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Importance of Plant Genetic Resources in Sustainable Development: Global Challenges, and Solutions Being Developed in the Philippines

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Plant genetic resources (PGR) for food and agriculture (PGRFA) are vital components of biodiversity. They meet human needs for food, fiber, shelter, and medicines, and contribute to trade and cultural traditions. They form building blocks for the adaptation, evolution, and survival of species and for crop improvement programs that support sustainable development. PGR loss is occurring at an alarming rate, and threatens global food security by decreasing the ability of crops to adapt to environmental and biotic challenges. Here, I discuss the causes of this genetic erosion.

Crop genetic diversity must be conserved and used sustainably to ensure sustainable development. We must also train a critical mass of scientists to manage this resource, undertake research to increase utilization of PGRFA, and develop policies and legislation to guide their conservation and utilization.

Conservation via *ex situ* or *in situ* strategies can guarantee the availability of PGRFA for present and future generations. Conservation through sustainable utilization promotes long-term conservation of these resources.

Education and training in PGR conservation and management are important to increase the critical mass of trained staff on all aspects of PGR conservation and management. Post-graduate degrees in PGRFA conservation and management are now offered by the Philippines, India, and Malaysia to meet the regional need for trained staff. In addition, short-term training for stakeholders is provided by governments and nongovernmental organizations.

Research on "allele mining", especially to detect genes for adaptation to climate change and emerging pests and diseases, is necessary to increase the utilization of conserved germplasm, determine the scientific underpinnings of on-farm conservation, and develop the potential to identify and utilize novel products.

Awareness of national and international policies and laws on biodiversity conservation and PGRFA must also be increased to improve the conservation and sustainable utilization of PGRFA.

Key words: conservation, capacity building, laws and policies, plant genetic resources for food and agriculture, sustainable use

Introduction

Biodiversity represents the "variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD, 1994). Biodiversity at all levels is the basis for sustainable development. Plant genetic resources for food and agriculture (PGRFA) are vital components of agrobiodiversity, the subset of biodiversity related to agriculture. Agrobiodiversity comprises the diversity of genetic resources of plants, animals, and microorganisms that are important to food production and agriculture. Agriculture that is sustained by this biodiversity provides food, fiber, medicines, shelter, ornaments, and a range of services. PGRFA is defined as "any genetic material of plant origin of actual or potential value for food and agriculture" (ITPGRFA, 2004). Genetic diversity gives a

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species the ability to adapt to changing environmental conditions and to the emergence of new pests and diseases. Genetic adaptation therefore depends on the genetic diversity found within crop species. This diversity is the raw material for the creation of new crop varieties that will become critical tools in the world's fight against hunger (Hammer and Teklu, 2008). These new crop varieties also play a crucial role in maintaining a nation's agricultural competitiveness, and constitute the foundation upon which agriculture and world food security are based.

An estimated 925 million people are undernourished (FAO, 2010a). Three factors that have increased the number of hungry people since 1995 were identified by the Food and Agriculture Organization (FAO): neglect of the forms of agriculture that are most relevant to the poorest people by governments and international agencies, the current global economic crisis, and the significant recent increase in food prices.

Nearly all (98%) of the undernourished live in rural areas of developing countries, where they depend mostly on agriculture for their livelihoods (FAO, 2010a). Reducing the percentage of undernourished people in these areas will therefore depend on the development of sustainable agriculture based on the resources available to these farmers. Agriculture depends on maintaining a sufficient diversity of crop species to overcome environmental stresses and pathogens or diseases. Farmers and breeders have utilized PGRFA to develop new and improved varieties of crops with increased productivity that are capable of feeding the world's growing population. Sustained efforts to promote the conservation and sustainable use of PGRFA should therefore become a priority to cope with the challenges of meeting the demands created by an increasing population, climate change, and emerging pests and diseases.

