The Second Report on
THE STATE OF THE WORLD's

PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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GENETIC RESOURCES
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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE
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Foreword

Plant genetic resources for food and agriculture are playing an ever growing role on world food security and economic development. As an integral component of agricultural biodiversity, these resources are crucial for sustainable agricultural production intensification and ensure the livelihood of a large proportion of women and men who depend on agriculture.

In a world where around one billion people go hungry every day, with an expectation of a world population of nine billion by 2050, countries must make greater efforts to promote the conservation and sustainable use of the plant genetic resources for food and agriculture.

Agriculture has a key role to play in reducing poverty and food insecurity in the world. The effects of longstanding underinvestment in agriculture, food security and rural development, spikes in food prices and the global financial and economic crisis have led to increased hunger and poverty in many developing countries.

In the 21st century agriculture faces a number of challenges. It has to produce more food and fibre to meet the demand of a growing world population, mainly living in urban areas, while relying on a decreasing rural labour force. It has to produce more feedstock for a potentially huge bio-energy market and to contribute to overall development in the many agriculture-dependent developing countries, while adopting more efficient and sustainable production methods. Natural resources are also facing increasing pressure at the global, regional and local levels.

In addition, climate change is threatening to increase the number of hungry people even further in the future, and creating new and difficult challenges for agriculture. While the effects of climate change are only beginning to be felt, there is general agreement that unless appropriate measures are taken, their future impact will be enormous. Plant genetic resources that are also threatened by it, are the raw materials to improve the capacity of crops to respond to climate change and must be protected. An enhanced use of plant genetic diversity is essential to address these and other future challenges.

The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture provides a comprehensive picture of the global situation and trends regarding the conservation and use of plant genetic resources. The report was endorsed by the intergovernmental Commission on Genetic Resources for Food and Agriculture in 2009 as the authoritative assessment of the sector and a basis for updating the *Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture*.

The report was prepared with the active participation of member countries as well as the public and private sectors. It describes the most significant changes that have occurred since the publication of the first report in 1998 and focuses on the major gaps and needs which will serve countries and the world community to set future priorities for the conservation and sustainable utilization of plant genetic resources for food and agriculture. The report emphasizes the importance of an integrated approach to the management of plant genetic resources for food and agriculture. It points out the need to secure broad diversity of crop plants, including their wild relatives and underutilized species, in accessible conservation systems, and to increase capacities for plant breeding and seed delivery worldwide in order to tackle the challenges of climate change and food insecurity.

I hope and trust that the information in this report will be used as the basis for policy and technical decisions to strengthen national efforts to conserve and utilize the treasures incorporated in the world's plant genetic resources to address the urgent problems faced by agriculture today and tomorrow.

Jacques Diouf
FAO Director-General

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Preface

The first report on *The State of the World's Plant Genetic Resources for Food and Agriculture* (first SoW report) was presented to the Fourth International Technical Conference on Plant Genetic Resources held in Leipzig, Germany, in 1996. The Conference welcomed the report as the first comprehensive worldwide assessment of the state of plant genetic resource conservation and use. The full version of the first SoW report was published by the Food and Agriculture Organization of the United Nations (FAO) in 1998.

The Commission on Genetic Resources for Food and Agriculture (CGRFA), at its Eighth Regular Session, reaffirmed that FAO should periodically assess the state of the world's plant genetic resources for food and agriculture (PGRFA) to facilitate analyses of changing gaps and needs and contribute to the updating process of the rolling *Global Plan of Action on the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture* (GPA).

The CGRFA, at its Eleventh Regular Session, reviewed progress on the preparation of *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture* (SoWPGR-2) and noted that it should be a high quality document to identify the most significant gaps and needs, in order to provide a sound basis for the updating of the rolling GPA. It agreed that the SOWPGR-2 needed to be updated with the best data and information available, including country reports, information gathering processes and thematic studies, with the largest possible participation of countries, and should focus on changes that have occurred since 1996.

The preparatory process of the SoWPGR-2 used country reports as the main source of information on the status and trends of plant genetic resource conservation and use at the national level. As additional sources of information, FAO used scientific literature, thematic background studies and other relevant technical publications. Throughout the preparation, FAO strived to ensure high quality of the data and made considerable efforts to ensure that the process was country-driven, participatory and involved relevant international organizations.

