

COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

PAPUA NEW GUINEA



**The State of Plant Genetic Resources
for Food and
Agriculture**

**Country Report
of
Papua New Guinea**

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Note by FAO

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EXECUTIVE SUMMARY



Papua New Guinea (PNG) has a landmass of 463 000 km² and hundreds of islands, the larger ones are New Britain, New Ireland and Bougainville. The country has extensive mountain range the largest and longest is the Owen Stanley Range that runs through the middle of the country dividing the country into New Guinea in the north and Papua in the south. The country is richly diversified in languages, culture, customs and traditions, people and native flora and fauna. It is one of the 'last frontiers' in the world where natural diversity of both flora and fauna are still intact and where indigenous people are still hunting and gathering their foods and other basic needs from the forests and the wild habitats. The country is naturally rich with diversity of food crops species, wild plant relatives, timber tree species, ornamental plants, birds, animals and microorganisms.

However, it is also evident that a lot of destruction to the environment is taking place through human interventions through lumbering activities, commercial agricultural plantings, urbanization, mining and oil field operations and construction of roads and bridges. Studies by the Research & Development organizations in the country have revealed that the food crops species diversity and landraces diversity are eroding at an increasing rate at the moment. As old generation of rural people die, the traditional recipes using local staple food crop species and foods from the wild are also dying away. The generations of modern Papua New Guineans do not know how to prepare local food crop dishes anymore. Modern lifestyle has forced the population into consuming more of the process foodstuff like rice, flour, tinned and frozen foodstuff than consuming locally grown food crops. When that happens, the rich diversity of food crops in farmer's fields (gardens) are being lost. No one is planting and maintaining crop diversity anymore.

Demands by urban consumers for certain species of crops and cultivars is another contributing factor to eroding crop diversity in farmer's fields. Subsistent farmers tend to grow crop species and cultivars or landraces that are preferred by urban consumers and can be easily sold in urban markets for few cash. These factors together with the effect of climate changes occurring throughout the world is also contributing to erosion of PGRFA diversity in PNG at the moment.

The Government through the National Agricultural Research Institute (NARI) under the Ministry of Higher Education, Research Science & Technology (HERST) and the Department of Agriculture and Livestock (DAL) has taken initiative in establishing a national programme on PGRFA collection, conservation, management and sustainable utilization. A national network on conservation, management and use of biodiversity in PNG, formally known as PNG Biodiversity Network (PNGBioNET) is established under the Department of Environment & Conservation (DEC). These two National Programmes are jointly administering funding and providing technical assistance in PGRFA conservation, management, evaluation, utilization and documentation of information and data on biodiversity of the country.

This country report highlights the status of collection, management, evaluation, utilization and documentation of PGRFAs in PNG for the last ten years, from 1999 to 2009. The report discusses the *in situ* management approaches that are taken by the national authorities and the indigenous farmers and resource owners in conserving genetic diversity or PGRFAs on farms and under wild habitats. The problems that they faced in conserving diversity on-farm and the factors that contribute to 'genetic erosion' on-farm and in the wild habitats.

The national approach taken in conserving PGRFAs under *ex situ* establishments is also discussed in this report. The PNG government has mandated the National Agricultural Research Institute (NARI) to be a custodian to all agro-biodiversity of the country. All main staple food crop species and fruits and nut species of the country have been collected over the years and are now conserved in 'living collections' or field gene-banks at various NARI Research Programme Centers throughout the country. The genetic diversity of major cash crop species such as sugarcane, coffee, cocoa, coconut, palm oil, rubber and tea are maintained by their own R&D institutes or companies at different locations in the country. Most of this diversity is introduced from over sea's genebanks. The report also discusses in brief the PGRFA utilization Programmes undertaken by NARI and other R&D organizations in the country. The main utilization programme involves selection of superior landraces and improved PGRFAs from the evaluation programmes for dissemination to farmers for production. Few PGRFAs are used in 'Crop Improvement Programmes' to produce products that are high yielding, tolerance to climate change challenges and high nutritive values. The status of the National Programmes, training and legislations on PGRFAs in PNG as well as the current status of the national, regional and international collaborations within and between various stakeholders and R&D organizations are also discussed.

Some highlights are also given on the importance of PGRFAs in the country towards food and nutritional security for the 85% of the rural populace of PNG.

AN INTRODUCTION TO THE COUNTRY AND THE AGRICULTURE SECTOR

The island of New Guinea is the second largest in the world. It lies between 3.5 and 12 degrees south of the equator in the region referred to as 'equatorial' or the 'hot-wet' tropics. The island is approximately 2 500m² from east to west with an area of around 775 000 m². It is divided politically into Papua New Guinea (PNG) an independent country since September 1975, in the east and Irian Jaya, a province of Indonesia in the west. PNG includes the islands of New Britain, Bougainville and New Ireland and hundreds of smaller islands. The land area is approximately 463 000 km². The country is divided into islands, the lowlands (0-1 200 m) and the highlands (1 200 – 2 800 m). PNG has extensive mountain ranges cover many areas and there are a number of peaks over 4 000 metres. A number of major rivers drain the mainland, including the Sepik River in the north and the Fly River in the south. These rivers have associated swamps and seasonally inundated floodplains that cover large areas.

The average annual rainfall varies from very high and continuous with more than 8 000 mm in some mountainous areas to relatively low and seasonal with 1 000 – 1 500 mm in a number of coastal areas. Average temperatures vary mainly with altitude, with tropical temperatures in the lowlands and islands and milder temperatures in the highland areas. Areas above 1 500 mm often experienced the occurrence of frosts.

The general vegetation of the country varies with elevation and rainfall. PNG flora has some similarities with those occurring in Indonesia, Malaysia, Australia and other Pacific Island countries. The tropical rainforest areas of the central and the north western parts of the mainland PNG are rich 'store houses' of millions of species of flora and fauna, many of which are unique to this part of the world.

The diversity in the natural environment is matched by diverse cultural traditions. The diverse mountainous environment has resulted in the presence of over 800 distinctive local languages. Three main languages are spoken and used in communication systems throughout the country; the Pidgin language, which is spoken by the majority of the people especially in the northern part of the country, and the Hiri Motu language spoken by the people in the southern part of the country. English is the official language of the country and is used in government systems, academic arenas and by business houses and private enterprises.

Preliminary census figure obtained in 2000 showed that the population of PNG was just over 5 million. Approximately 85 percent of these people live in rural areas. Population densities range from one person per km² in remote areas to over 500 people per km² on some small islands. The average population growth rate was 2.7 percent per year from 1980 to the year 2000. The total population of PNG had doubled over the last 30 years and is expected to double again in the next 30 years. Present projections indicated that a population of around 8 million by 2020.

Over 85 percent of the indigenous people live in rural areas on their own land under customary titles. Customary land accounts for about 97 percent of the total land area. The government does not formally administer this land and the title documents are not issued.

Most rural people are semi-subsistence farmers who produce food from own gardens and raise farm animals like pigs, chickens and ducks for own consumption and for selling in local markets for few cash. John Gibson in 2001 reported that locally grown food crops provides for 80 percent of the calories consumed by rural people. Sweet potato (*Ipomoea batatas*) is the number one food crop grown and consumed in the country. It is a staple food crop for over 60 percent of the rural population and the main staple food for the people living in the highlands of PNG. The second most important staple food crop is cooking bananas (*Musa* spp.). All three main genomic groupings of bananas and seven wild species are found in PNG. Most landraces or farmer cultivars from the 'Diploid' and 'Triploid' genomes are grown and consumed as cooking bananas. PNG, Solomon Islands, Vanuatu and New Caledonia are perhaps the only few countries in the world that are still cultivating and consuming AA 'Diploids'. The other important staples crops in terms of ranking would include; taro (*Colocasia esculenta*), yam (*Dioscorea* spp.), cassava (*Manihot esculenta*), potato (*Solanum tuberosum*), sago (*Metroxylon sagu*) and Chinese taro (*Xanthosoma sagittifolium*). The important vegetable crops especially the leafy vegetables would include; aibika (*Abelmoschus manihot*), aupa (*Amarath* spp.), tulip (*Gnetum gnemon*), ficus (*Ficus copiosa*), kangkong (*Ipomoea aquatica*), tree ferns (*Cyathea angiensis*), pumpkin tips (*Cucurbita moschata*) and choko tips

(*Sechium edule*). Other popular traditional vegetable species are the lowlands pitpit (*Saccharum edule*) and highlands pitpit (*Setaria palmifolia*).

The most important cash crops that PNG is currently exporting are oil palm (*Elaeis guineensis*), Arabica coffee (*Coffea arabica*), cocoa (*Theobroma cacao*) and copra (*Cocos nucifera*). Other minor export crop includes various species of spices, pyrethrum and tea. The main crops that are sold in domestic urban markets are diversity of fresh vegetables and beetle nuts (*Areca catechu*).

