International Training-Workshop (2007)
The Conservation and Utilization of Tropical/Subtropical Plant Genetic Resources
91-116

Conservation and Utilization of Plant Genetic Resources in the Philippines: Status and Directions

By

Susan Sandra L. Ilao[1]

Introduction

Plants are essential in the development of human society and serve as the key to food security, as they provide not only food, but also fiber and shelter. Conserving and using plant genetic diversity are essential to meet the world's future development needs, considering that the earth's population places enormous pressure on the environment. Before the end of the 21st century, a huge increase in the production of food and non-food commodities would be required. The wise use of plant genetic resources can help eradicate poverty, and also protect and enhance the environment.

The Country: Philippines

Geography, Area and Climate

The Philippines has a total land area of 115,830 square miles (300,000 square kilometers), constituting two percent of the total land area of the world. The country's 7,107 islands and islets are clustered into three groups: Luzon, Visayas, and Mindanao. Of these, Luzon and Mindanao comprise the two largest islands with land areas of 105,000 and 95,000 square kilometers, respectively. Together, they represent two-thirds of the total land area of the country. The archipelagic character has given the country extensive territorial waters (679,800 square kilometers) and the longest discontinuous coastline in the world. Ancestral domains cover a total area of at least two million hectares. The area covered could be larger since most indigenous communities inhabit the forest zones, which account for about 15 million hectares or half of the country's total land area.

[1] Supervising Science Research Specialist and Head, Program Development and Resource Generation Unit, Crops Research Division, PCARRD, Los Baños, Laguna, Philippines.

The country is part of the Southeast Asian region, and about 1,000 kilometers from the southeast coast of the mainland of Asia lying on the western margin of the Pacific Ocean. Its boundaries are formed by three bodies of water: on the west and north by the South China Sea, on the east by the Pacific Ocean; on the south by the Celebes Sea and the coastal waters of Borneo. The country's location makes it strategically important not only as meeting ground for various cultures but also as a distribution center of goods which include seeds in the region. Its abundant natural resources coupled with its location have attracted traders, explorers and adventurers for centuries. The legacy of these early visitors remains today, and manifested in the language, culture, ethnology, religion, architecture, and cultivated crops.

The climate of the Philippines is tropical and maritime. It is characterized by relatively high temperature, high humidity, and abundant rainfall. The mean temperature is between 25 to 27°C with a range of 21 to 34°C. The average monthly relative humidity varies between 71% in March and 85% in September. The country has two marked seasons, dry and wet on the western shores facing the South China Sea, where the dry season generally begins in December and ends in May, with the wet season covering the rest of the year. The dry season shortens progressively eastward, and the rain is heaviest along the eastern shores facing the Pacific Ocean. From June to December, typhoons frequently pass the archipelago at an average of 19 typhoons per year.

Population

The present population exerts tremendous pressure on the resources of the country. There are now about 84 million Filipinos, and the population is growing at a rate of 2.36% or 1.7 million births a year. The population of the Philippines is unevenly distributed throughout the islands due to the geographical, historical and social forces, and to the uneven development in the various regions of the country. This distribution affects the degree of exploitation of natural resources.

Biodiversity

The Philippines plays a vital role in preserving global species because of its status as a mega-diversity country and a biodiversity hotspot. As one of the 17 mega-diversity countries, it is one of the biologically richest in the world, with about 52,177 species of plants, animals and other life forms that are unique to tits territorial boundaries. More than half of the described species in the Philippines are endemic and cannot be found elsewhere in the world. According to Ong, *et al*. (2002) every parcel of land that is converted, cultivated, or developed will likely result in the loss of unique life forms found nowhere else on the planet. It is also the second smallest country in

that list, but the combination of its complex geological origins, fragmented layout, varying exposures to shifting winds and typhoons, peculiar rainfall distribution has given rise to the existing complex mix of ecosystems and habitat types.

However, as one of the 25 biological hotspots, only about 6% of its natural vegetation remains, and 499 species are listed in the 2004 IUCN Red List of Threatened Species (DENR, 2005). Of this number, more than half of the species are plants. There is a high rate of biodiversity loss due to high commercial and social demand, and the biodiversity is under constant threat of extinction from overharvesting or overcollection, pollution, widespread land conversion, urbanization, burgeoning population, and poverty.

PGR and Philippine Agriculture

As in most of the tropics, the natural vegetation of the Philippines is highly diverse. It supports one of the world's richest floral communities. In many ways, the vegetation constitutes one of the country's greatest resources. Out of 4.5 million living species in the world, 1.4 million species of flora and fauna were given descriptive names by scientists and of these about 52,177 species have been identified in the Philippines. There are approximately 15,000 species of plants in the country composed of 8,120 species of flowering plants; 33 species are gymnosperms; 1,030 species of ferns and fern-allies; and 1,271 species of bryophytes. The International Union for the Conservation of Nature (IUCN) ranks the country as fourth in the world in terms of species diversity and endemism. More than 3,000 species in the country are utilized for food, feed, fuel, shelter, fiber, medicine, beverage and ornaments.

Philippine agriculture is mostly smallhold. However, there are large-scale plantations for the production of exportable products such as banana, pineapple, and papaya. It also has competitive advantage in trading traditional export products like coconut oil, sugar, and abaca. Although the Philippines is predominantly rural, majority of the population lives in urban areas. The agriculture-dependent households represent 40 percent of the total population, but accounts for over two-thirds of the poor. Poverty incidence among rural households is more than 50% compared with 26% among urban households.

Crop improvement and development continue to be the top priority of the different national commodity programs and these rely on plant genetic resources as initial building blocks of new and improved varieties. In the pursuit of attaining food security and agricultural self-reliance, the

importance of plant genetic resources as sources of novel genes becomes even more pronounced. Recognizing the value of plant genetic resources, efforts have been made to conserve these important resources for present and future needs. In an agricultural country like the Philippines, the performance of the economy depends ultimately on PGR, whether exotic or introduced.

Status

Management and Coordination of PGR Research

As defined by IPGRI, PGR research involves exploring, collecting, characterizing and conserving plant genetic resources.