The country reports were prepared based on the Guidelines for the Preparation of the Country Reports agreed by the CGRFA and made available in 2005. These Guidelines streamlined the process that had been established for the preparation of the SoWPGR-2 and introduced a new approach to monitor the implementation of the GPA.

The SoWPGR-2 was produced based on information provided by 113 countries (see Annex 1). FAO received the first of the 111 country reports in 2006, however, the majority were received in 2008. Two additional countries supplied data using a simplified reporting format. Reports from countries are available on the CD attached to this publication.

The progressive application of the new approach for the monitoring of the GPA implementation, that started in 2003, led to the establishment of National Information Sharing Mechanisms (NISM) in more than 60 countries worldwide (see Annex 1). Providing comprehensive information on the implementation of all the 20 priority activity areas of the GPA, the NISMs were widely used in the preparation of a large number of country reports.

A wide range of partners, including Bioversity International on behalf of the Consultative Group on International Agricultural Research (CGIAR), the Global Crop Diversity Trust (GCDT) and the Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), as well as other relevant international organizations, provided inputs throughout the preparation process. Specific information from the CGIAR and other regional and international genebanks was gathered in 2008 under the coordination of the System Wide Genetic Resources Programme.

The CGRFA requested that the SoWPGR-2 address the same seven chapter topics that were selected for the first SoW report, with one additional chapter discussing the contribution of PGRFA management to food security and sustainable development.

The CGRFA requested the preparation of in-depth studies on specific topics, including climate change, nutrition and health, as well as indicators on genetic erosion and seed systems, to complement the information provided through country reports. These studies were prepared in collaboration with several partners, including the CGIAR centres, and are available on the CD attached to this publication.

The SoWPGR-2 identifies the most significant gaps and needs on the conservation and use of PGRFA that have arisen since the first SoW report, provides the basis for the updating of the rolling GPA and for designing strategic national, regional and international policies for the implementation of its priority activities. At its Twelfth Session the CGRFA endorsed the report as the authoritative assessment of this sector. On the request of the CGRFA, a synthetic account of the report was also prepared containing the main findings and highlighting the gaps and needs that need urgent attention.

Acknowledgements

The SoWPGR-2 has been possible thanks to the contribution of time, energy and expertise by many individuals. FAO would like to take this opportunity to acknowledge their generosity. The report was prepared by FAO's Plant Production and Protection Division under the overall supervision of Elcio P. Guimarães. The core FAO team was composed of Stefano Diulgheroff, Kakoli Ghosh, Robert Gouantoueu Guei and Barbara Pick. Linda Collette, Juan Fajardo, Brad Fraleigh and Nuria Urquia also contributed to the work of the team. During the preparation process of the SoWPGR-2, there was very close collaboration with the Bioversity International team composed of Kwesi Atta-Krah, Ehsan Dulloo, Jan Engels, Toby Hodgkin and David Williams; the Global Crop Diversity Trust team was composed of Luigi Guarino and Godfrey Mwila.

The core information used to prepare the SoWPGR-2 was provided by 113 countries through country reports and data supplied through other mechanisms. The SoWPGR-2 team wishes to thank those governments and individuals for their contributions on the national status of PGRFA in their countries.

The preparation of this report would not have been possible without the generous financial support provided by the Governments of Canada, Italy, Japan, the Netherlands, Norway and Spain, and by FAO. Each chapter, annex and appendix of this report was prepared and reviewed by the individual experts or expert teams that are acknowledged below.

Chapter 1 – The state of diversity, was written by a team led by Bert Visser in association with Jan M.M. Engels, V.R. Rao, J. Dempewolf and M. van D. Wouw. The chapter was revised by Luigi Guarino and Danny Hunter.

Chapter 2 - The state of *in situ* management, was written by a team led by Ehsan Dulloo in association with Devra Jarvis, Imke Thormann, Xavier Scheldeman, Jesus Salcedo, Danny Hunter and Toby Hodgkin. The chapter was revised by Luigi Guarino.