Most people in rural areas are 'food secured' because they grow and consume what they produce from the gardens. There are cases where people are not consuming the right kind of food or are having an imbalance diet which results in "Nutritional Security" rather than food security. In some areas of the country rural households just leave on 'carbohydrate' diets of roots and tuber crops with no protein, leafy vegetables or fruits. The urban population or people living in the fringes of urban towns live mostly on 'oily take away foods' from fast food shops that have no nutritional values at all. However, food security can be threatened now by 'climate extremes', including excessive rainfall, drought and frost conditions. Effect of global climate change and the emerging AIDS epidemic in PNG may have a negative impact on food security in the future



THE MAIN BODY OF THE COUNTRY REPORT

The whole country report will cover eight main chapters on status of biodiversity conservation, management and use in Papua New Guinea since the last reporting of the same some ten years ago. The chapters that will be discussed in this country report includes:

Chapter 1: The State of Diversity

Chapter 2: The State of *In situ* Management

Chapter 3: The State of *Ex situ* Management

Chapter 4: The State of Use

Chapter 5: The State of National Programmes, Training and Legislation

Chapter 6: The State of Regional and International Collaboration

Chapter 7: Access to Plant Genetic Resources and Sharing of Benefits Arising out of their Use, and Farmer's Rights

Chapter 8: The Contribution of PGRFAs Management to Food Security and Sustainable Development

THE STATE OF DIVERSITY



The main objective of this chapter is to describe the state of diversity of plant genetic resources that contribute most to food security and agricultural developments in PNG.

1.1 State of diversity of major crops for food security

Papua New Guinea is the secondary center of genetic diversity for sweet potato (*Ipomoea batatas*), taro (*Colocasia esculenta*), banana (*Musa* spp.), yam (*Dioscorea* spp.), cassava (*Manihot esculenta*) and aibika (*Abelmoschus manihot*). The diversity of these crops includes more than 1 000 sweet potato, 800 taro, 200 banana, 300 yam, 100 cassava and 100 aibika landraces or farmer cultivars that are currently being conserved under *ex situ* collections. There are numerous accessions or landraces of these food crops species in farmers' fields or growing under *in situ* conditions that were not collected, especially in isolated and most remote areas of the country.

Additionally, PNG is blessed with a broad genetic base of food crops that provides for tolerance against major pests and diseases. This means that crops are at less risk of being lost through attacks by pests and diseases unlike those with a narrower genetic base. A good example of a narrow genetic base was the Samoan taro diversity that had only three varieties of taro and was easily destroyed by taro leaf blight disease caused by a fungus (*Phytophthora colocasiae*) some 10 years ago.

There are various Research and Development (R&D) Organizations in PNG that are responsible for biological resources of the country. The main government Department that is responsible for conservation, management and use of diversity of biological resources of the country's flora and fauna is the Department of Environment & Conservation (DEC). They are responsible for the formulation of policies and development of legal framework in collaboration with the Attorney Generals Office. They are also responsible for the maintenance of national Parks, nature reserves and Wildlife Centuries that have been identified in the country.

The forest resources are looked after by PNG National Forest Authority and their R&D Organization, the PNG Forest Research Institute (FRI). The National Fisheries Authority (NFA) is responsible for the marine resources of the country including the conservation and replanting of eroding 'mangroves' along the coastlines of the country.

The PNG National Agricultural Research Institute (NARI) has been entrusted by the Government to look after the rich genetic diversity of the agro biodiversity including food crop species of the country.

The Institute officially comes under the Ministry of Higher Education, Research, Science & Technology, but mandated to look after the Agricultural Sector needs. NARI has taken an active interest in increasing crop production and productivity through improving crop quality by using superior genetic materials from the national germplasm collections and gene-banks from abroad.

Over the years NARI together with the Department of Agriculture & Livestock (DAL) undertook number of germplasm collecting expeditions throughout the country, collected genetic diversity of sweet potato, banana, taro, yam, cassava, aibika, fruits & nuts and traditional vegetables. These collected germplasm were assembled into field collections that formed the bases of the National Germplasm Collections of sweet potato (at Aiyura & Keravat), banana, yam, cassava & aibika (at Laloki), taro (at Bubia) and fruits, nuts and traditional vegetables (at Keravat).

The conservation and safe keeping of the genetic diversity of food crops is important for food and nutritional security for our current and future generations.

1.2 State of diversity of minor crops and underutilized species for food security

PNG is home to many exotic and under-utilized fruits and nuts species such as the *Pometia pinnata* (ton), *Canarium indicum* (galip nut) and traditional vegetables such as pitpit (*Saccharum edule*) and tulip (*Gnetum gnemon*). It is also a rich haven for crop genetic resources diversity and the center of origin for 'noble cane' (sugar cane) and winged bean (as bin) of New Guinea. Apart from the staple crop species mentioned above, most under-utilized crop species are found in

the wild habitats and in farmers' fields and home gardens. They are harvested only when needed and usually these crop species provide food during the time when garden foods are in short supply. Some of the common under-utilized fruits, nuts and vegetables are; karuka (*Pandanus julianettii*), pao (*Barringtonia novae-hiberae*), Tahitian chestnut (*Inocarpus fagifer*), marita (*Pandanus conoideus*), golden apple (*Spondia cytherea*), Malay apple (*Eugenia malaccensis*) and watery rose apple (*Eugenia aquea*).

Some of these crop species are still collected from the wild habitats. Occurrences of many species are limited to certain locations due to changes that are now taking place due to the effect of 'climate change'. The wild stands of fruits and nut tree species like *Pometia pinnata*, *Canarium indicum* and Okari nuts (*Terminalia* spp.) are declining in some areas of the country due to limbering and logging activities. These species also provide very good timber and are removed for their timber quality.

There are no formal arrangements in place in collecting and conserving these under-utilized crop species. No national inventory or survey has taken place to take stock of the different species and kinds of plant species available in the country. PNG NARI has taken initiative in collecting some species of the under-utilized crop species, especially the fruits; nuts and traditional vegetables and a small *ex situ* collection of these germplasm are maintained at NARI Research Centre, Keravat.

1.3 State of diversity of wild plants harvested for food

Over 85 percent of PNG population live in rural areas and depend very much on the diversity of wild plants and animals for food. Some local communities of the country, especially the people from the inland and mountain areas of Western and Sandaun Provinces are still practicing the 'hunting and gathering' way of life. They do not have permanent gardens, instead, they wander around the forest habitats to collect wild food plants and hunt for wild animals and birds and catch fish and other food resources from natural streams, creeks, rivers and lakes for food.

Those rural communities who have permanent gardens also collect from the wild as well. Most wild plant species collected by the rural population are referred to as 'taim hungre kaikai', which means crops that they fall back on during the time when they do not have any staple foods or garden food to eat. This food plant diversity includes number of yam species such as the *Dioscorea pentaphylla*, *D. hispida* and *D. nummularia*. Other plant species including; Giant taro (*Alocasia macrorrhiza*), Elephant foot yam (*Amorphophallus campanulatus*), seeded breadfruits (*Artocarpus altilis*), wild karuka (*Pandanus brosimos*) and variety of leafy vegetables including Kumu musong (*Ficus copiosa*) highlands kapiak (*Ficus dammaropsis*), tree ferns (*Cyathea angiensis*), climbing swamp fern (*Stenochlaena palustris*), kumu gras (*Callipteris prolifera*), *Diplazium esculentum*, Indian coral tree (*Erythrina variegata*) and a tufted fern with slender runners (*Nephrolepis biserrata*).

Like the under-utilized crop species, the wild plant diversity of PNG is not officially recorded or no formal surveys or inventory taken on these wild food plant resources. All these plant species are growing in the wild habitats, especially in the rain forest habitats, which should be a concern for the country because of habitat destructions by human interventions including mining operations, large agricultural developments, urbanization and limbering and logging activities.

1.4 State of diversity of crop varieties

The staple food crop diversity in PNG is mostly farmer cultivars or land races collected originally from farmers' gardens and fields. The crop diversity of sweet potato (over 1 000 accessions), taro (over 800 accessions), banana (221 accessions), yam (over 300 accessions), cassava (112 accessions) and aibika (49 accessions) were collected from farmers' fields and conserved under *ex situ* collections in field gene-banks and duplicate collections maintained under *in vitro* slow growth storage by PNG NARI.

NARI also maintains some elite and improved varieties of sweet potatoes from Solomon Islands, some banana hybrids from the International Breeding Programme at Honduras, some taro germplasm from Asia and some grain crops including rice and maize and legumes such as peanuts, cowpea, mungbeans, soybean and field/yard long beans from international gene-banks overseas. The elite rice varieties are from the International Rice Research Institute (IRRI) in the Philippines while the legumes came from Australia, ICRISAT and other CGIAR Organizations.

NARI is undertaking research on Crop Improvement and so far the programme has bred and released four taro varieties (hybrids) resistant to taro leaf blight disease (*Phytophthora colocasiae*). Farmers throughout the country are now growing these hybrids. The taro-breeding programme is continuing with more materials being selected for certain traits including resistance to other foliar diseases as well.

1.5 Main factors affecting the state of diversity

The main factor that contributes to the unrecorded status of diversity in PNG is the 'lack of formal Implementation Strategies to facilitate and make effective the national Policy on biodiversity conservation, management and sustainable use. PNG has signed and ratified the Convention on Biological Diversity (CBD) in 1992 and the National Focal Point for CBD matters is with the Department of Environment & Conservation (DEC) of the Government of PNG (GOPNG). DEC has identified biodiversity rich areas in the country that are now declared as "nature reserves", "national parks" and "wildlife centuries". There are rangers responsible for maintaining and looking after these sites. Due to inadequate technical knowledge and basic technical/scientific resources as well as infrastructure, the Department is unable to undertake inventory of the species diversity in these areas.

