA have a national information-sharing tool.

The need for more work in this area is also confirmed by the average rating of 4.8 provided by 31 countries. This is a figure just above average and thus clearly indicates that countries know that more work is needed.

Priority Activity

14 Promoting and strengthening networks for plant genetic resources for food and agriculture

NFP Rating

4.9

The extent of interdependence among countries with respect to their need to access PGRFA and information held by others is arguably more important than ever as the world increasingly faces new environmental conditions and pest and disease spectra resulting from climate change. Networks not only facilitate the exchange of PGRFA, they also provide a platform for scientific discussion, information sharing, technology transfer and research collaboration.

The regional and global crop strategies developed with support from the Global Crop Diversity Trust highlight the value of networks in identifying and sharing responsibilities for important PGRFA activities. In addition, they can help set priorities for action, develop policy and provide the means whereby crop-specific and regional views can be conveyed to various organizations and institutions. The importance of networks is also recognized by the International Treaty.

Many regional, crop-specific and thematic networks are now operating, some of which have either been established or significantly strengthened in the past decade. Each has an important role to play in supporting the coordination of efforts in the sustainable conservation and use of PGRFA. The synergistic relationship between national programmes and these networks is the key to the sustainability of both: networks support national programmes and national programmes support networks. As such, networks are of particular importance in regions where there is limited national capacity in PGRFA management (for example, many of the least developed countries and small island states), as it gives them easier access to information, technology and materials, and, importantly, a stronger voice in the development of global policies and actions.

Crop-specific networks have a particular role to play in bringing conservation and use closer together. Thematic networks are an effective means of bringing experts and interested parties together around a common theme, thereby strengthening coordination and avoiding duplication of efforts. One of the challenges faced by all types of networks, however, is the long-term availability of resources. Countries should be prepared to contribute to supporting them in a sustainable fashion.

Fostering partnerships and synergies among countries to develop a more rational and cost-effective global system for PGRFA conservation and use is therefore an important long-term objective. Analysing and identifying the benefits of participation in networks and highlighting the contribution they make to sustainable conservation of PGRFA at national, regional and global levels are important means of sustaining such networks.

A total of 56 countries across all continents reported being members of one or more regional or international networks. A total of 124 networks were listed, including regional and global PGRFA network, as well as crop networks. In addition, the international agricultural research centres played an active role in at least 29 PGRFA conservation and use networks. Only a relatively small number of countries reported on the production of publications and negatively rated their achievements in this regard.

The overall rating for all the indicators of this PA was 4.9, indicating that the countries are satisfied with their performance and at the same time accept that more efforts will be needed.

Indicator 49: Membership to regional PGRFA networks		
Number of reporting countries: 34 Number of countries with NFP rating: 32	NFP Rating	5.7

Thirty-four countries reported on their respective memberships of regional PGRFA networks. A total of 75 distinct entities were reported, though only 31 of them could be strictly considered regional PGRFA networks. Among the others, 16 were working groups within a regional PGRFA network, three were regional agricultural research networks without an explicit focus on PGRFA, five were broad regional agricultural development networking initiatives (two in Asia and three in Latin America), four were not formal networks but rather collaborative initiatives coordinated by a national research centre from a donor country, eight were initiatives coordinated by international research centres, four were initiatives coordinated by international institutions with a global rather than regional, scope, one an international society, and three were national networks. The most frequently reported regional PGRFA network was the European Cooperative Programme for Plant Genetic Resources (ECPGR), including its crop and thematic oriented working groups, which was reported by 15 countries. In addition, regional PGRFA networks for Latin America and the Caribbean (16 networks), the Near East and North Africa, Eastern Africa, Central and Western Africa, Central Asia and the Caucasus, and Southern Asia were reported.

It should be noted that being a member of a regional PGRFA network is not yet a guarantee that the country will benefit. Their active engagement is critical and this requires, *inter alia*, a functional national PGRFA system that facilitates and supports such participation.

Ten of the international centres provided information on their membership of 29 networks, including five times in the CGIAR Genebank CRP. Fourteen networks were conservation (and use) networks. Eleven were crop improvement networks. Twelve had a miscellaneous focus, including production (four), stakeholders (two), seed research (two), vegetable research (one) and intellectual property (one). Eighteen of the reported networks had global coverage. Eleven had regional coverage (all regions were mentioned at least once). Three had either a country or a CGIAR focus. In 12 of the networks, one of the international centres provided the coordinator or the chair. In 19 networks the centres were members, and in three other networks the centres were research partners.

Thirty-two countries rated their achievement with respect to their participation in regional PGRFA networks, providing an average score of 5.7. This is a good overall score, but does not exclude the need for further improvements. It should also be noted that better collaboration especially between neighbouring regional networks will be beneficial, as many crops are spread across two (or even more) regional networks.

Indicator 50: Number of crop improvement networks in which national stakeholders are members		
Number of reporting countries: 23 Number of countries with NFP rating: 28	NFP Rating	5.2

Forty-one national stakeholders from 23 countries reported being members of a total of 108 crop improvement networks, 12 of which were international agricultural research centres[8] plus the Joint Division of FAO and the International Atomic Energy Agency (IAEA) for Nuclear Techniques in

[8] AfricaRice, AVRDC, Bioversity International, CIAT, CIMMYT, CIP, ICARDA, ICRISAT, IITA, ILRI, IRRI.

Food and Agriculture. Four countries reported CIMMYT, three ICARDA and two AVRDC, CIP, ECPGR, IRRI and the International Society for Horticultural Science.

France was the country with stakeholders participating in the largest number of crop improvement networks (44), addressing a wide range of crops or crop groups, including vegetables, fruits, oil plants and cereals. The next were Bangladesh, which reported 11 networks, mostly the international centres mentioned above, and Ethiopia, which reported seven networks, including CGIAR centres and four regional crop networks, three of which on pulses.

Despite the limited reporting, 28 countries rated achievements for this indicator, providing a score of 5.2 on average, which implies a positive overall judgement.

Indicator 51: Number of publications produced by national stakeholders within the framework of networks		
Number of reporting countries: 14 Number of countries with NFP rating: 27	NFP Rating	4.0

Fourteen countries reported a total of 217 publications (an average of 6.2 publications per country and year) within the framework of PGRFA networks, either regional or crop-oriented. The majority of the publications were clearly crop-oriented, national-focused products. Only in a handful cases were regional studies presented. The country with the highest number of reported titles is United Kingdom (47), followed by Chile (45), Azerbaijan (28), Armenia (22), Estonia (20), Germany (17) and Cuba (14). All the other countries reported fewer than eight publications.

Twenty-seven countries rated their achievements with respect to this indicator, providing an average score of 4.0. This is a relatively low score and could indicate that countries are not completely satisfied with the achieved results.

Priority Activity		
15	**Constructing and strengthening comprehensive information systems for plant genetic resources for food and agriculture**	NFP Rating 4.5

Transparent and rational decision-making in the conservation and sustainable use of PGRFA can only be achieved on the basis of solid information. The revolution in communication and information management systems over the past 15 years has created important improvements in the availability and accessibility of PGRFA-related information. Several decisions of the Commission since the adoption of the first GPA aimed to improve precisely these aspects of PGRFA information management, including the further development of WIEWS, the adoption of the indicators and Reporting Format for monitoring GPA implementation, the establishment of NISMs and the preparation of *The Second Report on the State of the World's PGRFA*. Furthermore, information exchange is given high importance throughout the International Treaty and in particular in Article 17, the Global Information System, and is one of the main mechanisms for sharing fairly and equitably the benefits derived from the use of PGRFA under the Treaty's Multilateral System.

Recent developments aimed at supporting documentation and exchange of genebank information include the release of GRIN-Global, a genebank management information system with built-in networking features, and Genesys, a plant genetic resources portal that gives breeders and researchers a single access point to information on about a third of the world's genebank accessions, including those in the international collections managed by the CGIAR, the USDA's National Plant Germplasm System and EURISCO. In this period, the design of the Global Information System (GLIS) called for by Article 17 of the International Treaty is advancing.

Despite this progress, significant gaps in documentation and information-sharing on PGRFA still persist and need to be addressed, as they represent a serious obstacle to the effective conservation, efficient planning and increased use of PGRFA in crop improvement and research. Many existing data are not accessible electronically and documentation of on-farm genetic resources and CWRs is particularly inadequate. There is significant imbalance among regions and even among countries within regions.

Thus, the facilitation of better management and use of PGRFA through improved access to, and exchange of, high-quality, up-to-date information is an important objective. Developing and strengthening national information systems, including but not limited to accession-level information systems, improving the management of PGRFA data and supporting countries' participation in, and use of, global information systems are also important priorities. Enhancing the use of regional and global information systems through continual improvement of the overall functionality and productivity of the genebank-user interaction is another critically important objective. The same is true for strengthening the exchange and use of information and the sustainability of current systems by promoting compatibility and usability among datasets through the establishment and adoption of common descriptors.

Only a very small number of countries reported maintaining information on CWRs and farmers' varieties and landraces in publicly available information systems. The corresponding indicator for CWRs was rated the lowest of all. However, countries reported more than 1.375 million *ex situ* conserved accessions documented in such information systems. The international centres, on average, updated their data in Genesys rather irregularly. Characterization and evaluation data were available for, respectively, a little over 40 percent and less than 2 percent of conserved accessions. Characterization and evaluation data were available for more than 56 percent of the accessions in the genebanks of international centres. In addition, 19 countries indicated that a total of almost 16 500 released varieties were recorded in publicly available information systems.

The overall average rating for all indicators of this PA 15 was 4.5, exactly the average score between satisfaction and the realization that more work is required.

Indicator 52: Number of crop wild relatives conserved *in situ* and documented in a publicly available information system		
Number of reporting countries: 4 Number of countries with NFP rating: 29	NFP Rating	2.6

Only four countries reported having documented a total of 3 945 CWR samples in five different national publicly available information systems. Germany reported the highest number of CWRs (2 874) occurring *in situ* and reported in two different information systems, followed by Spain (930), Armenia (105) and Albania (36). For each of the reported systems, an internet address was provided, and all except one were functional.

Twenty-nine countries reported their rating of achievements with respect to this indicator, scoring an average of 2.6. This is a very low number and demonstrates that the countries have generally made little progress and that much work remains to be done. This rating confirms the disappointingly low number of countries that were able to report on this indicator.

Indicator 53: Number of farmers' varieties/landraces cultivated on-farm and documented in a publicly available information system		
Number of reporting countries: 6 Number of countries with NFP rating: 28	NFP Rating	3.0

Six countries reported a total of 1 126 farmers' varieties/landraces cultivated on-farm and documented in six different publicly available information systems. The largest numbers of landraces were reported by Azerbaijan (631), Germany (310) and Armenia (150). Three countries reported fewer than 20 varieties each. The percentage of farmers' varieties/landraces with published morphological description was 13 percent (including four countries reporting either zero or only two varieties with published descriptions); 32.0 percent of the varieties had an agronomic description (including four countries reporting either zero or only two varieties with published descriptions).

Of the five different information systems reported, two were regional and three national. All information systems except one provided a functional internet address.

The very low number of countries reporting on this indicator is disappointing and reflects the difficulty of on-farm monitoring of farmers' varieties/landraces and the overall lack of systems for this. The average rating of 3.0 by 28 countries supports this assessment and demonstrates that countries realize that much more needs to be done to meet global expectations and to enable farmers to benefit more from their cultural and agronomic heritage, which is threatened in many countries and production systems.

Indicator 54: Number of accessions from *ex situ* collections documented in a publicly available information system		
Number of reporting countries: 21 Number of countries with NFP rating: 31	NFP Rating	5.1

Forty-seven stakeholders from 21 countries reported that a total of 578 324 accessions in *ex situ* collections were documented in a publicly available information system at the end of the reporting period (i.e. 30 June 2014). However, taking into account the other information sources that contributed the assessment of indicators 18 to 21 for *ex situ* conservation in long- or medium-term conditions, i.e. Genesys, EURISCO, plus some individual genebanks (e.g. NIAS Genebank), in June 2014, the total number of accessions from *ex situ* collections documented in a publicly available information system is estimated to be 2.60 million from 52 countries or 72.4 percent of the total number of accessions conserved *ex situ* under medium- or long term conditions as reported under indicator 20.[9] This percentage is overall too small. Improving it would have a multiplicative positive effect on the overall conservation and use of PGRFA.

Analysis of the state of on-line publication of associated characterization and evaluation data is based on data from the 21 countries that reported on this indicator. The percentage of accessions with published characterization data is overall rather low: 16.8 percent. Such data have been published by only 19.1 percent of the stakeholders that reported that their *ex situ* collections are accessible on the web.

The situation with regard to the publication of the evaluation data is even less encouraging. Only about 1.2 percent of the published collections include evaluation data. These data belong to only seven out of the 47 stakeholders (14.9 percent) that reported that they had published their *ex situ*

[9] This figure does not include the *Arabidopsis* collection in the United Kingdom.

collections. The situation described by the limited number of reporting countries does not seem too far from what the overall global situation appeared to be at the end of June 2014 with respect to the accessibility of PGRFA characterization and evaluation data on the internet.

Considering these data and the importance of characterization and evaluation data in allowing users to preselect accessions, it is very clear that the value of the published *ex situ* collections would be significantly enhanced by the publication of existing characterization and evaluation data.

The reported average rating of 5.1 by 31 countries reflects a relatively positive judgement of the state of implementation of this indicator.

Ten international centres provided data on the extent of characterization and evaluation data. They reported that a total of 427 748 accessions have been characterized and evaluated and the data published. Two centres referred to the website where the data are available; another centre has not yet published its data. Based on the reported data 56.7 percent of the total holdings of the international centres are characterized and evaluated and the data published. Two centres reported a 100 percent coverage and publication of characterization and evaluation data; three other centres reported a percentage between 50 and 100 percent. The other centres reported levels below 50 percent; of these, one centre reported having published data only on 3.9 percent of conserved accessions.

Indicator 55: Number of released varieties documented in a publicly available information system		
Number of reporting countries: 19 Number of countries with NFP rating: 29	NFP Rating	5.9

Nineteen countries reported a total of 16 498 released varieties (an average of 868.3 varieties per country) that are documented in a publicly available information system. The largest number of published varieties was reported by Spain (4 358), followed by Germany (4 264), Turkey (2 287), Lebanon (1 082) and Costa Rica (1 000). Five countries each reported less than 100 varieties documented in a publicly available information system.

No information was reported in response to the sub-question on whether the published information includes pedigree information, agronomic descriptions and/or seed source. Ten countries reported a national information system used for the publication of the information; five reported NISM/WIEWS as their system; one reported a regional system and another referred to a department. Eighteen countries provided an internet address where the information can be found.

Twenty-nine countries rated their achievements with respect to this indicator, providing an average score of 5.9. This indicates satisfaction with the progress but also recognition that more work needs to be done.

Indicator 56: Participation in publicly accessible, international/regional PGRFA information systems		
Number of reporting countries: 26 Number of countries with NFP rating: 32	NFP Rating	5.8

Twenty-six countries reported that a total of 48 stakeholders regularly contribute information to publicly accessible international/regional PGRFA information systems. Collectively they contribute to 13 different information systems of which WIEWS was mentioned by 24 stakeholders from 13

countries, followed by EURISCO (16 stakeholders from 9 countries), ECPGR crop databases, Genesys, SESTO, regional network databases and international crop databases.

The reported frequency of updating information varied, with 25 stakeholders updating every three years or more, 16 every two years, 24 annually and two monthly. The reported information looks good and the listed information systems are predominantly well-known. The frequency of updating is acceptable, although where the frequency is less than once in every three or more years, the situation could be improved.

The 12 international centres publish their *ex situ* collection holdings on the web through Genesys and, in some cases, on their own portals. Asked about the frequency of their updates in Genesys for each year of the reporting period (2012, 2013 and 2014), three centres indicated that they did not do any updating and one centre that it only updated in 2015. Four updates during 2012 were reported, three during 2013 and eight during 2014. Two centres reported updates of their data in Genesys in 2015; of these one has yet to be validated.

Thirty-two countries reported their rating for this indicator, with an average score of 5.8, a relatively high score that seems to imply that countries see their performance as satisfactory, although with room for improvement.

Priority Activity		NFP Rating
16	**Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of PGRFA**	3.6

Erosion of PGRFA occurs in farmers' fields and in nature, but can also occur in ex situ collections. With modern molecular genetic techniques, it has been possible to generate data on the extent and nature of genetic erosion, in particular crops in particular areas. The emerging picture is complex and it is (still) not possible to draw clear conclusions about the magnitude and extent of these effects. Better techniques and indicators are needed for monitoring genetic diversity, for establishing baselines and monitoring trends. Unfortunately, to date no really practical and internationally accepted indicators of genetic erosion are available.

A number of factors, both natural phenomena and the results of human behaviour, including urbanization, agricultural development, civil strife and war, have historically been recognized as drivers of erosion of PGRFA. Loss of genetic resources in crops occurs mainly through adoption of new crops or new varieties, with the consequent abandonment of traditional farmers' varieties/landraces, frequently without appropriate conservation measures. More recently, climate change and modern dietary preferences have also been recognized as threats. The threat of alien invasive species is yet another factor that needs to be considered. The loss of PGRFA varies within countries and from country to country. Rural areas with extended traditional agriculture seem to be the most threatened with loss of invaluable genetic resources. In general, support should be provided to develop and establish monitoring mechanisms at all levels.

The concept of systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion embraces any activity or mechanism that directly or indirectly contributes to the conservation and continued use of PGRFA, including surveying/inventorying systems, monitoring systems, conservation systems and information systems.

Almost 20 years ago, the WIEWS application for remote search, update and reporting of genetic erosion, was developed and published on the web. The scope of the information covered by WIEWS has been expanded to host NISMs, which also address issues related to genetic erosion, and only recently the application was converted into an on-line reporting system for all the PAs of the Second GPA.

The main objective of this PA is to minimize genetic erosion and its impact on sustainable agriculture through effective monitoring of genetic diversity and the drivers of genetic erosion, and the implementation of appropriate remedial or preventative action as required. The establishment and implementation of monitoring mechanisms to ensure the timely transfer of information to appropriate points designated as responsible for analysis, coordination and action have been recognized as important actions.

Fourteen countries had one or more systems in place to monitor and safeguard genetic diversity and minimize genetic erosion. Less than half of the international centres reported various approaches to monitoring genetic diversity and minimizing genetic erosion for their mandate crops. Sixteen countries had undertaken a number of remedial measures that resulted from these monitoring systems. However, compared with the other PAs, countries' ratings were among the lowest, reflecting their disappointment with achievements for this PA.

The overall average rating for all indicators of this PA 16 is 3.6. This is a low rating and shows that countries are not satisfied with what they were able to achieve over the last two and a half years of the reporting period.

Indicator 57: Existence of national systems to monitor and safeguard genetic diversity and minimize genetic erosion		
Number of reporting countries: 16 Number of countries with NFP rating: 26	NFP Rating	3.4

Fourteen countries reported the existence of 52 national systems or mechanisms to monitor and safeguard genetic diversity and minimize genetic erosion. These systems varied from national genebanks, NISMs, plant protection schemes, biodiversity action plans, specific landrace protection schemes, national inventories, environmental databases through to biological pest management and integrated pest management. Guyana reported the existence of 35 contributing systems, followed by Cuba (three), Estonia and Malawi (two each) and the other countries (one each). The majority of the references of the systems were published in 2012 (14), 2013 (17) and 2014 (14). Seven references were published between 1992 and 2010.

The international centres were asked to report on any systems they had in place to monitor and safeguard genetic diversity and minimize genetic erosion. Only five centres provided information on such systems, of these one centre reported using gap analysis for their germplasm collection to identify countries that were under-represented (six African countries were identified). Another centre reported the field verification of *in vitro* material. Tracking known CWRs of beans was mentioned by another centre. One centre reported a monitoring framework for potato. Another used the CGIAR Knowledge Base on Best Practices as a tool. No specific references of publications were provided.

These responses suggest that apart from CIAT's work using GIS and gap analysis to develop a powerful tool to monitor genetic diversity of CWRs, the international centres have not dedicated particular efforts to the development of systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion during the target period of this report.

Thirty countries rated their achievements for this indicator, providing an average score of3.4, a rather low score that indicates that the achievements are modest and that much work remains to be done.

Indicator 58: Number of remedial actions resulting from the existing national systems to monitor and safeguard genetic diversity and minimize genetic erosion		
Number of reporting countries: 16 Number of countries with NFP rating: 26	NFP Rating	3.7

Sixteen countries reported 51 remedial actions (with an average of 3.2 actions per country) that resulted from the existing national systems to monitor and safeguard genetic diversity and minimize genetic erosion. The Islamic Republic of Iran reported eight remedial actions, Armenia and Panama six each, Ecuador and Morocco five each, and Ethiopia four. The other countries reported three or fewer actions. Twenty-nine types of remedial action were listed, including the establishment of protected areas (six times), long-term programme to increase genetic diversity in crops through breeding techniques (eight times), adjustments of national PGR programmes (three times), implementation of agroforestry projects (three times), combining conservation and community development (3 times), re-introduction of wild species (twice), mainstreaming of agricultural biodiversity in production systems (twice) and as environmental protection efforts (twice). The remaining remedial actions were listed only once each. This is a very variable list of activities, some of which are rather routine operations whereas, others very targeted.

Five international centres reported 23 different actions to correct or improve genetic diversity and to minimize genetic erosion. A total of 16 different countries were mentioned and one action had global coverage. Collecting genetic resources was reported as the main remedial action (14 events, of which five were training courses). Furthermore, the safety duplication of precious and threatened material was reported twice as action. Field verification of *in vitro* material, restoration efforts for potato diversity, development of a model benefit-sharing arrangement with the private sector and farming communities, the establishment of a baseline plus diversity studies and assessment, and the promotion of on-farm conservation actions were all reported once.

Twenty six countries rated their achievements, with an average score of 3.7, a relatively low score confirming that more actions are needed to safeguard, monitor genetic diversity and/or minimize genetic erosion.