Chapter 3 - The state of *ex situ* conservation, was written by Stefano Diulgheroff and Jonathan Robinson with the assistance of Morten Hulden, except for Section 3.10 Botanical Gardens, which was prepared by Suzanne Sharrock. The whole chapter was revised by Toby Hodgkin and Luigi Guarino.

Chapter 4 – The state of use, was written by Jonathan Robinson and Elcio P. Guimarães and was revised by Clair Hershey and Eric Kueneman.

Chapter 5 - The state of national programmes, training needs and legislation, was written by a team led by Patrick McGuire in association with Barbara Pick and Raj Paroda and was revised by Geoffrey Hawtin and Elcio P. Guimarães.

Chapter 6 - The state of regional and international collaboration, was written by Geoffrey Hawtin and Raj Paroda and was revised by Kakoli Ghosh.

Chapter 7 - Access to plant genetic resources, the sharing of benefits arising out of their utilization and the realization of Farmers' Rights, was written by Gerald Moore and was revised by Maria José Amstalden Sampaio and Geoffrey Hawtin.

Chapter 8 - The contribution of PGRFA to food security and sustainable agricultural development, was written by a team led by Leslie Lipper in association with Romina Cavatassi and Alder Keleman and was revised by Kakoli Ghosh and Robert Gouantoueu Guei.

Annex 1 - List of countries that provided information for the preparation of *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*, was prepared by Barbara Pick, Patrick McGuire and Elcio P. Guimarães.

Annex 2 - Regional distribution of countries, was prepared by Barbara Pick and Marike Brezillon-Millet.

Appendix 1 - Status by country of national legislation related to Plant Genetic Resources for Food and Agriculture, was prepared by Barbara Pick.

Appendix 2 - Major germplasm collections by crop and institute, was prepared by Morten Hulden and Stefano Diulgheroff.

Appendix 3 – The state-of-the-art: methodologies and technologies for the identification, conservation and use of plant genetic resources for food and agriculture, was prepared by Patrick McGuire and revised by Theresa M. Fulton and Chike Mba.

Appendix 4 – State of diversity of major and minor crops, was prepared by Patrick McGuire, revised by Stefano Diulgheroff and received inputs from Steve Beebe, Merideth Bonierbale, Hernan Ceballos, Bing Engle, José Esquinas, Luigi Guarino, Lorenzo Maggioni, Cesar P. Martínez, Elisa Mihovilovich, Matilde Orrillo, Rodomiro Ortiz and Hari D. Upadhyaya on specific crops.

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Executive summary

This report describes the current status of the conservation and use of PGRFA throughout the world. It is based on country reports, information gathering processes, regional syntheses, thematic background studies and published scientific literature. It describes the most significant changes that have taken place since the first SoW report was published in 1998 and describes major continuing gaps and needs. The structure follows that of the first SoW report with an additional chapter on the contribution of PGRFA to food security and sustainable agricultural development.

1 The state of diversity

The total number of accessions conserved *ex situ* worldwide has increased by approximately 20 percent since 1996, reaching 7.4 million. While new collecting accounted for at least 240 000 accessions, and possibly considerably more, much of the overall increase is the result of exchange and unplanned duplication. It is estimated that less than 30 percent of the total number of accessions are distinct. While the number of accessions of minor crops and crop wild relatives (CWR) has increased, these categories are still generally under-represented. There is still a need for greater rationalization among collections globally.

Scientific understanding of the on-farm management of genetic diversity has increased. While this approach to the conservation and use of PGRFA is becoming increasingly mainstreamed within national programmes, further efforts are needed in this regard.

With the development of new molecular techniques, the amount of data available on genetic diversity has increased dramatically, leading to an improved understanding of issues such as domestication, genetic erosion and genetic vulnerability. The introduction of modern varieties of staple crops appears to have resulted in an overall decrease in genetic diversity, although within the released varieties themselves the data are inconsistent and no overall narrowing of the genetic base can be discerned. The situation regarding genetic erosion in landraces and CWR is equally complex. While many recent studies have confirmed that diversity in farmers' fields and protected areas has eroded, this is not universally the case.