The National Department that is responsible for all FAO matters in PNG is the Department of Agriculture & Livestock (DAL). The national DAL is the focal point for all FAO matters in the country and various implementation agencies in the country are responsible for agro-biodiversity work in the country. PNG NARI handles the plant genetic resources for food and agriculture while the commodity institutes are responsible for their own commodity crops. The Coffee Industry Cooperation (CIC) through their Research Institute, the Coffee Research Institute (CRI) is responsible for conservation, management and utilization of coffee germplasm and all research and development (R&D) activities carried out in the country on coffee. The Cocoa-Coconut Institute (CCI) undertakes the cocoa and coconut R&D activities, a Research Institute owned by the Cocoa Board and the Kopra Industri Koperasin (KIK) of PNG. These entities are maintaining germplasm of cocoa and coconuts. The Regional gene-bank of coconuts for the South East Asian Region is currently held at CCI Stewart Research Station outside Madang town.

The germplasm of the commodity crops have been introduced into the country many years ago where they are screened and elite cultivars were selected for commercial production. The commodity Research Institutes also utilized these germplasm in breeding programmes to develop best suitable materials for PNG climatic conditions. They are maintaining and conserving their own developed materials and the introductions from overseas gene-banks in field collections as well as *in vitro* storage under slow growth conditions. The commodity boards are able to conserve and maintain the diversity of the commodity crops and if lost they are able to re-introduce the elite materials again from international gene-banks. The main factor that affecting the production of commodity crops such as cocoa and coffee is the pest and diseases status of the crop. Climate change has also affected production of these crops especially large-scale plantings.

The plant genetic resources for food and agriculture (PGRFAs) are most affected. In farmers' fields, the diversity of food crops is being lost at an alarming rate. The pro-long dry spells in the drier areas of the country are causing 'genetic erosion' to food crop diversity on-farm. Farmers are able to maintain only the crop species that are hardier and can withstand dry spells to certain extent. For example for bananas, the triploids ABB cultivars/landraces are hardier and can tolerate dry spell to certain period of time compared to the diploid AA group of bananas.

In 1989 the research staff from Laloki Research Station undertook a Banana Production Survey of the Gabadi-Vanapa area of Central Province. The research team recorded 15 common banana cultivars and some less important accessions (King & *et al* 1989). Sixteen years later (2005), the scientists from NARI Laloki visited the Gabadi area to assess the food crop diversity on-farm and collaborated with the farmers in an on-farm conservation study. A survey was conducted to assess the diversity in farmer's fields. It recorded eight common banana varieties now grown by the farmers in the Gabadi area as compared to 15 cultivars in 1989 (Apa 2006 Cadetship Report). Only five cultivars are traditional ones and the other three were introduced from other areas. Farmers lost 10 traditional cultivars between 1989 and 2005 (see Table 1).



THE STATE OF *IN SITU* MANAGEMENT

2.1 Plant genetic resources inventories and surveys

The country has not taken national inventories or surveys on its' valuable plant genetic resources within its legal boundaries. There are certain diversity rich areas in the country that have been declared as nature reserves and national parks, but no detail inventories are taken of what biodiversity is contained in these areas. For agricultural biodiversity, some initiatives have been taken by DAL in the past and now by NARI in collecting PGRFAs from the farmer's fields, the wild habitats and market places and assembled into *ex situ* collections in field gene-banks and some species under *in vitro* storage. Inventories comprising of passport information are recorded during collecting trips when the accessions are collected. This information is entered into Excel Spreadsheet files maintained by each crop curator at various NARI Research Centres. Some inventory information is available on germplasm diversity of banana, sweet potato, taro, yam, cassava and aibika conserved and managed under *ex situ* collections. There are no inventories or information/data on PGRFAs still existing in farmer's fields or in the wild habitats throughout the country.

Great diversity of PGRFAs is still conserved and maintained by farmers on-farm, in their backyard gardens and kitchen gardens. Again there is no National Inventory on these valuable PGRFAs on farmers' fields, but farmers themselves know their resources and possess 'indigenous knowledge' (IK) on how to use these resources in traditional dishes and recipes.

2.2 Conservation of wild plant genetic resources for food and agriculture in protected areas

PNG has number of protected areas including National Parks, Nature Reserves, Wildlife Centuries and Conservation Areas. Many of these protected areas are 'store houses' for rich and valuable biodiversity including diversity in flora and faun species, which provide food sources for the rural population. What diversity contains in these protected areas is not known. No inventory has been undertaken officially on these areas. The locals are advised by the Department of Environment & Conservation (DEC) not to hunt, collect or make gardens in these protected areas and they are encouraged to take good care of these areas. Unavailability of technical manpower and the 'know how' in the country has been the main obstacle in finding out the status of biodiversity in these protected areas.

2.3 Ecosystem management for conservation of PGRFAs outside protected areas

Information on PGRFAs outside the protected areas in the country is to be provided by Department of Environment & Conservation. At this stage this information is not made available. The Ecosystem management is an area that the Government of PNG has to look into in the coming 10 years.

2.4 On-farm management and improvement of PGRFAs

The *in situ* conservation (on-farm) of PGRFAs is currently all in the hands of the informal agricultural sector and/or resource owners. The informal sector in PNG comprises of over 85% of the rural households or farmers who are maintaining their own food crop diversity on-farm or in the wild habitats owned by the tribes or local communities. The genetic materials conserved on-farm is usually maintained in old garden sites and when new garden is made, the planting materials are then moved to the new gardens. Some materials are lost during the shift to new gardens and other landraces that are not popular are often left behind in old gardens. Normally, farmers would select the best varieties with good eating qualities to take to new gardens. They often overlook other important traits like resistance/tolerance to pests/diseases or

drought and water logging conditions. The farmers are now selecting certain crop species and cultivars to grow basing on demands in local markets by urban consumers. This is one of the contributing factors to 'genetic erosion' on-farm, thus poses a serious threat on food security for the rural farm families or households. PNG rural communities are still collecting food, materials for shelters, clothing and other household needs from the wild or forest habitats. Germplasm collected from wild are declining at a faster rate due to environmental degradation as a result of lumbering and mining activities, large-scale agriculture production, and urbanization and infrastructure developments.

NARI undertook a two-year cadetship project on *in situ* (on-farm) conservation in September 2006 at a banana-yam based farming system of Gabadi in Central Province of PNG. A survey was undertaken to investigate the kind of food crop diversity that exists in farmer's fields, how many traditional cultivars existed as compared to the introduced ones, information on the local knowledge of 'genetic erosion' and reasons for the erosion, the main uses of the existing diversity on-farm and farmer's reasons for maintaining diversity on-farm and their perception of what would happen to their food system or their livelihood if inter or intra-species diversity of food crops are lost. The project is part of NARI's 2005-2010 Strategic Plan for *in situ* (on-farm) conservation activity. The study is continuing and will be concluded in 2012.

The study so far revealed that each farmer maintains around 8-10 cultivars of banana and 5-6 cultivars of yams plus many cultivars and landraces of other food crops in his/her gardens. Altogether there are more than 30 cultivars of bananas and six cultivars of yams found in the area studied. The farmers expressed openly that they are concerned about the loss of their cultivars and want to learn ways to safely maintain them on-farm. They relate the loss of their genetic diversity to abiotic factors such as fire, dry conditions, floods, damage by wild animals and admitted that this happened because they neglected the crops. The study further revealed that farmers in the area are innovative in trying new and introduced crop varieties as shown by their liking of the new introduced banana varieties. Basing on this study, NARI is now working on developing an *in situ* (on-farm) conservation strategy for this project site for the next five years.

Table 1 shows the common and traditional banana cultivars maintained by farmers in the Gabadi-Vanapa area in 1989 that are now lost from the system due to factors such as market demands and unfavorable climatic conditions. Farmers are adapting to new innovations and technologies all the time. The table also shows three new varieties farmers themselves introduced into their system from other areas for food security purposes.

TABLE 1

Genetic Erosion of Common and Traditional Banana Cultivars of Gabadi-Vanapa Areas of Central Province

Local name	Genomic Groups	Year of Survey 1989	Year of Survey 2005
Kurisa Kurokurona	AA	X	
Omido	ABB	X	X
Kurisa Koremana	AA	X	
Inebi	ABB	X	
Karoma	ABB	X	X
Oroua	ABB	X	
Naonao (Cavendish)	AAA	X	X
Karari	unclassified	X	
Rairobo	unclassified	X	
Kaeap	ABB	X	
Koro	ABB	X	
Purita	unclassified	X	
Karokoni	ABB	X	X
Avairi	unclassified	X	X
Gros Michel	AAA	X	
Guiara	ABB		X
Misuriki	ABB		X
Tanipana	ABB		X

The farmers in the area traditionally follow a banana-yam based farming system, however cassava is now becoming a dominant staple food crop in the area because of its tolerance to poor soil conditions and long dry spells.



More than 50 percent of the farmers interviewed have indicated that they have lost some of the traditional cultivars of their main staple food crops. The women who mostly grow yams have indicated that they now maintain less than 5 cultivars of yam as compared to more than 10 traditional cultivars in the past. Similarly the men who traditionally grow bananas have stated also that they only maintain less than 10 cultivars of the perennial “Kalapua” type and the “diploid” types of bananas unlike in the past. Genetic erosion has been acknowledged as a concern by older generations but the younger farmers see it as an inevitable trend in income-driven semi-commercial food production.