Priority Activity		
17	**Building and strengthening human resource capacity**	NFP Rating 5.0

Effective and efficient PGRFA conservation and use are very dependent on human resource capacity and their continuous development. Capacity-building over the past ten years or so has improved, resulting in stronger collaboration in training among national, regional and international organizations. Training courses are more frequent and new training materials and facilities have been developed. Higher education opportunities have also expanded and there are now more universities offering a wider range of courses in areas related to PGRFA, especially in the application of biotechnology to conservation and crop improvement.

However, despite these efforts, human-resource capacity is still far from being adequate at virtually all levels and in all disciplines related to PGRFA conservation and use. In many countries, genebank staff are too few in number and are inadequately trained to collect, classify, conserve, regenerate, characterize, document and distribute PGRFA. One of the reasons for this is that young people do not see career opportunities in the PGRFA field. Limited plant breeding and pre-breeding capacity

in most developing countries severely limits effective and sustainable use of PGRFA. In many cases, extension services and NGOs also lack qualified personnel to impart appropriate training on on-farm conservation to farming communities.

Thus, ensuring long-term availability of adequate human resources capacity in all areas of PGRFA conservation and use, including management, legal and policy issues is a key concern.

Educational and training programmes on PGRFA were reported by 30 countries. The international centres trained more than 1 000 persons on various research and routine operations related to the conservation and sustainable use of PGRFA. The employment of almost 1 500 PGRFA professionals was reported by 33 countries, and 28 national PGRFA programmes reported a staff strength that included 508 professionals. Countries also reported encouraging figures on the upgrading of the skills of their scientific staff, both through formal education (PhD and MSc levels) and through ad hoc in-service training. More than 50 percent of staff received further training in one or more disciplines relevant to the conservation and sustainable use of PGRFA. The overall average rating for all indicators for PA 17 was 5.0, a relatively good rating compared to the ratings of the other PAs of the Second GPA.

Indicator 59: Existence of postgraduate, graduate and secondary educational and training programmes with incorporated aspects on PGRFA conservation and sustainable use		
Number of reporting countries: 30 Number of countries with NFP rating: 33	NFP Rating	4.8

Educational and training programmes that incorporate PGRFA-related topics exist in all 30 reporting countries. Secondary educational and training programmes exist in 33 percent of them, graduate programmes in all countries, and postgraduate in 26 out 30. Nine countries reported programmes at all three levels.

The international centres were asked to report on the main PGRFA subject areas on which they had organized training courses during the reporting period. The 12 centres reported a total of 51 training events (including training courses, on-the-job training and 4 PhD and BSc supervisory activities; one centre mentioned that many routine activities are also used for on-the-job training). In total, trainees from 31 countries were involved and three courses were international.

During these training events a total of 1 025 trainees/students were trained, an average of 85.4 trainees per centre. The number of trainees per centre and training event varied from one to 47, with an overall average of 19.3 trainees. Regarding the main PGRFA subject areas, genebank management was reported nine times (including once field genebank management), followed by in vitro and cryopreservation (seven),vegetable production and genetic resources (five), characterization and evaluation (four), data analysis and computing skills (four), genetics and genetic diversity (four), genebank documentation (three), crop genetic resources conservation (three), seed multiplication and production (three), molecular genetics/biotechnology (three), seed physiology/conservation (two) and five other genetic resources conservation and use topics.

The international centres are encouraged to continue providing training on relevant PGRFA topics to countries and, whenever possible, to expand them.

In all, 33 countries rated their achievements, providing an average score of 4.8, a relatively good score that demonstrates satisfaction, but also awareness that more needs to be done.

Indicator 60: Percentage of staff whose skills in conserving and using PGRFA have been upgraded		
Number of reporting countries: 33 Number of countries with NFP rating: 31	NFP Rating	5.2

Thirty-three countries reported on the upgrading of staff from 111 stakeholder institutions, an average of 3.4 institutions per country. Collectively, these 111 stakeholder institutions reported the employment of 1 462 PGRFA conservation and use professionals, an average of 13.2 professionals per stakeholder institute and 44.3 per reporting country. Spain reported 17 institutes, with a total of 107 professionals and an average of 6.3 professionals per institute; Azerbaijan reported 12 institutes, with a total of 448 staff members and an average of 37.3; Cuba reported 11 institutes and 113 professionals, an average of 10.3; Lebanon reported 9 institutes, with 38 professionals and an average of 4.2.

The 16 countries that reported only one institute, referred to the agricultural research institute managing the national PGRFA genebank. These institutes, which are mainly from developing countries, employed on average 11.5 professionals, a lower figure than the overall average across all institutes (13.2). Because of the broader research mandates of these institutes, professionals employed at them usually also have other responsibilities apart from PGRFA conservation and use. This could point to a possible capacity constraint in PGRFA management in such countries. Collectively, all 28 reported national genetic resources programmes employed a total of 508 staff members, an average of 18.1. This is well above the average number of PGRFA professionals per stakeholder, a good figure that makes logical sense and that might be regarded as satisfactory.

About 10 percent of the total professional staff (1 462 professionals) completed PhD programmes during the reporting period. They were from 23 countries only. Furthermore, 156 professional staff from 21 countries completed MSc programmes. Finally, a total of 449 professionals (or 30.7 percent of the total) from all 33 countries attended short courses and seminars.

Out of all the employed PGRFA professional staff of the 33 countries 51.6 percent upgraded their capacity during the reporting period. This looks like a very impressive figure and gives good cause for hope for the future. However, it should also be noted that 12 countries were below average, one country, Egypt, reported capacity enhancement for only 19 percent of its staff and nine other countries reported levels below 40 percent. This shows that more work will have to be done.

Thirty-one countries rated their achievements for this indicator on average with a score of 5.2, a good score that reflects satisfaction with achievements, but also indicates the recognition that more work is needed.

Priority Activity		
18	**Promoting and strengthening public awareness on the importance of plant genetic resources for food and agriculture**	NFP Rating 4.4

Public awareness is the key to mobilizing popular opinion and generating and sustaining appropriate political action nationally, regionally and internationally. Effectively communicating the widespread benefits that PGRFA can bring to food security and sustainable livelihoods is critical to the success of any conservation programme. Recent years have seen increased understanding of the importance of PGRFA in addressing the challenges posed by climate change. Interest is growing in neglected

and underutilized crops, in recognition of their potential as "novel" crops that will be productive under different climate scenarios. They also provide opportunities for the development of high-value niche products.

There is increasing recognition in the scientific community of the potential of CWRs to contribute to sustainable intensification of production, but this has not yet reached a wider audience. Concern over the global increase in lifestyle-related diseases and an increasing consciousness about food in general has led to a growing interest in the nutritional benefits that can be gained from exploring and exploiting PGRFA. Many countries are aiming to reduce the cost of imported food by revitalizing local food production, which often has cultural value. New social networking tools provide an extremely effective way to get such messages through to a significant mass of people, in particular the young generation. However, raising the awareness of policy-makers, donors and the general public of the value of PGRFA is a continuing challenge.

A targeted public-awareness programme can promote the development of international linkages and collaborative mechanisms such as networks involving different sectors, agencies and stakeholders. Within countries, public awareness can support efforts to involve communities and local and non-governmental organizations in national genetic resources activities, thus ensuring a broader base for conservation and improvement. Working with the media at local and national levels is a key aspect of raising awareness.

Supporting and strengthening mechanisms, particularly in developing countries, for coordinated public-awareness activities that involve and target all stakeholders are an important objective. Furthermore, full integration of public awareness into all national, regional and international programme activities is seen as a critical step towards more success in this area.

Countries carried out more than 130 public-awareness programmes or activities with the participation of a broad spectrum of stakeholders. The development of a wide range of advocacy and information-dissemination products was also reported and relevant media were used to reach the target groups. The overall average rating of PA 18 was 4.4, a rating that clearly shows that countries believe that more work in this area is needed but also that good progress has been achieved during the reporting period.

Indicator 61: Existence of a public-awareness programme promoting PGRFA conservation and utilization		
Number of reporting countries: 27 Number of countries with NFP rating: 31	NFP Rating	4.0

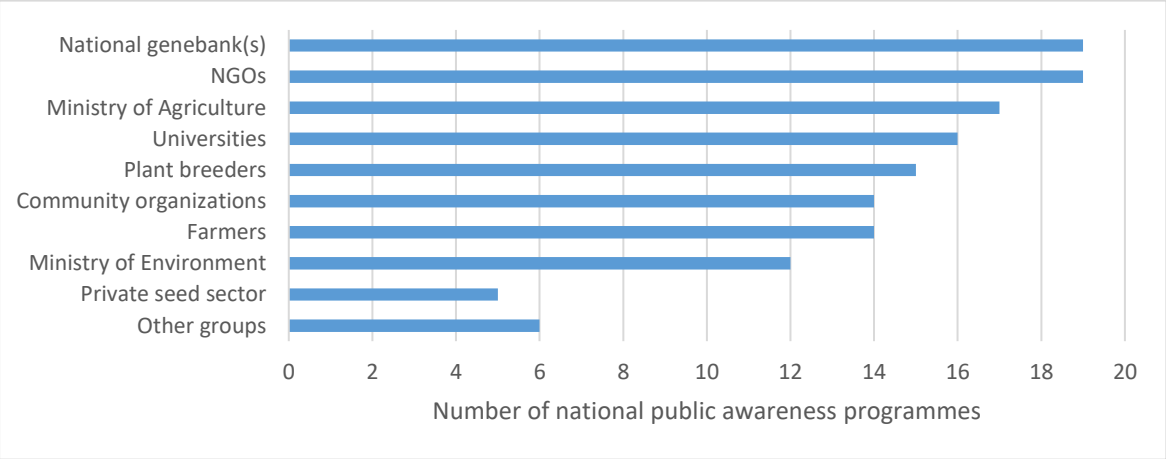
Indicator 62: Number of stakeholder groups participating in the implementation of the public-awareness programme		
Number of reporting countries: 22 Number of countries with NFP rating: 26	NFP Rating	4.8

Indicators 61 and 62 are treated together as the information is drawn from responses to one and the same question and they are closely related.

A total of 27 countries reported on indicator 61. Out of these, 20 countries reported on the existence of public-awareness programmes that actively promoted PGRFA conservation and utilization during the reporting period. Two additional countries reported some public-awareness activities that were, however, not part of an structured programme.

The participation of key stakeholder groups was rather wide in the 22 reporting countries for indicator 62. On average over six main stakeholder groups participated in the implementation of the public awareness programmes and/or activities. Countries reporting the widest participation included Germany (12 stakeholder groups), followed by Bulgaria, Costa Rica, Cuba and Morocco (9 groups) and Armenia, Ethiopia, Guyana, Malawi and Turkey (8 groups). The remainder of the countries reported the involvement of seven or fewer groups. Figure 4 show the frequency of participation of major stakeholder groups in national public-awareness programmes. National genebank(s) and NGOs are the two groups that most frequently participated in national public-awareness programmes or activities. These groups were followed by ministries, universities, breeders, community organizations and farmers, each participating in between 17 and 12 national programmes. Other participating stakeholders included the private sector, local governments, museums, botanic gardens, students, federal research institutes and ministries of rural development.

Figure 4. Frequency of participation of stakeholder groups in national public-awareness programmes



Programmes, projects or activities resulting from PGRFA awareness-raising programmes were reported by six countries, including capacity development for sustainable PGRFA conservation and use in Ethiopia, the establishment of a NISM in Guyana, the establishment of a national park in Armenia, the inclusion of agricultural biodiversity issues in national policies in Ecuador, the creation of a project on participatory characterization of local germplasm in Zambia, and the promotion of food security as a right in Senegal.

The reporting on public awareness shows that this activity is seen as important by countries. This is demonstrated by the wide array of stakeholders mentioned by the 22 reporting countries. Furthermore, the reported examples of activities that resulted from awareness raising programmes demonstrate the potential benefits of such programmes. This is duly reflected in the rating by 31 countries of their achievements for indicator 61; the average score of 4.0 shows that much more work needs to be done. For indicator 62, 26 countries rated their performance, with an above average score of 4.8, a positive judgement overall.

Indicator 63: Number of types of products developed to raise public awareness		
Number of reporting countries: 28 Number of countries with NFP rating: 29	NFP Rating	4.4

Seventy-eight stakeholders from 28 countries reported on the types of products that were developed to raise public awareness of the importance of PGRFA during the reporting period.

Eight types of products were reportedly developed by 78 stakeholders. On average, 3.1 types of products per stakeholder were developed during the reporting period. The most frequently developed

products were panels and posters, followed by web pages, audio-visual products and fact sheets, as shown in Table 19.

Table 19. Percentage of stakeholders reporting on different types of product developed for raising awareness on PGRFA

Types of products developed	Stakeholders (percent)
Display panels and posters	59
Web pages	56
Audio-visual products	46
Fact sheets	46
Reports	38
Newsletters	31
Magazines	24
Accessories (t-shirts, caps, bags, etc.)/gadgets	13

Twenty-nine countries rated their achievements with respect to the public-awareness products indicator with an average score of 4.4, just at the middle of the range and thus indicating satisfaction with the achievements and the realization that more work is required.

PART III: THE SECOND GLOBAL PLAN OF ACTION FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

SECOND GLOBAL PLAN OF ACTION

FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

COMMISSION ON
GENETIC RESOURCES
FOR FOOD AND
AGRICULTURE

SECOND GLOBAL PLAN OF ACTION

FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

ADOPTED BY THE FAO COUNCIL, ROME, ITALY, 29 NOVEMBER 2011

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Foreword

The Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture, prepared under the aegis of the Commission on Genetic Resources for Food and Agriculture, was adopted by the FAO Council on 29th November 2011. It updates the Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture, adopted in 1996, at the Fourth International Technical Conference on Plant Genetic Resources.

The Second Global Plan of Action responds to the needs and priorities identified in the *Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*, a global assessment that FAO published in 2010. It was prepared through a series of regional consultations, with the participation of 131 countries and representatives of the international research community, the private sector and civil society.

The need to conserve and sustainably use the world's plant genetic diversity is more critical than ever. It is the basis of food security, in a world facing many challenges. Over one billion people already suffer from chronic hunger and malnutrition, while the world's population is projected to reach 9.2 billion by 2050. To feed them all, we will need to increase agricultural production by 60%. At the same time, the resource base is threatened, by global warming and climate change, dwindling land and water resources, and environmental degradation. The continuing loss of plant genetic diversity for food and agriculture greatly reduces our options, and the options of future generations, for adapting to these changes and ensuring food security, economic development, and world peace.

The Second Global Plan of Action lays out a series of agreed priority plans and actions that can protect our rich portfolio of diverse genetic resources, while ensuring a sustainable flow of improved varieties, by harnessing enhanced traits to deliver better quality foods, in quantities that match our burgeoning needs. Only by doing so can we put an end to food insecurity and poverty. International cooperation has become even more imperative than a few decades ago. It is urgent that we together broaden and deepen our efforts to conserve and sustainably use plant diversity.

The adoption of the Second Global Plan of Action reflects an international consensus, and testifies the political will to identify and carry out agreed priorities to achieve these aims. It plays an important role in the international policy framework for world food security, as a supporting component of the International Treaty on Plant Genetic Resources for Food and Agriculture, as a crucial contribution to achieving the Millennium Development Goals, and in the implementation of the Strategic Plan for Biodiversity 2011-2020.

Difficult as the world economic situation currently is, we cannot afford not to continue and increase national and international investments in the priorities and programmes that Governments have agreed on through the Second Global Plan of Action. This means a substantial increase in current activities in countries, and the active involvement of international and regional organizations, donors, scientists, farmers, indigenous and local communities, the public and private sectors, civil society, and research and educational institutes. The full implementation of the Second Global Plan of Action will require cooperation between countries and regions, and mutual support between agriculture and the environmental and food sectors.

This is not something that we can delay, or only partially achieve, without putting the world's environments at risk, particularly as climate change accelerates, and without mortgaging our children's future. Progress so far, particularly since the first Global Plan of Action was adopted, demonstrates that sound strategies can overcome the many current obstacles, when backed by political will and adequate financial resources. Plant genetic resources are a common concern of humanity, and it is both sound economic management and a moral imperative to conserve the resources that millions of years of evolution and thousands of generations of farmers all over the world have given us, and use them sustainably and profitably, to ensure that we can feed the generations to come.

FAO is committed to the implementation of the Second Global Plan of Action. I call upon all countries, together, to seize the moment, and strengthen our investment in the sound stewardship of the world's heritage of plant genetic resources, by carrying out the Second Global Plan of Action with realism, determination and commitment.

José Graziano da Silva
Director-General
Food and Agriculture Organization
of the United Nations

Executive Summary

1. Plant genetic resources for food and agriculture provide the biological basis for agricultural production and world food security. These resources serve as the most important raw material for farmers, who are their custodians, and for plant breeders. The genetic diversity in these resources allows crops and varieties to adapt to ever-changing conditions and to overcome the constraints caused by pests, diseases and abiotic stresses. Plant genetic resources are essential for sustainable agricultural production. There is no inherent incompatibility between the conservation and the use of these resources. In fact, it will be critically important to ensure that the two activities are fully complementary. The conservation, sustainable use and fair and equitable sharing of benefits from the use of genetic resources are international concerns and imperatives. These are the objectives of the International Treaty on Plant Genetic Resources for Food and Agriculture, which is in harmony with the Convention on Biological Diversity. In the context of the sovereign rights of states over their biological resources and the interdependence of countries with regard to plant genetic resources for food and agriculture, the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture is an appropriate manifestation of the international community's continued concern and responsibility in this area.

2. Over the past 15 years, the Global Plan of Action has been the main reference document for national, regional and global efforts to conserve and use plant genetic resources for food and agriculture sustainably and to share equitably and fairly the benefits that derive from their use. As part of the FAO Global System for the conservation and sustainable use of plant genetic resources for food and agriculture, the Global Plan of Action has been the key element used by the FAO Commission on Genetic Resources for Food and Agriculture to fulfil its mandate with respect to plant genetic resources. The Global Plan of Action has also provided an important reference for other genetic resources sectors. It has assisted governments in the formulation of national policies and strategies on plant genetic resources for food and agriculture. It has also been used by the international community to define priorities at the global level, to improve coordination of efforts and to create synergies among the genetic resources stakeholders. The Global Plan of Action has proven to be instrumental in reorienting and prioritizing the research and development agendas of relevant international organizations with regard to activities related to plant genetic resources for food and agriculture.

3. The adoption of the Global Plan of Action by 150 countries in 1996 in Leipzig was a milestone in the development of the international governance of plant genetic resources for food and agriculture. It set the stage for the successful completion of the negotiation of the International Treaty on Plant Genetic

Resources for Food and Agriculture under the FAO Commission on Genetic Resources for Food and Agriculture.

4. Since its adoption, there have been a number of major developments with respect to the conservation and use of plant genetic resources for food and agriculture, which called for an update of the Global Plan of Action. The recently published *Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture* has provided a solid foundation for this updating process. The world is facing increasing food insecurity, reflected *inter alia* in highly volatile food prices. Climate change, increasing urbanization, the need for more sustainable agriculture and the need to safeguard plant genetic diversity and minimize genetic erosion all require that greater attention be given to the conservation and use of plant genetic resources for food and agriculture. At the same time, there are important new opportunities that can improve the management of plant genetic resources for food and agriculture, including powerful and widely available communication and information technologies as well as significant advances in biotechnology and the development of bioproducts derived from agriculture. Furthermore, the policy environment has changed significantly over the past 15 years, particularly with the entry into force of the International Treaty on Plant Genetic Resources for Food and Agriculture, and among others, the Cartagena Protocol on Biosafety, as well as with the adoption of the Strategic Plan for Biodiversity 2011-2020 and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization. The world has also seen a renewed commitment to agriculture and related research and development activities. An updated Global Plan of Action is needed to respond to, and reflect, these developments.

5. The Second Global Plan of Action addresses the new challenges and opportunities through 18 Priority Activities. The *Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*, a series of regional consultation meetings, as well as inputs from experts worldwide have provided the inputs needed to make the Second Global Plan of Action current, forward looking and relevant to global, regional and national perspectives and priorities. Updating the Global Plan of Action also strengthens its role as a supporting component of the International Treaty on Plant Genetic Resources for Food and Agriculture.

6. Based on the various inputs listed above, it has been possible to streamline the number of Priority Activities, reducing them from 20 in the original Global Plan of Action to 18. This was done by merging former Priority Activities 5 and 8 (*Sustaining existing* ex situ *collections and Expanding* ex situ *conservation activities*) into the new Priority Activity 6, *Sustaining and expanding* ex situ *conservation of germplasm*. Former Priority Activities 12 (*Promoting development and commercialization of underutilized crops and species*) and 14 (*Developing new markets for local varieties and "diversity-rich" products*)

have been merged into the new Priority Activity 11, *Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species*.

7. In addition, the focus of a number of other Priority Activities has been adjusted so as to accommodate newly defined priorities. The Second Global Plan of Action gives greater emphasis and visibility to plant breeding, as reflected in Priority Activity 9, *Supporting plant breeding, genetic enhancement and base-broadening efforts*. An effort has also been made, based on guidance from the regional consultations, to simplify and clarify the document.

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Introduction

Continued need for plant genetic resources for food and agriculture and their conservation and sustainable use

1. Agriculture in the twenty-first century will face many new challenges. Food and fibre production will have to increase dramatically to meet the needs of a growing and modernizing population with a proportionally smaller rural labour force. Changes in diets and food habits will drive changes in crop and livestock production systems. Faced with the world's food security, energy and sustainable development needs, countries will have to address the challenges and opportunities posed by the production and use of biofuels. In many parts of the world, the effects of climate change are likely to require changes in the adaptability of many crops and forages, increasing the interdependence of countries on plant genetic resources for food and agriculture (PGRFA). Climate change will also lead to changes in production areas and practices as well as in the occurrence of pests and diseases of crops and livestock. Agriculture will need to continue to reduce its negative impact on the environment and biodiversity and to adopt more efficient and sustainable production practices. Changes in land use will limit the area available for agriculture and increase the pressure on populations of crop wild relatives (CWR) and wild food plants.