Many country reports expressed continuing concern over the extent of genetic vulnerability and the need for a greater deployment of diversity. However, better techniques and indicators are needed to monitor genetic diversity, to establish baselines and monitor trends.

There is evidence of growing public awareness with regard to the importance of genetic diversity, both to meet increasing demands for greater dietary diversity, as well as to meet future production challenges. The increased environmental variability that is expected to result from climate change implies that in the future, farmers and plant breeders will need to be able to access an even wider range of PGRFA than today.

2 The state of *in situ* management

Since the first SoW report was published, a large number of surveys and inventories have been carried out in many different countries, both in natural and agricultural ecosystems. Awareness of the importance and value of CWR and of the need to conserve them *in situ* has increased. A global strategy for CWR conservation and use has been drafted, protocols for the *in situ* conservation of CWR are now available, and a new Specialist Group on CWR has been established within the International Union for Conservation of Nature/ Species Survival Commission (SSC-IUCN). The number and coverage of protected areas has expanded by approximately 30 percent over the past decade and this has indirectly led to a greater protection of CWR. However, relatively little progress has been achieved in conserving wild PGRFA outside protected areas or in developing sustainable management techniques for plants harvested from the wild.

Significant progress has been made in the development of tools and techniques to assess and monitor PGRFA within agricultural production systems. Countries now report a greater understanding of the amount and distribution of genetic diversity in the field, as well as the value of local seed systems in maintaining such diversity. More attention is now being paid in several countries to increasing genetic diversity within production systems as a way to reduce risk, particularly in light of changes in climate, pests and diseases. The number of on-farm management projects carried out with the participation of local stakeholders has increased somewhat and new legal mechanisms have been put in place in several countries to enable farmers to market genetically diverse varieties.

There is still a need for more effective policies, legislation and regulations governing the *in situ* and on-farm management of PGRFA, both inside and outside protected areas, and closer collaboration and coordination are needed between the agriculture and environment sectors. Many aspects of *in situ* management still require further research and strengthened research capacity is required in such areas as the taxonomy of CWR and the use of molecular tools to conduct inventories and surveys.

3 The state of *ex situ co*nservation

Since the publication of the first SoW report, more than 1.4 million accessions have been added to *ex situ* collections, the large majority of which are in the form of seeds. Fewer countries now account for a larger percentage of the total world *ex situ* germplasm holdings than was the case in 1996.

While many major crops are well-, or even overduplicated, many important collections are inadequately so and hence potentially at risk. For several staple crops, such as wheat and rice, a large part of the genetic diversity is currently represented in collections. However, for many others, considerable gaps remain. Interest in collecting CWR, landraces and neglected and underutilized species, is growing as land-use systems change and environmental concerns increase the likelihood of their erosion.

Many countries still lack adequate human capacity, facilities, funds or management systems to meet their *ex situ* conservation needs and obligations, and as a result, a number of collections are at risk. While significant advances have been made in regeneration in both national and international collections, further work remains to be done. The

documentation and characterization of many collections is still inadequate and in cases where information does exist, it is often difficult to access.

Greater efforts are needed to build a truly rational global system of *ex situ* collections. This requires, in particular, strengthened regional and international trust and cooperation.

The number of botanical gardens around the world now exceeds 2 500, maintaining samples of some 80 000 plant species. Many of these are CWR. Botanical gardens took the lead in developing the Global Strategy for Plant Conservation adopted by the Convention on Biological Diversity (CBD) in 2002.

The creation of the GCDT and the Svalbard Global Seed Vault (SGSV) both represent major achievements since the first SoW report was published and the world's PGRFA is undoubtedly more secure as a result. However, while seed collections are larger and more secure overall, the situation has progressed less in the case of vegetatively propagated species and species whose seeds cannot be dried and stored at low temperatures.

4 The state of use

The sustainable use of PGRFA primarily through plant breeding and associated seed systems remains essential for food security, viable agricultural enterprise and for adaptation to climate change. By aggregating data globally, it appears that plant breeding capacity has not changed significantly during the last 15 years. A modest increase in the number of plant breeders has been reported in some countries and a decline in others. In many countries public sector plant breeding has continued to contract, with the private sector increasingly taking over.