Institutional Structure

National PGR research and undertakings in the Philippines are coordinated through three national agencies, namely the Department of Science and Technology (DOST), the Department of Agriculture (DA) and the Department of Environment and Natural Resources (DENR). Depending on the task or area of concern, such coordination is carried out by the Philippine Council for Agriculture Forestry an Natural Resources Research and Development (PCARRD) for the DOST, the Bureau of Agricultural Research (BAR) for the DA, and the Parks and Wildlife Bureau (PAWB) for the DENR.

Previously, a National Committee on Plant Genetic Resources (NCPGR) was created by DOST to oversee the National Plant Genetic Resources Program of the Philippines. The NCPGR operated from 1984 to 2000 through PCARRD, its commodity R&D teams, and various crop technical committees, with the National Plant Genetic Resource Laboratory (NPGRL) of the Institute of Plant Breeding (IPB) as secretariat. In 2001, upon the recommendation of an ad hoc committee to review NCPGR's mandate, the committee's coverage was expanded to include animal and microbial genetic resources. The NCPGR effectively filled in the gap of coordinating PGR activities even without an operational budget. Its activities were funded and coordinated by PCARRD-DOST.

Then, in 2001, the Philippine National Network for Plant Genetic Resources for Food and Agriculture (PGRFA) was established to sustainably manage and safeguard the country's PGR, through the Department of Agriculture and coordinated by the Bureau of Agricultural Research

(BAR). The Seed Industry Act of 1992 which served as the basis for the establishment of the National PGRFA Network spelled out the participation of PCARRD in its implementing rules and regulations as……"the PCARRD shall coordinate, evaluate, and monitor the research and development components of the Seed Program in line with the National Commodity R and D Programs". Part of the Seed Program relates to conservation and utilization of the plant genetic resources (Eusebio and Lopez, 2002). The PGRFA Network aimed to operationalize a national system for collecting, conservation, regeneration, multiplication, characterization, evaluation, documentation and utilization of PGR. The Network's role was to review existing programs and policies related to PGR conservation and utilization, develop and package national agenda for PGRFA and identify and substantiate the institutional capability of each member institution. The Bureau of Plant Industry under DA was the base of the PGRFA Network.

Further, at the DA, the Office of the Undersecretary for Policy and Planning coordinates activities related to policy. To accomplish the task at hand, this office taps PGR experts from various institutions on an on-call basis. The experts do their best to fulfill their assigned tasks, but the strength and validity of the output reflects the composition of the expert group.

Different institutions in the Philippines continue to make deliberate efforts to collect and maintain plant germplasm as part of their crop improvement programs; these institutions are members of the National Agriculture and Resources Research and Development Network (NARRDN). But for national initiatives on PGR related to agriculture and food, the National Plant Genetic Resources Laboratory (NPGRL) of the Institute of Plant Breeding (IPB), the University of Philippines, Los Baños (UPLB) is the national center for conservation and utilization of important and potentially useful agricultural crops. As such, NPGRL has the mandate to conserve the endemic and introduced PGR, provide plant breeding projects and programs in the national research system with a broad genetic base for crop improvement, and monitor and coordinate national effort in the collection, conservation, utilization and exchange of PGR.

PCARRD and its R&D Network

PCARRD participates actively in PGR research management, specifically in monitoring and evaluation; proposal packaging, evaluation and funding; resource generation and collaborative linkages. PCARRD is one of the sectoral councils under the Department of Science and Technology. IT is the government arm that plans, coordinates, monitors, and evaluates the national R&D directions and efforts in agriculture, forestry, and natural resources sectors. Its primary clients are member-agencies of the National Agriculture and Resources R&D Network

and the regional R&D consortia. Other key clients include policy makers, R&D workers, non-government organizations (NGO), local government units, and the private sector.

International Initiatives and Collaborative Linkages

From the perspective of international initiatives, compliance with the Convention on Biological Diversity (CBD), particularly concerns relating to the environment and biosafety, are undertaken and spearheaded by the Department of Environment and Natural Resources (DENR), through the Parks and Wildlife Bureau (PAWB). On the other hand, food and agriculture concerns of the FAO are undertaken and spearheaded by the Department of Agriculture (DA), through the Office of the Use for Policy, Planning Research and Regulation.

Collaborative arrangements are facilitated through networking. Networks provide a mechanism for sharing information/knowledge and germplasm, transferring technology and standardizing procedures, as well as in undertaking collaborative R&D programs, including capability building. The crop germplasm networks facilitate the standardization of germplasm collection, maintenance, evaluation and documentation, and also enhance capacity building that includes exchange of experts/scientists and upgrading of facilities. Networks also help delineat responsibilities and optimize the use of available financial and material resources (Escaño and Tababa, 1997).

In the Asian region, a network, like the Regional Cooperation in Southeast Asia for Plant Genetic Resources (RECSEA-PGR), provides an appropriate and excellent avenue for translating the Global Plan of Action into specific and regional concerns. RECSEA was established in 1977. It is a network envisioned to protect and harness the plant genetic resources diversity in SEA for food, nutrition and health; poverty reduction; and sustainable environment protection. Guided by the principle that collaboration among member countries in the utilization of PGR for the well-being of the region and humankind is essential, RECSEA-PGR operates in accordance with each country's legislations and commitment to international agreements on PGR. RECSEA-PGR builds and enhances the national research capacity of member countries through collaboration in and support for database development and sharing, exchange of experts, and policy advocacy. Likewise, RECSEA-PGR develops and implements a resource mobilization strategy and establishes effective linkages with regional and international organizations.

Moreover, like most countries in the region, the Philippines is a member of several networks involved in PGR collecting or other PGR-related activities. The base institutions of these networks also take part in providing services to the management of the collections. These networks and institutions are the following:

1. AVRDC - Asian Vegetable Network (AVNET), Allium Network
2. ICRISAT - Cereals and Legumes Asian Network (CLAN)
3. IPGRI/INIBAP/BAPNET – Musa Germplasm
4. CIP/UPWARD - Asian Network on Sweet Potato Genetic Resources (ANSWER)
5. IRRI - International Network for Genetic Evaluation of Rice (INGER)
6. IPGRI - International Coconut Genetic Resources Network (COGENT)

The Philippines also links with CIMMYT for corn germplasm and information exchange, and is a member of the Council of Partnership for Rice Research in Asia (CORRA) which is a joint initiative to strengthen partnership among rice research systems in Asia.