2. PGRFA underpin the ability of agriculture to cope with changes, whether environmental or socio-economic. They will therefore have to play an increasingly important role in securing continued improvements in agricultural production and productivity, not only by providing new genes for improved crop varieties but also by contributing to effective agro-ecosystem function and bioproduct development. In many rural areas around the world, PGRFA are an essential component of the livelihoods strategies of indigenous and local communities.

History of the Global Plan of Action

3. The Global Plan of Action (GPA) for the Conservation and Sustainable Utilization of PGRFA was formally adopted in 1996 by representatives of 150 countries during the Fourth International Technical Conference on Plant Genetic

Resources in Leipzig, Germany. The same conference also adopted the Leipzig Declaration, which underlined the importance of PGRFA for world food security and committed countries to implementing the GPA. More than 150 countries, as well as the public and private sectors, actively participated in preparing the GPA. FAO committed itself to facilitating and monitoring the implementation of the GPA, under the guidance of the intergovernmental Commission on Genetic Resources for Food and Agriculture (the Commission) as part of the FAO Global System for the Conservation and Use of Plant Genetic Resources.

4. At its Eighth Regular Session in 1999, the Commission reaffirmed that FAO should periodically assess the state of the world's PGRFA to facilitate analyses of changing gaps and needs and to contribute to the process of updating the rolling GPA. At its Tenth Regular Session in 2004, the Commission agreed to apply a new approach for monitoring GPA implementation based on internationally agreed indicators, which led to the establishment of the National Information Sharing Mechanisms (NISMs). At its Twelfth Regular Session in 2009, the Commission endorsed the *Second Report on the State of the World's PGRFA* (Second Report) as an authoritative assessment of the sector and requested FAO to update the GPA, based primarily on the Second Report, and, in particular, on the identified gaps and needs, taking into account further contributions from governments as well as inputs received from regional meetings and consultations. The Commission decided that the Second GPA would be considered at its Thirteenth Regular Session.

5. In 2001, the FAO Conference adopted the International Treaty on Plant Genetic Resources for Food and Agriculture (the International Treaty), whose Article 14 recognizes the GPA as a supporting component. In 2006, the Governing Body of the International Treaty decided that the GPA's priorities are also priorities for the International Treaty's Funding Strategy. In 2009, the Governing Body noted the need to ensure close collaboration between itself and the Commission with regard to the GPA and invited the Commission, in revising the GPA, to take into account specific issues of relevance to the International Treaty and to reflect adequately the provisions of the International Treaty in the Second GPA.

Implementation of the Global Plan of Action

6. Since the formulation of the first GPA, based largely on information generated during the preparatory process for the *First Report on the State of the World's Plant Genetic Resources for Food and Agriculture* in the early 1990s, considerable progress has been made in the implementation of the GPA around the world. Nearly 20 percent more accessions are conserved in gene banks worldwide than was the case in 1996, reaching 7.4 million in 2010. Over 240 000 new samples have been collected and added to *ex situ* collections. There were 1 750 gene banks identified in 2010 compared to approximately 1 450 in

1996. The number of botanical gardens has grown from about 1 500 in 1996 to more than 2 500 in 2010. The number of national PGRFA programmes has increased, often with a broader participation of stakeholders. Most countries have now either adopted or revised national legislation dealing with PGRFA and seed systems. The application of modern plant biotechnologies in the conservation and use of PGRFA has grown. Farmers increasingly participate in breeding programmes, and the conservation and use of CWR and landraces has improved. The important role of information in the conservation and use of PGRFA and technological advances in this field are reflected in improved information management at the national, regional and global levels.

7. Overall, international activity in the conservation and sustainable use of PGRFA has increased. The International Treaty has established a Funding Strategy with the activities of the rolling GPA as priorities. Many new regional and crop networks and programmes have been established, largely in response to the priority activities of the GPA. Networks remain very important for promoting cooperation, sharing knowledge, information and ideas, exchanging germplasm and carrying out joint research and other activities. Initiatives, such the Global Crop Diversity Trust (the Trust), that promote and support more rational *ex situ* conservation especially for the crops included in the Multilateral System of Access and Benefit-sharing (Multilateral System) of the International Treaty (i.e. the Annex I crops), build on this type of network. The network of international *ex situ* collections of major crops played an important role in the negotiations of the International Treaty. These collections continue to form the backbone of the FAO Global System for the Conservation and Sustainable Use of PGRFA. The Svalbard Global Seed Vault now provides an additional level of security to existing *ex situ* collections. Furthermore, the development of a global portal of accession-level data and the imminent release of an advanced gene bank information management system are additional important steps towards the strengthening and more effective operation of a global system for *ex situ* conservation. Complementing this is the establishment of NISMs in more than 65 countries to facilitate access to relevant information, monitor GPA implementation and strengthen national decision-making processes as well as collaboration among stakeholders. The Global Partnership Initiative on Plant Breeding Capacity Building (GIPB) represents an effort to fill an important gap in national programmes, by linking the conservation of PGRFA to use in crop improvement. In addition, the GPA Facilitating Mechanism identifies and disseminates information on funding opportunities for all priority activities.

The rationale for the Second Global Plan of Action

8. Since the GPA was formulated and adopted, a number of substantial changes have occurred with respect to the conservation and use of PGRFA, leading to new challenges and opportunities. These developments, which have been

highlighted in the Second Report and which featured prominently in the discussions of the regional meetings and consultations, provide the justification and rationale for updating the GPA.

9. It is anticipated that the following **developments and trends in agriculture** will have significant impacts on the conservation and use of PGRFA:

a) Throughout most of the developed world, the majority of food is supplied by industrialized food production systems, which are driven by strong consumer demand for cheap food of uniform and predictable quality. Crop varieties are bred to meet the requirements of these systems and strict market standards, often under monocropping and monoculture production systems, but also to address biotic resistance, nutritional quality and yield stability. These developments have strengthened the downward trend in genetic and species diversity in farmers' fields.

b) In the developing world, however, a substantial proportion of food is still produced with few, if any, chemical inputs and any food surplus from subsistence farming or home gardens is sold locally. Many millions of small-scale farmers throughout the world depend on locally available PGRFA for their livelihoods and well-being.

c) Urbanization continues to accelerate and it is expected that more than 70 percent of the world's population will live in cities in 2050 as compared with about 50 percent today. Income levels are expected to rise steadily to many times their current levels.[1] Nonetheless, the income disparity between rich and poor will remain very high.

d) There has been a major increase in the international seed trade, which is dominated by fewer and larger multinational seed companies.

e) The ever increasing production and marketing of genetically modified varieties for a growing number of crops is closely related to the previous point and needs close monitoring by the genetic resources community.

f) According to national policies and needs, there is increasing implementation of the International Treaty's Article 9 on Farmers' Rights and greater recognition of the important role that farmers play in the conservation and sustainable use of PGRFA.

10. **Climate change** is an immediate and unprecedented threat to livelihoods and food security and may well be a major barrier to achieving the 60 percent increase in global food production that will be needed by 2050. The following

1 AO. 2009. *How to feed the world in 2050*. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

strategic elements are needed to safeguard PGRFA and use them optimally to help cope with climate change:

- Greater emphasis on *in situ* conservation of genetically diverse populations, especially CWR, to allow evolution to continue and thus permit the continued generation of adaptive traits;

- A significantly expanded programme on *ex situ* conservation, especially of CWR, to ensure the maintenance of diversity of species, populations and varieties, including those adapted to extreme conditions and those from areas expected to be highly affected by climate change;

- Increased research and improved availability of information on the characteristics of material held *ex situ* that will become useful under new climate conditions;

- Increased support for access to and movement of PGRFA to meet the greater interdependence of countries resulting from the new environmental conditions;

- More support for building capacity in plant breeding and seed-systems management that make effective and sustainable use of PGRFA;

- Targeted and increased involvement of farmers and farming communities in national and local crop-improvement activities, including support for participatory research and plant breeding.

11. Over the past 15 years, considerable information has become available about the extent and nature of the genetic erosion and vulnerability of PGRFA. Genetic erosion is reported to continue in many regions of the world and the genetic vulnerability of crops has further increased. The major causes of erosion include the replacement of farmers' varieties/landraces, land clearing, overexploitation, reduced water availability, population pressures, changing dietary habits, environmental degradation, changing agricultural systems, overgrazing, legislation and policy, pests, diseases and weeds. Changes in the seed sector and production methodologies have an impact on the vulnerability of crops. This vulnerability applies in particular to underutilized species that do not find much support from research, plant breeding and/or development/ marketing, and are increasingly neglected by farmers. Yet these species have great potential in the context of climate change, eco-agriculture, dietary diversity and the sustainability of agricultural production systems.

12. Major **advances in key areas of science and technology** have occurred over the past 15 years that are relevant to PGRFA conservation and use. The most important of these advances have been the rapid development of information and communication technologies (ICT), which include the Internet and mobile

phones, the management and analysis of information and developments in molecular biology.

a) **Information management and exchange technologies** have greatly advanced over the past 15 years. There is significantly greater access to information as well as enhanced analytical capacity available to genetic resources workers. The latter includes geographic information systems (GIS) and satellite-based methods such as Global Positioning System (GPS) and remote sensing, which allow PGRFA data to be combined with a wide range of other data in order to locate specific areas of diversity or to identify material from particular habitats.

b) Recent **advances in molecular and genomic methods** have already had a profound impact on key areas of GPA implementation. These methods allow the generation of additional and much more detailed information on the extent and distribution of genetic diversity and can be used in the development of strategies for PGRFA conservation and use. In addition, significantly improved technologies for identifying and transferring genes between related and even unrelated species open completely new horizons for the exploitation of genetic diversity.

c) Whereas relatively few major developments have occurred with respect to ***ex situ* conservation** practices and procedures over the past decade, the new information and molecular tools have the potential to make the conservation and use of PGRFA more effective and efficient. Much work has been undertaken on ***in situ* conservation**, both of CWR and wild food plants, and to an even greater extent, on-farm conservation. The experience gathered and knowledge created have resulted in the recognition of the importance of an integrated, multidisciplinary approach, in which farmers and indigenous and local communities play a leading part and livelihoods and well-being perspectives are fully reflected.

13. There have been major **policy developments** with respect to the conservation and use of PGRFA. These include the adoption in 2000 of an Agricultural Biodiversity Programme of Work by the Conference of the Parties to the Convention on Biological Diversity (CBD), the adoption of the Millennium Development Goals in 2000, the establishment of the Global Strategy for Plant Conservation in 2002, the establishment of the Global Crop Diversity Trust in 2004 and the adoption by the Commission of its Multi-Year Programme of Work (MYPOW), which includes substantial work on PGRFA, in 2007.

14. Undoubtedly, the most important development has been the entry into force of the International Treaty in 2004. Article 14 of the Treaty recognizes the importance of the rolling GPA and commits Contracting Parties to promoting its effective implementation, including through national actions and, as appropriate, international cooperation to provide a coherent framework, among others, for capacity building, technology transfer and exchange of information, taking into account the provisions of benefit-sharing in the

Multilateral System. Contracting Parties also recognize that the ability – particularly of developing countries and countries with economies in transition – to implement priority activities, plans and programmes on PGRFA, taking into account the GPA, will depend largely upon the effective implementation of Articles 6 (Sustainable use of PGRFA) and 13 (Benefit-sharing in the Multilateral System) and the Funding Strategy as provided in Article 18. The GPA framework has been taken into account by the Governing Body of the International Treaty in establishing the priorities of the Benefit-sharing Fund to enable its strategic use in catalysing the sustainable use and conservation of PGRFA. The Second GPA will be an important resource for identifying future priorities.

15. At its tenth meeting in 2010, the Conference of the Parties to the CBD adopted the Strategic Plan for Biodiversity for the period 2011–2020, with 20 Targets. Target 13 of the "Aichi Biodiversity Targets" is the key objective relating to genetic diversity: "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." A number of the other targets also relate to the conservation and sustainable use of plant genetic resources.[2] The Second GPA aims to contribute significantly to the achievement of these targets. Work has been initiated on international indicators related to these targets. The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, adopted in 2010, may, when in force, also have implications for access and the use of certain plant genetic resources.

2 Including **Target 2** (By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems), **Target 5** (By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced), **Target 6** (By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits), **Target 7** (By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity), **Target 11** (By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes), **Target 12** (By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained), **Target 18** (By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels).

16. The GPA mandates the Commission to develop a procedure for reviewing the GPA. Such a review should deal with progress made at the national, regional and international levels in the implementation, elaboration and adjustment as appropriate, of the GPA, thus making it a "rolling" plan as recommended in Agenda 21.

Aims and strategies of the Second Global Plan of Action

17. At its Twelfth Regular Session in 2009, the Commission recommended that the Second GPA be focused, so as to assist priority setting, including identifying priorities for the Funding Strategy of the International Treaty. The Second GPA is based on clear, succinctly stated aims and principles and includes a strategy and information on each priority activity.

18. The main aims of the Second GPA, as agreed by the Commission at its Thirteenth Regular Session and approved by the FAO Council at its 143rd Session in 2011, are:

a) to strengthen the implementation of the International Treaty;

b) to ensure the conservation of PGRFA as a basis for food security, sustainable agriculture and poverty reduction by providing a foundation for current and future use;

c) to promote sustainable use of PGRFA, in order to foster economic development and to reduce hunger and poverty, particularly in developing countries, as well as to provide options for adapting to and mitigating climate change, addressing other global changes and responding to food, feed and other needs;

d) to promote the exchange of PGRFA and the fair and equitable sharing of the benefits arising from their use;

e) to assist countries, as appropriate and subject to their national legislation, to take measures to protect and promote Farmers' Rights, as provided in Article 9 of the International Treaty;

f) to assist countries, regions, the Governing Body of the International Treaty and other institutions responsible for conserving and using PGRFA to identify priorities for action;

g) to create and strengthen national programmes, to increase regional and international cooperation, including research, education and training on the conservation and use of PGRFA and to enhance institutional capacity;

h) to promote information sharing on PGRFA among and within regions and countries;

i) to set the conceptual bases for the development and adoption of national policies and legislation, as appropriate, for the conservation and sustainable use of PGRFA;

j) to reduce unintended and unnecessary duplication of actions in order to promote cost efficiency and effectiveness in global efforts to conserve and sustainably use PGRFA.

19. The GPA is based on the fact that countries are interdependent with respect to PGRFA and that substantial regional and international cooperation will therefore be necessary to meet its aims effectively and efficiently. In this context, the GPA has developed a broad strategic framework comprising seven basic and interrelated aspects:

a) A large and important amount of PGRFA, vital to world food security, is stored in *ex situ* collections. Whereas the maintenance of genetic resources in gene banks and by networks is a well-established procedure in most countries, many of the existing collections need to be further developed and strengthened. Securing adequate storage conditions for the genetic materials already collected and providing for their regeneration and safety duplication is a key strategic element of the GPA. In general, there is a need to establish standard operating procedures for all routine gene bank operations.

b) Linking conservation with use and identifying and overcoming obstacles to the greater use of conserved PGRFA are necessary if maximum benefits are to be obtained from conservation efforts. Effective information management, including the sharing of relevant information widely with users by taking full advantage of advanced information technologies, will be an important prerequisite to achieving this objective. This will increasingly include molecular and genomic information which will need to be linked to, and analysed together with, the characterization and evaluation data of morphological and agronomic traits managed in gene bank databases.

c) Enhancing capacity at all levels is a key strategy for supporting the individual activities of the GPA. The GPA seeks to promote the pragmatic and efficient use and development of institutions, human resources cooperation, and financial mechanisms among others by enhancing the mobility of human and financial resources as a contribution to the establishment of a true global system for PGRFA. Furthermore, there is a need to enhance linkages between scientific

and technological innovation and their application to the conservation and use of PGRFA.

d) Strengthening the efforts of, and partnerships between, public and private sector breeders to conserve and use PGRFA is essential. In addition, participatory breeding and selection, as well as participatory research in general, with farmers and farming communities, need to be strengthened and recognized more broadly as appropriate ways of achieving the sustainable and long-term conservation and use of PGRFA.

e) *In situ* conservation and development of PGRFA occur in two contexts: on farm and in nature. Farmers and indigenous and local communities play a crucial role in both. Enhancing their capacity through linkages to extension agencies, the public and private sector, non-governmental organizations and farmer-owned cooperatives, as well as through providing incentives for *in situ* conservation, will help promote food security, adaptability and resilience, particularly among communities that live in areas with low agricultural potential.

f) Considering the importance of CWR for crop improvement and the fact that they have not been given adequate attention, specific conservation and management activities will be required, including their better protection through improved land-use practices, nature conservation and strengthened indigenous and local communities involvement.

g) Conservation and use strategies at the community, national, regional and international levels are most effective when they are complementary and well coordinated. *In situ* conservation, *ex situ* conservation and sustainable use need to be fully integrated at all levels.

20. Resource mobilization to allow the timely and adequate implementation of the strategic elements described above will require due attention and efforts at all levels, including coordination with the numerous initiatives underway within countries, regionally and globally (the CBD, the UN Framework Convention on Climate Change, etc.).

Structure and Organization of the Second Global Plan of Action

21. The Second GPA has 18 priority activities. For pragmatic and presentational purposes, these are organized into four main groups. The first group deals with ***In Situ* Conservation and Management**; the second with ***Ex Situ* Conservation**; the third with **Sustainable Use**; and the fourth with **Building Sustainable Institutional and Human Capacities**. As the GPA is a set of integrated and intertwining activities, the placement of the activities into four groups is

intended simply to help order the presentation and guide the reader to areas of particular interest. Many priority activities relate and are relevant to more than one group.

22. For each priority activity, there is a basic set of headings or sections, intended to aid in the presentation of the proposed area. In some cases, recommendations found under one heading might just as appropriately been placed under another. While no strict section definitions are considered necessary, a few explanatory remarks may be useful:

a) The Background section provides a rationale for the priority activity and a summary of achievements since 1996, mainly based on the findings reported in the Second Report.

b) The Objectives section specifies the ultimate and intermediate objectives to be accomplished under the priority activity. The explicit articulation of objectives can aid the international community in judging the extent of implementation of the priority activity over time.

c) The Policy/strategy section proposes national and international policies and strategic approaches to implement the objectives of the priority activity. In some cases, there are recommendations for new international policies; in other cases there are proposals for changes in approaches, priorities and visions.

d) The Capacity section indicates the human and institutional capabilities that should be developed or provided through the implementation of the priority activity.

e) The Research/technology section, which includes technology development and transfer, identifies areas of scientific, methodological or technological research or action relevant to the implementation of the priority activity.

f) The Coordination/administration section addresses how such issues might be approached as the priority activity is planned and implemented. The focus of this section has mainly been limited to the national level to avoid repetitions, as the need further to strengthen collaboration with relevant international organizations and agricultural research centres and to increase the sharing of information among all organizations and stakeholders applies in all priority activities. International collaboration is critical to gaining maximum benefits under legal and policy instruments such as the CBD and the International Treaty and to meet associated obligations.

23. On occasion, institutions or constituencies are specifically identified in the body of a particular priority activity. This is not meant to imply their exclusion from activities where they are not mentioned. Such references are used to highlight a role that is particularly critical or that may otherwise be overlooked, or both.

In Situ Conservation and Management

1. Surveying and inventorying plant genetic resources for food and agriculture

24. **Background:** Rational conservation of PGRFA (*in situ* and *ex situ*) begins with surveys and inventories, as highlighted in Article 5 of the International Treaty. In order to elaborate policies and strategies for the conservation and sustainable use of PGRFA, national programmes need to know what resources exist in their countries, their distribution and the extent to which they are already being conserved. Countries that have ratified the CBD have acknowledged specific responsibilities in this regard (for example in the Programme of Work on Agricultural Biodiversity). Wider accessibility to georeferencing tools has facilitated surveying, and the development and application of modern molecular biology techniques have assisted in assessing the extent of genetic diversity and, in some cases, of genetic erosion. During the past decade, most surveys have been restricted to individual crops or limited areas, although some progress has been made in inventorying CWR and establishing specific sites for their *in situ* conservation. Nonetheless, efforts in protected areas to survey, inventory and conserve PGRFA have been limited in comparison with those devoted to other components of biodiversity. Several international organizations have contributed to monitoring the conservation status of wild plants of agricultural relevance regionally and globally, but stronger partnerships with organizations in the environment sector need to be pursued, especially at the country level.

25. **Objectives:** To facilitate the development, implementation and monitoring of complementary conservation strategies and national policies related to the conservation and sustainable use of PGRFA. To strengthen linkages between ministries of agriculture and of the environment and to promote monitoring of the status and trends in PGRFA and thereby to ensure their adequate conservation.

26. To develop and apply methodologies for surveying and inventorying PGRFA *in situ* and *ex situ*, including GIS, satellite-based methods (for example GPS and remote sensing) and molecular markers. To identify,

locate, inventory and assess threats to PGRFA, particularly from land-use and climate changes.

27. **Policy/strategy:** The ability to identify species will be a key element for this priority activity. The surveying and inventorying of PGRFA, as needed, should be considered as the first step in the process of conservation and reducing the rate of biodiversity loss. Without the capacity to conserve and/or use biodiversity, however, such work may be of marginal utility. Thus, surveying and inventorying should be linked to specific objectives and plans for *in situ* conservation, collecting, *ex situ* conservation and use. Standard definitions and methods need to be promoted for directly assessing genetic vulnerability and genetic erosion. There is also an urgent need to develop improved indicators, including proxy indicators, of diversity, genetic erosion and vulnerability that can be used to establish national, regional and global baselines. These indicators should be objective and balanced, taking into account the systems in use at the national level. They should not establish punitive measures, nor affect country sovereignty over genetic resources, nor impose specific information systems. General agreement needs to be pursued on the design and use of such indicators.

28. Local and indigenous knowledge should be recognized as an important component of survey and inventory and should be carefully considered and documented where appropriate and with the prior informed consent of indigenous and local communities.

29. **Capacity:** Countries should provide, and may benefit from, financial and technical support for surveying and inventorying PGRFA. There are numerous obstacles to surveying and inventorying PGRFA, including a lack of adequately trained staff. Training and capacity building should be undertaken in several areas of research, including plant identification, population biology, ethnobotany, use of GIS and GPS, and molecular tools. The capacity to gauge the impact of climate change and to assess adaptation is also increasingly relevant, particularly if genetic diversity conserved *in situ* is to be maintained sustainably over the longer term.