The second objective of this On-farm Conservation Study is to re-introduce the elite or superior PGRFAs from the National Germplasm collections held by NARI back to farmer’s fields. So far the NARI Genetic Resources Programme has introduced over 1 000 planting materials of the different diversity of the main staple food crops including banana, taro, cassava, yam, sweet potato and aibika and some good quality fruits and nut tree species. This Activity is undertaken to broaden the genetic-base of food crop species on-farm mainly for food and nutrition security and sustenance of livelihoods.

2.5 Assessment of major needs for *in situ* management of PGRFAs

The diversity of PGRFAs on-farm is eroding at a faster rate now than before. The study currently being carried out by NARI on the banana-yam based farming system at Gabadi area in Central Province is showing this trend. The main factors identified in the study to be causing this erosion are; people’s preferences for processed foodstuff as a result of lifestyle changes; urban markets demand for certain food crop species and cultivars; effect of climate change – long dry spells or very wet conditions; floods and bush fires and damage by wild animals. This trend would be true also for the whole country and will continue for sometime unless the rural households or farmers are made aware of the importance of maintaining diversity on-farm for nutritional and food security and sustenance of their livelihoods.

This calls for all levels of the PNG government (nation, provincial and local level governments) to develop policies supported by implementing strategies in educating the general population, especially the rural communities throughout the country on conserving and looking after their food crop diversity on-farm. People should be made aware of the nutritive values of the traditional food crop species and the importance of maintaining these food crops for food and nutritional security for their families.

These staple food crops are highly perishable and therefore to encourage keeping diversity and continuous production of these crops, the appropriate government authorities need to look at simple down stream processing involving cottage industries. Products from these industries can be sold cheaply to the rural households. Most roots and tuber crops can be made into flour that can be stored and used later.

One way to encourage rural farmers to continue maintaining diversity of PGRFAs on-farm is for the government to set up domestic and ensure international ‘niche markets’ for selling of these unique crop species grown and produce under ‘Organic production’ label. When the markets are available, the rural communities will be encouraged to ensure that they conserve and maintain their food crop diversity on-farm and also in the wild habitats.

Another way to encourage rural farmers to conserve and maintain diversity and consume and use locally grown PGRFAs is to officially organized annual “Agriculture Diversity Fares” where rural farmers are encouraged to come and display, cook and sell the diversity their maintained. Some incentives be made available by the Organizing Committee and the Government to recognize farmers who display and use the greatest diversity.

The main need now is for the government to development national policies along these lines and supports the appropriate authorities like DAL, DEC, Department of Trade & Industry (DTI), Department of Health (DOH), Department of Community Services, Academic Institutions and their Implementing Agencies to ensure that these policies and strategies are effectively and efficiently implemented.

THE STATE OF *EX SITU* MANAGEMENT



3.1 State of collections

The *ex situ* collections refer to germplasm held in collections in field gene-banks, *in vitro* storage and seed genebank.

3.1.1 Field collections

NARI is conserving genetic diversity of sweet potato, taro, banana, yam, cassava, aibika, traditional vegetables and fruits & nuts in field collections. The rich diversity of these crop species are conserved and maintained in National Germplasm Collections in field gene-banks at four NARI Research Centres in the country. Banana, cassava, yam and aibika national germplasm collections are conserved and maintained at NARI Southern Region Research Centre, Laloki 28 km outside Port Moresby. The national taro germplasm collection is maintained at NARI Momase Region Research Centre, Bubia outside Lae, while the highlands sweet potato collection is maintained at NARI Highlands Regional Research Centre, Aiyura outside Kainantu and the lowlands collection is held at the Islands Regional Research Centre, Keravat in East New Britain province. The collection of traditional and exotic fruits and nuts species and traditional vegetables are also maintained at Keravat. A small field collection of recently collected wild rice, wild *vigna* and three accessions of sago are maintained at Laloki and the duplicate collection of wild rice is maintained by University of Technology (Unitech), Department of Agriculture (DOA).

A lot of information and data has been generated from the national germplasm collections held by NARI, but the system for storing and managing this information is not fully developed and appropriate for easy access by the general public. All PGR information is stored in Excel Spreadsheet files in computers held by various gene-bank curators. The collected germplasm are conserved in field-gene banks at ten plants per accessions in single rows and are re-located to new sites every six months for crops like aibika, sweet potato and taro, nine months for yam and cassava and every two years for banana

3.1.2 *In vitro* storage

Some cultivars of staple food crops of sweet potato and taro and introduced crop varieties of banana and potato are maintained under *in vitro* slow growth storage at NARI Keravat and Aiyura. PNG has no cryo-preservation facility. In the South Pacific Region the cryo-preservation activity is only undertaken by the Secretariat of the Pacific Community (SPC) at the Regional Centre for the Pacific Crops and Forestry (CePaCT) in Fiji.

The germplasm conserved under tissue-culture storage in PNG are sub-cultured every six months and the seed crops are re-generated every two years for viability. Germplasm stored in tissue culture and in seed storage conditions are working collections except for the taro 'core' collection (20%) that is maintained by the Biotechnology Centre at University of Technology, in Lae.

3.1.3 Seed genebank (active collection)

NARI's National Grain & Rice Research Programme introduced some superior and elite rice varieties from the International Rice Research Institute (IRRI) in the Philippines and some elite varieties of pulses including soybean, mungbean, yardlong bean and cowpea high yielding open-pollinated maize varieties and peanuts for testing under PNG conditions. These varieties are kept as seeds under cool room seed storage facility at NARI Bubia, operating at 10-15°C.

The composition of the current *ex situ* collections of the major food crop species is given in Table 2 below.

TABLE 2

Plant genetic resources held in *ex situ* collections at various NARI Programme locations

NARI Sites	S/potato	Banana	Taro	Yam	Cassava	Aibika	Rice	Trad. Veggies	Fruits & Nuts
Laloki (field)	5 (w/c)	230 (n/c)	16 (w/c)	348 (n/c)	77 (n/c)	93 (n/c)	4 (w/c)	0	28 acc. 7 spp.
Bubia (field)	19 (w/c)	46 (w/c)	859 (n/c)	47 (w/c)	34 (w/c)	5	>100 (w/c)	0	0
Keravat (field)	103 (n/c)	60	10	0	36	10	5	48 8 spp.	11 spp
Keravat (T/culture)	5 (w/c)	23 w/c IMTP vars	5	0	0	0		0	0
Aiyura (field)	1 161 (n/c)	42 (w/c)	5 (w/c)	0	34 (w/c)	5	10	0	0

Note: w/c - working collections
n/c - national collections

3.2 Collecting expeditions

Numbers of collecting missions were undertaken in PNG prior to 1992 before PNG signed and ratified the Convention on Biological Diversity (CBD). After the Convention, the externally funded collecting missions to PNG were halted or reduced to few bi-lateral arrangements. The national R&D organizations responsible for PGRFAs were unable to organize anymore-collecting expeditions in the country due to inadequate scientific, technical and financial resources. The Rice and *Vigna* collecting expedition funded by

National Institute of Agro-Biological Sciences (NIAS) of Japan was the last collecting expedition undertaken in PNG until now.

3.2.1 Rice & *Vigna* collecting mission

NARI established and signed a Memorandum of Agreement (MOA) with the National Institute of Agro-Biological Sciences (NIAS) of Japan in September/October 2003 to undertake three collecting missions to collect wild rice, wild *vigna* and sago in certain areas in PNG. The first mission was undertaken in June 2004 looking at wild *vigna* both in PNG and in Japan. A PGR cadet scientist from NARI went to Japan October 2004 for the collecting of wild *vigna* in Japan and to study how the genes flow from the cultivated *vigna* into the wild population. The second collecting trip was taken to East Sepik and Madang Provinces looking at wild rice, wild *vigna* and sago. A total of 16 accessions of sago, five species of wild *vigna* and three species of wild rice were collected. All these collected germplasm are deposited in field collections at NARI Laloki and Bubia. No more large collecting trips were undertaken after the rice and *vigna* collecting expedition.

Little is known about the wild rice and wild *vigna* found in PNG. There is incomplete information on the herbarium specimens held in Europe and also in the PNG Lae herbarium. According to the Japanese experts on these crops there is very little genomic information on these wild species. The purpose of these collecting missions was to identify the wild population of these crops and collect samples for the genomic studies. Information from the genomic studies would be able to reveal how related these wild progenitors are to the cultivated crops and would also broaden the scientific knowledge of these crops and their wild relatives.

The duplicate samples of the collected materials of wild rice and wild *vigna* were deposited in PNG and sufficient samples were taken back to Japan to carry out the genomic study on these crop species. All sago germplasm collected were sent to NARI Bubia to establish the national sago germplasm collection as a source for genetic materials for sago research by NARI in PNG. The scientists from NIAS believed that wild rice *Oryza schlechteri* is a tetraploid and they want to find out more about the genomics of this particular speci and how it is related to the cultivated rice that is a diploid. It is very difficult to get both *O. rufipogon* and *O. schlechteri* to flower.