The scope of collaborative arrangements include: planning and implementation of R&D projects; capacity building through exchange of scientists, participation in scientific and technical activities of mutual interest such as symposia, trainings/workshops, conferences, R&D projects; exchange of germplasm/genetic or plant materials, scientific/technical literature, information, methodology genetic/ plant materials required for the collaborative projects.

Current and New Undertakings

Conservation in simple and practical ways had been ongoing for ages, as reflected in the way the indigenous people cultivate and protect the plants identified and selected by their forefathers for several generations.

The government's PGR conservation activities are conducted within the respective institutional mandates. Special projects in collaboration with local and foreign donors and counterpart scientists in other countries/regions augment and complement ongoing conservation efforts. There are specialized agencies that have the mandate to develop specific crop-based industries, and identified to conduct R&D functions, and they are able to focus their PGR activities through a regular program on collecting, maintenance, characterization and evaluation of their priority crops. However, the scope, extent and duration of these efforts usually depend on the availability of funding.

PGR Collecting, Characterization and Evaluation, Documentation and Utilization

Existing Philippine collections (Table 1) are conserved by 45 institutions. Majority are seeds maintained in cold storage facilities while the asexually propagated species are maintained in field genebank and through *in vitro* conservation.

Of the total PGR accessions, 90% have complete passport data. Characterization and evaluation of the accessions are still being completed; currently only 40% have been characterized morphologically, 3% using biochemical and 7%, molecular markers. Diversity assessments using micro-satellite markers (simple sequence repeats) have been conducted in coconut in field genebank and farmers' fields. NPGRL (2004) reported that 60% of the total Philippine collections were evaluated against biotic and abiotic stresses; only NPGRL has data on indigenous knowledge (20% of the collections), and on distribution (only 20-30%).

Table 1. National germplasm collection in Philippines.

Crop Group	Number of Species	Number of Accessions
Cereals	4	9,700
Food Legumes	30	15,926
Forage/pasture	7	27
Plantation/Industrial crops	55	4,890
Root Crops	13	3,969
Medicinal and Spices	98	793
Fruit trees	138	2,970
Nut trees	13	257
Ornamentals	196	3,224
Botanical collection	75	75
Vegetables	115	13,067
Unknown species		8,636
Total	**744**	**64,351**

Source: NPGRL, 2004.

Utilization of germplasm materials is basically through requests by research institutions in their R&D activities and crop improvement programs, for the development of improved varieties and the selection of outstanding genotypes. The varieties released by these programs are

ultimately used by small farmers and other resource users in the communities, both locally as well as in other Asian countries. End-users of these germplasm materials consist of students, farmers, international research institutions, and other private entities.

NPGRL

In pursuit of its functions, the NPGRL holds 644 accessions consisting of cereals, legumes, forage and pasture crops, fruit trees, legumes, plantation/industrial crops, root crops, ornamental crops, medicinal spices, and vegetables. A large proportion of this collection, estimated at 75%, is of local origin. For several crops (except rice), it is the NPGRL as national center for conservation and utilization of important and potentially useful agricultural crops, that conserves germplasm under cold storage for long- and medium-term seed conservation, characterization (morphological, cytological, biochemical, and molecular levels), documentation, and utilization, maintains *in vitro* conservation in the laboratory, and maintains field gene bank for selected crops.

The NPGRL holds an extensive collection of maize with over 2,400 accessions, 49% of which are collected locally and representing unique germplasm of the crop that are now difficult or impossible to find in the farmers' fields. A great majority of its germplasm collection of vegetables consists of indigenous species and collected from farms and other habitats all over the country, as well as vegetable germplasm from Thailand, Laos, Cambodia, Vietnam, Bangladesh, and South Korea. Majority is the world base collection center for germplasm of winged bean (*Psophocarpus tetragonolobus*), snake gourd (*Trichosanthes* spp.), bitter gourd (*Momordica charantia*), and wax gourd (*Benincasa hispida*).

NPGRL also holds the duplicate world collection of mungbean (*Vigna radi*ata) totaling 6,889 accessions, the duplicate Asian collection of tomato (*Lycopersicon lycopersicum*) with 4,751 accessions, and the country's largest collection of tropical fruits and nuts, including mango, banana, pili (*Canarium ovatum* Engl.) , and over 100 species of endemic or indigenous fruit and nut trees.

Other Institutions

Examples of institutions providing conservation of priority collections for selected crops are elucidated below:

1. Rice

The DA-PHILRICE does cold storage conservation, characterization, and evaluation of rice and maintains database for rice germplasm collection. Samples of germplasm are available through a standard material transfer agreement. Data on germplasm are available through the Germplasm Management System (GEMS). PhilRice conserves about 6,376 accessions (Eusebio and Lopez, 2002).

IRRI-GRC (Genetic Resource Center) collects, conserves, characterizes, evaluates and ensures the continued availability and exchange of rice genetic resources, and ecogeographic and agronomic data related to the germplasm in the International Rice Genebank Collection, in accordance with international conventions, agreements, and policies. IRRI distributes rice germplasm materials with conformity to all relevant national, international, and bilateral agreements and legislation (phytosanitary regulations, import/export regulations, appropriate Material Transfer Agreement (MTA). All data about the IRGC are publicly available on-line through the Internet.

The UPLB Department of Agronomy collects, characterizes, evaluates and conserves rice germplasm at short-term storage facility. It documents and makes available information on conserved materials.

Organized dissemination of improved rice germplasm and information is facilitated by the International Network for Genetic Evaluation of Rice (INGER), which makes sure that there is unrestricted, free and safe exchange of rice germplasm and the free sharing of information not only among NARES and IARC partners, but also with the private sector. There is also a joint initiative to strengthen partnership among rice research systems in Asia through the Council for Partnership on Rice Research in Asia (CORRA). The Council is the body that sets policy issues that run across the existing partnership mechanisms for rice research in Asia.

2. Banana

In the case of banana, the DA-BPI-DNCRDC maintains germplasm collection of banana, Conserves banana germplasm *in vitro* (slow growth), and maintains database for banana germplasm collection (MGIS).