30. **Research/technology:** Adequate support should be given to developing better methodologies for surveying and assessing inter- and intra-specific diversity in agro-ecological systems. There is also a strong need to develop scientifically sound and easily implemented indicators for monitoring the status and trends of PGRFA, especially at the genetic level.

31. There are specific research needs related to the *in situ* conservation of PGRFA. More complete inventories are needed to enable better targeting of *in situ* conservation activities. If such inventories were associated with actual or predicted data on specific traits of interest, they would have even more value and would provide a useful link to *ex situ* conservation and

use. Existing information sources should be used to determine the extent to which CWR exist in protected areas.

32. A particularly important research area is the development of indicators that can be used to monitor changes in the extent and distribution of diversity at different scales and to aggregate information on individual species and populations. This research will materially strengthen national conservation planning and decision-making.

33. **Coordination/administration:** Coordination must take place in-country between ministries dealing with agriculture, environment, research, science and technology, and regionally, given that species cross national boundaries. Regional- and global-level coordination is needed to strengthen linkages between existing *ex situ* and *in situ* conservation efforts.

34. 34. Strong links need to be established with national, regional and crop networks and with the users of PGRFA (breeders, researchers and farmers) in order to inform, direct and prioritize the entire conservation process. Countries should collaborate in surveying and inventorying activities in order to build capacity.

2. Supporting on-farm management and improvement of plant genetic resources for food and agriculture

35. **Background:** Plant breeding has helped to raise crop yields, improve resistance to pests and diseases and enhance the diversity and quality of agriculture and food products, especially in favourable environments. Farmers choose to grow modern varieties for many reasons, including market conditions, family food security and environmental sustainability. Although these choices often result in significant genetic erosion, the last two decades have provided substantial evidence that many farmers in the developing world, and increasingly in developed countries, continue to maintain significant crop genetic diversity in their fields. This diversity constitutes an important element in the livelihood strategies of farmers because of its ability to adapt to marginal or heterogeneous environments. Crop diversity is also maintained to meet changes in market demands, labour availability and other socio-economic factors, as well as for cultural and religious reasons.

36. A range of initiatives and practices has become available to help farming communities continue to benefit from maintaining and using local crop genetic diversity in their production systems. Building capacity

and leadership in communities and local institutions is a precondition for implementing such community-based initiatives. Promoting and supporting on-farm management of genetic resources have become firmly established key components of crop conservation strategies. As a result, on-farm management of PGRFA is one of the three first priorities of the Benefit-sharing Fund of the International Treaty.

37. Despite this progress, significant technical and methodological questions remain. In particular, there is room for improving the coordination of on-farm management with *ex situ* conservation and use. In order to realize the full potential of on-farm improvement, these practices need to be fully integrated into rural development policies.

38. Concerns about the impact of climate change on agriculture have grown substantially over the past decade. Farmers may no longer be able to grow their own traditional varieties and landraces in changed climates, and they will therefore need access to new germplasm. Furthermore, agriculture is both a source and a sink for atmospheric carbon. PGRFA are becoming recognized as critically important for the development of farming systems that are resilient to climate change, capture more carbon and produce fewer greenhouse gases. They will underpin the breeding of new adapted crop varieties that will be needed for agriculture to cope with future environmental conditions. There will be an increased need for linkages between local seed systems and gene banks and networks to secure new germplasm adapted to changed climates.

39. **Objectives:** To use the knowledge generated during the past two decades in order to promote and improve the effectiveness of on-farm conservation, management, improvement and use of PGRFA. To achieve a better balance and integration between *ex situ* and *in situ* conservation. To realize Farmers' Rights as detailed in Article 9 of the International Treaty at the national and regional levels and according to national legislation and priorities. To promote the equitable sharing of benefits arising from the use of PGRFA as called for in Article 13 of the International Treaty. To foster the future emergence of public and private seed companies and cooperative enterprises that address local needs as an outgrowth of successful on-farm crop selection and breeding. To maintain traditional seed exchange and supply systems, including community gene banks, and strengthen local markets for products, especially for small-scale and subsistence farmers in developing countries and taking into account phytosanitary constraints. To take full account of the role of women in agricultural production in many developing countries, particularly regarding on-farm management of PGRFA. To foster successful selection and breeding, particularly in the light of climate change.

40. To address gaps in knowledge about the dynamics, methodologies, effects and potential of on-farm conservation and crop improvement. To establish or strengthen programmes and networks for on-farm management of farmers' varieties/landraces, CWR, wild food plants and rangeland genetic resources and to integrate their work into rural development policies and activities. To extend the role of national, regional and international gene banks and networks to include support for, and provision of materials to, on-farm improvement programmes in a more integrated manner. To build on-farm programmes based on local and traditional systems of knowledge, institutions and management, ensuring local participation in planning, management and evaluation. To focus greater public and scientific attention on the diverse roles that gender and age play in production and resource management in rural households.

41. **Policy/strategy:** Although on-farm management activities have now moved beyond the stage of small-scale research through methodological projects, these activities still need to be fully integrated into wider conservation and development strategies and/or action plans. On-farm activities complement more formal crop variety development and strengthen seed supply systems. Institutional flexibility will be needed in working with farming communities. Specific strategies need to be developed for conserving PGRFA *in situ* and for managing crop diversity on farm and in protected areas. Special attention should be paid in these strategies to conserving CWR in their centres of origin, centres of diversity and biodiversity hotspots. Best practices must be disseminated on conservation and sustainable use of PGRFA that support and maintain the social, economic and cultural values of local and indigenous communities and improve the quality of life. This will be best achieved by involving such communities in all aspects of managing and improving PGRFA on farm.

42. Governments should consider how production, economic incentives and other policies, as well as agricultural extension and research services might facilitate and encourage the on-farm management and improvement of PGRFA. Increasingly, the value of conservation needs to be demonstrated in terms of its continued provision of ecosystem services. The importance of PGRFA as one of these services is just beginning to be fully recognized and efforts to document the value of CWR and landrace diversity in this regard should continue and intensify.

43. There will be a specific need to integrate CWR and landrace conservation into existing conservation strategies to ensure that agricultural biodiversity and biodiversity more generally are not addressed as separate entities. This will require that the conservation of agricultural biodiversity becomes a feature of wider biodiversity conservation initiatives and programmes at national, regional and international levels.

44. Where appropriate, national policies should aim to strengthen the capacity of indigenous and local communities to participate in crop improvement efforts. Decentralized, participatory and gender-sensitive approaches to crop improvement need to be strengthened in order to produce varieties that are specifically adapted to socio-economically disadvantaged environments. This may require new policies and legislation – including appropriate protection, variety release and seed certification procedures for varieties bred through participatory plant breeding – in order to promote and strengthen their use and ensure that they are included in national agricultural development strategies.

45. Greater attention needs to be paid to on-farm conservation and use of underutilized species, many of which can make a valuable contribution to improving diets and incomes. In order to capture the potential market value of such crops, there must be greater cooperation at different stages in the production chain, from the development and testing of new varieties, through value-adding activities, to the opening up of new markets.

46. **Capacity:** Adequate support should be given to community-based organizations and user groups engaged in providing practical assistance to on-farm conservation and improvement work. The ability of farmers, indigenous and local communities and their organizations, as well as extension workers and other stakeholders to manage agricultural biodiversity sustainably on farm needs to be strengthened.

47. To support on-farm improvement activities, gene banks, networks and national and international organizations should consider identifying appropriate farmers' varieties/landraces for multiplication and/or for developing new breeding populations that incorporate specific traits into locally adapted materials.

48. Interdisciplinary training programmes should be developed for extension workers, non-governmental organizations and others to facilitate and catalyse on-farm activities, including selection and breeding techniques appropriate to supplementing and improving those already used by farmers.

49. The focus of training programmes should be on helping farmers to gain new knowledge and technologies and to explore new markets for their products and on helping researchers to become better enablers and supporters of farmers. Training should be aimed at four different groups: scientists (including plant breeders, researchers and agricultural economists), technical support staff, extension agents (including non-governmental organizations) and farmers. Support for advanced degree work should include relevant training in the biological and social sciences. Training for extension agents should aim to increase their skills in

ethnobotany, participatory selection and breeding, seed maintenance and the use of ICT tools.

50. Training for farmers should be carried out in the context of the whole production chain and mainly focus on the identification of plant traits, selection/breeding, use and maintenance of local crops, and the promotion of product sales. It is important to develop farmers' skills in selecting plants at the vegetative state and not only after harvest.

51. Training programmes should be designed in close collaboration with the National Agricultural Research System (NARS), farmers, farmer organizations and other stakeholders, and should be based on the needs expressed by these partners. Such programmes should not neglect the central role that women play in influencing and directing the evolution of crops. Training programmes should consider the different uses of biological resources by women and men, including the concern of women for the multiple uses and processing requirements of crops.

52. **Research/technology:** Eight types of rigorous, multidisciplinary scientific research are needed:

a) further ethnobotanical and socio-economic/sociocultural research to understand and analyse farmers' knowledge, selection/breeding, use and management of PGRFA, consistent with the approval of the farmers involved and with applicable requirements for protection of their knowledge and technologies;

b) population and conservation biology to understand the structure and dynamics of genetic diversity in local farmers' varieties/landraces, including population differentiation, gene flow including introgression, degree of inbreeding and selective pressures;

c) crop improvement research, including participatory breeding, as a means of increasing crop yields and reliability without significant losses of local biodiversity;

d) research and extension studies for underutilized crops, including production, marketing and distribution of seed and vegetatively propagated planting materials;

e) studies of the most effective ways to integrate on-farm and *ex situ* conservation, considering the complementarity of different seed systems;

f) studies on the extent and nature of possible threats to existing diversity on farm and *in situ*, particularly climate and land-use change, including their effects on pollinators;

g) spatial analysis to identify varieties likely to have climate-adapted traits as an aid to plant breeding;

h) studies to quantify genetic erosion.

53. Scientific research should, when possible, be combined with on-farm activities so that the context and purpose of the work can be fully evaluated. Phenotyping techniques can be used to characterize farmers' varieties/landraces in relation to specific traits and adaptability to various field conditions. Research should assist the monitoring, evaluation and improvement of on-farm activities. Research should be undertaken in a participatory and collaborative manner to foster interaction and cooperation among stakeholders, including farmers, breeders and the staff of national institutions. Other institutions should be involved appropriately when necessary.

54. Methods should be developed and assistance provided for integrating *in situ* and on-farm management and conservation of PGRFA with national and regional gene banks/networks and research institutes.

55. **Coordination/administration:** Coordination efforts in this area should encourage community-level initiatives to support on-farm management and improvement of PGRFA. Small, grassroots projects should receive priority funding and support services. Precedence should be given to farmer-initiated technical projects that promote crop diversity and collaboration between farming communities and research institutions. Such projects should be sufficiently long in duration (10 years or more) to guarantee significant results.

56. Links between organizations that are primarily concerned with conservation of PGRFA and those concerned with its use are often weak or absent in many countries and these should be strengthened.

3. Assisting farmers in disaster situations to restore crop systems

57. **Background:** Natural disasters and civil strife often challenge the resilience of crop systems; this especially affects small-scale and subsistence farmers in developing countries. Seed security is a key component of resilience. Whereas immediate seed assistance can help farmers affected by an acute disaster, a more systematic approach to re-establishing seed security and crop systems is needed in the case of chronic stress. In particular, there is growing recognition of the threats posed by climate change to seed

and food security and the potential role that PGRFA can play in helping agriculture remain productive and robust under changed conditions. When crop varieties are lost from farmers' fields, they can often be re-introduced over time from nearby areas, with some support, through local markets and farmer-to-farmer exchange. They can also be re-introduced from national, regional or international gene banks and networks. However, gene banks are sometimes themselves compromised by natural and human-induced disasters and, in such cases, their ability to support the restoration of crop systems will rely on their capacity to access materials held in other gene banks. Article 12 of the International Treaty provides a sound basis for improving and facilitating such access. National, regional and global information systems are needed to support crop restoration activities.

58. Grain imported as food aid is often used as seed and is often poorly adapted to local conditions. This can result in reduced yields for years. Imported seed of poorly adapted varieties has the same effect. In the long run, inappropriate food and seed aid practices can exacerbate hunger, undermine food security, distort local seed systems and increase the cost of donor assistance. In recognition, a fundamental shift in thinking over the past decade has led to a seed security framework. The objective of the framework is to investigate the functioning of seed systems and to describe the situation in terms of availability, access and quality of seed. After disasters, farmers often have difficulty accessing seeds of locally adapted varieties, even though they may be available, because they have lost financial and other assets. The new thinking has led to better coordination among agencies and to new types of seed interventions that go beyond direct distribution of seeds and other inputs to farmers. These interventions include market-based approaches such as seed vouchers and input trade fairs, and community-based seed multiplication initiatives for both farmers' varieties and improved varieties.

59. **Objectives:** To rehabilitate affected crop systems based on locally adapted PGRFA, including the restoration of germplasm as appropriate, in support of farming community livelihoods and sustainable agriculture.

60. To develop the capacity to assess and establish seed security, including helping farmers to access locally adapted PGRFA.

61. To establish institutional responsibilities and mechanisms to identify, acquire, multiply and deliver appropriate PGRFA.

62. To strengthen the capacity of relevant rural communities and farmers to identify and access relevant PGRFA held *ex situ*.

63. To ensure that crop varieties delivered to stressed communities are adapted to local conditions.

64. **Policy/strategy:** Governments, with the cooperation of relevant farmers' organizations and communities, UN bodies and regional, intergovernmental and non-governmental organizations should establish policies at all levels to allow the implementation of appropriate seed security activities in response to disasters, including climate change.

65. Governments should develop policies and strategies for disaster risk planning and response that fully consider seed security issues and the location-specific requirements of seed security interventions. This will include promoting seed security assessments and developing guidelines for best practices for seed interventions.

66. Efforts are needed to conserve farmers' varieties/landraces and CWR before they are lost due to changing climates and other threats. Special efforts are needed to identify the species and populations that are most at risk and that carry potentially important traits.

67. Countries need to establish or strengthen genetic erosion monitoring systems, including easy-to-use indicators. Support should be given to collecting farmers' varieties/landraces in particularly vulnerable or threatened areas, where these are not already held *ex situ*, so that these genetic resources can be multiplied for immediate use and conserved for future use. National gene bank collections should be duplicated outside the country, for example in the gene banks of neighbouring countries, and/or in regional or international gene banks. To avoid excessive duplication, a systematic global assessment is needed of the extent to which existing collections are backed-up.

68. Gene banks and networks should make characterization and evaluation information available to assist in identifying useful accessions for restoring crop systems, respecting access and benefit-sharing agreements. The Multilateral System of the International Treaty should facilitate this process.

69. **Capacity:** National and international agricultural research institutions should collaborate with FAO and other appropriate agencies to establish mechanisms for rapidly acquiring, multiplying and providing PGRFA to countries in need. Such agencies should ensure that they have adequate capacity for the task. Cooperation among public, private and non-governmental organizations is an important contribution to efforts to distribute locally adapted germplasm in regions that are recovering from disasters.

70. Information systems must be established to identify, and assist in obtaining, appropriate germplasm for restoration or reintroduction.

71. Governments and international emergency agencies should consider making adequate funds available to multiply seeds of locally adapted PGRFA in response to emergency demand following disasters.

72. Response interventions can be complemented by preventive national and community-based seed multiplication initiatives, and governments should strengthen capacities to cope with disasters and support the re-emergence of local seed-supply networks and crop systems. The role of farmers in conserving local varieties/landraces should be recognized as this represents an important source of genetic diversity for restoration.

73. **Research/technology:** Studies are needed on the extent and nature of possible threats to existing diversity on farm and *in situ*. Previous experience should be reviewed and options developed to enhance gene bank preparedness to rescue *ex situ* collections and to collect seed in the context of emergencies, including civil strife, industrial accidents and natural disasters. These efforts will benefit from close collaboration among governments of the countries affected, donors, non-governmental and private organizations, national, regional and international agricultural research institutes, regional plant genetic resource networks and relevant intergovernmental agencies. Research on how rural communities can identify, obtain and use PGRFA held *ex situ* is also needed.

74. Studies are also needed on pre-disaster seed production and delivery systems, including agro-ecologies, crop calendars, local seed flows, seed markets and seed stocks. Information that can assist planners in disaster risk reduction and response is lacking, especially regarding the anticipated impacts of climate change.

75. **Coordination/administration:** At the national level, there is a need for coordination among ministries of agriculture and the environment and agencies involved in disaster preparedness and response. Non-governmental organizations will have a particularly important role to play. Public awareness efforts are needed to sensitize the donor community and non-governmental organizations to the importance of adapted PGRFA in relief and rehabilitation efforts. Such efforts should also increase awareness of the need for safety duplication of *ex situ* collections in other countries.

4. Promoting *in situ* conservation and management of crop wild relatives and wild food plants

76. **Background:** Natural ecosystems contain important PGRFA, including rare, endemic and threatened CWR and wild food plants. These species

are becoming increasingly important as sources of new traits for plant breeding. Ideally, CWR and wild species are conserved *in situ*, where they can evolve under natural conditions. Unique and particularly diverse populations of these species must be protected *in situ* when under threat. Most of the world's national parks and other protected areas, however, were established with little specific concern for the conservation of genetic diversity of any plants, let alone CWR and wild food plants. Management plans for protected areas do not specifically address genetic diversity of these species, but could be modified to complement other conservation approaches. It can be argued that actively conserving CWR genetic diversity in protected area networks will significantly improve the understanding of their value in ecosystem services, which in turn will underpin the long-term security of the protected area itself.

77. Many protected areas are under threat of degradation and destruction. Climate change represents an additional serious threat. It is therefore necessary to complement conservation in protected areas with measures aimed at conserving genetic diversity outside such areas, including through *ex situ* conservation as appropriate. *In situ* conservation implies comprehensive planning, which should consider and accommodate the often-conflicting demands of environmental protection, food production and genetic resources conservation.

78. **Objectives:** To use the genetic resources of CWR and wild food plants sustainably, and conserve them both in protected areas and on lands not explicitly listed as protected areas.

79. To promote planning and management practices in important *in situ* conservation areas for CWR and wild food plants. To assess the threats to, and conservation status of, priority CWR and wild food plants and develop management plans for their protection *in situ*. To improve knowledge of the uses of wild plants as sources of income and food, particularly by women.

80. To create a better understanding of the contributions of CWR and wild plants to local economies, food security and environmental health. To improve management and planning and promote complementarity between conservation and sustainable use in parks and protected areas by, among other things, increasing the participation of indigenous and local communities in ensuring the active conservation of CWR and wild food plant genetic diversity.

81. To establish better communication and coordination among the various bodies engaged in *in situ* conservation and land-use management at national and regional levels, especially between the agriculture and environment sectors.

82. **Policy/strategy:** Governments, subject to national legislation, in collaboration with stakeholders and non-governmental organizations and taking into account the views of farmers and indigenous and local communities, should:

a) include, as appropriate, among the purposes and priorities of national parks and protected areas, the conservation of PGRFA, in particular appropriate forage species, CWR and species gathered for food or feed in the wild, including in their biodiversity hotspots and genetic reserves;

b) consider integrating the conservation and management of PGRFA, particularly CWR and wild food plants, in land-use plans in their centres of origin, centres of diversity and biodiversity hotspots. The centres of diversity are primarily located in developing countries, where resources may be limited and capacity building and technology transfer required. *In situ* conservation strategies should be complementary to *ex situ* strategies;

c) support the establishment of national and local objectives for protected area management through broad-based participation, involving the groups of people who are most dependent on wild food plants;

d) support the creation of advisory panels to guide the management of protected areas. Where appropriate, involve farmers, indigenous and local communities, PGRFA scientists, local government officials from various ministries and community leaders, according to national legislation;

e) note the interrelationship between genetic resources and traditional knowledge, their inseparable nature for indigenous and local communities, the importance of traditional knowledge for PGRFA and for the sustainable livelihoods of these communities, especially in protected areas, according to national legislation;

f) recognize that women are a valuable source of information on the feasibility of *in situ* conservation and management practices;

g) adopt improved measures to counter the threat of invasive alien species that could affect negatively the *in situ* conservation of CWR and wild food plants;

h) support efforts by indigenous and local communities to manage CWR and wild food plants in protected areas;

i) review existing requirements for environmental impact statements to include an assessment of the likely effect of the proposed activity on local biodiversity for food and agriculture, particularly on CWR;

j) integrate genetic conservation objectives into the sustainable management of CWR and wild food plants in protected areas and other managed resource areas;

k) collate information on CWR and wild food plants and make the information available through NISMs and specialized global information systems.

83. Governments, in cooperation with relevant UN bodies, regional, intergovernmental and non-governmental organizations, and farming, indigenous and local communities living in non-protected areas should seek, where possible and appropriate, to:

a) develop national strategies for CWR management considering *in situ* and *ex situ* conservation and sustainable use;

b) take action to conserve the diversity of CWR and wild food plants as an integral component of land-use planning;

c) encourage indigenous and local communities to conserve and manage CWR and wild food plants and provide for their participation in decisions relating to local conservation and management.

84. As appropriate and feasible, protected area policies should promote and sustain, rather than restrict, those human activities that maintain and enhance genetic diversity within and among plant species. Participatory approaches to the management of protected and related areas should also be encouraged in order to reconcile the sometimes conflicting goals of conservation and local livelihood security.

85. In parallel with the national approach, there is also a need for a complementary global perspective that focuses on securing the *in situ* conservation of the world's most important CWR species, including through the establishment of a global network of genetic reserves. While it is recognized that the prime locations for the *in situ* conservation of CWR diversity will be in existing protected areas, because these have been established with ecosystem conservation in mind, the possibility of *in situ* conservation of CWR outside protected areas should also be evaluated.

86. FAO should promote the adoption and implementation of a global strategy for CWR management that can serve as a guide for government action, recognizing that there is a requirement for action at both national and global levels.

