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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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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

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

Target 3. Progress in the implementation of each PA is assessed through a set of indicators adopted by 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 27 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 17 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.

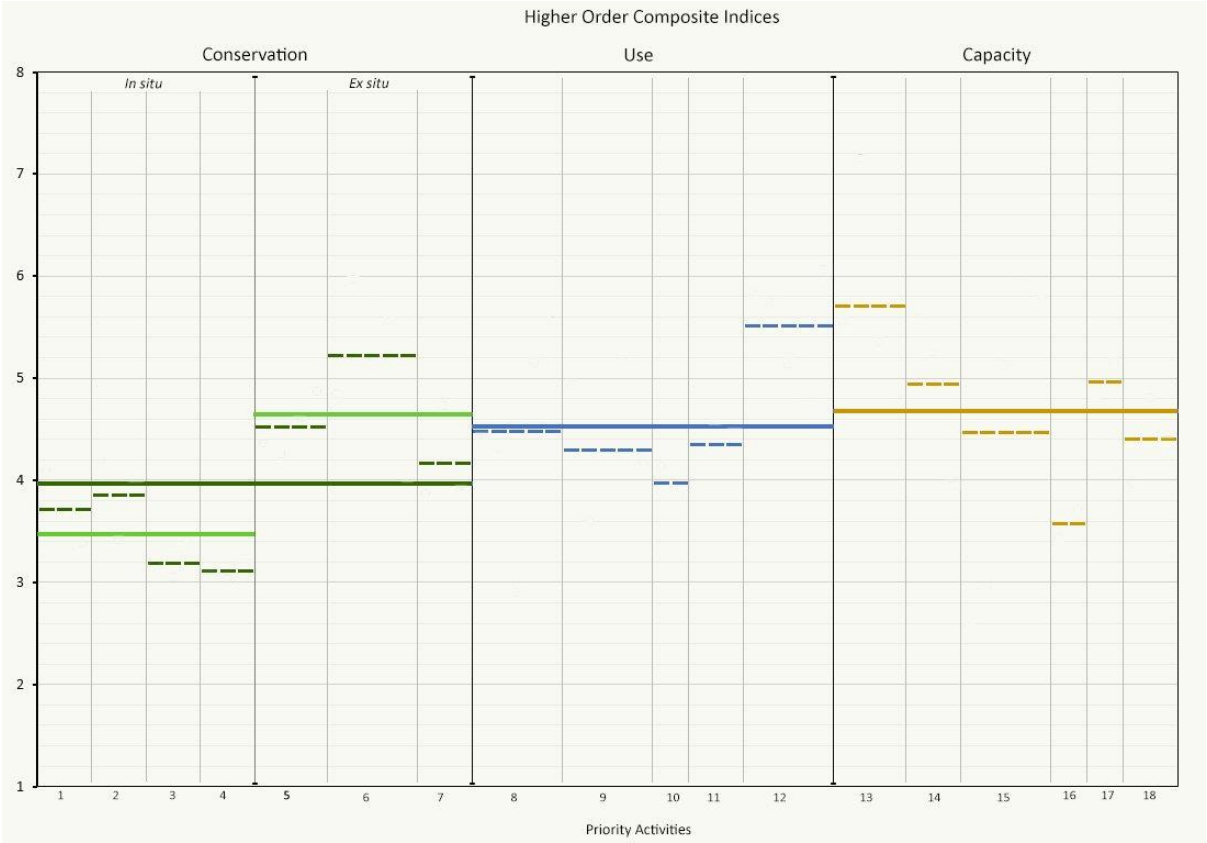
PA16, Developing and strengthening of systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of PGRFA. Fourteen countries had one or more systems in place to monitor and safeguard genetic diversity and minimize genetic erosion. Less than half of the international centres 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.