3.3 Types of collections (major and minor crops)

The major PGRFA collections held in PNG include the traditional staple food crops of sweet potato, taro, banana, yam, cassava and aibika and a collection of exotic and indigenous fruits, nuts and traditional vegetables mostly leafy vegetable species (refer to Table 2). These major collections are held in field gene-banks. There are no "duplicate" collections of these national collections held elsewhere, except for the 20% core collection of the taro collection, which is duplicated at

Unitech Biotechnology Centre, in Lae and also at the Regional CePaCT centre in Fiji. Part of the national banana collection is held at the Banana International Transit Centre (ITC), in Leuven, Belgium and a field collection is held at the South-east Asian Regional field gene-bank in Davao, Philippines.

For the commodity tree crops, the Regional Coconut Germplasm collection is held at the Stewart Research Station (SRS) of the PNG Cocoa-Coconut Institute (CCI), outside Madang, the Cocoa germplasm is held at Tavilo Research Station outside Rabaul and the Coffee germplasm is held at the Coffee Research Institute (CRI) at Aiyura outside Kainantu. The Oil Palm Industry Cooperation (OPIC) through its Research agency, the Oil Palm Research Association (OPRA) is also maintaining some superior and elite varieties from their Breeding Programme and from overseas gene-banks in field collections at various sites where oil palm is growing.

The regional coconut germplasm collection composed of germplasm from the South-east Asia and the Pacific regions and is coordinated by the regional network, the Coconut Germplasm Network (COGENT).

The other types of field collections maintained by NARI are the “Working Collections”. These are elite or selected crop varieties from the Improvement Programmes or good farmer cultivars/landraces that have been selected for useful traits and are released for production by farmers and/or for research purposes. The “duplicates” of these materials are conserved in national germplasm collections.

No national efforts have been taken on collecting minor or under-utilized food crop species. These groups of PGRFAs are still maintained in farmer’s fields and in the wild habitats.

Some selected materials of taro, sweet potato, English potato, vanilla, bananas, cassava and coffee are conserved under *in vitro* slow growth conditions in the laboratories at NARI Aiyura and Keravat. The New Britain Palm Oil Ltd has a modern Biotechnology laboratory where they are conserving some elite and selected palm oil materials for their research purposes and also multiplying quality clonal materials for their own plantings and for export to other countries.

3.4 Storage facilities

PNG has neither national seed storage facilities nor national seed producing organizations. Almost all vegetable seeds are imported from overseas and are sold by private companies responsible for agricultural inputs, machinery and equipments. Few Research and Development (R&D) Organizations like NARI are maintaining seeds of introduced vegetables and grain crops including rice, maize and pulses in “cool room” facilities operated at 10-15°C. All these seed crops are introduced from regional and international gene-banks for research purposes. Currently PNG is heavily relying on regional and international seed gene-banks for the supply of quality seeds of elite and superior varieties of vegetables and grain and pulse crops.

Almost all traditional staple food crops of the country are vegetatively propagated and therefore the conservation approach taken until now is conserving and maintaining the diversity of PGRFAs in field gene-banks. With the effects of climate change, it is risky now to maintain germplasm in field collections only. Complementary conservation approach of *in vitro* storage under slow growth and cryopreservation should be taken as part of the national PGR Conservation Strategy. The country’s consumption of grain crops like rice, flour and maize has increased in the last 10 years and will continue to do so. The consumption of vegetables has also gone up. This calls for the government to look at setting up an appropriate national seed storage facility together with a tissue culture laboratory for conserving and maintaining these PGRFAs.

3.5 Security of stored material

There is no national level storage facility for conserving and maintaining diversity of PGRFAs. The seed crop species that R&D organizations are using in their research programmes and the commercial companies are selling in the country are stored and maintained in overseas gene-banks and by private commercial companies and are imported into the country when needed for use. The current focus in the country in PGRFAs conservation and management is on field gene-banks. Recently NARI is trying to ‘duplicate’ the 20% core collections of the national germplasm collections of sweet potato, banana, yam, cassava and aibika under *in vitro* slow growth storage and hopefully in the long-term to look at conservation under cryopreservation storage. To date the only ‘duplicate collections’ held in other gene-banks apart from the national field gene-banks are that of taro and banana. The 20% core collection of taro is duplicated at Biotechnology Centre, Unitech Lae in PNG and at SPC CePaCT in Fiji, both under *in vitro* slow growth storage. Part of the PNG national banana collection is duplicated at ITC, Leuven, Belgium and at field gene-bank in Davao, Philippines.



Genetic diversity is lost, not only under *in situ* conditions, but also under *ex situ* establishments due to effects of climate change, poor management practices and inadequate resources, particularly funds to maintain them. This calls for the government to re-look at the PGR conservation and management approaches used so far and assist in setting up a national facility to hold 'duplicate' national germplasm collections of PGRFAs or officially organized these 'duplicates' to be conserved and maintained by regional or international gene-banks.

3.6 Documentation and characterization

There is no national standardized Documentation and Characterization format used in the country. Different stakeholders use their own format in creating database system to manage information and data on PGRFAs they are dealing with. NARI is maintaining three sets of PGRFA information/data. The three sets of information includes; Passport information, Characterization information and Preliminary Evaluation information/data.

Passport information is collected when the accessions are collected from farmers' fields through collecting trips/expeditions. The Characterization information is generated when the accessions are grown and conserved under field gene-banks. The NARI gene-bank curators are using both the International Plant Genetic Resources Institute (IPGRI) Descriptor Lists and NARI developed Minimum Descriptor Lists to generate Characterization and Preliminary Evaluation information. At this stage the curators only characterize morphological characteristics of the accessions. No molecular characterizations or DNA fingerprinting is undertaken in PNG due to lack of scientific and technical capacity.

Currently all information and data on PGRFAs maintained and conserved by NARI are stored in Excel Spreadsheet files, held by gene-bank curators at various NARI Research Centres in the country.

On the national front, the various national stakeholders responsible for PGRFAs of the country got together in 2004 and formed a National Steering Committee known as the PNG Biodiversity Network or PNGBioNET with the mandate of developing a 'national hub' for gathering, collating, storing and disseminating information and data on Biodiversity of the country and have that information available for access by all concerns. It is a networking arrangement and has nine Programmes of which Programme three is dealing with PGRFAs conservation, management and sustainable utilization. The committee members of PNGBioNET Programme 3 are also members of the National PGRFA National Committee. The Secretariat of PNGBioNET is at the moment housed under the Department of Environment & Conservation. The network is still working on establishing the database system to take in PGRFA information/data from member stakeholders, store them in some database system that can be easily accessible by others.

To create a good national documentation system for PGRFAs the country needs to standardize its system, so that every stakeholders dealing with PGRFAs are talking on the same wavelength and information stored by each one of them can be easily accessible by another. Exchange of information and germplasm materials is only possible when organizations sharing or exchanging information are using standardized documentation system.

3.7 Germplasm movement

PGRFAs from PNG are moved mostly in the Pacific region, especially to the Centre of the Pacific Crops and Trees (CePaCT). This a regional laboratory set up under the Secretariat of the Pacific Community (SPC) that is responsible for maintaining and conserving genetic diversity of PGRFAs of the Pacific Islands and the Territories (PICTs). PNG has sent taro and sweet potato germplasm collections to CePaCT for virus indexing and for safe keeping under *in vitro* storage.

Other times when PNG germplasm for food crops were moved out of the country were when the collecting expeditions took place. After the germplasm are collected, the collectors normally leave the "duplicates" in PNG and take the collected materials with them. For example the banana germplasm materials collected by Queensland Department of Primary Industry (QDPI) and IPGRI are currently held at South Johnston Research Station, Innisville Australia. A 'duplicate' of that collection is held at the International Transit Centre (ITC) for bananas in Leuven, Belgium. Some germplasm of Aibika (*Abelmoschus manihot*) collected by the Japanese collecting missions together with sweet potato, taro and yam were taken to Japan. The fate of this collection is not known. These collecting trips took place well before the Convention of Biodiversity (CBD) came into force. After the nineties, there has been only one international collecting expedition in PNG. That was the collecting of wild rice and wild *vigna*. Materials from this collecting expedition were taken to the National Institute of Agro-Biological Sciences (NIAS) in Japan for research purposes.

Virus indexed and cleaned food crop germplasm are moved often from the Pacific Regional Gene-bank (CePaCT) in Suva, Fiji to PNG and to other Pacific Island Countries and the Territories for research purposes and for multiplication and distribution to local communities. These germplasm includes materials of taro, sweet potato, cassava, yam and bananas.

3.8 Roles of botanical gardens

There are only two botanical gardens in PNG, the Lae Botanical Garden located in Lae Morobe Province and the Port Moresby Botanical Garden on the same campus as the University of Papua New Guinea (UPNG). The botanical gardens are mainly conserving the biodiversity of native or indigenous flora and fauna of PNG. Both botanical gardens are housing plants, animals and birds that were collected, from other parts of the country and re-established there in the 'created' forest habitats. The main roles are for educational purposes and for tourist attractions. There is section in both the botanical gardens that houses some exotic species of 'ornamental plants' including species of orchids and other flowers that are imported from other countries.

The PNG University of Technology (Unitech) campus in Lae has a small eco-system habitat known as the "Forest Habitat". This habitat is also housing some exotic biodiversity of flora and fauna found in and around the Morobe area and other parts of the country as well. This habitat is basically used by the students for research work and is also open to the public for educational and awareness purposes and open as a tourist attraction site.