Valmayor *et al. (2002)* accounted for 91 cultivars of wild and cultivated species classified according to the three-tier system: species, genome group, and cultivar. More than half (45) are *acuminata* clones. The hybrids, *Musa x paradisiaca* follow in importance with 29 varieties while 14 pure *balbisiana* are recognized. One *Musa fehi* clone and 2 unidentified accessions complete

the national banana variety collection lists. According to type and usage, dessert bananas are the most common with 47 cultivars. The cooking bananas with 34 clones are second in importance while 7 are classified as dual purpose, consumed either fresh or cooked.

Collaborative arrangements are made with the International Network for the Improvement of Banana and Plantain (INIBAP) of the International Plant Genetic Resources Institute (IPGRI) and the Southeast Asia Banana Germplasm Resources Center (SABGRC) based in the Bureau of Plant Industry – Davao National Crop R&D Center, Philippines and national germplasm centers maintaining banana germplasm in the region. INIBAP coordinates a global research effort on *Musa*, promotes and strengthens research collaboration in national and global levels, while SABGRC retrieves and collects all banana cultivars within the Southeast Asian region.

Strong collaboration with INIBAP has strengthened the country's banana germplasm conservation and utilization activities and consequently contributed significantly to the improvement of existing banana cultivars. INIBAP was instrumental in the maintenance of a regional banana germplasm in the country located at Davao, Philippines under the supervision of the Bureau of Plant Industry-Davao National Crop Research and Development Center. This Center serves as repository of important banana cultivars and accessions coming from different Southeast Asian countries. The Center maintains the banana field genebank using suckers as materials for replants. Eusebio and Lopez (2002) reported that there is a total of 205 accessions consisting of 88 from the Philippines; 45 from Papua New Guinea; 17 from Thailand; 5 from Indonesia; 22 from Malaysia; 32 ITC accessions and 4 reference materials are planted. For *in-vitro* genebank, a total of 147 accessions consisting of 64 from the Philippines; 33 from Papua New Guinea; 13, Thailand; 8, Indonesia; 18, Malaysia; 2 ITC accessions and 9 from IMTP Sigatoka Trial Phase II were reestablished.

Regional collaboration is enhanced through the Banana Asia Pacific Network (BAPNET), as INIBAP facilitates BAPNET activities in the following areas: germplasm management, information development and exchange, and strategic planning. Thus, regional priorities are established and reviewed regularly by the BAPNET secretariat. INIBAP also upgrades the capability of scientists/researchers and banana growers through trainings, particularly on the production and utilization aspects.

3. Root crops

The Philippine Root Crops Research and Training Center (PRCRTC) at Leyte State University (formerly VisCA) and the BSU-NPRCRTC have regular programs on collection, maintenance, characterization and evaluation for sweet potato, cassava, taro, and other root

crops. For instance, in the case of sweetpotato, LSU-PRCRTC and the BSU-NPRCRTC conserve germplasm in vitro (slow growth) and in field gene bank (FGB). Non-government organizations also initiated community-based projects to conserve PGR *in situ*.

There are 850 sweet potato accessions maintained in pots and 925 accessions maintained in plots. For cassava, 301 accessions maintained in the field composed of local, introduced and elite clones from the advance selection of materials from CIAT (Centro International de Agricultura Tropical) in Colombia. All accessions have been characterized based on IPGRI's descriptor list. For taro, 312 accessions are now being maintained in the field. The collection was substantially boosted by introduced varieties acquired from Indonesia, Malaysia, Thailand, Vietnam, and Vanuatu. For other root crops, PRCRTC has 35 arrowroot and 392 yam collections (Eusebio and Lopez, 2002).

Collaborative arrangements are made with the International Potato Center (CIP) through the Asian Network for sweet potato Genetic Resources (ANSWER). CIP supports germplasm conservation at national and global levels by monitoring duplicate collections, supplying clones as potential parent material for national breeding, providing training and expertise support in germplasm characterization. Sweet potato is one of CIP's mandate crops through which it seek to achieve food security and reduce poverty through scientific research and related activities. On the other hand, ANSWER employs various strategies (e.g. *ex situ, in vitro*, cryo-preservation) for the conservation of sweet potato genetic resources. ANSWER has also initiated capacity building among member-countries with regard to maintenance, characterization, evaluation and documentation of their respective sweet potato genetic resources.

4. Coconut

The DA-PCA maintains germplasm collection of coconut and does pollen and slow growth conservation of coconut and maintains database for coconut germplasm collection. The country holds the world's largest collections, now with a total of 256 accessions consisting of 106 talls, 52 dwarfs, and 98 hybrid lines (Rivera, 2006 personal communication). The LSU-NCRC and UPLB-Department of Horticulture maintain some coconut germplasm in relation to their crop improvement projects.

PCA reported that the agency's coconut accessions, including duplicates, are listed in the International Coconut Genetic Resources Database (CGRD) established by IPGRI-COGENT. The Philippine Coconut Authority has an ongoing project with IPGRI-COGENT on "Collection and evaluation of coconut cultivars and conservation of genetic resources" which enabled it to assemble the world's largest coconut collection.

The International Coconut Genetic Resources Network (COGENT) of IPGRI has a regional network in Southeast Asia. The coconut accessions of Southeast Asia are listed in the Coconut Genetic Resources Database (CGRD) established by IPGRI-COGENT.

A project on "*Poverty reduction in coconut growing communities"* in collaboration with IPGRI and other Asian countries, found that involving landowners in communities where most farmers are tenants is beneficial in promoting the diversity of coconuts and other crops. In most project sites, availability of space and tenurial status of farmers and their perceived benefits were major factors that dictated the extent of planting coconut seedlings, particularly the number of seedlings to be planted.

5. Sugarcane

Conservation of this crop involves a public-private sector partnership where germplasm collection is maintained both in a public specialized agency, the Sugar Regulatory Agency (SRA) and a newly created private institution tasked to pursue R&D activities in sugarcane, the Philippine Sugar Research Institute (PHILSURIN). The SRA-La Granja Research Center has a total of 1,244 collections with 590, foreign; 409, local; and 6 noble canes. On the other hand, PHILSURIN – Victorias Milling Corporation has about 1,000 germplasm collections, 50% of which are foreign.

Special Projects

Government institutions augment and complement ongoing conservation efforts through special projects funded by other government agencies and/or in collaboration with the private sector, growers, industry stakeholders or foreign counterpart institutions. Such projects contribute immensely to the genetic resources collection, as well as in their characterization, evaluation and utilization.