Biodiversity, including that of PGRFA, is declining at an unprecedented rate. Genetic erosion, which represents the loss of populations and species or of variability within populations, has been documented in many crop species. Since the 1900s, an estimated 75% of PGRFA has been lost in farm fields worldwide (FAO, 2004). The principal cause of this genetic erosion has been the widespread adoption of modern crop varieties within areas where ancient agricultural varieties were formerly used. Paradoxically, the quest for increasing food production and the ensuing successes achieved in several crops have displaced the traditional landraces and varieties on which modern varieties are based. Acculturation, globalization of food systems and marketing, deforestation, population pressure, land conversion, urbanization, pests and diseases, overgrazing, civil strife, and natural calamities have also contributed to genetic erosion. Climate change could also lead to the loss of unadapted crop species in some areas. As a result of all these factors, many plant species are threatened or endangered. The Philippines was identified as one of 25 global biodiversity hotspots (Conservation International, 1999).

A related problem is that relatively few species are currently being utilized in agriculture. Of the 250 000 plant species that have been identified and described, only 10 000 (4%) are being used for food production, and just four species (maize, wheat, rice, and potato) supply almost 60% of the calories in the human diet (FAO, 2004). This has resulted in dependence on fewer varieties and fragmentation of remaining populations, thereby limiting food security. Needless to say, humanity depends heavily on maintaining the immense diversity within these species for our survival.

Land degradation is another problem that is increasingly affecting the world's agricultural land. As a result, agricultural productivity has declined sharply in many regions while the number of mouths to feed continues to increase. The Green Revolution boosted global agricultural productivity for the major cereal crops, but requires inputs that are not available to most of the world's farmers. Climate change further exacerbates the risk to food security, especially in environments that are marginal for farming. The impact of climate change on food security is projected by UNFCCC (2007) to be most severe in the least-developed developing countries, such as the Philippines, because it will decrease crop production as a result of the forecast changes in temperature and rainfall patterns, and rising sea levels will lead to sea water intrusion in many low-lying coastal areas, leading to increased soil salinization and stress on the plants. The loss of genetic variation will decrease the potential of species to adapt to abiotic and biotic environmental changes and will decrease a population's ability to cope with short-term challenges such as pathogens and herbivores (Hammer and Teklu, 2008). Research and development must be designed to enhance our ability to utilize genetic diversity to respond to the many challenges facing agriculture.

Initiatives for the Conservation and Sustainable Use of Agrobiodiversity in the Philippines

In response to the abovementioned threats to biodiversity and in recognition of the value of agrobiodiversity to the economy of the Philippines and the well-being of its people, the government and nongovernmental organizations have begun efforts to conserve, safeguard, and sustainably manage and utilize the country's valuable resources. To accomplish this, the Philippines developed the National Biodiversity Strategy and Action Plan (NBSAP) in 1997 with the following goals: effective conservation of biodiversity components (genetic, species, and ecosystem), sustainable use of biodiversity components, and fair and equitable sharing of benefits from the sustainable use of biological resources (DENR, 1997).

In the rest of this paper, I will focus on PGRFA. The following PGRFA initiatives support NBSAP strategies to ensure sustainable development and meet the Philippine's need to conserve and sustainably utilize its diversity of crop genetic resources. As well, one goal is to build a critical mass of scientists trained in PGRFA conservation and management, undertake scientific research to increase the utilization of PGRFA, and increase awareness of the policies and legislations that affect their conservation and sustainable utilization.

1. Conservation of PGRFA

There are two conservation strategies for PGRFA, namely *ex situ* and *in situ* conservation. *Ex situ* conservation means conservation of PGRFA outside their natural habitat, such as at a research institute or genebank, whereas *in situ* conservation means the conservation of ecosystems and natural habitats so that viable populations of species can be maintained or helped to recover in their natural surroundings; in the case of domesticated or cultivated plant species, these are the surroundings where they developed their distinctive properties (ITPGRFA, 2003).

In the Philippines, 45 government and nongovernmental institutions hold germplasm collections of crop species that are significant for food security and human survival (Altoveros *et al*., 2002). These collections, totaling 173 205 accessions, are maintained in genebanks as seeds, living plants, or *in vitro* (Table 1).

There are no *in situ* PGRFA conservation programs *per se* for specific wild species. However, many of these species are components of protected forest ecosystems. Those wild species that are useful for food and agriculture, when they exist within these protected areas, are therefore simultaneously protected and conserved by fiat. Examples include wild species of *Mangifera*, *Citrus*, *Garcinia*, *Nephelium*, *Durio*, *Artocarpus*, and *Dioscorea* (Altoveros and Borromeo, 2007).