3.9 An assessment of major *ex situ* needs

Almost all main PGRFAs of PNG are vegetatively propagated and therefore their conservation approach is largely in field gene-banks. Only taro and banana collections have "duplicate collections" under *in vitro* storage at CePaCT and ITC respectively. Due to the effect of climate change and the fact that people's preferences for food consumption is rapidly changing with the kind of life style their live in, there is an urgent need now to re-look at the current *ex situ* conservation approaches to help minimize genetic erosion.

Countries like PNG that has rich genetic diversity of PGRFAs should be assisted to develop modern and State of the Art Tissue Culture facilities for conserving genetic diversity under both slow-growth and cryopreservation conditions as 'complementary' conservation approaches to field gene-banks. Any germplasm that are not of any immediate use and need to be put into long-term storage can be placed in cryopreservation storage facility. What is currently happening in the field is most of these "not so useful" germplasm are either thrown away or left in the fields to die a nature death. Study on "Economics of Conserving Genetic Diversity of Food Crop Species of PNG" conducted in 1999 (Kim Wells & *et al*, 2001), showed that the 'fixed costs' involved in establishing a new field collection can be very high depending on the number of accessions being maintained. Once the collection is established, then the main costs incurred would be the 'variable costs', which is also high especially with the increase in fuel prices, costs of agriculture inputs (fertilizer, insecticides etc) and cost of labor.

Taking a new look at "Conservation Approaches", perhaps the way to go would be to only have "Active Collections" in field gene-banks, the Medium Collections under *in vitro* slow-growth storage and Long-term Collection be put into cryopreservation storage. This is currently happening for germplasm diversity for 'Seeded Crop' species. This should be the approach taken for all vegetative propagated PGRFAs as well.



THE STATE OF USE

4.1 Importance of utilization

The use of genetic diversity for crop improvement should be the ultimate objective of conserving PGRFAs. While it is essential to ensure that PGRFAs are adequately safeguarded from erosion for future generations, they cannot just be placed in field gene-banks in case of vegetatively propagated crop species and maintained only as 'museum blocks'. The vital stages of evaluation and incorporation of valuable characters such as disease resistance or tolerance to environmental stress factors into new varieties are the justification of PGRFAs activities. The immediate value of PGRFAs depends considerably on the extent of their use in breeding or crop improvement programmes by breeders. The basic and vital "raw materials" used in any crop improvement programmes are the "plant genetic resources" which are essential for sustaining life on earth. Without PGRs, the breeders will not have any raw materials to use and so the food and nutritional security of the whole world would be at stake.

4.2 Utilization of conserved PGR and major constraints of their use

PGRFAs of food crop species in PNG are mostly utilized in "Selection Programmes", where elite or superior accessions in national germplasm collections are identified, selected and multiplied in fields, then distributed to farmers for production. Only few crop species including taro, sweet potato and aibika are currently used in crop improvement programmes by NARI, using the conventional/traditional method of breeding. Crop improvement through "Modern Biotechnology" techniques (eg. genetic engineering) is not used in PNG yet.

Elite materials of coffee and cocoa are brought in from overseas gene-banks, and then evaluated at different sites in the country to select superior varieties that are then multiplied and distributed to growers. The PNG Coffee Research Institute (CRI) undertook some breeding activities in the past ten years, but this activity is halted now due to problem with scientific capacity. PNG Oil Palm Research Association (OPRA) carries out research on oil palm in PNG. The selected oil palm varieties brought in from overseas are being used in the breeding programme to produce materials that have high fresh fruit bunches and disease resistance that are being tested, multiplied and distributed for commercial production. No breeding work is carried out in PNG on coconuts. GOGENT activity in the country is focusing on maintenance of the regional germplasm coconut collection and selection of the promising materials for distribution purposes.

The main constraint seen in utilizing the PGRFAs in crop improvement programmes in PNG is in relation to inadequate scientific/technical manpower and inappropriate institutional infrastructure to facilitate the crop improvement processes.

4.3 Utilization activities

4.3.1 Characterization

Over the years, the genetic diversity of the major staple food crops (sweet potato, taro, banana, yam, cassava, aibika, fruits and nut species and traditional vegetables) has been collected from farmers' fields and market places. They have been morphologically characterized and evaluated for their qualities and conserved in field gene-banks at NARI's Research Centres. Through the evaluation process, superior landraces or farmer cultivars are selected, multiplied and then distributed to farmers throughout the country for production. The materials in the national collections may have 'duplicates'. These duplicates can only be identified through molecular characterization or DNA fingerprinting. Molecular

characterization work is on a priority list for PNG for assistance. Once molecular characterization is carried out, the duplicates will be removed and only the real diversity of PGRFAs will be conserved and maintained in *ex situ* collections.

4.3.2 Evaluation

The genebank curators undertake Preliminary Evaluation activities. When the conserved PGRs are maintained and growing in field gene-banks, the curators use either the IPGRI Descriptor Lists or NARI Minimum Descriptor Lists to characterize the accessions and carry out preliminary assessment on them for their agronomic potential and pest/disease tolerance as well as moisture stress, dry conditions and salinity tolerance. Information from the Preliminary Evaluation is then provided to the breeders for selection of elite materials to be utilized in crop Improvement Programmes.

Crop species that have gone through such processes include; taro, sweet potato, banana and cassava. Ten banana landraces/accessions from the PNG National Banana Germplasm Collection were preliminary assessed and selected for their orange/yellow flesh, which are believed to contain high carotene content. These materials were analyzed for their carotene contents by the Analytical Laboratory at the University of the South Pacific in Fiji. The results are given in Table 3 below.

TABLE 3

Analytical results of 10 cultivars of bananas with orange/yellow fruit flesh

Customer ID Lab. No.	Cultivar Kokopo	Cultivar Halaemoemoh	Cultivar Gunih	Cultivar Suruh	Cultivar Dagere	Method Ref. No.
α-Carotene (µg/100g)	399	249	621	829	777	AO950.46
β-Carotene (µg/100g)	262	523	655	795	531	AO950.46
Sum of Carotene (µg/100g)	651	772	1 276	1 624	1 308	AO950.46
Customer ID Lab. No.	Cultivar Maleb	Cultivar Manameg Red	Cultivar Kurisa	Cultivar Iriwa	Cultivar Waema	Method Ref. No.
α-Carotene (µg/100g)	273	1 777	140	542	196	AO950.46
β-Carotene (µg/100g)	196	1.651	131	487	654	AO950.46
Sum of Carotene (µg/100g)	469	3 428	271	1 029	860	AO950.46

Analysis done by The University of the South Pacific, Institute of Applied Sciences, Analytical Laboratory, USP Lower Campus, Suva. <http://www.usp.ac.fj>, April 2009

The results showed that PNG banana cultivars have high carotene contents with the highest level recorded in Cultivar Manameg Red with 3 428 mg/100 g of fresh fruit pulp.

The evaluation activity on bananas is continuing to include another 10 cultivars for carotene content analysis this year. Funding for this project comes from HarvestPlus in collaboration with IPGRI.

4.3.3 Pre-breeding

Pre-breeding process is undertaken during the preliminary evaluation stage. All accessions in PNG National Germplasm Collections in the fields are preliminary assessed for their potential for various traits including; high yielding, pest/disease tolerance, water logging and drought tolerance and now the curators are also screening for salinity tolerance and nutritional values like high carotene contents. The pre-breeding process has been carried out for PGRFAs for major food crops species including; banana, sweet potato, taro, yam, cassava and aibika. However, due to inadequate scientific and technical capacity and facilities, the only crop species currently used in breeding programmes are sweet potato, taro and aibika.

4.3.4 Genetic enhancement

PNG NARI has taken up the challenge of developing its Crop Improvement Programme to address the issues of low yield, poor quality and declining productivity of subsistence food crop production. Crop improvement through the use of genetic resources offers opportunities for improving food security by overcoming constraints that limit food production. This will increase productivity, food quality and nutrition. NARI's current Crop Improvement Programme involves evaluation and



selection of indigenous varieties (germplasm), introduction of new and improved genetic materials (rice, peanut, maize, bananas, potatoes and mangoes) and the development of these materials through 'conventional breeding' or crossing two varieties of the same species to produce a 'hybrid' that has the desired genes for wanted traits. The conventional breeding program of NARI is currently focusing on breeding taro lines that are resistant to taro leaf blight disease, sweet potato accessions that have orange/yellow flesh tubers for nutritional purposes and aibika for tolerance to water logging conditions.

The introduction of international banana varieties from the International Musa Testing Programme (IMTP) is basically to introduce high yielding and disease resistant genetic materials to broaden and enhance genetic base of bananas in PNG, especially for potential 'dessert banana' industry.

The grain and pulse crop species were introduced as complementary food crop and nutritional food sources for the indigenous people of the country. The country is importing a lot of rice and wheat products, which are, reflected in high import bills each year. Introduction of genetic materials of these PGRFAs is in line with the Government's Medium Term Development Strategy (MTDS) to increase and expand production of these crops in the country with the aim of eventually replacing imports, thus reduction the country's import bill.

4.3.5 Seed supply

There are no companies in PNG that grow and produce seeds at the moment. Private companies including Brain Bells, Chemica and some private supermarkets import small quantities of vegetable seeds from overseas. These agencies import vegetable seeds into the country where they repacked them into small packages and sell to growers. The R&D organizations also import seeds of vegetables, grain crops and pulses from international and regional gene-banks basically for research purposes. Seeds of rice, wheat, maize, beans, peanuts and vegetables are currently introduced from overseas gene-banks for agronomic screening at different locations throughout the country.