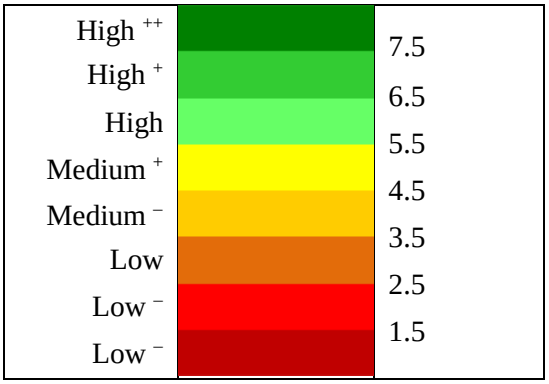
As of March 2016, 35 countries had completed the online Reporting Format (answering on average 67 percent of the questions). An additional eight countries reported only partially (about 16 percent of the questions answered). For one specific question and its three indicators associated with *ex situ* 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.

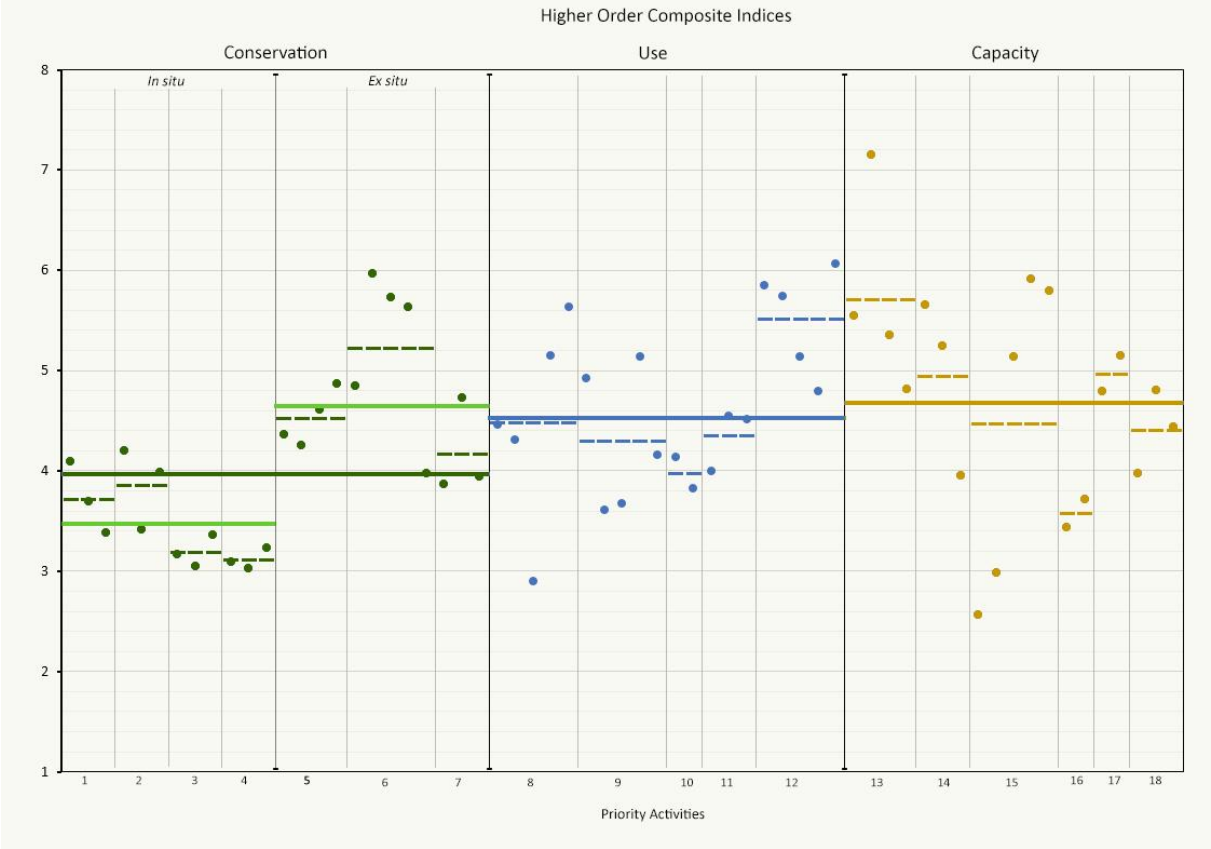
The implementation of the Second GPA as a whole contributes to the achievement of the adopted PGRFA targets, and each PA covers a particular dimension of, and contributes, to one of the three targets. PAs 1 to 7 of the Second GPA contribute to Target 1, PAs 8 to 12 to Target 2, and PAs 13 to 18