On-farm *in situ* conservation complements *ex situ* approaches. A number of nongovernmental organizations such as the Southeast Asian Regional Initiative for Community Empowerment (SEARICE) and Magsasaka at Siyentipiko Para sa Pag-unlad ng Agrikultura are undertaking on-farm conservation of rice, sweet potato, and yam.

Conservation through sustainable use of PGRFA is also prioritized. This includes the development of new agricultural products and improvement of market chains, especially for minor or underutilized crop species. This approach benefits conservation while contributing to the livelihood of farmers and to regional food security.

2. Capacity development

The importance of education and training to achieve sustainable improvements in PGRFA conservation and use cannot be overemphasized. The Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture stated that there is a dearth of well-trained personnel at all levels in all scientific and technical specialties in many developing countries (Borromeo, 1998).

The University of the Philippines Los Baños offers undergraduate and graduate programs in agriculture, biology, engineering, environmental science, economics, and forestry, among others. PGRFA education began with the institution of an undergraduate course on the principles and methods of conservation and management by what was then the Department of Agronomy. The course was one of the offerings in the department's plant breeding program. PGR conservation and management courses (at an intermediate undergraduate level) are now being offered by four Universities: Benguet State University, Visayas State University, the University of Southern Mindanao, and Central Mindanao University.

A survey of 59 institutions across 12 countries in the Asia-Pacific and Oceania region by the International

Table 1. Germplasm holdings by government and nongovernmental institutions in the Philippines.

AGENCY/INSTITUTION	NUMBER OF ACCESSIONS
Bureau of Plant Industry(BPI)-Baguio National Crop Research and Development Center	389
BPI-Crop Research Division	275
BPI-Davao National Crop Research and Development Center	624
BPI-Los Baños National Crop Research and Development Center	884
BPI-La Granja National Crop Research and Development Center	275
BPI-National Mango Research and Development Center	25
Benguet State University	306
Central Luzon State University	355
Central Mindanao University	707
Cotton Development Administration	661
Cagayan State University	5
Cavite State University	14
Department of Agriculture-Iloilo	84
Don Mariano Marcos Memorial State University	254
Department of Agronomy-UPLB	1,394
Ecosystems Research and Development Bureau	197
Eastern Visayas Agricultural Research Center	76
International Rice Research Institute	116,928
Ifugao State College of Agriculture and Forestry	24
Isabela State University	29
Lipa Agricultural Experiment Station	78
Leyte State University (now Visayas State University)	31
Mariano Marcos State University	6
National Abaca Research Center	773
National Coconut Research Center	41
National Plant Genetic Resources Laboratory	35,492
Northern Philippines Rootcrops and Training Center	1122
National Tobacco Administration	414
Palawan Agricultural Experiment Station	219
Philippine Coconut Authority	224
Philippine Rice Research Institute	5,861
Philippine Rootcrops Research and Training Center	2,013
Philippine Sugar Research Institute	580
Philippine Industrial Crops Research Institute	176
Quirino State College	94
Ramon Magsaysay Technological University	100
Southeast Asia Regional Initiatives for Community Empowerment	769
Sugar Regulatory Administration	1,204
University of Southern Mindanao	227
Western Philippines University	275
NATIONAL TOTAL	173,205*

*Including IRRI's Philippines rice germplasm holdings

Plant Genetic Resources Institute (IPGRI), which is now Bioversity International in 1995, projected the demand of 171 scientists trained to the M.Sc. and Ph. D. levels in PGRFA conservation and management. Most of the institutions (83%) planned to send their students to the University of the Philippines Los Baños (UPLB). The survey results justified the implementation of the Master's of Science in Plant Genetic Resources (MScPGR) degree program. The program was instituted in 1997 and was the first attempt in the region to provide a graduate program focused on this emergent discipline. Three graduate courses were developed and instituted, namely (Assessment of Diversity in Plants), (Plant Genetic Resources Conservation Methods and Management), and (Database and Information Management).

A regional meeting for South Asia, Southeast Asia, and the Pacific identified UPLB as one of the centers of excellence in the region for human resource development in PGR at all levels. Being the first institution to offer the MScPGR degree in the region, UPLB can provide insights to others and share our experiences in the development of a PGR curriculum.