Agriculture in many developing countries that reduced their support to public sector crop development, leaving instead, the sustainable use of PGRFA to the private sector, is more vulnerable than in the past as private sector breeding and seed enterprise is restricted largely to a few crops for which farmers buy fresh seed each season. Considerably more attention and capacity building is urgently needed to strengthen plant breeding capacity and the associated seed systems in most developing countries, where most of the important crops are not, and will not be, the focus of private enterprise.

The number of accessions characterized and evaluated has increased in all regions but not in all individual countries. More countries now use molecular markers to characterize their germplasm and undertake genetic enhancement and base-broadening to introduce new traits from non-adapted populations and wild relatives.

Several new important international initiatives have been established to promote the increased use of PGRFA. The Global Partnership Initiative for Plant Breeding Capacity Building (GIPB), for instance, aims to enhance the sustainable use of PGRFA in developing countries through helping to build capacity in plant breeding and seed systems. The GCDT, and the new Generation and Harvest Plus Challenge Programs of the CCGIAR, all support the increased characterization, evaluation and improvement of germplasm.

Genomics, proteomics, bioinformatics and climate change were all absent from the first SoW report but are important now, and greater prominence is also given to sustainable agriculture, biofuel crops and human health. Although progress in research and development of neglected and underutilized species, as recommended in the first SoW report, is difficult to gauge, it is clear that further efforts are needed.

In many countries there is a need for more effective strategies, policies and legislation, including seed and intellectual property (IP) legislation, to promote a greater use of PGRFA. Good opportunities exist to strengthen cooperation among those involved in conservation and use, at all stages of the seed and food chain. Stronger links are needed, especially between plant breeders and those involved in seed systems, as well as between the public and private sectors.

5 The state of national programmes, training needs and legislation

Although the first SoW report classified national programmes into three categories, it has since become clear that such a typology is too simplistic. There is huge heterogeneity among national programmes in terms of their goals, functions, organization and structure. Of the 113 countries that provided information for both the first and second SoW reports, 46 percent had no national programme in 1996 whereas 71 percent have one now. In most countries, national government institutions are the principal entities involved, however, the number of other stakeholders, especially universities, has expanded. Many of the country reports noted that funding remains inadequate and unreliable.

Even in countries with well-coordinated national programmes, certain elements are often missing. National, publicly accessible databases, for example are still comparatively rare, as are coordinated systems for safety duplication and public awareness.

Since the first SoW report was published, most countries have enacted new national phytosanitary legislation, or revised old legislation, in large part in response to the adoption of the revised International Plant Protection Convention (IPPC) in 1997. With respect to intellectual property rights (IPR), of the 85 developing and Eastern European countries that now recognize Plant Breeders Rights (PBR), 60 have done so in the last decade. Seven others are currently drafting legislation.

The importance of farmers as custodians and developers of genetic diversity was recognized in the ITPGRFA through the provisions of Article 9 on Farmers' Rights. Eight countries have now adopted regulations covering one or more aspects of Farmers' Rights.

Since the first SoW report, biosafety has emerged as an important issue and many countries have now either adopted national biosafety regulations or frameworks, or are currently developing them. As of February 2010, 157 countries and the European Union had ratified the Cartagena Protocol on Biosafety.

6 The state of regional and international collaboration

The entry into force of the ITPGRFA in 2004 marks what is probably the most significant development since the publication of the first SoW report. The ITPGRFA is a legally binding international agreement that promotes the conservation and sustainable use of PGRFA and the fair and equitable sharing of the benefits arising out of their use, in harmony with the CBD. International collaboration is strongly promoted by the ITPGRFA, for which FAO provides the Secretariat.

Given the high level of interdependence among countries with respect to the conservation and use of PGRFA, it is imperative that there be strong and extensive international cooperation. Good progress has been made in this area since the first SoW report was published. A number of new regional networks on PGRFA have been established and a few others have become stronger. However, not all have fared well. Several are largely inactive and one has ceased to function. Three new regional networks specifically addressing the issue of seed production, have been established in Africa.