In addition to the projects briefly mentioned earlier, other examples of special projects undertaken for conservation and development are the following:

Investigation into the conservation of biodiversity of indigenous orchids using seeds – this project collected and maintained 2,454 genotypes of indigenous orchids belonging to at least 181 taxa. In addition, a system of conservation of Philippine indigenous orchids using seeds has been developed adding new knowledge in orchid conservation.

Varietal development of papaya – 223 papaya germplasm materials were collected and used as sources of desired genes. The collections include 184 accessions from the different

regions of the country, and 39 accessions from Australia, Thailand, Malaysia, Sri Lanka, USA (Hawaii), and Indonesia Eusebio and Lopez, 2002). The genetic resources serve as gene pool wherein genes carrying desirable traits are utilized to increase yield, to improve quality, and to address specific problems such as adverse environments (saline, acidic, low fertility, high incidence of pest(s).

The two abovementioned projects received support from the Department of Science and Technology-PCARRD.

Development of advanced technologies for germplasm conservation of tropical fruit species – funded by ACIAR, this project enables IPB to develop protocols for cryo-preservation and alternative conservation and regeneration strategies, and testing of genetic fidelity of conserved materials.

Conservation and use of tropical fruit species diversity in the Philippines – jointly funded by IPGRI and DA-BAR, the project systematically collects, documents new and existing collections, provides improved guidelines for their management, and characterizes and evaluates the germplasm so that useful traits as well as valuable accessions are identified. The crops covered by the project include jackfruit and other *Artocarpus* species, pili (*Canarium ovatum*), mangosteen and other *Garcinia* species, and durian (*Durio zibethinus*). Collecting and exploratory expeditions resulted in the collection of 33 new durian accessions; likewise, 40 different tropical fruit species were found during a qualitative survey, 11 fruit species were evaluated using the descriptors for tropical fruits, and 20 pili accessions in Albay were characterized.

Enhancing adoption of ICRISAT legume varieties and technologies in the Philippines – in collaboration with various state universities and colleges and line agencies of the Department of Agriculture, the project aims to enhance the adoption of ICRISAT-bred peanut, pigeon pea, and sweet sorghum; introduce and fine-tune the associated technologies; and thereby also strengthen local regional capacity and collaboration.

Safeguarding and preservation of the rice genepool – a joint undertaking of IRRI and PhilRice which focuses on collection and *ex-situ* conservation of the wild and cultivated species and strengthening of germplasm conservation. The project is able to assemble 832 traditional rice varieties, and two wild rice species *Oryza meyeriana* and *O. officinalis* are being maintained at PhilRice – Los Baños (Eusebio and Lopez, 2002).

Moreover, PCARRD-DOST facilitated three new initiatives related to PGR conservation to commence in 2007. These projects are:

Collection, conservation, regeneration and re-introduction of indigenous orchids in selected protected natural habitats – Applying the orchid germplasm conservation method previously developed in a PCARRD-funded project, "Investigation into the conservation of biodiversity of indigenous orchids using seeds", this project will collect and conserve seeds of indigenous orchids, concentrating on species in the Philippines cited by IUCN as critically endangered, endangered or vulnerable, or listed in the CITES database, to be used for additional source of regenerated plants. These will be regenerated into planting materials using *in vitro* protocols; and the plants will be re-introduced to selected protected habitats and home gardens in strategic areas of the country. Funded by DOST-PCARRD, this new project will reinforce the concept of conservation by enhancing the utilization of the indigenous orchid germplasm collection.

The re-introduction of indigenous orchids to home gardens, a novel concept in Philippine PGR conservation and management, would initiate the commercialization of indigenous orchids through family level operations. Likewise, it is expected that gathering of orchids from the wild would be reduced, as there will be alternative sources of plants derived from the laboratory or artificial sources. In addition, the new project can also link with concerned commercial gardens at or near the vicinity of the target sites to propagate and market the indigenous orchids derived from plants obtained from the project.

The project has social and economic value by providing livelihood opportunities; scientific value by giving scientists, breeders and researchers access to plants that they could work on as possible source of genotypes for improvement of the orchids; ecological value through the conservation of the indigenous orchids, especially the species that are threatened, endangered and vulnerable; and still offers to all the opportunity to appreciate the aesthetic value of these orchids. Home garden owners, ornamental plant growers, commercial garden owners, researchers, and plant breeders stand to benefit from the output of this project.

Collection, evaluation, and utilization of exportable agricultural products – this is a collaborative project of the government with the private sector. Breeders in various state colleges and universities in the Philippines, as well as from different countries, have developed many new crop varieties in the last five years. With a new paradigm involving private stakeholders, such as Mama Sita Foundation (MSF) and Exotica, instead of government research institutes, this project would make available the best of these varieties to the local growers who intend to have these grown in large scale for export. Since the private stakeholders are the primary users themselves, they have great determination to succeed and the willingness to commit funds and other resources. This project will collect, conserve and evaluate new varieties of selected crops

developed in other countries and those indigenous to the Philippines. Initially, some of the agricultural crops that will be collected, evaluated and utilized include fruit crops such as calamansi, peach palm, jackfruit, mangosteen, tamarind, mango, and guava.

Varietal improvement of selected ornamental crops through gamma irradiation – funded by DOST, this project will develop new or improved varieties of selected ornamental plants, such as *Spathoglottis* orchids, foliage-type anthuriums and Hoyas, using gamma irradiation. This project will generate a new technology on mutation induction of the ornamental crops, conserve rare species of the endangered one, and multiply newly discovered species or varieties for commercialization.

There are also sporadic studies on ethno-botany, and participatory inventory and conservation. Ethno-botanical studies in specific provinces identify the culturally significant plants and their uses as well as the farm technologies used and socio-cultural activities or traditions practiced by the indigenous people in the locality. Participatory inventory and conservation of endemic, endangered and economically important flora and fauna in selected forests are also conducted; a recent one is a study done by Amoroso *et al* (2003) in Mindanao.

Biodiversity conservation using ecosystem or landscape approaches that aim to successfully integrate strategies for conservation and development are usually conducted in protected areas. Classic examples of these types of research are (1) the SANREM-CRSP project that used the participatory approach in looking at the interdependence of ecosystems specifically the protected forest and the agro-ecosystems that extended outward, and (2) the SEARCA Biodiversity Research Program for Development in Mindanao, with funding support from the Netherlands (Arboleda, 2006). The project introduced a new approach to biodiversity research – one that is interactive, participatory, and multi-disciplinary, and used learning-based strategies to generate knowledge on biodiversity in general.