87. **Capacity:** Governments should, whenever possible, and as appropriate:

a) develop a prioritized plan, particularly for those ecosystems in which high levels of diversity of CWR and wild food plants are found, and conduct national reviews to identify management practices needed to safeguard the desired level of genetic diversity of CWR and wild food plants;

b) assist indigenous and local communities in their efforts to identify, catalogue and manage CWR and wild food species;

c) monitor the holdings, distribution and diversity of CWR and wild food plants, integrate and link data and information from *in situ* conservation programmes and *ex situ* programmes, and encourage private and non-governmental organizations to do likewise.

88. **Research/technology:** Research needs relating to *in situ* management of CWR and wild food plants include:

a) studies on their reproductive biology and ecological requirements;

b) species classification and identification and ethnobotany;

c) description of gene pools and population surveys, using molecular tools as well as models for assisted migrations of CWR populations that may be threatened in their natural habitats;

d) understanding the value of CWR *in situ* and the role they play in ecosystem services.

89. **Coordination/administration:** Governments should, as appropriate:

a) link protected-area planning and management with organizations that are responsible for the conservation and sustainable use of CWR and wild food plants, such as centres for crop genetic resources, national crop genetic resources coordinators, national protected area network managers and botanical gardens, including organizations involved in the environment sector;

b) designate focal points, as appropriate, to catalyse the coordination of *in situ* protection programmes and liaise with other countries in the region;

c) establish mechanisms for periodic review and modification of conservation plans;

d) include information on CWR in specialized global information systems to aid information exchange and dissemination.

Ex Situ Conservation

5. Supporting targeted collecting of plant genetic resources for food and agriculture

90. **Background:** The prime motivating forces for most collecting are gap filling, imminent risk of loss and opportunities for use. The germplasm currently conserved in gene banks does not represent the total variation in PGRFA. Many major crops have generally been well collected, but some gaps still exist. Collections of most regional, minor, and underutilized crops are much less complete. CWR, even of major crops, have received little attention relative to their potential importance in breeding. The global crop strategies supported by the Trust make an attempt to identify gaps in global holdings of some major food crops. However, in the absence of comprehensive analysis of all the genetic diversity represented in the world's gene banks, these conclusions remain tentative. In addition, collecting missions conducted with inadequate methodologies may not have successfully sampled diversity. Also, the extent and distribution of diversity in wild populations and farmers' varieties/landraces, particularly for annual crops, change over time. Suboptimal conditions in gene banks may also have led to the loss of collected materials.

91. Global threats to PGRFA *in situ* and on farm have increased during the past 20 years as a result of the increased impact of human activities. Major threats to landraces and CWR conservation are linked to the lack of funds and the long-term impact of agricultural policies, as well as the replacement of such varieties by modern varieties, climate change, alien invasive species and land-use change, including urbanization. A recent assessment indicates that up to 20 percent of plant species may be threatened with extinction globally. It is unlikely that the figure is lower for CWR. An urgent need for resistance to biotic and abiotic stresses, as well as for nutritional and other traits, also warrants further collecting.

92. **Objectives:** To collect and conserve the diversity of PGRFA and associated information, focusing on diversity that is missing from *ex situ* collections, under threat or anticipated to be useful.

93. To identify priorities for targeted collecting in terms of missing diversity, potential usefulness and threatened environments.

94. **Policy/strategy:** Policy-makers need to be made aware of the continuing need to improve the coverage of diversity in *ex situ* collections, including CWR, farmers' varieties/landraces and wild food plants and forages. Best practices should be documented with regard to the objectives and obligations set forth in the CBD and Articles 5 and 12.3 h of the International Treaty, for example the right of Contracting Parties to the CBD to require prior informed consent before providing access to genetic resources and their obligation, subject to national legislation, to respect the knowledge of indigenous and local communities regarding the conservation and sustainable use of biological diversity.

95. **Capacity:** Collected material should be deposited in facilities with the capacity to manage them in the country of origin, and elsewhere for safety duplication, as agreed by the country of origin prior to the collecting mission. Where such facilities do not exist in the country of origin, they should be developed, as appropriate, and, in the meantime, the materials could be managed in other countries as agreed with the country of origin prior to the collecting mission.

96. Full consideration should be given to the capacity to conserve collected material effectively and sustainably before collecting is initiated.

97. Training in scientific collecting methods for PGRFA should be undertaken, especially in connection with the use of tools and methods that enhance collecting efficiency and effectiveness, such as GPS, spatial modelling programs and ecogeographic surveying.

98. **Research/technology:** Research is needed to identify gaps in existing *ex situ* collections in order to ensure that the entire gene pool is adequately represented; this will require access to and availability of accurate passport and other data. The use of GIS and molecular technologies can also help to identify gaps and facilitate the planning of collecting missions. In the case of some CWR, research may be needed on the taxonomy and botany of the targeted species.

99. **Coordination/administration:** Coordination in the country concerned, as appropriate, should involve gene banks and herbaria and other institutes with taxonomic expertise. Regional- and international-level coordination may be needed to provide linkages with certain *ex situ* collections and gap-filling and regeneration efforts. Such coordination might concern the identification of global needs or specific national needs that could be met by PGRFA in another country.

100. Strong linkages need to be established with regional and crop networks and with the users of PGRFA (breeders, researchers and farmers) in order

to inform, direct and prioritize the entire conservation process, including surveying, inventorying and collecting.

101. Mechanisms must be developed at all levels for emergency collecting of PGRFA, in particular endangered CWR. These mechanisms should make full use of, and therefore should be closely linked with, information and early warning systems.

102. Governments should designate a focal point within their PGRFA programmes for administering collecting requests.

6. Sustaining and expanding *ex situ* conservation of germplasm

103. **Background:** Currently, seed, field and *in vitro* gene banks conserve approximately 7.4 million germplasm accessions, about a quarter of which are estimated to be distinct samples duplicated in several collections. These are complemented by over 2 500 botanical gardens worldwide that grow over one-third of all known plant species and maintain important herbaria and carpological collections. Driven by an increasing need for diversification, interest in collecting and maintaining collections of underutilized crops, wild food species, forages and CWR is growing; however, such species tend to be more difficult to conserve *ex situ* than major food or forage crops. Many important crop species do not produce seed that can be stored under conditions of low temperature and humidity, and the conservation of such plants, with recalcitrant seeds or vegetatively propagated, is still not being given sufficient attention.

104. Globally, governments and donor agencies need to invest more in conservation infrastructure, in particular for species that cannot be conserved in seed banks, taking particular account of maintenance costs over the long term. This will stem the steady deterioration of many facilities and enhance their ability to perform basic conservation functions. The severity of the threat to *ex situ* collections is reflected in the high percentage of accessions identified as needing regeneration in country reports[3], as well as in the lists of technical and administrative problems associated with maintaining gene bank activities. The Trust aims to support better planning and more coordination and cooperation in order to limit redundancy and promote rationalization at the global level. The goal is to reduce the overall costs of conservation and place gene bank operations

3 Submitted for the preparation of the Second Report.

on a scientifically sound and financially sustainable basis. Options need to be further explored for more cost-effective and rational conservation.

105. Regional collaboration on *ex situ* conservation must be strengthened.

106. The Svalbard Global Seed Vault, which opened in 2008, represents a major new international initiative to improve the safety of existing collections of orthodox seed. Similar efforts are not yet planned for recalcitrant species and vegetatively propagated crops.

107. **Objectives:** To develop a rational, efficient, goal-oriented, economically efficient and sustainable system of *ex situ* conservation and use for both seed and vegetatively propagated species.

108. To develop and strengthen national, regional and international networks, including the existing Multilateral System of the International Treaty. To develop sufficient capacity to provide options to countries for the voluntary storage of useful genetic materials and their duplicates. To develop management strategies for *ex situ* conservation of vegetatively propagated and non-orthodox seeded plants, as well as for species and genetic and genomic stocks that have been neglected in current conservation activities. To promote the development and transfer of appropriate technologies to conserve such plants and to encourage and strengthen the involvement of botanic gardens in the conservation of PGRFA. To promote the exchange of information about PGRFA in gene banks. To set conservation priorities using more complete characterization and evaluation data.

109. To reduce unnecessary redundancy of germplasm accessions in current conservation programmes, make use of available germplasm storage space and promote the exchange of information about PGRFA in line with national priorities and laws and relevant regional and international agreements, including the International Treaty. To provide for the planned replication and safe storage of materials not currently safety duplicated.

110. **Policy/strategy:** The international community has interests in and responsibilities for the *ex situ* conservation of PGRFA. It is this understanding that provides the basis for an effective, integrated and rational global plan to secure existing collections. Countries have national sovereignty over, and responsibility for, the PGRFA they conserve; nevertheless, greater rationalization of the global system of *ex situ* collections is needed.

111. Governments, international agricultural research centres, non-governmental organizations and funding agencies should provide adequate, appropriate and balanced support for the conservation of vegetatively propagated and recalcitrant seeded plants in addition to the support provided to conserve the seeds of orthodox species. In this regard,

botanic gardens and field gene banks should be strengthened in their capacity to conserve important underutilized species.

112. Full use should be made of existing facilities, including national, regional and international centres. Conserved materials should be replicated and stored in long-term facilities that meet international standards, in accordance with applicable international agreements. Unintended and unnecessary duplications between collections should be reduced to promote cost efficiency and effectiveness in global conservation efforts. Countries could be assisted in identifying which genetic resources have already been stored and duplicated in long-term facilities.

113. FAO, in cooperation with countries and with relevant institutions, should facilitate the formalization of agreements to safeguard diversity in *ex situ* collections in conformity with applicable regional or international agreements, including the International Treaty. This would allow those countries to voluntarily place collections in secure facilities outside their boundaries.

114. Capacity: Relevant personnel should be trained at all levels to implement and monitor the policies and agreements described above. National institutions should evaluate current gene bank management practices with the aim of creating more rational, efficient and user-oriented *ex situ* conservation systems. Appropriate facilities, human resources and equipment should be made available to national PGRFA programmes.

115. Existing PGRFA collections should be secured. Particular care must be taken to safeguard the original accessions in threatened collections.

116. Support should be given to training on *in vitro* techniques and other new and appropriate technologies. In accordance with national, subregional and regional needs and priorities, backing should be given to establishing the capacity to use such technologies.

117. Support should be given to defray expenses incurred by institutions that are providing storage and related conservation and research/documentation services for other countries. This support could help ensure that all unique material is identified, suitably duplicated, stored safely, characterized, regenerated, evaluated and documented. This would include the identification of both inadequately and excessively duplicated materials. Materials not yet duplicated should be multiplied and placed in secure storage, in accordance with relevant international agreements and national legislation. Additional *ex situ* duplications of accessions would be maintained at the discretion of countries. The expansion of existing storage facilities and the creation of new facilities may be desirable in some countries.

118. **Research/technology:** Research should aim to develop improved conservation methods, including *in vitro* and cryopreservation, and, in particular, reliable low-cost techniques that are appropriate to local operating conditions. Technologies and procedures that are transferred from temperate climates might not be appropriate for conditions in tropical countries and vice versa.

119. Research based on the improved documentation foreseen under the GPA should be undertaken to assist decision-making on the development of a rational, effective system. Such research might include, among other things, identifying priority germplasm and duplications, developing methods to identify duplicates and test the viability of accessions, expanding procedures for the rational conservation and duplication of vegetatively propagated species, and working out modalities and technologies for conserving genes, genotypes and gene complexes.

120. Research is needed on the best storage conditions for orthodox seeds, non-orthodox seeds and vegetative material. Genomic and phenotypic studies should be undertaken that better link molecular data with phenotypic descriptor data. Protocols are needed for *in vitro* conservation and other conservation technologies for important vegetatively propagated and non-orthodox seeded plants. An assessment should be made of the conservation needs of plant species for food and agriculture that are not adequately conserved.

121. **Coordination/administration:** In-country coordination of this priority activity should involve all PGRFA stakeholders, including national gene bank(s), national crop working groups, breeders, researchers, farmers and non-governmental organizations. Strong links need to be established with regional networks and international centres.

122. Periodic administrative and technical reviews should be encouraged in order to assess the effectiveness of any initiatives under this priority activity. Subject to these reviews, as well as to the specific provisions of relevant agreements, financial support should foster long-term security and allow efficient planning.

123. NARS, crop and regional networks and relevant international botanic garden organizations, with the support of international agricultural research centres and regional organizations, should regularly assess the state of conservation of vegetatively propagated and non-orthodox seeded plants and make recommendations and take action where necessary.

124. Botanic gardens should be encouraged to participate actively in the activities of international associations. Links should be strengthened between organizations such as the International Association of Botanic

Gardens and Botanic Gardens Conservation International and the organizations responsible for PGRFA conservation (for example FAO, Bioversity International and other international agriculture research centres). Similar linkages should be made between organizations, including those in the private sector (such as the nursery trade), at the national level. Practical cooperation should be encouraged as a matter of priority.

7. Regenerating and multiplying *ex situ* accessions

125. **Background:** As accessions stored *ex situ* decline in viability, both genes and genotypes are lost. Even under optimal *ex situ* storage conditions, all accessions eventually require regeneration. Regeneration capacity was often not considered when assembling collections and disseminating accessions, with the unintended consequence that much material collected in the past cannot now be properly maintained. Consequently, there is a large backlog of materials needing regeneration. Low initial sample size, low viability and frequent demand for samples from long-term storage facilities can shorten the regeneration/multiplication cycle. But, because proper long-term storage conditions should obviate the need for regeneration for decades, average, routine, ongoing annual regeneration requirements (as opposed to multiplication needs) amount to fewer than 10 percent of conserved accessions. Nevertheless, some 55 percent of countries reporting on regeneration to the World Information Sharing Mechanism on GPA implementation (WISM) indicated that capacity has declined in 20 percent of the national gene banks and this has resulted in significant backlogs. The global crop strategies supported by the Trust point out that regeneration backlogs occur in all crops and regions. However, significant advances have been made, including at the global level as a consequence of funding provided to the Centres of the Consultative Group on International Agricultural Research (CGIAR) for the "Global Public Goods" projects, and, at the national level, as a result of funding from the Trust. The Trust has also supported the development of regeneration guidelines for a number of Annex I crops. Inadequate documentation about accessions continues to be a constraint to a rational global approach to regeneration, although the necessary information is now increasingly available electronically. Many countries cite lack of facilities for handling cross-pollinated species and inadequate funds and human resources as major problems. Good planning and coordination will minimize the amount of material that needs to be regenerated, but continued intervention is necessary to maintain viability of much of the stored genetic diversity of PGRFA.

126. **Objectives:** To regenerate and multiply *ex situ* accessions to satisfy needs for conservation, distribution and safety duplication.

127. To establish the processes, partnerships and capacities needed to regenerate and multiply *ex situ* collections to satisfy needs for conservation, distribution and safety duplication.

128. **Policy/strategy:** Priority should be given to:

a) regenerating samples currently in long-term storage or intended for placement in long-term storage and that are experiencing a loss of viability;

b) regenerating samples that meet the criteria of being globally unique, threatened and having the potential of maintaining the diversity of the original sample.

129. Input from crop and regional networks should be sought in refining priorities and identifying priority germplasm for regeneration and multiplication.

130. The identification of specific samples for regeneration and multiplication should be made in cooperation with national programme breeders and curators, who often have intimate and detailed knowledge of collections and of the availability of similar materials from *in situ* locations.

131. Regeneration and multiplication should strive to maintain the allelic and genotypic diversity and adapted complexes of the original sample. Minimizing the frequency of regeneration is an important goal and consequence of other activities in the GPA.

132. Governments, the private sector, international organizations, including in particular the CGIAR, and non-governmental organizations should:

a) cooperate to make efficient use of existing capacity and to ensure that regeneration and multiplication can take place, if scientifically, technically and administratively feasible, at sites where conditions approximate those where the sample was collected;

b) promote and facilitate access to PGRFA stored *ex situ* to minimize the need for storing identical samples in several locations and the consequent need to regenerate each of them.

133. Characterization should be undertaken in conjunction with regeneration without compromising the effectiveness or scientific goals of the regeneration exercise. Characterization should be conducted in line with globally accepted standards.

134. **Capacity:** Proper facilities, adequate human resources, appropriate technology and necessary equipment should be available to national programmes and international organizations involved in regeneration and multiplication activities undertaken as part of the GPA. Particular attention should be given to establishing or strengthening capacity to regenerate and multiply cross-pollinated, vegetatively propagated and recalcitrant species, including building capacity for their safety duplication. Consideration should also be given to involving the private sector, farmers and non-governmental organizations in the activity.

135. Gene banks should ensure that monitoring systems are in place and should be able to determine the current status of their accessions and to prioritize those in need of regeneration and multiplication.

136. Training programmes should take into consideration the differences in regeneration and multiplication requirements among species.

137. **Research/technology:** Guidelines for regeneration, including standards and specific technologies, should continue to be developed, especially for cross-pollinated, vegetatively propagated and recalcitrant species.

138. There is a need to reinforce research to improve conservation technologies in various key areas: lengthening the interval between regeneration cycles (orthodox seeds); physiological mechanisms linked to low temperature tolerance and dehydration (recalcitrant seeds); and *in vitro* conservation technologies.

139. Research should be undertaken to increase the effectiveness and efficiency of regeneration efforts, including methodologies to minimize genetic drift, to identify markers associated with seed longevity in order to assist in devising regeneration strategies, to develop an understanding of the causes of mutations in conserved germplasm and to eliminate seed-borne pests. Important questions remain concerning breeding systems, reproductive biology, dormancy mechanisms and technical problems associated with regeneration practices.

140. **Coordination/administration:** The active involvement of crop and regional networks is important to the success of regeneration and multiplication efforts, particularly in identifying and prioritizing germplasm to be regenerated and multiplied. National plans for regeneration should be formulated with their assistance, particularly with regard to PGRFA of national priority.

141. There should be ongoing monitoring of the need for regeneration and multiplication, which should include giving consideration to the necessity for duplication, storage behaviour of the species, storage conditions and the viability of individual accessions.

Sustainable Use

8. Expanding characterization, evaluation and further development of specific subsets of collections to facilitate use

142. **Background:** Gene bank collections should help users respond to new challenges and opportunities to improve crop productivity, enhance sustainability and respond to change – particularly climate change and pest resistance – and meet human needs related to PGRFA. Today, germplasm collections of major crops house much of the diversity that will be needed to meet these challenges. In order for plant breeders, researchers and other users of PGRFA to make the most effective use of collections, they need quickly to identify a manageable number of genotypes that possess or are likely to possess the many different traits needed in their programmes. Improved characterization and evaluation can encourage greater and more efficient use of collections. Understanding genetic variability and expression is also important for improving the use of plant genetic resources. The establishment of limited sets of genetic material – based on either capturing total diversity in a small number of accessions or the variation in particular traits – has been found to improve the use of collections. These efforts require close collaboration between germplasm curators and plant breeders in the delineation of manageable collection subsets. Characterization and evaluation can also aid the identification of germplasm with potential for further improvement by breeders and farmers, as well as for direct use by farmers for production and marketing.

143. In the past decade, significant progress has been made in the characterization and evaluation of crop germplasm collections. Many countries have acquired the capacity for using molecular techniques in germplasm characterization, a development that is leading to the generation of more comprehensive and reliable data. Efforts will have to continue in developing such capacity where it is needed. Significant advancements have also been made in developing high-throughput phenotyping techniques and related infrastructure. In order to efficiently characterize and evaluate germplasm accessions and breeding materials for traits associated with adaptation to, and mitigation of, the effects of climate change, and with response to consumer demand, it is equally important to continue developing phenotyping capacity.

144. Despite such overall progress, there are still large data gaps and many of the existing data are not easily accessible. The lack of adequate characterization

and evaluation data and the capacity to generate and manage them, remain serious constraints to the use of many germplasm collections, especially those containing underutilized species and CWR. With improved access to molecular and computational biology techniques, information technology and GIS, the utility of PGRFA collections could be greatly enhanced by increasing the types and volume of data available. Efforts should equally be invested in developing standard descriptors and uniform characterization methodologies for more crops and species. Greater funding and more capacity building will help increase the breadth and depth of germplasm characterization efforts, making it easier to mine gene banks for traits of interest.

145. **Objectives:** To enhance the use and management of plant genetic resources in gene banks. To identify germplasm of potential value for research and crop improvement and for direct use by farmers in the rehabilitation of degraded ecosystems and other forms of direct use in agro-ecosystems.

146. To develop innovative, crop-specific characterization and evaluation activities, with participatory approaches as appropriate, including for underutilized species, to identify potentially useful accessions and genes for improved productivity and sustainability, especially in the context of climate change.

147. To improve the efficacy of the evaluation process by developing and adapting high-throughput evaluation methods for identifying accessions with valuable traits. These methods include rapid computerized assays of genetic diversity and metabolic content, new biochemical analyses and novel methods for rapidly capturing morphological and structural variation in the field via hand-held devices.

148. To establish subsets of genetic material including trait-specific collections for crops of global importance.

149. To improve and facilitate exchange of and access to quality characterization and evaluation data across gene bank collections, including through national, regional and global information systems.

150. **Policy/strategy:** Governments, with the cooperation of relevant UN bodies and regional, intergovernmental and non-governmental organizations, international agricultural research centres, regional networks and the private sector, and taking into consideration the views of the scientific community, breeders' and farmers' organizations and their communities, should:

a) establish baseline characterization and evaluation data, define priorities and periodically assess progress in evaluation in relation to the different needs of the various users of PGRFA, with emphasis on identifying traits that counter limits to production in staple crops and crops of national economic importance, as well as underutilized crops and crops of dietary interest;

b) support collaboration and complementarities between breeders, researchers, extension services, farmers and gene banks;

c) encourage the exchange of characterization and evaluation information, including through networking gene bank databases within and among countries;

d) note that access to PGRFA is subject to applicable regional or international agreements, such as the International Treaty. To comply with such agreements, PGRFA users should be encouraged to agree to provisions for sharing relevant evaluation data with source institutes, giving due regard to the special needs of commercial users for confidentiality as appropriate;

e) use characterization and evaluation data to help improve the *in situ* management of landraces, CWR, wild food plants and forages;

f) give appropriate financial support to characterization and evaluation programmes for crop species of primary importance to food security, given the importance of medium- and long-term financing, and promote synergies with existing funding mechanisms (for example the Benefit-sharing Fund of the International Treaty).