The M.ScPGR program at UPLB is now nearly 15 years old. There has been decreasing enrollment (Fig. 1) and a decreased number of graduates (Fig. 2) in the MSPGR program compared with other interdisciplinary programs offered by UPLB, such as Molecular Biology and Biotechnology, Wildlife Sciences, and Natural Resources Conservation. The lack of scholarships and the relatively fewer career opportunities the major reasons for low enrolment (Altoveros and Borromeo, 2010).

To increase the number of potential enrollees, Borromeo and Altoveros (2000) conducted a survey of the demand for an M. Sc. PGR, delivered by means of distance education. Of the 54 institutions that we surveyed, 29 (54%) indicated their willingness to sponsor their staff for this kind of education. Laude (2002) obtained a similar response. To pilot-test offering of the MSPGR program as distance education, an initial offering of a course on Laws and Policies on Biodiversity Conservation and Management was initiated in cooperation with the University of the Philippines Open University in 2005. UPLB developed a syllabus for this course (Altoveros *et al*., 2005). There were only eight enrollees, so the course was not offered again. Another option put forward by Rudebjer *et al*. (2009) was to integrate agrobiodiversity content within existing curricula being offered by universities and colleges. Table 2 shows the entry points identified by Bioversity International (Rudebjer et al, 2010) for introducing agrobiodiversity content into existing curricula.

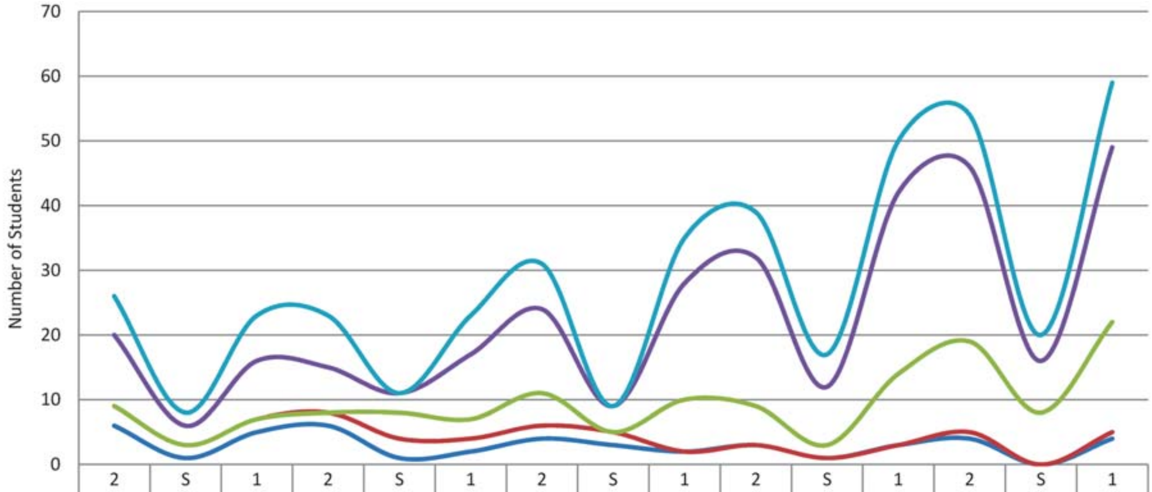
The importance of training in PGRFA has also been recognized by informal sectors. Farmers are provided training by local nongovernmental organizations on all aspects of PGRFA. SEARICE has established a Farmers' Learning Resource Center in the Philippines to provide assistance to all stakeholders who want to enhance and enrich their knowledge and skills related to on-farm research on sustainable agriculture and participatory plant breeding. Farmers also participate in national, regional, and international forums and meetings.

Capacity development among stakeholders is necessary to analyze the diversity of PGRFA and to exploit their potential for use in crop improvement programs and biotechnology. As well, enhancement of the capacity of stakeholders is important to help them manage the sustainable conservation and utilization of biodiversity in general and of PGRFA in particular.