Other examples of how plant genetic resources of an institution are utilized specifically through development or generation of varieties benefiting farmers, growers and consumers of specific crops/commodities are cited below. The accessions acquired from the genebank or laboratory are evaluated, selected and either directly recommended as variety to the farmers or used in hybridization work.

Farmers have limited direct access to seeds stored at national genebanks. Desirable genes get to them through the approved varieties that are commercially available. In 2004, the National Seed Industry Council (NSIC) approved 42 new varieties for commercial planting, including the following: corn – 16 varieties; rice – 8 varieties; three each of sweet potato and

mandarin; two each of tobacco, cassava, mango and tomato; and one variety each of potato, taro, mungbean, and pomelo. The respective characteristics of these varieties and the sources of planting materials are contained in a Seed Catalog published by the NSIC (Bureau of Plant Industry, undated). Prior to their approval, these varieties were tested in various locations for their agronomic and horticultural characteristics, and they were scientifically evaluated and documented against a given standard. A number of fruit varieties registered to the NSIC include those outstanding germplasm directly utilized as commercial cultivars. They can be grouped into (1) new varieties registered from direct utilization of the germplasm – consisting of 16 varieties from 11 fruit species, and (2) traditional and introduced varieties evaluated and registered, and now used as standard varieties by NSIC – consisting of 11 varieties from 8 fruit species (Catibog, 2006).

To ensure that approved varieties possess outstanding characteristics and adapted to farmers' conditions, the National Seed Industry Council through the Technical Secretariat and Technical Working Groups established standards and procedures before a variety gets approved for commercial release. The procedures include system of screening of entries, field testing and evaluation appropriate for the crop, gathering and analysis of data from different locations, selection of nominations, approval and release.

In addition to the public institutions involved in crop improvement, private entities also participate actively in crop development. Their activities began as importation and distribution of seeds (initially vegetable and ornamental seeds) and then later to actual breeding work. With the advent of hybrid corn and the growing acceptance of hybrids, big foreign companies entered into the picture and started to avail of the multi-location testing facility of the NSIC-TWG (Eusebio and Lopez, 2002).

Other activities on PGR documentation and database management, such as those concerning information, education and communication materials/information and communication technologies (IEC/ICT) include the preparation of a publication on "State of the art on Philippine PGR." This publication contains the status of PGR conservation and management in the country, with major inputs taken from the study and survey conducted by the NPGRL of the Institute of Plant Breeding, UPLB. Another one is the development of a database on germplasm through National Information Sharing Mechanism (NISM). The Philippine Bureau of Plant Industry leads in the development of the database. The activity is being coordinated by the FAO. According to Altoveros (2005), there are existing databases on banana, corn, coconut, rice, beans, Brassica, yam, and potato that can be accessed on-site and in some cases, through the internet.

Capability Building

To fast track training and enhance the capability of personnel involved in PGR conservation, trainings/workshops are conducted consisting of lectures and practical exercises on germplasm collecting, characterization at the morphological, cytological, chemical, and molecular levels; seed, field, and *in vitro* conservation of germplasm; regeneration protocols, documentation and information management; use of internet resources; and field visits to operational genebanks.

Pilot testing of on-line course on "International laws and policies on PGR" at U.P. Open University was started in October 2005. The course is a joint project of the University of the Philippines Open University and IPGRI. It includes 8 modules and is conducted for 16 weeks on distance mode. That is standardization of the curriculum, outline and syllabus for the introductory course on PGR conservation and management in four universities teaching the course (*UPLB, BSU, LSU, USM*).

PGR R&D Management

Reactivation of the National Committee on PGR (NCPGR). Cognizant of the importance of PGR in Philippine economy, there are ongoing efforts to reconstitute the NCPGR and continue/initiate collaborative efforts between/among three departments: Agriculture, Science and Technology, Environment and Natural Resources, and the national commodity centers and institutes, the academe, private sector and non-government organizations. This undertaking is envisioned to satisfy the felt need for a coordinative body that could unify all institutional efforts and direct the focus of PGR conservation and utilization. While there are existing programs, plans and strategies, the country has to put working mechanisms in place to effectively coordinate and manage all the efforts.

Enabling Policies and Legislations

Recognizing the value of biodiversity and the need for wise utilization and conservation, policies and legislations have been and continue to be promulgated. Such policies are also spurred by the need to protect the right of communities and nations to their own biological resources. A milestone for PGR advocacy is the recent Senate approval of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). PCARRD participated actively in this advocacy. The Treaty was approved on 28 August 2006, paving the way for the Philippines' accession to the Treaty on 11 September 2006. This marked the Philippines' entry

into the community of nations in its efforts toward the conservation and sustainable use of PGR, and the fair and equitable sharing of benefits derived from their use. Also, this opened the country's access to the Global Crop Diversity Trust fund.

Other relevant policies and laws governing the protection of biological genetic resources and their habitats are the following:

Conservation and Protection of Wildlife Resources and their Habitats (*RA 9147*) – regulates access to genetic resources.

Indigenous Peoples Right Act (*IPRA Law, RA 8371*) – protects the right of the indigenous people to exclude others in exploiting natural resources within their ancestral domain. Also there is the Recognition, Protection and Promotion of the Rights of Indigenous Cultural Communities/ Indigenous Peoples and Creating a National Commission on Indigenous Peoples (*RA 9168*).

Plant Variety Protection Act (*RA 9168*) – local communities can document various plant materials into a registry of commonly known, publicly-used PGR. This registry will protect the use of these varieties.

Establishment and Management of National Integrated Protected Areas System (*RA 7586*) – provides for establishment and management of a comprehensive system which encompasses outstandingly remarkable areas and biologically important public lands that are habitats of various species of plants and animals.

Seed Industry Act (*RA 7308* – provides for the promotion and development of the Seed industry and the creation of the National Seed Industry Council.

Traditional and Alternative Medicine Act (*TAMA, RA 8423*) – gave rise to the Philippine Institute of Traditional and Alternative Health Care to formulate policies for the protection of indigenous and natural health resources an technology from unwarranted exploitation.