151. Crop networks and gene banks should be encouraged to identify useful traits and establish trait-specific and other small collections of interest to users with a special focus on adaptation to climate change, sustainability and food security. Characterization and evaluation should be strengthened and standardized and the data made more accessible through improved information systems.

152. **Capacity:** Support should be given to continuing targeted characterization and evaluation programmes for selected priority germplasm. The characterization and evaluation process begins with an assessment of current information and an effort to assemble, collate, computerize and make available existing information contained in notes, reports, punched cards, etc. A great deal of evaluation work needs to be done in a use-oriented, site-specific manner.

153. Governments and appropriate organizations should identify institutions and individuals who may have the capacity and expertise to characterize and evaluate germplasm for specific stresses and develop a national portfolio of such expertise, including breeders and farmers in high-stress areas who may perform preliminary evaluations to identify subsets of accessions that hold promise for further evaluation under more stringent scientific conditions. The cost efficiency of subcontracting evaluation should also be investigated as should the feasibility of cooperative programmes involving national programmes and the private sector.

154. National programme staff should receive training in germplasm characterization and evaluation techniques on a crop-specific basis. Such training should begin with crops that are important nationally and for which there are current or planned breeding programmes. Capacity building should aim for a critical mass of personnel that are skilled in the use of standardized characterization methodologies, including molecular biology techniques and data management using modern information platforms.

155. Support should be given to training breeders and farmers who participate in on-farm PGRFA evaluation programmes. Emphasis should be placed on the extensive knowledge that women have about the uses and usefulness of plants, as their responsibilities often range from propagating, producing and harvesting crops to processing, storing and preparing food/feed.

156. Students at all levels should be trained in basic topics related to the characterization, evaluation and use of PGRFA.

157. **Research/technology:** Various types of research must be undertaken in the effort to achieve cost-effective use of current collections. Using the latest technology, and with support from plant breeding, research should seek to:

a) improve the use of molecular methods in characterization and evaluation in order to identify useful genes and understand their expression and variation;

b) improve methods of germplasm characterization and evaluation using biochemical assays and high-throughput phenotyping, in particular for adapting to and mitigating climate change and increasing nutritional values;

c) improve data exchange through further development and harmonization of standards for characterization and evaluation data.

158. Research is also needed to develop more useful subsets of material, including core collections, mini- and micro-cores and specific trait collections. This will require systematic development and testing of different sampling procedures, as well as increasing the availability of characterization and evaluation data through improved documentation systems. Further work is also needed to optimize the way in which such subsets are used by breeders to access best-bet materials from the full collection.

159. **Coordination/administration:** Characterization and evaluation efforts should be planned and implemented with the active participation of national programmes, plant breeders and crop and regional networks. As appropriate, breeders' and farmers' organizations, private and public companies and related associations and other relevant stakeholders should also be involved.

160. Limited user-friendly collections such as trait specific collections, core or micro-core collections should be developed with the active participation of

breeders and other users as well as relevant crop networks. Work on such collections must be integrated firmly in the context of the entire effort to improve use.

161. Cooperation and exchange of information are needed, especially by developing-country gene banks that manage very diverse collections but do not have staff with expertise in all of the species they conserve.

9. Supporting plant breeding, genetic enhancement and base-broadening efforts

162. **Background:** Germplasm collections can be used both to identify specific alleles that are useful for developing new varieties adapted to new conditions and needs and to broaden the overall genetic base of breeding programmes. While some materials can be used directly by breeders for either of these purposes, prebreeding or genetic enhancement is often necessary to produce material that can be easily used by breeding programmes. Newly bred varieties are a means to deliver PGRFA to farmers.

163. The challenge of using PGRFA is made more difficult by the stagnant or dwindling plant-breeding capacity in many countries. There is a serious shortage of plant breeders in both public and private sectors and a declining enrolment in conventional plant breeding courses in agricultural universities/schools and institutions, with students opting for careers paths in what are seen as more modern sciences, such as molecular biology. There is a compelling need to redress this situation as the role of conventional plant breeding in crop varietal development is irreplaceable.

164. Currently, global challenges, in particular climate change, place increasing demands on breeding programmes, and these are likely to intensify. Significantly strengthened human capacity and infrastructure are necessary for breeding programmes to deliver varieties with the enhanced tolerance to biotic and abiotic stresses needed for adaptation to climate change, as well as for diversification and food security. Such capacity enhancement must be accompanied by a rethinking of strategies. Breeding must be needs based, with greater integration of the perspectives of farmers and other users on setting priorities and defining goals. The efficiency of traditional plant-breeding activities must be enhanced by the judicious integration of cost-efficient novel biotechnology and phenotyping strategies.

165. Prebreeding and genetic enhancement must be encouraged, including by pooling the resources of germplasm curators and plant breeders, so that the most appropriate germplasm can be identified and used in addressing clearly

defined objectives. Greater emphasis must be paid to improving the less-studied crops that constitute important staples in many parts of the world. CWR must be used more systematically to identify the genes needed for generating the resilient crop varieties needed to safeguard food security in the face of changing climatic conditions.

166. Improving the sustainability, resilience and adaptability of crop production will require the use and deployment of increased diversity of both the crops and the varieties available to farmers. An important contribution can be made through base-broadening strategies that seek to widen the genetic diversity in plant breeding programmes and in the products of such programmes.

167. An example of a multilateral effort to enhance capacity in breeding is the FAO-convened Global Partnership Initiative for Plant Breeding Capacity Building (GIPB). This multi-stakeholder partnership of public and private sector parties from developing and developed counties was created in direct response to Article 6 of the International Treaty. GIPB aims to enhance plant-breeding capacity and seed delivery systems in developing countries and to improve agricultural production through the sustainable use of PGRFA. The Generation Challenge Programme (GCP), an initiative of the CGIAR that aims to create improved crops for small farmers through partnerships among research organizations, is another example of a multi-stakeholder initiative that promotes the use of PGRFA in crop improvement. The GCP focuses on using novel biotechnology tools, including genomics, molecular breeding and bioinformatics, to enhance efficiencies in crop varietal development.

168. **Objectives:** To contribute to food security and improved farmer livelihoods through the deployment of adapted crops and the development of resilient crop varieties that guarantee high yields under adverse environmental conditions and minimal input agricultural systems. To increase the use of genetic resources and thus provide further tangible ways to conserve them.

169. To reduce vulnerabilities by increasing genetic diversity in production systems as well as in crop-breeding programmes through the use of CWR, farmers' varieties/landraces, improved varieties and introductions, as appropriate. To increase the sustainability of agricultural systems and the capacity to adapt to environmental changes and to emerging needs. To strengthen the capacity of national plant breeding programmes and other sectors, where required and as appropriate, and to encourage participatory breeding. To provide the tools and resources needed to increase the genetic diversity used by breeding programmes for both major and minor crops, through appropriate base-broadening and genetic-enhancement approaches.

170. **Policy/strategy:** Governments, international and non-governmental organizations, and funding sources should:

a) recognize the importance of providing long-term funding and logistical support to plant breeding and research, prebreeding, genetic enhancement and base-broadening activities;

b) recognize the importance of providing adequate support for the routine use of novel biotechnology tools, computational biology and information technology in PRGFA management, especially in characterizing germplasm and facilitating the introgression of desired traits into breeding materials;

c) encourage the development of public–private and other partnerships that foster participatory approaches to setting and implementing crop-improvement priorities and goals;

d) develop policies and legislation that support participatory breeding, including appropriate regulatory frameworks for varieties developed through participatory plant breeding;

e) encourage the institutionalization of participatory, gender- and youth-sensitive approaches to plant breeding as part of national PGRFA strategies in order to facilitate the adoption of new crop varieties;

f) help improve access by plant breeders to the widest possible genetic diversity in order to identify the traits needed for developing crop varieties adapted to novel climatic conditions; and

g) when devising national strategies and fostering collaborations, as appropriate, be fully cognizant of the provisions of the Multilateral System of the International Treaty, according to which material can be accessed "for the purpose of utilization and conservation for research, breeding and training for food and agriculture."

171. **Capacity:** Support should be given to national systems, regional networks, international agricultural research centres, non-governmental organizations, universities, breeding programmes and other relevant organizations to carry out plant breeding, including genetic enhancement and base-broadening. Priority should be given to addressing problems identified by crop and regional networks, regional research and development forums, other competent scientific bodies and institutions and, breeders' and farmers' organizations. Efforts should extend beyond addressing the most pressing problems facing crops on Annex I of the International Treaty to include crops that support local food security around the world.

172. Capacity building under this activity should give priority to creating personnel skilled in traditional as well as modern plant genetic improvement techniques. In addition, capacity needs to be strengthened in both field and laboratory evaluation. Capacity building should be accompanied with adequate incentives

– such as structured career opportunities – in order to facilitate the attraction and retention of experienced staff. Greater international collaboration – for example, with regional centres of excellence – could help cut national training costs and reduce unnecessary duplication of investments.

173. **Research/technology:** Institutions should further develop, adapt and use validated efficiency enhancing biotechnologies and ancillary tools for genetic enhancement. They should extend research and development activities to include increased domestication efforts and to optimize the use of CWR in breeding programmes. CWR contain important genes for biotic and abiotic stress resistance and for improved productivity and can be important sources for base broadening. Procedures are needed to improve the identification and transfer of useful genes.

174. Research is needed to develop selection procedures and breeding methods that support base broadening and improve sustainability at the same time as enhancing productivity. This is likely to include research on the selection of appropriate base materials for breeding programmes and population breeding procedures.

175. **Coordination/administration:** Activities should be planned and undertaken in close collaboration with national programmes, crop and regional networks, other scientific bodies and institutions and breeders' and farmers' organizations. Close communication among gene bank curators, plant breeders and other scientists in both the public and private sectors should be encouraged. Networking among communities of practice for breeders should be promoted as a vehicle for mentoring and exchanging ideas. The cooperation of key stakeholders in the development of crop value chains at the national level is another effective way to coordinate the activities and efforts needed to ensure sustainable progress in this priority activity.

10. Promoting diversification of crop production and broadening crop diversity for sustainable agriculture

176. **Background:** Despite progress in the diversification of crop production, various crop production systems, which increasingly dominate agricultural systems, could result in yield losses due to pests, diseases and abiotic stresses, as well as a lack of stability and resilience. Several new challenges have been recognized in the past decade that will require strengthening diversification. These include the need for long-term sustainability in agricultural practices, the challenges

and opportunities posed by the production and use of biofuels, food and nutritional security and rural development, and climate change.

177. To cope with such challenges, a broader range of crop varieties and species will need to be incorporated into agricultural systems. These include crops that produce raw materials for agro-industry and energy, crops that are currently underutilized, wild food plants and forages. Similarly, plant breeders will need to include more diversity in their improvement programmes. The participatory evaluation, selection and improvement of farmers' varieties/landraces and early breeding lines are measures that could bring higher levels of diversity, adaptation and stability to crops. Diversification at the species and genetic level should be complemented by diversification of production systems. Diverse production systems will both provide enhanced ecosystem services and be better able to benefit from the services provided by surrounding landscapes. Together with solutions such as rotation, varietal mixtures and multilines, these practices will help to improve the resilience and stability of agricultural systems and thus ensure food, nutritional and income security. The development of varieties by local breeders is highly relevant to adapting agriculture to environmental changes and meeting the demands of farmers and farming communities. There is a need, however, for varieties that are adjusted to practical and local requirements to move more rapidly from development to commercialization.

178. **Objectives:** To promote sustainable agriculture through diversification among and within crops.

179. To periodically review genetic vulnerability in crops and encourage breeders, and other relevant groups to take the necessary mitigating action at national, regional and international levels.

180. To develop models for diversified production that are consistent with higher productivity and stability as well as meeting consumer preference.

181. **Policy/strategy:** Governments and relevant intergovernmental organizations, in cooperation with crop networks, research institutions, extension agencies, the private sector, farmers' organizations and non-governmental organizations, should:

a) regularly monitor genetic diversity and assess crop vulnerability;

b) promote policies that support diversification programmes and the inclusion of new species in production systems;

c) increase diversification by planting mixtures of adapted varieties and species where appropriate;

d) promote awareness among policy-makers, donors and the general public of the value of diversified production systems;

e) encourage countries to adopt appropriate and effective strategies, policies, legal frameworks and regulations that promote diversified production systems;

f) support the management of diversity by breeders and farmers;

g) increase investment in improving underutilized crops and the development and use of traits in major crops that are relevant to human and environmental health and to the effects of climate change.

182. Funding agencies should be encouraged to continue to provide support to indigenous and local communities, national agricultural research systems, international agricultural centres, breeding programmes and other relevant research bodies and non-governmental organizations for work aimed at enhancing levels of diversity in agricultural systems.

183. **Capacity:** Governments and national agricultural research systems, supported by the international agricultural research centres and other research and extension organizations should:

a) increase their capacity to develop and use multilines, mixtures and synthetic varieties;

b) increase their capacity to adapt different integrated pest management strategies to production systems;

c) develop strategies for the deployment and use of a range of varieties;

d) explore and, in appropriate circumstances, make use of decentralized and participatory plant breeding strategies to develop plant varieties specifically adapted to local environments;

e) make use of biotechnological techniques to facilitate broadening the genetic base of crops; and

f) strengthen the ability of farmers, indigenous and local communities and their organizations, as well as extension workers and other stakeholders, to manage agricultural biodiversity and ecosystem services sustainably.

184. **Research/technology:** Support efforts to identify plant breeding and agronomic practices that foster the diversification of crop production. This might include reviewing the track records of different practices.

185. Research is needed on domesticating wild species, increasing the use of underutilized crops to develop more nutritious adapted varieties, and developing crops and varieties adapted to climatic change.

186. It will be important to develop improved tools and methodologies for assessing the genetic vulnerability of crops, the provision of services by agro-ecosystems, including pollination, and application of the ecosystem approach to sustainable agriculture.

187. Coordination/administration: There is a need for close collaboration between ministries of agriculture and of the environment in the development and implementation of policies and strategies for diversification of crop production for sustainable agriculture. Such policies should be coordinated at the regional level to be truly effective.

11. Promoting development and commercialization of all varieties, primarily farmers' varieties/ landraces and underutilized species

188. **Background:** Commercial production increasingly dominates agricultural systems. In commercial production systems, a few major crops provide for a large proportion of global needs. However, many more species, including farmers' varieties/landraces of both major and minor crops, are used by farmers and indigenous and local communities to meet local demands for food, fibre and medicine. Knowledge concerning the uses and management of these varieties and species is often localized and specialized. Increasingly, this diversity at both the species and variety levels is being replaced by a certain level of uniformity in the agricultural marketplace as varieties are bred to meet the needs of production, industrial processing and demanding market standards.

189. Underutilized species, farmers' varieties/landraces and other crop varieties not commonly used in agricultural production systems are being lost, along with associated knowledge. Although there has been a modest increase in efforts to conserve such species *ex situ*, overall, their diversity is not yet adequately represented in collections. Nor are many underutilized crops included in Annex I of the International Treaty. Nonetheless, many of these species and varieties have great potential for wider use, particularly in breeding, and could contribute significantly to sustainable livelihoods through improved food and nutritional security, income generation and risk mitigation.

190. However, there is a growing global recognition of the value of farmers' varieties/landraces and underutilized species in the face of uncertain climates,

malnutrition and rural poverty. For example, there is evidence of increasing awareness both among the public and among policy-makers of the importance of traditional vegetables and fruits and of potential new energy crops. So-called "niche" or "high-value" markets are expanding as consumers grow more willing to pay higher prices for better-quality, novel or heritage foods from sources they know and trust. New legal mechanisms enable farmers to market farmers' varieties/landraces, and legislation supporting the marketing of geographically identified products is increasingly available, providing ways for farmers to conserve and use local crop genetic diversity.

191. In order to capture the potential market value of farmers' varieties/landraces and underutilized species, there is a need to better integrate the efforts of individuals and institutions with a stake in the different stages of the production chain. In particular, the involvement of indigenous and local communities is essential and must fully take into account traditional knowledge systems and practices.

192. Recently, a new organization, Crops for the Future[4], has been established to promote the use and conservation of underutilized plant species.

193. **Objectives:** To contribute to sustainable livelihoods, including improved food and nutritional security, income generation and risk mitigation, through the sustainable management of all varieties, focusing primarily on farmers' varieties/landraces and underutilized species.

194. To stimulate stronger demand and more reliable markets for all varieties, primarily farmers' varieties/landraces and underutilized species, and their products. To promote local processing, commercialization and distribution of the products of such varieties/landraces and underutilized species. To increase public awareness of their value.

195. **Policy/strategy:** Governments and national agricultural research systems, with the support of the international agricultural research centres and non-governmental organizations, and taking into account the views of breeders' and farmers' organizations, seed producers, indigenous and local communities and the private seed sector, are encouraged:

a) to promote policies that are consistent with the sustainable use, management and development of underutilized species, as appropriate, identified as having the potential to make significant contributions to local economies and food security;

4 Crops for the Future evolved from a merger of the International Centre for Underutilized Crops and the Global Facilitation Unit for Underutilized Species.

b) to develop and adopt policies on extension, training, pricing, input distribution, infrastructure development, credit and taxation that will serve as incentives for crop diversification and the creation of markets for biodiverse food products;

c) to create enabling environments for managing and monitoring local diversity and to develop local and export markets for a wider range of traditional and new products originating from plant varieties, primarily farmers' varieties/landraces and underutilized species;

d) to foster public–private partnerships and put in place legislation to promote benefit sharing targeting farmers and traditional custodians.

196. **Capacity:** Training and capacity building should be provided for scientists, breeders, and extension specialists and for seed producers, farmers, indigenous and local communities (with a particular emphasis on women) on the topics of establishing, running and advising local small-scale enterprises concerned with the commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species. The training should include lessons on:

a) identifying all varieties, primarily farmers' varieties/landraces and underutilized species, with potential for increased commercialization and sustainable use;

b) developing and implementing sustainable management practices for underutilized species of importance to food and agriculture;

c) developing or adapting post-harvest processing methods for such varieties and species;

d) developing marketing methods for all varieties, primarily farmers' varieties/landraces and underutilized species; and

e) documenting local and traditional knowledge about farmers' varieties/landraces and underutilized species.

197. Appropriate bodies, including non-governmental organizations, should promote public awareness of the value of all varieties, primarily farmers' varieties/landraces and underutilized species, in various media and through additional mechanisms such as street fairs and school initiatives.

198. Appropriate bodies should promote awareness among policy-makers and entrepreneurs of the value of such species and varieties.

199. **Research/technology:** Research should be undertaken to:

a) develop sustainable management practices for all varieties, primarily farmers' varieties/landraces and underutilized species, of importance to food and agriculture;

b) characterize and evaluate farmers' varieties/landraces and underutilized species;

c) document ethnobotanical information on farmers' varieties/landraces and underutilized species;

d) develop post-harvest processing and other methods to improve marketing possibilities for all varieties, primarily farmers' varieties/landraces and underutilized species;

e) develop marketing strategies and brand development for all varieties, primarily farmers' varieties/landraces and underutilized species.

200. Commercialization processes and activities that have or are likely to have significant adverse impacts on the conservation and sustainable use of agricultural biodiversity should be identified and their effects monitored.

201. **Coordination/administration:** Coordination should be strengthened between gene banks, breeders, farmers and indigenous and local communities in order to identify material of potential value. Regional networks, together with national programmes, and in cooperation with international agricultural research centres, and non-governmental and other relevant organizations, should regularly review the status of all varieties, primarily farmers' varieties/landraces and underutilized species, in their regions, to:

a) identify possibilities for commercialization;

b) identify common research and development needs; and

c) facilitate and, as appropriate, coordinate requests for financial and technical assistance.

12. Supporting seed production and distribution[5]

202. **Background:** Effective seed systems must be in place to ensure that farmers have access to planting materials in adequate quantity and quality, in a timely

5 In this priority activity the term "seed" refers to all planting materials.

manner and at reasonable cost. Only in this way will farmers benefit from the potential of both local and improved varieties to increase food production and adapt to climate change. Over the last 20 years, the private agricultural sector has grown significantly in developed and developing countries; however, the main focus of its interest has been high-value products, such as maize, wheat, rice, oil crops, pulse crops and vegetable crops. The expansion of the seed trade over the past decade has been accompanied by the promotion of seed regulatory harmonization at regional and subregional levels. Investment by the public sector in seed production, already low in most developed countries in 1996, has also decreased significantly in many developing countries, where access to improved varieties and quality seed remains limited. In many developing countries, farmers' seed systems remain the main purveyors of seed for local and, in some cases, even improved varieties. Different seed systems often operate side by side, with different levels of success depending on the crop, the agro-ecological zone and market opportunities. There is therefore a need to develop integrated approaches that strengthen seed systems and the connections between them in order to ensure the production and distribution of seed of crop varieties that are useful for diverse and evolving farming systems.

203. **Objectives:** To increase the availability of high-quality seed of a wider range of plant varieties, including improved and farmers' varieties/landraces.

204. To contribute to the maximization of both agrobiodiversity and productivity.

205. To improve the complementarity of seed production and seed distribution in the public and private sectors as well as between different seed systems.

206. To develop and expand viable local-level seed production and distribution systems for varieties and crops that are important to farmers, including small-scale farmers.

207. To make new crop varieties available to farmers and to make suitable germplasm stored *ex situ* available for multiplication and distribution to farmers to fulfil their needs for sustainable crop production.

208. To develop/review seed regulatory frameworks that facilitate the development of seed systems and the harmonization at regional level, taking into account the specificities of different seed systems.