3. Scientific Research

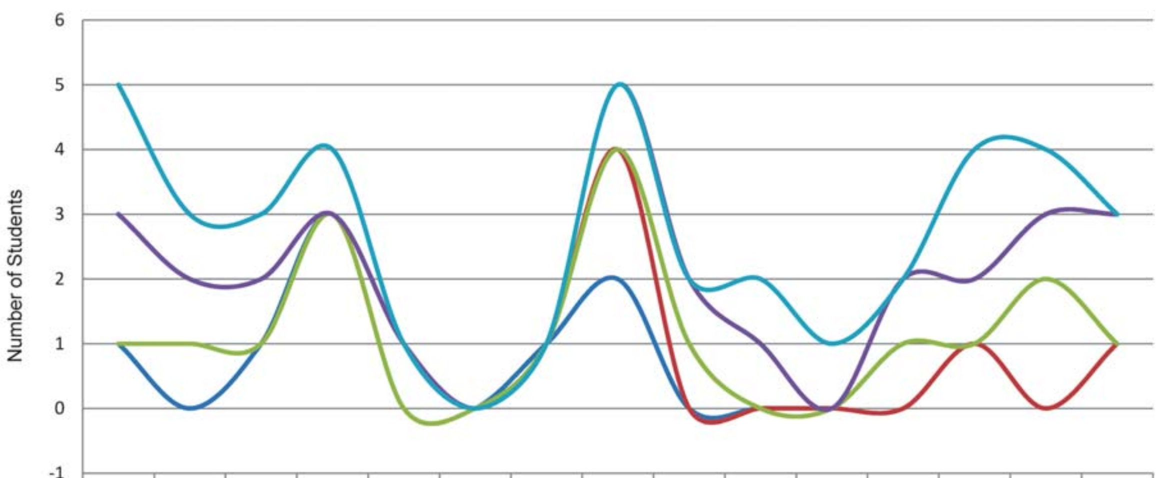
Research must be continued to increase our knowledge and understanding of the effective utilization of PGRFA. For a long time, PGRFA collections in genebanks have been poorly utilized. In recent years, advances in biotechnology have offered new methods that let researchers more effectively utilize these resources. Genetic technology has increased the use of traditional varieties of crops and distantly related species as donors of genes for resistance to biotic and abiotic stresses and for various quality traits. The hidden genetic diversity of plants holds the key to improved yields, and crops that not only produce more food, but also produce more nutritious food. The tools of genomics research are useful for unlocking the genetic potential of both wild and cultivated germplasm resources. This is important for generating novel gene combinations that will be useful in breeding programs to produce varieties with enhanced production of food, fiber, and other agricultural products, and for generating varieties that respond better to climate change.

In rice, for example, useful molecular markers have been developed for a major quantitative trait locus (QTL), *Sub1*, for submergence tolerance (Septiningsih *et al*., 2009). Several markers specific to this locus are



	2006			2007			2008			2009			2010		
	2	S	1	2	S	1	2	S	1	2	S	1	2	S	1
PHD MBB	6	2	7	8	0	6	7	0	7	7	5	8	8	4	10
MS MBB	11	3	9	7	3	10	13	4	18	23	9	28	27	8	27
MS NRC	0	0	0	0	4	3	5	0	8	6	2	11	14	8	17
MS WLDL	3	2	2	2	3	2	2	2	0	0	0	0	1	0	1
MS PGRCM	6	1	5	6	1	2	4	3	2	3	1	3	4	0	4

Fig. 1. Five-year enrollment trends for the interdisciplinary programs offered by the University of the Philippines Los Baños (UPLB) Graduate School. PHD, Doctoral Degree; MS, Masters Degree; MBB, Molecular Biology and Biotechnology; NRC, Natural Resources Conservation; WILD, Wildlife Sciences; PGRCM, Plant Genetic Resources Conservation Management. Semesters: 2, spring and summer; S, summer; 1, fall and winter.



	2006			2007			2008			2009			2010		
	2	S	1	2	S	1	2	S	1	2	S	1	2	S	1
PHD MBB	2	1	1	1	0	0	0	0	0	1	1	0	2	1	0
MS MBB	2	1	1	0	1	0	0	1	1	1	0	1	1	1	2
MS NRC	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0
MS WLDL	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0
MS PGRCM	1	0	1	3	0	0	1	2	0	0	0	0	1	0	1

Fig. 2. Five-year graduation trends for the interdisciplinary programs offered by the University of the Philippines Los Baños (UPLB) Graduate School. See Fig. 1 for abbreviations.