In addition, quarantine laws regulate the import and export of PGR to and from the Philippines, and the National Committee on Biosafety of the Philippines (NCBP) provides the framework for enhancing cooperation among various sectors in order to improve prevention, eradication and/or control of invasive alien species.

Problems and Constraints in the Conservation and Utilization of PGR

Financial

Unlike international institutions (e.g. IRRI) which have sustained funding, continuity of personnel and even personal dedication of staff, the public institutions that are holders of germplasm collections are beset by fund constraints and fast turnover of personnel that in turn lead to more limitations and technical problems.

Technical (R&D and Capability Building)

1. Sustained maintenance of project-based collected germplasm – Germplasm collection as a component of crop improvement projects/programs is a strategy for enriching the *ex situ* collections. However, projects have definite life span, and after the project has been completed, some of these collections are lost due to lack of resources to continue maintaining them. This problem is particularly evident in crops that require *in vitro* conservation and regular field re-planting.
2. Lack of technologies/protocols for *in vitro* conservation suitable for specific crops - Field conservation requires large area and exposes important collections to risk, but land is a scarce resource in experimental stations. Hence, *in vitro* conservation is needed but protocols are not available locally. Exchange of information and technologies should be promoted among member countries. A compilation of available technologies will go a long way to answer this need.
3. Need for rationalization of collections - Resources invested for maintenance grow proportionately with the number of collections. To have a cost-effective use of resources, there is a need to minimize unnecessary duplication of genotypes that leads to increase in number of collections. Determining the important collections – what and where to collect and conserve, and how to conserve – is crucial.
4. Need for germplasm valuation, and economic value analysis and projection of existing germplasm collections – A conserved plant has social, economic, ecological and scientific value. There is a need to assess and present the value of PGR in a manner that is understandable to policymakers as they are involved in decision-making and resource allocation and to the layman or the public as they are part of the resource users. Case studies or documentation of success stories depicting how PGR have been utilized to increase productivity will also put more meaning to the conservation and utilization paradigm as truly integrated activities.

5. Developing, establishing and adopting a database management system – A national inventory exists but this is not yet available on the web. There is no national documentation system yet. About 10% of existing PGR information is available in electronic format. Some institutions use descriptors and passport data but no standard is being followed. Use of passport data is not efficient in all institutions. Moreover, a webpage for PGR needs to be developed for inclusion in the existing websites of PCARRD-DOST, UPLB-IPB, and DA. Concomitantly, training of focal persons involved in database management should keep pace with the database system used, not only locally, but also in the regional and global arena.

Management/Institutional

1. Lack of national PGR program – A national PGR program has not been formally established, but genebanks with national PGR responsibility exist. Management of PGR initiatives lacks sustainability and leadership. PCARRD is providing leadership of the PGR ad hoc committee (specifically for PGR for food and agriculture) only at the interim until the lead agency is identified.

2. Need to satisfy the manpower requirements and upgrade facilities - in a recent mini-survey, PGR experts identified the need for recruitment of additional staff, upgrading of farm equipment to improve field genebank maintenance, upgrading of greenhouse and nursery, and upgrading of in vitro facilities. In addition, stability and sustainability of conservation infrastructures in the face of *force majeure* will be given serious attention. DENR (2005) reported that approximately 27.3 % of the country is vulnerable to drought, alternating with yearly floods and typhoons, causing serious land degradation and declining land productivity. A recent case in the country dramatizes the effect of such natural calamities on PGR conservation – in October 2006, a strong typhoon ("Milenyo" – international code name "Xangsane", with a velocity of about 190 kph) hit Luzon and severely wrought damage to the NPGRL genebank building and its facilities. The two-meter high mud and floodwater damaged the service units located at the ground floor of the building, including the seed research unit, morpho-anatomical unit, the germplasm documentation unit, and the greenhouse for asexually propagated germplasm.

3. Need for integration of different conservation efforts into the development plans of local government units that host biodiversity areas – there is a need to put biodiversity conservation in general into the mainstream of community development. Local government officials must also make decisions on how to balance the need to conserve biodiversity and protect the environment with the need for national development and poverty alleviation.

4. Lack of awareness of the importance (value and use) of PGR to the economy and national security – There is a need to enhance public awareness and participation in the conservation and wise utilization of PGR.

Directions, Opportunity & Plans

Directions

PCARRD crafted the Integrated S&T Agenda for 2006–2010 that will set the direction of S & T activities and investment patterns in the next four years. The PCARRD S&T Agenda includes enhancing conservation and improvement of PGR among the priority R&D agenda to address the following thematic areas: natural resource management and sustainable development, poverty alleviation, frontier and cutting edge science, and food security.

Specific R&D areas include germplasm collecting, conservation and maintenance; varietal improvement; and development of new varieties through molecular studies and genetic engineering. These R&D areas will focus on the specific crops and products (Table 2). These crops include the following: Export fruit crops – mango, banana, papaya, pineapple, pili, durian, jackfruit, pomelo; Vegetables; Root crops – yam, sweet potato, cassava; Industrial crops – coffee, abaca, rubber; Coconut and oil palm; Ornamental plants; and Sugarcane.

Opportunities & Plans

Genebanks, the enabling policies and laws, the farmers' action on conserving and using diversity and the farm production technologies that they adopt, as well as the consumers' choices for diversity in their food provide opportunities for securing food in the future. The strategies for PGR conservation and utilization will depend on the choice of the country and responsible institution. Major considerations for decision-making are usually resources, limitations, and capabilities. Funds for genebank maintenance are very limited. Each institution has to prioritize projects, define roles and deliverables.

The decision on what crops to collect and conserve, and how to conserve them takes into consideration the national importance of the crops in terms of comparative advantage and importance of collection; vulnerability or threat of genetic erosion to *ex-situ* collection, and the need for utilization and crop improvement. To cite an opportunity for such decision-making process, was a collaborative undertaking through RECSEA-PGR, wherein prioritization was done in 2005 involving 13 crops; the crops were ranked using the following as indicators of importance:

the country is a primary or secondary center of diversity for the crop, food security (it is a staple crop), agricultural development (it is a source of livelihood), income generation (it is an export or industrial crop). That process resulted in the following prioritization: rice, mango, coconut, banana, sweet potato, cassava, yam, potato, citrus, Brassica, beans, peas, and breadfruit.