209. **Policy/strategy:** Governments, NARS and seed producers, subject to national laws and regulations as appropriate, with support from international agricultural research centres, regional and bilateral cooperation programmes and non-governmental organizations, and taking into account the views of the private sector, farmers' organizations and indigenous and local communities, should:

a) develop appropriate policies that provide an enabling environment for the development of different seed systems, including small-scale seed enterprises. The efforts of governments should focus in particular on the crops and varieties needed by resource-poor farmers, especially women. Such an approach should be complemented by policies that facilitate the development of commercial seed companies to meet the needs of larger-scale commercial farmers. Governments should prioritize major and minor crops that are not adequately addressed by the private sector where appropriate. These policies should be integrated with general agriculture policies;

b) strengthen links between gene banks, networks, plant breeding organizations, seed producers and small-scale seed production and distribution enterprises to ensure wide use of available germplasm;

c) consider seed quality-control schemes, particularly schemes that are appropriate for small-scale enterprises and enable them to meet plant-health requirements;

d) adopt legislative measures that create adequate conditions for deploying all varieties, primarily farmers' varieties/landraces and underutilized species, in different seed systems, taking into account their specificities; and

e) develop subregional/regional agreements that streamline seed quality control, certification, plant quarantine requirements and other standards in order to facilitate the development of cross-border seed trade.

210. **Capacity:** Governments, subject to regional legislation, national laws, regulations and policies, as appropriate, and in conjunction with international aid agencies, non-governmental organizations and existing seed enterprises, should:

a) establish/strengthen seed systems, based on public–private partnerships, to ensure the maintenance of plant breeding programmes for significant crops and the multiplication of early generation seed;

b) encourage existing seed production systems, in particular seed enterprises, to increase the range of varieties they offer, by strengthening links with gene banks, networks and agriculture research institutes;

c) strengthen capacities to implement efficient seed quality systems;

d) provide appropriate ways to facilitate the emergence of seed enterprises, as appropriate, paying attention in each country to the needs of the small farming sector, women and other vulnerable or marginalized groups;

e) provide infrastructural support and training to small-scale seed enterprises in the fields of seed technology and business management in order to facilitate the establishment of a sustainable quality seed-supply system;

f) improve the linkages between breeders' and farmers' organizations and seed producers (public or private) so that farmers, in particular women and other vulnerable or marginalized groups, can access high-quality seed of the varieties they need; and

g) provide training and infrastructural support to farmers on seed technology and conservation in order to improve the physical and genetic quality of seeds.

211. **Research/technology:** Governments should:

a) assess current incentives and disincentives as well as the needs of seed production and distribution systems for support, including small-scale, farmer-level efforts; and

b) develop approaches for supporting small-scale, farmer-level seed distribution, drawing on the experiences of community and small-scale seed enterprises already established in some countries.

212. **Coordination/administration:** Governments should regularly monitor the degree to which farmers are able to acquire appropriate seed. Coordination is needed in the seed sector among the public and the private sectors and farmers to ensure that farmers have access to high-quality seed of the crops and varieties they need to respond to the challenges of increasing food production.

Building Sustainable Institutional and Human Capacities

13. Building and strengthening national programmes

213. **Background:** National PGRFA programmes are the foundation of regional and global PGRFA efforts, contributing to the objectives of international instruments such as the GPA, the CBD and the International Treaty. Especially in the context of climate change, national programmes are the key to maximizing the contribution of PGRFA to food security, rural development, poverty alleviation and sustainable development. Strong national programmes are needed to contribute fully to, and take full advantage of, international cooperation on access to PGRFA and the fair and equitable sharing of the benefits arising from their use. Effective national programmes provide the enabling policies, support strategies and concrete action plans that are necessary for setting well-defined goals and clear priorities, allocating resources, distributing roles and responsibilities and identifying and strengthening linkages between all relevant stakeholders. A successful national programme requires commitment from governments to providing funding and designing supportive policies and legal and institutional frameworks.

214. PGRFA activities are carried out by public entities, private companies, non-governmental organizations, botanic gardens, farmers, indigenous and local communities, and individuals from the agriculture, environment, research and development sectors. The integration of such different PGRFA actors in the framework of a unified and coherent national programme provides the opportunity to add value to their diverse efforts so that the whole becomes bigger than the sum of its parts.

215. Over the past decade, considerable progress has been made in establishing national PGRFA programmes and enhancing stakeholder participation in national strategies and action plans, especially with regard to the private sector, non-governmental organizations, breeders' and farmers' organizations, and research and educational bodies. The commitment that this indicates is seen also in the fact that several important international agreements relating to PGRFA have been negotiated, adopted or revised during this period, including the International Treaty, the International Plant Protection Convention, the Cartagena Protocol on Biosafety and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization. National legislation has also been enacted in many countries

with respect to phytosanitary regulations, biosafety, seed regulations, plant breeders' rights and Farmers' Rights as defined in Article 9 of the International Treaty and subject to national legislations.

216. Nevertheless, many countries still lack adequate policies, strategies and/or action plans for PGRFA. Many existing national programmes suffer from inadequate and unreliable funding and are isolated from related activities. Areas that require particular attention include priority setting, enhancing collaboration between the public and private sectors, national and international cooperation, strengthening links between PGRFA conservation and use, developing information systems and publicly accessible databases (for example the NISMs on the implementation of the GPA), identifying gaps in the conservation and use of PGRFA (including CWR), increasing public awareness and implementing national policies and legislation and international treaties and conventions.

217. Often, the countries that lack strong national programmes and appropriate long-term conservation facilities have the most urgent food security problems, even if they have rich sources of PGRFA. Weak national programmes often limit efficient management of PGRFA collections.

218. National *ex situ* collections are an integral part of national PGRFA programmes. Gene banks work best as dynamic centres that integrate conservation, documentation and use. Overemphasis on conservation can detract from sustainable use, which supports progress in agriculture together with conservation of PGRFA. The increasing impact of climate change makes it essential to support national activities related to crop adaptation, including genetics, genomics and breeding. Indeed, the capacity to carry out crop adaptation is essential to the efficient and effective management of PGRFA. Since 1996, public–private research and development partnerships have increased in most countries, especially in the plant breeding and biotechnology sectors. However, in developing countries, public organizations are often on their own in managing conservation and plant breeding, which can result in inefficiencies, reduced benefits and lost opportunities.

219. **Objectives:** To meet national needs to conserve and use PGRFA sustainably through rational, effective, coordinated and sound approaches for the benefit of present and future generations.

220. To maintain adequate national capacity in all technical and political aspects of conservation, access and use of PGRFA, as well as the fair and equitable sharing of the benefits arising from that use.

221. To establish and strengthen the essential elements of an integrated national programme: (i) recognized national status; (ii) appropriate policy, legal and institutional frameworks, including mechanisms for coordinated planning and

action; (iii) programme strategy, including well-defined goals, clear priorities and adequate and sustainable funding; (iv) appropriate participation by all stakeholders; and (v) where appropriate, effective conservation and use facilities at the national and/or regional levels.

222. To improve institutional and sectoral linkages, enhance synergies among all stakeholders involved in conserving, developing and using PGRFA, including seed systems, and to strengthen the integration of institutional and community efforts.

223. To develop, strengthen and regularly update national capacities in technical, managerial, legal and policy areas.

224. **Policy/strategy:** National programmes should have a formally recognized status and be given high priority within the national development agenda. The contribution of national programmes to the objectives of international instruments, including the GPA, the CBD and the International Treaty, should be highlighted. The ecological, economic, social and cultural values of PGRFA, including the importance of crop improvement for increasing food security, mitigating climate change and meeting other global challenges, should be recognized in national planning and policies and in the prioritization and deployment of medium and, particularly, long-term financial and other resources. The latter could include financial support for the training and retention of qualified staff, for farmers to maintain and make local varieties available and for breeders to improve them. Specific funding allocations should be made to PGRFA programmes in the governmental budget process. In this regard, awareness among policy-makers and donors of the value of PGRFA to national development should be raised.

225. Government commitment to providing adequate and sustainable funding for national programmes and projects is essential; however, regional or international support is a necessary complement to domestic resources.

226. National programmes should set well-defined goals and clear priorities, including priorities for assistance from regional and international agricultural development programmes. National programmes should have the capability to assess and determine what PGRFA are required to meet national conservation and development needs and related international obligations. They should have supporting policies and strategies on the conservation, access and use of PGRFA, as well as on the fair and equitable sharing of the benefits arising from their use. National programmes should provide for the periodic adjustment of these policies and strategies as necessary. They should make available, as appropriate, the widest possible representative collection of PGRFA to meet the needs of farmers, breeders and other users and for the improvement of varieties, including farmers' varieties/landraces. Governments, in cooperation with national, regional and international institutions, should monitor the

development of new technologies that are relevant to the conservation, characterization and sustainable use of PGRFA. In addition, the adoption and implementation of appropriate, non-conflicting and complementary national legislation related to the conservation, exchange and sustainable use of PGRFA, should be fostered, taking into account the needs and concerns of all stakeholders.

227. National programmes should establish or strengthen coordination and linkages among all relevant individuals and organizations involved in conservation, crop improvement, seed production and seed distribution. National programmes should link with regional and international activities wherever possible, looking for synergies and possibilities for the division of labour. National strategies should encompass the conservation, development and use of PGRFA, including seed systems, and should coordinate with organizations in the environment and agriculture sectors. Broad-based national committees will help organization and coordination in most countries.

228. The structure and organization of a national programme will depend on the infrastructure and capacities available in the country. Policy decisions will determine strategies and modes of operation, in particular with regard to regional and international collaboration. In countries with limited capacity, the strategy may include the use of facilities and expertise from outside the country.

229. Existing programmes should consider establishing or strengthening partnerships with private enterprises, non-governmental organizations, rural, indigenous and local communities, breeders' and farmers' organizations, and research and educational organizations. Cross-sectoral links should be forged with agencies engaged in national planning and other programmes involved in agriculture, land reform and environmental protection.

230. The creation or strengthening of links should be promoted, as appropriate, among national institutions and entities specialized in technology transfer, in order to assist national bodies to negotiate the acquisition of technologies needed to conserve, characterize, and use PGRFA and associated information, in accordance with the International Treaty, the CBD and intellectual property rights (IPR).

231. **Capacity:** Assistance from regional and international institutions should be provided on request to facilitate regular national planning, priority setting and coordinated fundraising. High priority should be placed on assessing and improving management practices in gene banks and research stations. The capacities of farmers, indigenous and local communities, breeders, extension workers and other stakeholders, including entrepreneurs and small-scale enterprises, to manage and use PGRFA sustainably should be strengthened.

232. **Research/technology:** National programmes need to conduct research into on-farm management, *in situ* and *ex situ* conservation, plant breeding, including participatory plant breeding, and crop improvement. Research is also needed on the management of national PGRFA programmes, including testing institutional frameworks, evaluating use needs, database management, the economic efficiency of different approaches to conservation and use, the value of PGRFA, strengthening agricultural market information systems, and developing accurate and reliable measures, standards, indicators and baseline data for monitoring and assessing the specific role of PGRFA in food security and sustainable agricultural production.

233. Specific policy, legal and institutional issues, as well as those related to ownership, IPR, including plant breeders' rights, access and benefit-sharing, Farmers' Rights, in accordance with national needs and priorities, traditional knowledge, exchange, transfer, biosafety, trade and awareness-raising, including seed systems, are increasingly important for national programmes. Assistance in developing policies, strategies, legislation, regulations and practical measures in these areas is needed from bodies such as FAO and the International Treaty. Coordination is needed to provide national programmes with information on these issues, to assess the impact of international developments in the conservation and exchange of PGRFA, and to incorporate new research developments into national systems and practices.

234. **Coordination/administration:** National coordination mechanisms should be established to set priorities for deploying financial and other resources. Strong linkages should be set up between all relevant in-country stakeholders involved in conservation, development and use of PGRFA, including seed systems, as well as between the agriculture and environment sectors, in order to ensure synergy in developing and implementing policies, strategies, legislation, regulations and activities to realize the full potential of PGRFA. Governments should periodically review policies to evaluate their effectiveness and adjust them accordingly. Coordinated and prioritized action at the national level should be complemented by an international system that is likewise coordinated and prioritized. International organizations involved in conservation and use of PGRFA, agricultural production, sustainability and food security, as well as in related areas such as environment and health, should coordinate their efforts and activities. International collaboration is necessary in a world where countries are interdependent and where there is a need to establish practical, rational and economical means to conserve PGRFA, enhance their use, and encourage access and share benefits. PGRFA networks and regional and international fora provide useful mechanisms through which countries can coordinate activities and agree on common policies, as appropriate.

14. Promoting and strengthening networks for plant genetic resources for food and agriculture

235. **Background:** The extent of interdependence among countries with respect to their need to have access to PGRFA and information held by others is arguably more important than ever, as the world faces increasing needs for food/feed production, new environmental conditions, and the pest and disease spectra that will result from climate change. Networks not only facilitate the exchange of PGRFA, but also provide a platform for scientific discussion, information sharing, technology transfer and research collaboration. The regional and global crop strategies developed with support from the Trust highlight the value of networks in identifying and sharing responsibilities for such activities as collecting, conservation, distribution, evaluation, genetic enhancement, documentation, safety duplication and crop improvement. In addition, networks can help set priorities for action, develop policy and provide the means for conveying crop-specific and regional views to various organizations and institutions. International PGRFA networks are recognized as a supporting component of the International Treaty under Article 16.

236. Many regional, crop-specific and thematic networks are now in operation, some of which have been established or significantly strengthened over the past decade. Each network has an important role to play in supporting the coordination of efforts and promoting cost efficiency and effectiveness in the conservation and sustainable use of PGRFA. The synergistic relationship between national programmes and these networks is the key to the sustainability of both: networks support national programmes and national programmes support networks. As such, networks are particularly important in regions where there is limited national capacity in PGRFA (for example, many of the least developed countries and small island states) as they provide easy access to information, technology and materials, and, importantly, a stronger voice in the development of global policies and actions. Crop-specific networks have a particular role to play in bringing conservation and use closer together. Thematic networks are an effective means to bring together experts and interested parties around a common subject, thereby strengthening coordination and avoiding duplication of efforts. One of the challenges faced by all networks, however, is the long-term availability of resources to keep them going. Countries should be prepared to contribute to supporting networks in a sustainable fashion.

237. **Objectives:** To foster partnerships and synergies among countries in order to develop a more rational and cost-effective global system for PGRFA conservation and use.

238. To ensure the sustainability of networks by analysing and identifying the benefits of participation, highlighting the contribution they make to achieving the sustainable conservation and use of PGRFA at the national, regional and global levels.

239. To facilitate setting integrated ecoregional, regional and thematic goals and priorities for the conservation and sustainable use of PGRFA.

240. To promote the participation of all stakeholders in networks, in particular women farmers and local breeders, and to ensure the involvement of public–private partnerships.

241. **Policy/strategy:** Governments should, as a matter of policy, support the active participation of public and private institutions in regional, crop and thematic networks. Participation should be seen as benefiting countries and providing a means for countries with similar challenges to pool efforts and share benefits. The funding constraints experienced by networks require sustainable and innovative solutions that are mindful of the often intangible, though no less important, benefits of networks. In countries where it is required, studies should be developed and information should be gathered to highlight these benefits, which will both strengthen government support and assist in accessing funds. To underpin funding strategies, greater efforts are needed to raise awareness among policy-makers and the general public of the value of PGRFA, the interdependence of nations with regard to PGRFA and the importance of supporting international collaboration. Both cash and in-kind contributions by governments to networks should be considered as a priority.

242. Networks provide a way to identify gaps, develop collaborative systems and promote new initiatives. Given that international germplasm exchange is a key motivation for many networks, additional attention is needed both to promote the effective implementation of the International Treaty, and in particular its Multilateral System, and to develop arrangements for those crops that are not currently included in the Multilateral System but fall within the overall scope of the International Treaty.

243. **Capacity:** Building networks requires not only technical expertise, but also substantial coordination, communications and organizational skills. Resources and capacity should be available for activities such as planning, communications, travel, meetings, network publications such as newsletters and meeting reports, and network strengthening, including the preparation of successful proposals for submission to donors.

244. In the regional context, priority should be given to strengthening existing regional networks. Collaboration among networks also needs enhancing and would have a significant impact on capacity building and technology

transfer. The added value from this level of collaboration would highlight the importance of networks and illustrate how they can be used more effectively. Countries with more advanced PGRFA facilities and programmes are encouraged to support network activities by sharing expertise and providing greater capacity-development opportunities.

245. **Research/technology:** Networks provide a vehicle for collaborative research in mutually agreed priority areas. Funding obtained through research projects creates a basis from which networks can continue to cement relationships and develop further. As appropriate and feasible, research, training and technology transfer in PGRFA should be planned and/or implemented in collaboration with networks. The ease of planning and implementation using a network platform is especially evident when networks cover regions that are very fragmented but at the same time face common challenges.

246. **Coordination/administration:** Resources should be made available to continue to service existing networks, as appropriate, and to organize and facilitate the development of new regional, crop and thematic networks where appropriate. The effective use of resources is essential, and as such, coordination is not merely required within networks but also among networks to ensure efforts are not duplicated and resources are used efficiently.

15. Constructing and strengthening comprehensive information systems for plant genetic resources for food and agriculture

247. **Background:** Transparent and rational decision-making in the conservation and sustainable use of PGRFA must be based on reliable information. Along with the revolution that communication and information management systems have undergone over the past 15 years, there have been important improvements in the availability and accessibility of PGRFA information. Several recent decisions of the Commission have aimed to increase the availability and accessibility of PGRFA information, including the further development of WIEWS, the adoption of the indicators and reporting format for monitoring GPA implementation, the establishment of NISMs and the preparation of the Second Report. Information exchange is given a high priority throughout the International Treaty. In particular, it is recognized as one of the supporting components of the International Treaty in Article 17, the Global Information System, and is one of the main mechanisms for sharing fairly and equitably the benefits derived from the use of PGRFA under its Multilateral System.

248. Recent developments aimed at supporting the documentation and exchange of gene bank information include the release of GRIN-Global, a gene bank management information system with built-in networking features, and GENESYS, a plant genetic resources portal that gives breeders and researchers a single access point to information on about a third of the world's gene bank accessions, including those held in the international collections managed by the CGIAR, the National Plant Germplasm System of the United States Department of Agriculture and the European Internet Search Catalogue (EURISCO).

249. Despite this progress, significant gaps in documentation and information sharing on PGRFA still persist and need to be addressed, as they represent a serious obstacle to efficient planning and the increased use of PGRFA in crop improvement and research. Many of the existing data are still not accessible electronically and the documentation of on-farm genetic resources and CWR is particularly inadequate. A significant imbalance exists among regions and even among countries within regions with regard to their ability to access, manage and disseminate information. Many countries still lack national strategies and/or action plans on PGRFA management, or they are not fully implemented, and, as such, they do not maintain an integrated national information system on PGRFA. This situation is exacerbated by the fact that, at the national and institutional levels, data management and documentation activities are often given an inappropriately low priority in the allocation of funding.

250. **Objectives:** To facilitate the better management and use of PGRFA through improved access to, and exchange of, high-quality, up-to-date information.

251. To develop and strengthen national information systems including, but not limited to, accession-level information systems, to better manage PGRFA data and to support the participation of countries in global information systems.

252. To enhance the use of regional and global information systems through continual improvement of the overall functionality and productivity of gene bank–user interactions.

253. To strengthen the exchange and use of information and the sustainability of current information systems, by promoting compatibility and usability among datasets through the establishment and adoption of common descriptors.

254. To monitor the effectiveness of information systems and ensure that differences between systems are addressed to facilitate interoperability and promote use.

255. **Policy/strategy:** High priority should be given at all levels to developing, staffing and maintaining user-friendly documentation and information

systems for PGRFA based on international standards. Such systems should be able to contribute to decision-making, not just on PGRFA conservation and use, but also on the specific role played by PGRFA in wider issues of agricultural development and food security. Efforts should be made to develop more accurate and reliable standards and indicators and to collect baseline data for sustainability and food security that will enable better monitoring and assessment of the progress made in these areas and of the contribution made by PGRFA to such progress.

256. The effective management of collections and increased use of germplasm require strengthening and harmonizing documentation, characterization and evaluation, based on the adoption of common standards for data exchange. Better standardization of data and information management systems is needed, not only to facilitate access, but also to support technology transfer and global, regional and national assessments of PGRFA.

257. Information on PGRFA will be acquired and disseminated in accordance with the provisions of Article 8(j) of the CBD, as regards the knowledge, innovations and practices pertaining to *in situ* conservation by indigenous and local communities, in embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity, and of Article 17 of the International Treaty.

258. **Capacity:** Planning assistance should be provided to national programmes and, where appropriate, regional programmes, to encourage the development of rational and compatible strategies for information management and sharing. Such strategies must promote the application of standards for interoperability and exchange among systems.

259. Despite progress, data and information still exist in vulnerable and inaccessible systems. These data need to be verified and compiled into usable and easily accessible forms.

260. Access by national programmes to basic scientific, research and bibliographic information should be facilitated.

261. National and regional gene banks/networks should have sufficient personnel to manage information, thereby improving user accessibility and ensuring participation in global information systems. Appropriate training on data management and information systems should be supported as an essential element to rationalize genetic resources activities at the regional and global levels.

262. Appropriate self-teaching and/or e-learning should be developed as needed. Technical support should be provided on a continuing basis to improve the

management of data and information and to support the adoption of new technologies.

263. **Research/technology:** Research should be supported to:

a) develop appropriate and low-cost methodologies and technologies for compiling and exchanging data;

b) develop methods for adapting these technologies to the local level, as appropriate;

c) facilitate easy access and use of data by electronic means and through the Internet;

d) develop means and methodologies to make useful information readily and easily available to non-specialists as well as to stakeholders, including non-governmental organizations, breeders' and farmers' organizations and indigenous and local communities;

e) develop descriptors based on international standards for new and underutilized crops and CWR.

264. **Coordination/administration:** With the development of new information systems at the national, regional and global levels, coordination and collaboration are essential to ensure that these systems are compatible and useful. The harmonization of descriptors, as well as their expansion to cover new crops, remains very important.

265. Global and regional assessments, oversight, planning and coordination are needed to promote cost efficiency and effectiveness.

16. Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of plant genetic resources for food and agriculture

266. **Background:** The erosion of PGRFA occurs in *ex situ* collections, in farmers' fields and in nature. With modern molecular genetic techniques, it has been possible in the past decade to generate some data on the extent and nature of genetic erosion for particular crops in specific areas. The picture that is emerging is complex and it is not possible to draw clear conclusions about the magnitude of these effects. Nevertheless, in many countries there remains

continuing concern over the extent of genetic erosion and the need for greater deployment of diversity. Better techniques and indicators are needed for monitoring genetic diversity, for establishing baselines and monitoring trends. The Biodiversity Indicators Partnership has brought together a large number of international organizations to develop indicators relevant to the CBD's 2010 biodiversity target, including for monitoring trends in genetic diversity of crops. However, to date, no really practical and internationally accepted indicators of genetic erosion or genetic diversity are available; their development should be a priority.

267. Various factors, both natural phenomena and the results of human behaviour – including urbanization, agricultural development, civil strife and war – have historically been recognized as drivers of the erosion of PGRFA. The loss of crop genetic resources occurs mainly as a result of the adoption of new crop varieties, with the consequent abandonment of traditional varieties without appropriate conservation measures being taken. More recently, climate change and modern dietary preferences have also been seen as a threat. In some countries, the threat of invasive alien species should also be considered, as these may contribute to genetic erosion. The loss of PGRFA varies within countries and from country to country. Support should be provided to establish monitoring mechanisms at all levels.

268. Following a review in 1997, the WIEWS application for remote searching, updating and reporting on genetic erosion, was published on the Internet. More recently, the scope of the information covered by WIEWS has been expanded to host NISMs, which also address issues related to genetic erosion.

269. **Objectives:** To effectively monitor genetic diversity and the drivers of genetic erosion and to implement appropriate remedial or preventative action as necessary.

270. To establish and implement monitoring mechanisms to ensure the timely transfer of information to contact points designated as responsible for analysis, coordination and action. To expand the use of advanced technologies for monitoring the degradation of the most threatened diversity in crops, CWR and wild food species.

271. **Policy/strategy:** Governments should periodically review and report on the situation of PGRFA, designating a focal point to convey this information to FAO, and, as appropriate, to the Governing Body of the International Treaty, the Conference of the Parties to the CBD and other relevant bodies. Article 5 of the International Treaty requires Contracting Parties to monitor PGRFA, assessing threats and minimizing or, where possible, eliminating them. Special efforts are needed to identify the species and populations that are most at risk and are most likely to harbour traits that will be important in the future; this is particularly important with regard to farmers' varieties/landraces and CWR.

Improving the linkages between *in situ* and *ex situ* conservation strategies will reduce the risk of inadvertent loss of biological and cultural information.

272. Indicators and methods for assessing genetic diversity over time and minimizing genetic erosion and its drivers are required in order to be able to establish national, regional and global baselines for monitoring diversity and developing effective early warning systems. Efforts should be made to ensure that relevant information generated by extension services, local non-governmental organizations, the seed sector and farming communities can be linked to early warning systems at the national and higher levels. Novel ICT tools, including mobile telephones, can greatly facilitate reporting and collating information from such disparate sources.

273. **Capacity:** Stronger capacity is required for gathering and interpreting information on PGRFA – in particular CWR species identification – and for conducting inventories and surveys using new molecular and ICT tools and tools for the spatial analysis of diversity. Training on monitoring should be provided for breeders, farmers and indigenous and local communities. Training materials, including self-teaching tools, should be produced in local languages as needed.

274. Realizing the importance of global monitoring and early warning of the loss of PGRFA, the efficiency, purpose and value of the WIEWS should be re-evaluated, taking into consideration the potential role that the WIEWS can play as part of the Global Information System on Plant Genetic Resources as foreseen under Article 17 of the International Treaty.

275. **Research/technology:** Research is required to improve methods for surveying PGRFA, which would be useful in the development of monitoring systems. Continued research is needed on the development of practical and informative indicators of genetic erosion or genetic diversity.

276. Technical experts, representatives of national programmes, the United Nations Environment Programme, the CGIAR and other international institutions involved in PGRFA conservation, the International Union for Conservation of Nature, non-governmental organizations and the private sector should be invited by FAO to continue discussions on the development of monitoring systems for plant genetic diversity and minimizing genetic erosion.

277. Further research is needed on the use of GIS technology to monitor genetic diversity and to predict and minimize genetic erosion and on the incorporation of the resulting information into comprehensive information systems. Additional study is required in order to understand the nature and extent of possible threats to existing diversity on farm and *in situ*.

278. **Coordination/administration:** Multisectoral collaboration and coordination need to be strengthened at the national level, especially among the agriculture, environment and development sectors. National programmes should consider alerting regional and international networks as to when and where there are imminent risks of genetic erosion.

17. Building and strengthening human resource capacity

279. **Background:** Improvements in PGRFA conservation and use are very dependent on human resource capacity and its continuous development. Donor funding for capacity building has increased over the past 15 years, which has resulted in stronger collaboration in training among national, regional and international organizations. Training courses are more frequent and new training materials and facilities have been developed. Higher education possibilities have also expanded and there are now more universities offering a wider range of courses in areas related to PGRFA, especially as regards the application of biotechnology to conservation and crop improvement.

280. Despite these efforts, however, human resource capacity is still far from adequate at virtually all levels and in all disciplines related to PGRFA conservation and use. In many countries, gene bank staff are too few and are inadequately trained to collect, classify, conserve, regenerate, characterize, document and distribute PGRFA. This lack of capacity poses a serious threat to establishing and managing valuable PGRFA collections. Limited taxonomic plant breeding and prebreeding capacity in most developing countries severely limits the effective and sustainable use of PGRFA. In the context of on-farm conservation, extension services and non-governmental organizations often lack qualified personnel to deliver appropriate training to farming communities. There is also a lack of qualified personnel in relation to seed production and seed technology.

281. **Objectives:** To ensure the long-term availability of adequate human resources capacity in all areas of PGRFA conservation and use, including management, legal and policy aspects.

282. To develop national and regional ability to deliver training on PGRFA at all levels and to establish effective collaborative arrangements between organizations in developed and developing countries in order to strengthen and regularly upgrade the capacities of all PGRFA stakeholders. To maintain adequate national capacity in critical areas and to stem the loss of trained personnel from developing countries.

283. To develop quality training courses and educational materials for primary and secondary education in priority subjects at the national, regional and global levels. To encourage undergraduate and postgraduate educational institutions to include aspects of PGRFA in courses and programmes, including through the use of e-learning and distance education.

284. To facilitate access to external training for countries lacking national capacity. To encourage advanced institutions that manage PGRFA to offer capacity-development opportunities.

285. To develop a sound research agenda to bridge the gap between the science of PGRFA and its application to management and gene bank activities and the sustainable use of PGRFA, including plant breeding and seed technology.

286. To expand opportunities for hands-on learning, mentoring and leadership training in research and development and policy areas at policy and research organizations at the national, regional and international levels.

287. **Policy/strategy:** Governments should recognize the importance of including PGRFA in primary, secondary and advanced education. In collaboration with relevant organizations, governments should commit to providing training and advanced educational opportunities for young researchers, technicians and development workers, as well as to regularly upgrading the knowledge and skills of existing staff. Training opportunities and advanced education programmes should include technical and scientific aspects of the conservation, exchange and use of PGRFA in curricula for biology, agriculture, the environment, economics and health. Particular emphasis should be placed on providing training in conservation biology, especially with respect to agricultural biodiversity.

288. Regular assessments of human resource capacity and needs should be made; the results should assist countries to develop education and training strategies at the national, regional and global levels.

289. **Capacity:** Support should be given to enable national and regional organizations and programmes to update curricula, provide advanced education and strengthen research and technical capacity on all relevant aspects of PGRFA conservation and use. Support should also be given to students in undergraduate and postgraduate programmes and to continuous professional training. Collaboration should be encouraged between academic institutions in developed and developing countries, including in the private sector, and internships and staff exchanges should be promoted. Access to the Internet will be particularly important to promote e-learning, communication, and data and information exchange.

290. As national and regional organizations are strengthened, existing capacity in developed countries should be used and supported, particularly when tailored to the capacity needs of developing countries.

291. In addition to current efforts, specialized training courses, including practical hands-on training and mentorship programmes, should be developed and regularly held in all regions. Technical topics, including the links between conservation and use, management, law, policy and public awareness, should be addressed to improve understanding of international agreements and treaties.

292. Expertise on technology transfer related to the conservation, characterization, exchange and sustainable use of PGRFA should be enhanced. National organizations in both developing and developed countries and international organizations should play important roles in facilitating the improvement of such expertise, especially through staff exchanges.

293. Consideration should be given to preparing educational materials that are widely applicable in different regions, but that maintain a distinctive regional focus. Where feasible, courses should be offered in the language most appropriate for the region.

294. Special consideration should be given to gender integration, especially to on-site training for rural women, as they play a significant, but sometimes underappreciated, role in maintaining and developing PGRFA and the associated knowledge and traditions.

295. The capacity to produce training materials and offer or coordinate training courses should be enhanced at the international level.

296. **Research/technology:** Where possible, training should be linked to ongoing research and development in educational and professional organizations and national programmes. Efforts should be made to involve university students and professional staff in field and research activities.

297. **Coordination/administration:** Training courses should be developed and offered in close collaboration with international and regional networks and national programmes. In addition, advanced programmes should be prepared in cooperation with relevant international and regional academic consortia or associations in response to national needs.

18. Promoting and strengthening public awareness on the importance of plant genetic resources for food and agriculture

298. **Background:** Public awareness is the key to mobilizing popular opinion and to generating and sustaining appropriate political action nationally, regionally and internationally. Communicating effectively about the many benefits that PGRFA can bring to food security and sustainable livelihoods is critical to the success of any conservation programme. Recent years have seen a growing understanding of the importance of PGRFA in addressing the challenges posed by climate change. Interest in underutilized species is on the rise in recognition of their potential to be productive under different climate scenarios and to provide opportunities for high-value niche products. There is also an increasing recognition by scientists of the potential of CWR to contribute to the sustainable intensification of production, but this has not yet reached a wider audience. Concern over the global increase in lifestyle-related diseases has led to an increasing interest in the nutritional benefits that can be gained from exploring and exploiting PGRFA. Many countries aim to reduce the cost of imported food by revitalizing local food production, which often has cultural value as well. Social networking tools provide an extremely effective way to get such messages across to a significant number of people, in particular the young generation. Nevertheless, raising awareness among policy-makers, donors and the general public of the value of PGRFA is a continuing challenge.

299. A targeted public awareness programme can promote the development of international links and collaborative mechanisms such as networks, involving different sectors, agencies and stakeholders. Within countries, public awareness can support efforts to involve the private sector, indigenous and local communities, and local and non-governmental organizations in national genetic resources activities, thus ensuring a broader base for conserving and sustainably using PGRFA. Working with the media at the local and national levels is a crucial aspect of raising awareness. The creation of strong links between public awareness campaigns implemented by international organizations and national programmes and organizations can increase their effectiveness and reduce costs. Successful awareness programmes can bring financial rewards, as can be seen in the case of the Trust, established in 2004 as a specialized fund dedicated to supporting the conservation of PGRFA and promoting its use worldwide.

300. **Objectives:** To ensure continued support for PGRFA conservation and use from policy-makers and the general public.

301. To support and strengthen mechanisms, particularly in developing countries, for coordinated public awareness activities that involve and target all stakeholders. To fully integrate public awareness into all national, regional and international programme activities.

302. **Policy/strategy:** Greater efforts are needed to estimate the full value of PGRFA, to assess the impact of their use and to bring this information to the attention of policy-makers and the general public. Public awareness and the roles that specific target audiences can play in sustaining plant genetic resources should be considered when developing any PGRFA activity.

303. National strategies should recognize the role that all PGRFA stakeholders have to play in the development of public awareness activities. Governments should recognize and encourage the work of non-governmental organizations in raising public awareness, and efforts should be made to foster the development of public–private partnerships around public awareness campaigns. The important roles of indigenous and local communities in any *in situ* conservation or on-farm management effort, and their traditional knowledge systems and practices, need to be fully taken into account.

304. Public awareness materials should be produced in appropriate languages to facilitate broad use within countries and should exploit all available ICT options.

305. To be effective and ensure adequate reach, public awareness needs to be sufficiently supported in terms of both human and financial resources.

306. **Capacity:** National PGRFA programmes should have a trained focal point for public awareness to work closely with programme managers and develop the appropriate tools. Failing this, all staff in PGRFA programmes should develop at least some capacity to articulate the importance of the programme goals and activities within the broader context of sustainable agriculture and development. They should be able to communicate their message to all stakeholders using appropriate tools and keep abreast of new and innovative approaches to raising awareness.

307. National PGRFA programmes should work with well-known and influential people to increase access to the media and attract attention. Efforts are required to develop and strengthen relationships with the local media and to encourage them to cover PGRFA issues on a regular basis, involving them in communications workshops and meetings to gain a better understanding of the subject area.

308. National PGRFA programmes should draw on public awareness tools and technologies generated at the regional and international levels to use in their own communication efforts. These tools – and the messages they convey – may

have to be adapted to reflect national priorities and circumstances. However, it is likely that many of the messages they contain will be useful in supporting national public awareness strategies and activities. Adapting existing tools will substantially reduce costs to national programmes. This does not detract, however, from the need to enhance capacity for producing public awareness materials at the national level.

309. Awareness of the value of PGRFA and of the role of scientists, plant breeders, farmers, and indigenous and local communities in maintaining and improving these valuable resources should be promoted in schools at all educational levels as well as in specialized agricultural research institutions. This will involve producing education and training materials based on case studies. This would require working relationships with national education institutions. The important role that botanic gardens play in creating awareness should also be taken into account and promoted by the PGRFA community.

310. Simple, low-cost botanic gardens, arboreta and field gene banks associated with universities, schools and other institutions should be strengthened and encouraged to promote education and public awareness.

311. **Research/technology:** Research on the information needs of targeted audiences should be carried out before launching any major public awareness initiative. Policy-makers will undoubtedly be a critical target audience for any awareness campaign, and research is required to underpin the promotion of appropriate policies for the conservation and use of genetic diversity, including the economic valuation of PGRFA. At the international level, research should be carried out on the use of ICT tools to meet public awareness needs. The impact of promotional materials should not be assumed; there is need for impact analysis of awareness products so that limited resources can be used for maximum impact.

312. **Coordination/administration:** Coordination and facilitation is needed at all levels to rationalize and bring cost efficiencies to public awareness work. National programmes and others can take advantage of materials developed at the regional and international levels. Links between regional and international organizations, the private seed sector, and non-governmental organizations will facilitate the identification of opportunities for collaborative activities. A coordinated multisectoral and multi-agency approach enhances the strength of the message.

Implementing and Financing the Second Global Plan of Action

313. The Second GPA provides an important internationally agreed framework for the conservation and sustainable use of PGRFA. The Second GPA is a supporting component of the International Treaty as per its Article 14 and its implementation will be an essential contribution to achieving the objectives of the International Treaty. It will also facilitate the implementation of the CBD in the area of agricultural biodiversity and help reach the targets of the Strategic Plan for Biodiversity 2011-2020.

314. The follow-up processes call for action at the local, national, regional and international levels and should involve all relevant stakeholders: governments, local and regional authorities, regional and international organizations, both intergovernmental and non-governmental, the scientific community, the private sector, indigenous and local communities, breeders, farmers and other agricultural producers and their associations.

315. Overall progress on the implementation of the rolling Second GPA and the related follow-up processes will be monitored and guided by governments and other FAO Members through the Commission. In order to discharge this function, the Commission will plan the review of the implementation of the Second GPA as well as the review of the Second GPA itself within its Multi-Year Programme of Work, in close cooperation with the Governing Body of the International Treaty. The review should deal with the progress made at the national, regional and international levels in the implementation, elaboration, and adjustment, as appropriate, of the Second GPA. A first review of the implementation of the Second GPA should be undertaken by the Commission at its Fifteenth Regular Session, including an assessment of its achievements as well as gaps and financial and other needs for its implementation, in accordance with Resolution 1/2011 of the Commission.

316. To this end, the Commission, at its Fourteenth Regular Session, will agree on formats for progress reports as well as on criteria and indicators for monitoring the implementation of the Second GPA, building on previous work done by the Commission in the development of such indicators and reporting format. The conclusions of the Commission should be brought to the attention of concerned governments and international institutions to fill gaps, rectify imbalances or lack of coordination and consider new initiatives or activities. Any conclusions of the Commission that have major policy implications will be brought to the attention of the FAO Council and Conference, the Governing Body of the International Treaty and the

Conference of the Parties to the CBD and/or the Commission on Sustainable Development for action, endorsement or information, as appropriate.

317. The full implementation of the Second GPA requires a significant increase in the PGRFA activities that are currently taking place. The Second GPA will have to be implemented progressively and adequate financial resources should be mobilized commensurate with the scope of the Second GPA. Each country should determine its own priorities in the light of the priority activities agreed in the Second GPA and in the framework of its food and agriculture development needs.

318. So far, the most significant funding for PGRFA for the majority of regions has been provided by governments and other domestic sources of funds. Substantial funding sources for PGRFA also include bilateral and regional sources and multilateral organizations.

319. Given the importance of the contribution of domestic sources, including both the public and private sectors, each country should make every possible effort to provide, in accordance with its capacities, financial support with respect to national activities that are intended to achieve the objectives of the Second GPA, in line with national plans, priorities and programmes.

320. International cooperation for the conservation and sustainable use of PGRFA should be strengthened, in particular to support and complement the efforts of developing countries and countries with economies in transition. The Governing Body of the International Treaty will play a key role in this regard. The extent to which developing countries and countries with economies in transition will effectively meet their commitments under the Second GPA will largely depend on the effective implementation of the International Treaty and its Funding Strategy. Two relevant elements of the Funding Strategy that will support the implementation of the Second GPA are the Benefit-sharing Fund and the Trust. Funds in the Benefit-sharing Fund are under the direct control of the Governing Body and are used by the Governing Body to catalyse international cooperation in the area of PGRFA, taking the rolling GPA into account.[6] The Trust is an essential element of the Funding Strategy and promotes cost-effective and efficient

6 The three current priority areas are: 1. Information exchange, technology transfer and capacity building (reflecting priority activities 15 and 19 of the GPA, roughly corresponding to priority activities 13 and 17 of the Second GPA); 2. Managing and conserving plant genetic resources on farm (reflecting priority activity 2 of the GPA, roughly corresponding to priority activity 2 of the Second GPA); and 3. The sustainable use of plant genetic resources (reflecting priority activities 9, 10, and 11 of the GPA, roughly corresponding to priority activities 8, 9 and 10 of the Second GPA).

conservation activities in accordance with the GPA.[7] Every effort should also be made to seek new, additional and innovative sources of funding within the course of the implementation of the Second GPA.

321. Through the monitoring of the Funding Strategy of the International Treaty, the Governing Body will be able to monitor resources available for the implementation of the Second GPA. The priorities for support under the Funding Strategy are the priority activities of the rolling GPA. The monitoring of the Funding Strategy covers resources under the Benefit-sharing Fund as well as resources not under the Governing Body's direct control.

322. In order to enlist the widest participation and support for its implementation, the Second GPA should be reported to the major international, regional and national bodies and fora dealing with food and agriculture and biodiversity including, in particular, the FAO Conference, the Conference of the Parties to the CBD, the Commission on Sustainable Development, and the governing bodies of the United Nations Environment Programme, the Global Environment Facility, the United Nations Development Programme, the International Fund for Agricultural Development, the World Bank, the Common Fund for Commodities, Regional Development Banks, the CGIAR and the Trust, and their member constituencies should be invited to promote and take part, as appropriate, in the implementation of the Second GPA.

7 The objective of the Trust is to ensure the long-term conservation and availability of plant genetic resources for food and agriculture with a view to achieving global food security and sustainable agriculture. The Trust, in accordance with its Constitution shall in particular, without prejudice to the generality of the foregoing, (a) endeavour to safeguard collections of unique and valuable plant genetic resources for food and agriculture held ***ex situ***, with priority being given to those that are plant genetic resources included in Annex I to the International Treaty or referred to in Article 15.1(b) of the International Treaty; (b) promote an efficient goal-oriented, economically efficient and sustainable global system of *ex situ* conservation in accordance with the International Treaty and the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture; (c) promote the regeneration, characterization, documentation and evaluation of plant genetic resources for food and agriculture and the exchange of related information; (d) promote the availability of plant genetic resources for food and agriculture; and (e) promote national and regional capacity building, including the training of key personnel, with respect to the above.

List of acronyms and abbreviations

CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CWR	crop wild relatives
EURISCO	European Internet Search Catalogue
FAO	Food and Agriculture Organization of the United Nations
GCP	Generation Challenge Programme
GIPB	Global Partnership Initiative for Plant Breeding Capacity Building
GIS	geographic information systems
GPA	Global Plan of Action
GPS	Global Positioning System
GRIN	Germplasm Resources Information Network
ICT	information and communication technologies
IPR	intellectual property rights
Multilateral System	Multilateral System of Access and Benefit Sharing
MYPOW	Multi-Year Programme of Work of the Commission
NARS	National Agricultural Research System
NISM	National Information Sharing Mechanism on GPA implementation
PGRFA	plant genetic resources for food and agriculture
Second Report	Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture
the Commission	the Commission on Genetic Resources for Food and Agriculture
the International Treaty	the International Treaty on Plant Genetic Resources for Food and Agriculture
the Trust	the Global Crop Diversity Trust
WIEWS	World Information and Early Warning System on PGRFA
WISM	World Information Sharing Mechanism on GPA implementation

The Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture was adopted by the FAO Council at its 143rd Session in 2011. It updates the Global Plan of Action for Conservation and Sustainable Utilization of Plant Genetic Resources which was adopted at the Fourth International Technical Conference on Plant Genetic Resources held in Leipzig in 1996.

The Second Global Plan of Action addresses new challenges, such as climate change and food insecurity, as well as novel opportunities, including information, communication and molecular methodologies. It contains 18 priority activities grouped in four main groups: *In situ* Conservation and Management; *Ex situ* Conservation; Sustainable Use; and Building Sustainable Institutional and Human Capacities.

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