Table 2. Entry points for introducing agrobiodiversity content in curricula (Rudebjer, *et al.* 2010)

Entry point	Example of agrobiodiversity content
Example of agrobiodiversity content	• Matching of crop varieties to new climates • Breeding for adaptation to climate variability • Farmer resilience and adaptability
Agricultural economics	• Value chains for neglected or underutilized species • Marketing of specialty foods
Agricultural policy	• The International Treaty on Plant Genetic Resources for Food and Agriculture • The Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture • The FAO State of the World reports on plant, animal, and forest genetic resources
Agronomy	• Farmers' seed systems • The use of diversity to mitigate risk
Crop science and plant breeding	• Genebank management • Participatory plant breeding • Pre-breeding • Wild relatives of crops
Ecosystem conservation	• Pollination • Payment for environmental services • *In situ* and on-farm conservation
Ethnobotany	• Selection and management of wild plants • The cultural significance of crops and wild plants • Pharmacologically active plants
Health and nutrition	• Food diversity and food composition • Nutrition and traditional foods • Agrobiodiversity and traditional medicines
Soil and water management	• Resilience of agro-ecosystems • Microbial biodiversity

currently being utilized in marker-assisted backcrossing and have been used to successfully incorporate *Sub1* into rice varieties that are not tolerant of submergence (IR64, TDK1, and Samba Mahsuri). Similarly, a QTL for drought tolerance has been identified in rice (Ghimire, 2011). This could be useful in the development of drought-tolerant varieties for use in rainfed lowland and upland rice ecosystems. Niu *et al.* (2011) reported an improved chromosome engineering scheme for efficient elimination of a large amount of the *Aegilops speltoides* chromatin surrounding *Sr39*, a gene that provides resistance to multiple races of stem rust in wheat. This led to the rapid development of three molecular markers tightly linked to *Sr39*. The new wheat lines and markers developed based on this research provide useful resources for the ongoing global effort to combat stem rust. This example demonstrates the great potential of chromosome engineering in genome manipulation for plant improvement.

Advances in molecular genetics have also provided a range of new techniques to conserve the greatest possible genetic diversity of target species. Molecular markers can provide detailed genetic information that will significantly improve the effectiveness of locating, sampling, identifying, characterizing, monitoring, and maintaining genetic diversity (Engels *et al*., 2000).

To further increase the use of PGRFA, research on the development of new products originating from traditional and underutilized varieties and crops, and the development of markets for the products, will be necessary. The wild relatives of crops can be sources of alternative food products during periods of scarcity.

4. Policies and legislation

Awareness of the various local, national, and international conventions and protocols is important to develop a concerted national effort to conserve PGRFA. Various civil society organizations and government organizations conduct different activities and have different mechanisms for raising awareness of PGRFA-related issues in the Philippines.

The country is party to the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the International Plant Protection Convention, and the World Trade Organization's Trade Related Intellectual Property Agreement.

In addition, the Philippines has enacted several laws for the conservation and protection of genetic resources and their habitats:

- Joint development of National Commission on Indigenous People Administrative Order 1 (Guidelines for Bioprospecting Activities in the Philippines) by the Department of Environment and Natural Resources, the Department of Agriculture, and the Palawan Council for Sustainable Development.
- Republic Act (R.A.) 9147 (Conservation and Protection of Wildlife Resources and their Habitats)
- R.A. 7586 (An Act Providing for the Establishment and Management of National Integrated Protected Areas System)
- R.A. 7308 (Promotion and Development of the Seed Industry and the Creation of the National Seed Industry Council)
- R.A. 8371 (Recognition, Protection and Promotion of the Rights of Indigenous Cultural Communities/ Indigenous Peoples and Creating a National Commission on Indigenous Peoples)
- R.A. 9168 (Plant Variety Protection Act)

The Philippines acceded to the ITPGRFA on 28 September 2006. There is a need, therefore, to create a working domestic framework for the ITPGRFA implementation. National legislation and international commitments are in place to implement some provisions of the treaty.

To help ensure translation of the provisions of the ITPGRFA into national policies, plans, and programs, the Department of Agriculture has established an interagency committee to support the initial implementation of the treaty. The Technical Support Working Group was tasked to formulate modalities for implementation of the ITPGRFA through plans, programs, projects, and activities; to serve as technical experts and advisers to the Philippines representative to the Governing Body; to recommend guidelines and necessary institutional measures on access to and benefit sharing for PGRFA that are not included in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA); and to serve as a temporary clearinghouse for standardized material-transfer agreements entered into by individuals and legal entities (e.g., corporations).