FAO has further strengthened its activities in PGRFA since the first Sow report, for example, through establishing GIPB in 2006. The international centres of the CGIAR concluded agreements in 2006 with FAO, acting on behalf of the Governing Body of the ITPGRFA, in this way bringing their collections within the ITPGRFA's multilateral system of access and benefit sharing. The CGIAR itself is undergoing significant reform.

There have also been many other new international initiatives including the establishment of the International Center for Biosaline Agriculture (ICBA) in 1999, the Central Asia and the Caucasus Association of Agriculture Research Institution (CACAARI) and the Global Forum on Agricultural Research (GFAR) in 2000, the Forum for Agricultural Research in Africa (FARA) in 2002, the Global Cacao Genetic Resources Network (CacaoNet) in 2006, and the Crops for the Future and the SGSV in 2008. All have significant activities in PGRFA. In the area of funding, several new foundations now support international activities with regard to PGRFA. A special fund was set up in 1998 to support agricultural research in Latin America (FONTAGRO) and in 2004, the GCDT was established as an essential element of the funding strategy of the ITPGRFA.

7 Access to plant genetic resources, the sharing of benefits arising out of their utilization and the realization of Farmers' Rights

The international and national legal and policy framework for access and benefit sharing (ABS) has changed substantially since the publication of the first SoW report. Perhaps the most far-reaching development has been the entry into force of the ITPGRFA in 2004. The ITPGRFA established a Multilateral System of ABS that facilitates access to plant genetic resources of the most important crops for food security, on the basis of a Standard Material Transfer Agreement (SMTA). As of February 2010, there were 123 parties to the ITPGRFA. The FAO Commission on Genetic Resources for Food and Agriculture adopted a Multi-Year Programme of Work in 1997 that recommended that "FAO continue to focus on ABS for genetic resources for food and agriculture in an integrated and interdisciplinary manner…"

Negotiations under the CBD to develop an international regime on ABS are scheduled to be finalized in 2010. However, many issues remain to be settled, including the legal status of the regime. Discussions on matters related to ABS are also taking place in other fora such as the Trade-Related Aspects of Intellectual Property Rights Council (TRIPS), the World International Property Organization (WIPO) and the World Trade Organization (WTO). There is a need for greater coordination among the different bodies involved in these discussions at the national and international levels.

In February 2010, the CBD Database on ABS Measures listed 33 countries with legislation regulating ABS. Of these, 22 have adopted new laws or regulations since 2000. Most have

been developed in response to the CBD rather than the ITPGRFA. Many countries have expressed a desire for assistance in confronting the complex legal and technical issues involved in drawing up new legislation. So far, there are few models that can be emulated and several countries are experimenting with new ways of protecting and rewarding traditional knowledge and the realization of Farmers' Rights.

8 The contribution of PGRFA to food security and sustainable agricultural development

Sustainable development has grown from being a movement focusing mainly on environmental concerns, to a widely recognized framework that aims to balance economic, social, environmental and intergenerational concerns in decision-making and action at all levels.

There have been growing efforts to strengthen the relationship between agriculture and the provision of ecosystem services. Schemes that promote Payment for Environmenal Services (PES), such as the *in situ* or on-farm conservation of PGRFA, are being set up in an attempt to encourage and reward farmers and rural communities for their stewardship of the environment. However, the fair and effective implementation of such schemes remains a major challenge.

Concerns about the potential impact of climate change have grown substantially over the past decade. Agriculture is both a source and a sink for atmospheric carbon. PGRFA are recognized as being critically important for the development of farming systems that capture more carbon and emit fewer greenhouse gasses, and for underpinning the breeding of new varieties that will be needed for agriculture to adapt to the anticipated future environmental conditions. Given the time needed to breed a new crop variety, it is essential that additional plant breeding capacity be built now.

There is a need for more accurate and reliable measures, standards, indicators and baseline data for sustainability and food security that will enable better monitoring and assessment of the progress made in these areas. Standards and indicators that will enable the monitoring of the specific role played by PGRFA are needed particularly.

In spite of the enormous contribution by PGRFA to global food security and sustainable agriculture, its role is not widely recognized or understood. Greater efforts are needed to estimate the full value of PGRFA, to assess the impact of its use and to bring this information to the attention of policy-makers and the general public so as to help generate the resources needed to strengthen programmes for its conservation and use.