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

1 Surveying and inventorying PGRFA

NFP Rating 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

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

NFP Rating

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 27 percent, respectively, in the number of genera and species conserved, and the increased level of safety duplication

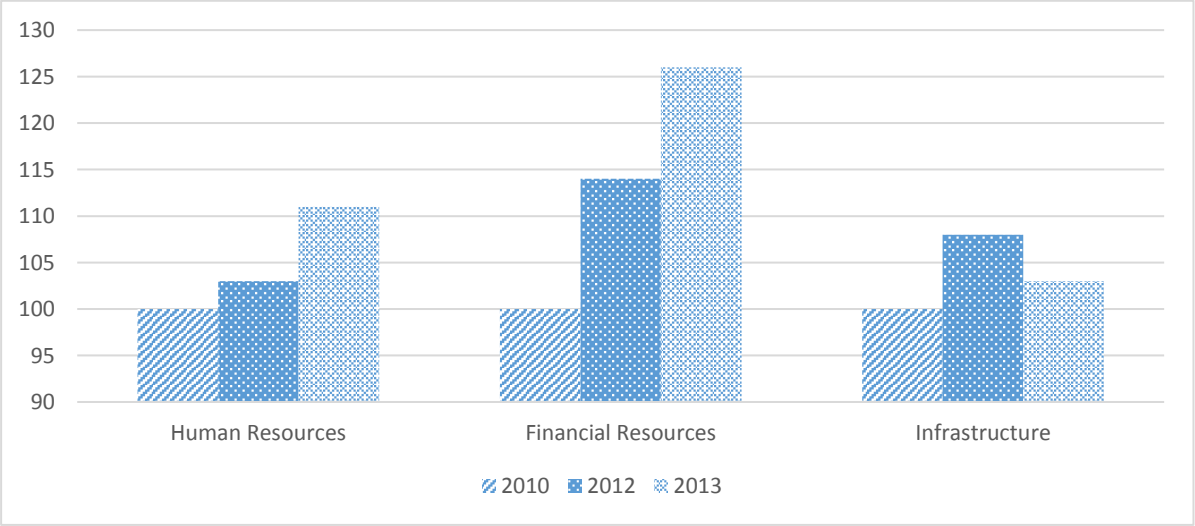
of individual accessions (on average 50 percent of the national collections and 62 percent of the collections held by the international centres). The 17 percent decrease in the number of accessions conserved was mainly the result of rationalization of conservation programmes in countries and more consistent 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	177	642	93 569	-	-	19	-47	-49	-61
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**	**450**	**1 800**	**117 639**	**65**	**50**	**26**	**-5**	**-8**	**-24**

[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
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
Japan	1	336	1 256	240 819	**1**	**177**	**642**	**93 569**	-47	-49	-61
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[16]	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

[16] Denmark, Finland, Norway, Sweden.

Country	2008 (no.)*				2014 (no.)				2008-2014 change (percent)		
	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[17]	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[18]	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**	**6 778**	**48 293**	**2 811 263**	**16**	**27**	**-17**

*Source: FAO WIEWS 2008

[17] Estimates based on the date of acquisition of the accessions reported in 2014.
[18] 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:[19] **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 6 778 genera and 48 293 species conserved *ex situ* under medium- or long-term conditions. The overall increase in the number of genera (16 percent) and species (27 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.

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

Indicator 18:[20] 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 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.