There is no national 'Seed Gene-bank' in PNG and therefore seeds are not conserved or maintained in PNG. For research purposes, seeds are maintained in cool-room facilities at NARI Research Centres, operating at less than 10°C only for short-term use. NARI Crop Improvement Programme is facilitating the processes of producing 'pure seeds' and distributing to farmers for production.

4.3.6 Breeding for pest/disease resistance and other traits

Taro, aibika and sweet potato germplasm are currently used in crop improvement programmes. Breeding for taro varieties resistance to taro leaf blight (TLB) has been the main activity for taro and sweet potato breeding is aiming at developing varieties with orange/yellow for nutritional purposes and aibika breeding is aiming at producing materials tolerance to water logging conditions. The taro-breeding programme is currently screening promising materials from Cycles 4 & 5 from the TaroGen Project. Sufficient planting materials of the four NARI released varieties resistant to TLB (NT 01, 02, 03 and 04) are being multiplied and distributed to farmers.

High yielding, disease tolerance and popular landraces from germplasm collections are selected, multiplied and distributed to farmers on request. Some promising genetic materials of bananas were selected for testing for tolerance to dry and salinity conditions in PNG. The landraces of bananas selected for this study are listed in Table 4 below.

TABLE 4

List of Selected Banana Accessions tested for tolerance for Dry and Salinity Conditions of Atoll Environment in PNG

PNG Common Names	Accession Numbers	Tolerance to Dry/Salinity
Yawa	PNG 155 (ABB)	Dry conditions
Dwarf Kalapua	PNG 171 (ABB)	Dry & Saline conditions
Small Kalapua	168 (ABB)	Dry conditions
Large Kalapua	MBR 6 (ABB)	Dry & Saline conditions
Dwarf Cavendish		Dry (noted only in highlands of PNG)
Daru	PNG 131 (ABB)	Saline conditions
Tukuru	PNG 118 (ABB)	Saline conditions
One hand	(AAB)	Saline conditions

4.3.7 Crop diversification

The subsistence farmers in the country mostly follow the 'mixed cropping or mixed farming' system where diversity of food crops, fruits and nuts and vegetables are inter-planted with each other in a mixed manner often at very high densities. Mono cropping is practiced where farmers are growing cash crops for commercial purposes. Crops that are grown under mono-cropping systems include coconut, coffee, oil palm, cocoa, rubber and tea. Even under mono-cropping systems, farmers in PNG are diversified in their agricultural activities. They still have subsistence gardens where they grow food crops, vegetables and fruits & nuts for their own consumption.

4.3.8 Assessment of needs to improve utilization

The main needs to improve utilization of PGRFAs in crop improvement programmes in the country are in relation to availability of scientific/technical manpower and appropriate institutional infrastructure to carryout the work.



THE STATE OF NATIONAL PROGRAMME, TRAINING AND LEGISLATION

5.1 State of national programmes, training and legislation

NARI is mandated by its Act of 1996 to maintain and conserve the diversity of genetic resources for food and agriculture and to act as a 'custodian' for these resources and promote the effective utilization of these resources in the country. The Act has allowed the Institute to develop a National Programme on Genetic Resources.

5.2 National programmes for PGRs

Conservation, management and use of Plant Genetic Resources (PGR) in Papua New Guinea (PNG) are on-going activities for 85% of the people living in rural areas of the country. Rural people conserve, manage, maintain and use PGR more often than any formal established programmes because of food security requirements. The formal PGR conservation strategies are carried out by organizations that are dealing with agricultural biological resources, especially the food crops and major crop commodities. PNG NARI is responsible for the national programme on PGRFAs for all food crop species and animal genetic resources (AnGRs) of the country. The programme covers collecting of these germplasm from farmers fields and conserve them in *ex situ* field collections, characterizing these accessions, evaluate them for certain traits, document the information and data associated with the materials and utilize the promising materials in crop improvement programmes. The PGR National Programme is also responsible for facilitating the sharing and exchange of genetic materials and information with national, regional and international research organizations.

The commodity Institutes handle their own national programmes for PGRFAs for commodity crops like coffee, cocoa, coconut, rubber, oil palm and so forth. Their programmes basically cover introduction of 'elite varieties' from overseas gene-banks for screening in PNG and are mostly doing selections for promising varieties that are released to growers for production.

5.3 Education and training

Training programmes for food crop species and their use are carried out by NARI through Open Days, Field Days, Agricultural & Innovation Shows and also through specialized skills training that are provided to farmers on requests. Some capacity building on how to maintain food crop diversity on-farm and the importance of maintaining diversity on-farm for food and nutritional security is being publicized to the rural households who are involved in NARI On-farm Conservation study.

The commodity institutes also provide hands-on training to their farmers on the techniques involved in managing their crop species.

PNG has two Universities offering Agricultural Degree Courses; the PNG University of Technology in Lae and the University of Vudal (VoU) located in East New Britian Province. There are number of Agricultural Colleges run by both the Government of PNG and the Private Organizations that offer Diploma and Certificate Courses in Agriculture. The courses offered by the Universities and the Agricultural Colleges do not go into details in teaching the students on PGRFAs conservation, management and utilization. Basically the students are taught the basic principles of agricultural production and productivity, plant protection courses and the theoretical concepts of plant and animal breeding. Some concepts and theories on looking after the environment with focus on maintaining and looking after the biodiversity of the country is emphasized through the courses on Environmental Sciences.



The message on “taking care of your environment” is also relayed to Primary and Secondary schools in the country. The national school curriculum is now considering the introduction of agriculture as a subject in some schools and also the issues relating to caring for your environment. The young generation of PNG is being educated to look after their environment and appreciate the valuable diversity the country possesses.

5.4 National legislation

The Government of PNG has set up a National Stakeholder Committee responsible for different aspects of biodiversity conservation, management and use including policy and legal matters.

PNG NARI provides a leadership in Programme # 3 of the PNG Biodiversity Network (PNGBioNET) that deals with conservation, management and use of agricultural biodiversity and plants with agro-chemical properties. In 2007 PNGBioNET allocated US\$9 000 (PNG K30 000) for conservation and management of agricultural biodiversity held by NARI, Coffee Research Institute (CRI), Cocoa-coconut Institute (CCI) and Ramu Sugar Ltd. The PNGBioNET Programme # 9 is responsible for developing national legal framework for PGR. The Programme held a national workshop in 2008 where a draft framework on Access and Benefit Sharing (ABS) was developed. The lawyers are now looking at the draft framework paper. The stakeholders who are members of PNGBioNET Programme # 3 are also the members of the National Committee on PGRFAs.

The PNG government also established a National Stakeholders Committee responsible for Biosafety & Biotechnology (NBBC) matters in the country. This Committee was responsible for developing the National Policy and Legal Framework on Biosafety and Biotechnology for PNG. During 2007 the NBBC had four workshops where a draft Policy and Legal Framework was produced to develop the ‘Act’ on Biosafety & Biotechnology for PNG. The final draft of the ‘Act’ is now before the National Executive Council (NEC) for their approval and endorsement.

5.5 Networks on plant genetic resources for food and agriculture

5.5.1 National networks

The main national networks on PGRFAs in PNG are operating under various National Stakeholder Committees include the PNGBioNET who are also the National Steering Committee of PGRFAs in PNG. Other networks include; the National Biotechnology & Biosafety Steering Committee, the National Biodiversity Strategy Action Plan (NBSAP) Committee, the National Stakeholder Committee on Integrated Assessment on Trade-Related Aspects of Agro-biodiversity and there are networks on specialized disciplines like the Plant Protection Group and the Crop Improvement Group.

5.5.2 Regional networks

PNG PGRFA Programme is linked up to various regional networks. Some of the most common networks include; Coconut Germplasm Network (COGENT), Pacific Plant Genetic Resources Network (PAPGREN), Banana-Asia Pacific Network (BAPNET), KaukauNet for sweet potato, Centre for Pacific Crops & Trees (CePaCT) and many other small crops networks operating in the Pacific and the Asian regions.

5.5.3 International network

The PGRFA Programmes in the country are linked up to the regional and international networks on PGRFAs. The important and main networks PNG PGRFA Programmes linked to are; most of the CGIAR R&D organizations, FAO agencies, Bioversity International and its Partners, the International Network on the Improvement of Bananas & Plantains (INIBAP) and the international R&D Centres like ACIAR, ICRISAT, CTA, CIAT, JICA, CYMMIT and AVRDC

5.6 Information systems

Different R&D organizations dealing with PGRFAs of PNG maintained some information and data on genetic resources they work with.

This discussion will only highlight the three sets of information on PGR that are collected and maintained by NARI gene-bank curators and PGR personnel. This information includes the Passport data, the Characterization data and information on Preliminary evaluation of the accessions held in each national germplasm collections. Passport data are collected when the accessions are collected from farmer's fields, the local markets or from the wild. When these germplasm entered the collections and are growing in the fields they are morphologically characterized and preliminary assessed for their potential traits.

NARI developed a general 'collecting form' that is used for collecting all germplasm. Using the 'Descriptor Lists' developed by the International Plant Genetic Resources Institute (IPGRI) NARI carries out characterization and preliminary evaluation. NARI is working on producing NARI Minimum Descriptor Lists from the IPGRI Lists for all major traditional food crops of the country for the benefit of the NARI gene-bank curators. The IPGRI Descriptor Lists are too long for some food crop species. To date NARI has produced two Minimum Descriptor Lists, one on aibika (*Abelmoschus manihot*) and the other one on cassava (*Manihot esculenta*).