In the case of field genebanks, a long-term option for some collections is to keep all materials and not focus on traditional varieties or those collected from the field. This means including traditional varieties, breeding lines, wild relatives, and obsolete varieties.

In database development and management, whatever database will be established and used should be able to synchronize or be consistent with regional and global databases.

To address the aforementioned needs, problems and issues facing PGR conservation and utilization and take advantage of favorable opportunities, some activities will be more vigorously pursued with concerted effort of key players, stakeholders and resource users. Following are future activities cited by Catibog (2006), the Philippine Country Report to the ICPGR, DENR (2005), and those raised by PGR experts and stakeholders in recent fora:

To enhance PGR management and capability building, a strong national PGR program will be developed that would harmonize the efforts of stakeholders from public and private sectors, and a coordinated networking system will be established and promoted. Cold storage facilities will be rehabilitated and upgraded. Education and formal training of PGR workers will be expanded and improved. Information exchange regarding PGR between the agriculture and natural resources sectors will be enhanced. Standard descriptors and appropriate characterization paraphernalia, such as refractometers and color charts, will be provided to germplasm-holding institutions. Consultations with stakeholders, non-degree trainings/workshops on PGR conservation, and IEC campaign promoting PGR activities as well as the importance and value of PGR conservation to increase public awareness will be continuing activities.

Packaging of focused project proposals for funding through the Global Crop Diversity Trust and other donors will be done. Product development would add value to PGR conservation through utilization. PGR research will focus on regeneration of accessions of low viability; development and utilization of standard documentation system for germplasm collections; promotion of the utilization of outstanding genotypes from genebanks; germplasm utilization through biotechnology; identification and utilization of potential wild and endangered species; further evaluation of the germplasm collections with respect to pest and disease reactions, biotic and abiotic stresses, and product quality; re-introduction of propagated endemic and rare plants; landscape approach to investigate interactions of natural, socio-economic and cultural

components of the ecosystem (spanning upland an lowland terrestrial ecosystems) to provide holistic analysis on effects to PGR diversity; development/promotion of informal systems of PGR conservation involving individual farmers, households and select groups to complement formal institutional conservation efforts; and farmer-participatory research.

The following table is R&D agenda: enhancing conservation and improvement of PGR.

Table 2. Priority R&D agenda, crops and products relevant to PGR conservation and utilization (2006-2010).

Crop	Product	R&D Area	Thematic Area
Exportable Fruit Crops			
Mango	Fresh fruits	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Banana	Fresh fruits; varieties	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Papaya	Varieties	Varietal improvement/ germplasm conservation and management	Poverty alleviation and food security; Natural resources management and sustainable development
		Development of new varieties thru molecular studies and genetic engineering	Frontier and cutting edge science
Pineapple	Fresh fruits	Germplasm conservation and maintenance	Natural resources management and sustainable development
Pili	Varieties	Germplasm conservation and maintenance	Natural resources management and sustainable development
Durian	Fresh fruits	Germplasm conservation and maintenance	Natural resources management and sustainable development
Jackfruit	Varieties	Germplasm conservation and maintenance	Natural resources management and sustainable development
Pomelo	Fresh fruits	Germplasm conservation and maintenance	Natural resources management and sustainable development
Vegetables	Fresh vegetables	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Yam (ubi)	Planting materials	Germplasm collection, conservation and maintenance	Natural resources management and sustainable

			development
Sweet potato	Planting materials	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Cassava	Planting materials	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Coffee	Planting materials	Germplasm conservation and management	Natural resources management and sustainable development
Abaca	Varieties	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Rubber	Varieties	Germplasm conservation and maintenance	Poverty alleviation and food security
Coconut	Planting materials	Germplasm conservation and maintenance	Natural resources management and sustainable development
Oil palm	Fresh nuts	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Ornamental plants	Varieties	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development
Sugarcane	Muscovado	Germplasm collection, conservation and maintenance	Natural resources management and sustainable development

Source: PCARRD (2006).

References

1. Amoroso, V.B., C.B. Amoroso and J.A. Escarlos, Jr. 2003. Participatory inventory and conservation studies of endemic, endangered and economically important flora and fauna in selected forests of Mindanao. Paper presented during NSARRD, 10 November 2003, Manila Hotel.
2. Arboleda, L.P. 2006. Undertaking biodiversity research to address development needs. 2006. SEARCA Policy Brief Series 2006-2.
3. Bureau of Plant Industry - National Seed Industry Council. (Undated). 2004 Approved and Registered Crop Varieties.
4. Catibog, N.A. 2006. Status of plant genetic resources conservation and utilization in the Philippines. Paper presented at the 1st APEC workshop on Effective Genebank Management

for an Integrated System on Sustainable Conservation and Utilization of Plant Genetic Resources in APEC Member Economies held in Suwon, Republic of Korea, 26-29 June 2006.

5. Coronel, R.M. Keizer and J.T. Oliver. 2005. Learning from experience: Lessons from the poverty reduction in coconut-growing communities project. IPGRI.
6. DENR. 2005. The Third Philippine National Report to the Convention on Biological Diversity.
7. Escaño, C.R. and S. P. Tababa. 1997. Documentation of plant genetic resources in the Philippines. *In*: Report of the Technical Meeting on the Methodology of the World Information and Early Warning System on Plant Genetic Resources (WIEWS) held at NBPGR, New Delhi, India, 28-30 July 1007.
8. Eusebio, J.E. and E.L.Lopez. 2002. Country paper report on plant genetic resources of the Philippines. Paper presented during the meeting on Regional Cooperation in Southeast Asia on Plant Genetic Resources held on November 14-15, 2002 at PCARRD, Los Banos, Laguna.
9. The Republic of the Philippines Country Report to the International Conference and Program on Plant Genetic Resources (ICPGR).
10. NPGRL. 2004. Status of *ex-situ* PGR conservation in the Philippines.
11. Ong, P., L. Afuang, and R.G.R. Ambal (eds). 2002. Philippine Biodiversity Conservation Priorities: a second iteration of the national biodiversity strategy and action plan. DENR-PAWB, Conservation International Philippines, Biodiversity Conservation Program – University of Philippines Center for Integrative and Development Studies and FPE, Quezon City, Philippines.
12. PCARRD-DOST. Information Bulletin No. 19-E/2004.