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

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

7 **Regenerating and multiplying *ex situ* accessions**

NFP Rating 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

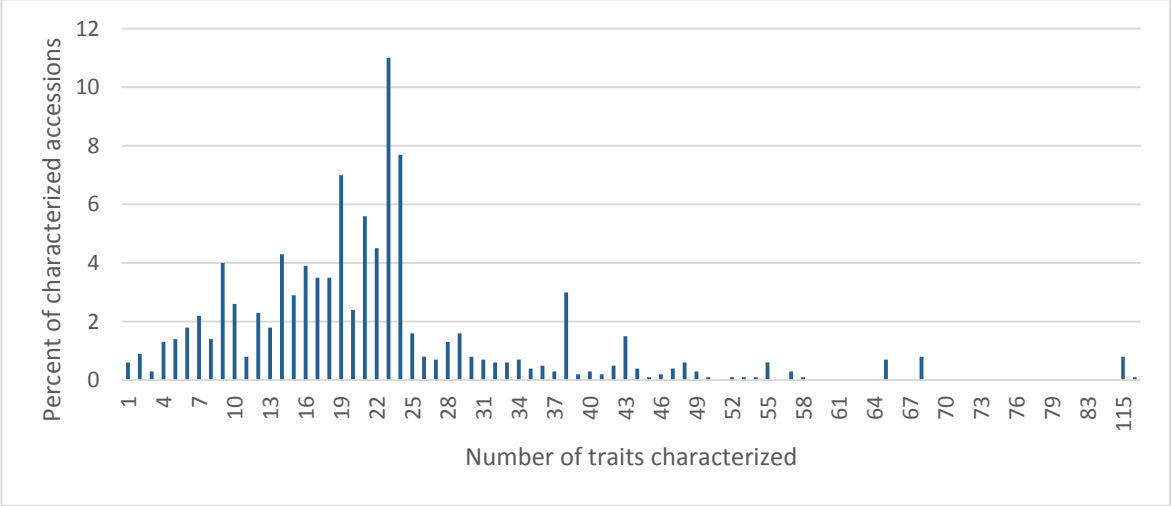


Table 8 summarizes for the five largest crop collections conserved by the reporting countries, the percentage of accessions characterized for at least one morphological trait and the average number of morphological traits used to characterize the collections. Highest levels of characterization are reported 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).[21] 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.

[21] 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

10

Promoting diversification of crop production and broadening crop diversity for sustainable agriculture

NFP Rating

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

12 **Supporting seed production and distribution**

NFP Rating

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).[22] 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.

[22] 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[23] plus the Joint Division of FAO and the International Atomic Energy Agency (IAEA) for Nuclear Techniques in Food and Agriculture. Four countries reported CIMMYT, three ICARDA and two AVRDC, CIP, ECPGR, IRRI and the International Society for Horticultural Science.

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

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.[24] 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* collections. The situation described by the limited number of reporting countries does not seem too far from what the

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

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 16

Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of PGRFA

NFP Rating 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		NFP Rating
17	**Building and strengthening human resource capacity**	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

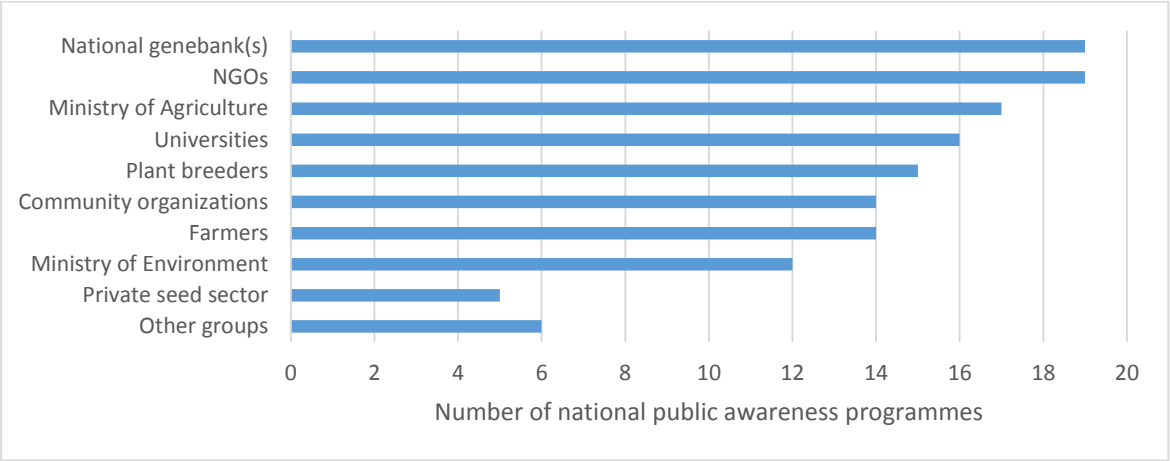
Indicators 61 and 62 are treated together as the information is drawn from responses to one and the same question and they are closely related.

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.