In 2010, a project entitled "Formulation of Domestic Framework on Access and Benefit Sharing of Plant Genetic Resources for Food and Agriculture" was carried out by the Department of Agriculture with financial assistance from the FAO and Bioversity International. The project aims to put into place a domestic framework for access to the country's plant genetic resources and sharing the benefits obtained from this access to enable the country to conserve and protect its PGRFA and to preserve and maintain agro-biodiversity. An integral part of this proposed domestic framework is the country's commitments to the ITPGRFA, and particularly to Part IV, articles 10 to 13, which relate to the Multilateral System of Access and Benefit Sharing.

The output of the project is a draft Executive Order: "Providing for the Collection, Characterization, Conservation, Protection, and Sustainable Use of Plant Genetic Resources for Food and Agriculture, Appropriating Funds Therefore and for Other Purposes". The draft Executive Order is ready for submission to the Office of the President.

PGRFA and sustainable development

Sustainable development can be defined as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. (*Our Common Future*, 1987). It integrates economic, environmental, and economic components.

The Philippines drafted the Philippine Strategy for Sustainable Development in 1987. In 2004, a case study was conducted to analyze the national strategies for sustainable development. The overall goal of the study was to achieve economic growth with adequate protection of the country's biological resources and its diversity, vital ecosystem functions and overall environmental quality (Tarradel, 2004). The strategy calls for an improved management of biodiversity and mineral resources. It focuses mainly on the economic and environmental dimensions of sustainable development.

- In some cases, plant genetic resources are maintained and hence conserved by the production system itself. The on-farm management of crops by farmers is still being practiced in many areas of the country; for example, farmers retain seeds from valuable landraces and use them to plant the next year's crop. Ecosystem balance is maintained through the crop-based ecosystems like rice, coconut, Manila hemp, coffee, cacao and fruit trees (Altoveros and Borromeo, 2007). Efforts to encourage farmers and communities to act as custodians of PGRFA and the environment, and to reward their efforts, have been initiated. The management of diversity in these crop-based ecosystems contributes to ecological resilience. The traditional practice of growing diverse populations composed of a range of varieties and crops ensures that sustainable production is achieved even when an outbreak of pests or diseases damages one of the crops. The future food supply of all societies depends on the exploitation of genetic recombination and allelic diversity for crop improvement, and many of the world's farmers achieve this goal by breeding of their own landraces and other resources; that they depend directly on the harvests of genetic diversity from the materials they sow for food and fodder and that they use to generate the next season's seeds (Smale *et al*., 2004).

Conclusion

Plant genetic resources are the foundation of agricultural productivity and sustainability. The key challenge in sustainable development is to increase food production to meet the needs of growing populations while mitigating genetic erosion that leads to the loss of crucial PGRFA. To meet this challenge, it is necessary to develop a sustained national research and development program that focuses on these resources. This will make precious crop genetic resources accessible and available to breeders, researchers, and farmers and will support the development of new crop varieties and new uses for traditional crops. The results will be improved regional food security and livelihoods for the farmers. Characterization and evaluation of germplasm collections using various methods, including molecular genetics techniques, should also be pursued to provide tools (such as genetic markers) that allow fuller utilization of valuable genetic resources. One recent problem is the recognition that most genebank accessions urgently require regeneration (FAO, 2010b). Another is that post-graduate education and short-term term training on all aspects of PGR conservation and management should be strengthened to increase the critical mass of PGR workers who are aware of the most recent developments and opportunities in this field. A coherent national policy and effective programs developed under the policy are necessary for the effective conservation and sustainable use of PGRFA within the Philippines.

PGRFA play a critical role in sustainable development. A comprehensive national conservation and sustainable use program, education and training, scientific research, and increased awareness of the policies and legislations related to PGRFA are essential for effective conservation of the country's genetic resources. The value of this resource to the Philippines' economy and to the well-being of its people must be explained to policy makers so they will be motivated to provide sufficient resources to sustain the conservation and use of PGRFA.

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