Currently the PGR information/data are stored and managed in Excel Spreadsheet files in computers. This is the information management system that is used by IPGRI. This system uses 'number codes' for each descriptor and requires users to refer back to the 'reference list' all the time when accessing information. It is a long process and takes up a lot of time in accessing the information. NARI is currently working on importing information/data from the spreadsheet files into an Access Database system. Work on developing a NARI PGR Information Management System (PGRIMS) is continuing. Information/data on PNG national banana collection is stored and managed in Musa Germplasm Information System (MGIS) developed by INIBAP. This information/data is collected and put in MGIS and send to INIBAP and the 'duplicate' information is held by NARI at Laloki. Information inputted into MGIS is also continuing.

NARI has a web site for the Institute where general information on PGR conservation and management is posted. There is no intranet or web-based system specifically for PGR information or programme in PNG.

5.7 Public awareness

The public in PNG are made aware of the importance of conserving, maintaining and sustainably using the rich agrobiodiversity of the country through various Provincial Annual Agricultural Shows and through articles in national newspapers, radio talks, TV shows and national stakeholders seminars and workshops.

Besides these national events, NARI also hosts Annual Field Days, Open Days, Innovation Shows and on-farm studies including demonstrations and hands on trainings for farmers. Through these avenues, the Institute distributes planting materials of elite and improved crop varieties, breeds of farm animals and new technologies to farming communities throughout the country.

5.8 Assessment of major needs for national programme development, training and legislation

The main activities on PGRFAs carried out by various national stakeholders are in relation to conservation, management and sustainable utilization of these germplasm in selection and improvement programmes. The PNGBioNET Programme # 9 is currently working on getting the policy and legal framework on Access and Benefit Sharing (ABS) formulated and developed. The "draft" ABS framework has been developed and is being commented upon by various stakeholders. Once it has gone through this process, the final draft will be developed and submitted to the National Executive Council (NEC) for their comments and endorsement. This process is taking a long time because of the complicated nature of the subject. Most legal advisers found it a difficult law to deal with, as it covers also Intellectual Property Rights (IPRs) aspects as well as the traditional knowledge (IK) and traditional processes that are associated with these PGRFAs.

The main needs for the development of the national programme on PGRFAs would be in the area of developing an appropriate "Policy and Legal Framework" for the country that will assist the government and the national R&D Organizations to facilitate assess and sharing of valuable PGRFAs.

Scientific and technical capacity is inadequate in PNG. There is no national scientist who has been trained to PhD level in PGR conservation, management and sustainable utilization, yet this country is endowed with wealth of genetic diversity of food crops including wild crop relatives and under-utilized crop species. Training need is required especially in the building of scientific and technical capabilities of young Papua New Guinean scientists.

THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION



6.1 Regional and sub-regional networks, international crop-specific networks and sub-regional collaboration for maintaining *ex situ* collections

The national, regional, sub-regional and international networks that PNG is associated with or linked to are discussed in Section 5.5 of this report.

6.2 International programmes and agreements

Research & Development Organizations in the country collaborate or are linked to various international programmes and agreements dealing with PGRFAs under some sort of agreements including Memorandum of Understanding (MOU), Letter of Agreement (LOA) or Memorandum of Agreement (MOA).

For PNG NARI collaborations with the regional and international organizations on all agro-biodiversity matters are through MOU and LOA arrangements between NARI and the international Organizations. The NARI Genetic Resources Programme facilitates the collaboration from NARI. For example the PGR staff attends all annual meetings of the Banana Asia-Pacific Network (BAPNET/INIBAP) and the Pacific Agricultural Plant Genetic Resources Network (PAPGREN). Another example of an international collaboration is in the collecting of wild rice, wild *vigna* and sago in PNG by the Japanese collecting Mission. This is a bi-lateral arrangement between the two countries in PGR conservation, characterization, evaluation and documentation of specific crops of wild rice, wild *vigna* and sago.

6.2.1 Situation with ITPGRFA and SMTA in PNG

Scientists from NARI with a lawyer from the Attorney Generals Office (AGO), International Law Division developed a National Executive Council submission (NEC) that has been signed by the Minister of Agriculture and is now with the Foreign Affairs Minister for signing before the Accession is deposited at FAO. PNG did not participate in the first meeting of the Governing Body.

PNG was represented by a lawyer, Mr Douveri Henao from the AGO at the SMTA meeting held in Sweden last year. Prior to the meeting Mr Henao held talks with the Department of Agriculture & Livestock (DAL) and NARI on the general ideas of the SMTA and getting views, suggestions and comments on various aspects of the draft SMTA. These views, suggestions and comments formed the bases of PNG's position paper that Mr Henao shared with the other Pacific Island Countries before it was presented at the meeting in Sweden.

6.2.2 CBD matters

PNG has signed and ratified the Convention on Biological Diversity (CBD) in 1994. The 'focal point' for CBD matters in PNG is the Department of Environment & Conservation (DEC). Since the signing and the ratification of the Convention PNG has gone into developing the National Biodiversity Strategy Plan which is now in the draft form and is working on developing the Access and Benefit Sharing Legal Framework for governing and facilitating the access of biological resources of PNG. The country has also put in place the Biotechnology and Biosafety Policy and Legal Framework.

If countries need to access PGRFAs from PNG for research purposes, they would do so under the CBD arrangements whereby the recipient country would have to access these materials through a Material Transfer Agreement (MTA). NARI has a general MTA for all crops that are under the custodianship of the Institute. This arrangement will change once PNG

sign and ratify the ITPGRFA for accessing crops on the Annex 1 list. CBD arrangements will continue for crop species that are not in the IT Annex 1 list.

6.3 The global system for the conservation and use of PGRs

PNG is going through the process of ratifying and signing the IT for PGRFA. Once this process is completed all national germplasm collections currently held by NARI and are in the Annex 1 list of the IT will be placed in the Multi-lateral System for access. These materials will be accessed through the SMTA.

However, while waiting for the process to be completed by the appropriate authorities, the country through NARI is involved in number of projects funded by the 'Crop Diversity Trust' under the LOA arrangements. These projects includes; the Banana germplasm regeneration; Regeneration of sweet potato, taro & yam Collections and evaluation of taro varieties resistant to drought and salinity conditions. The funding for these projects is facilitated through the SPC/PAPGREN.

6.4 Assessment of major needs to improve international collaboration

PNG is going through the process of signing and ratifying the International Treaty on Plant Genetic Resources for food and agriculture (ITPGRFA) and when that happens all the current *ex situ* germplasm collections that are in Annex 1 list will be put into the Multi-lateral System (MLS) for access. PNG may not be able to honor its international commitments because the information/data on these collections are not stored in a system that can be easily accessible by the regional or international scientific community.

A priority need for the National Gene-banks is to establish an appropriate workable PGR Information Management System for storing and managing PGR information/data that can be easily accessible by others including non-PGR personal.

Another priority is to ensure that cleaned and disease/pest free genetic materials are made available for access by others or distributed to farmers for production. Climatic conditions in PNG is very conducive to pest and disease infestation and therefore germplasm conserved in field collections have to be cleaned off pests/diseases before making them available to the Multi-lateral System or even distribution to farmers for production. Basic cleaning facilities should be set up at each location where the national germplasm collections are held to facilitate such service.

There is also a need to identify the genetic diversity of various food crop species through DNA finger printing. The molecular characterization would assist the gene-bank curators to identify the 'core' collections (20%) that should be put into *in vitro* storage as a complementary conservation approach to field gene-banks.

Conservation and maintenance of these germplasm collections in field gene-banks are very expensive. A study undertaken by the PNG Department of Agriculture & Livestock (DAL) and the Agriculture Economics Department of the University of Sydney through funding from the Australian Centre for International Agricultural Research (ACIAR) in 1998 revealed that it was costing PNG around K183 000 annually to maintain four national germplasm collections of banana, sweet potato, cassava, aibika and taro in field gene-banks. One of the priority needs for the effective management of field gene-banks is to have secure funding and technical manpower to be able to safely undertake the required field operations.

ACCESS TO PLANT GENETIC RESOURCES AND SHARING OF BENEFITS ARISING OUT OF THEIR USE, AND FARMERS' RIGHTS



7.1 Changes in international legal and policy framework in relation to access and benefit sharing for GRs

The national concerns on 'over protecting' PGRFAs from being accessed by other countries came out strongly because of IPRs issues. The farmers and the resource owners are ill informed in the past about the issues concerning the IPRs on the use of their genetic diversity. This situation is now changing gradually when farmers and resource owners are being made aware and educated on the benefits that can come out of the use of their germplasm in crop improvement programmes for food and nutritional security. Once the legal framework on ABS is agreed upon and approved and endorsed by NEC, the law will be implemented and this will facilitate the ABS process in the country.

Another issue is on the IPR protection law itself. Currently the PNG Intellectual Property Office (IPO) is only administering the intellectual protection of Patents and intellectual products that are related to Trade aspects. The current IPR law in PNG does not cover the protection of Biological Resources such as plants and farm animals. Further more it does not protect IK and any traditional processes and knowledge associated with the intellectual products. Almost all PGRFAs are landraces or farmer cultivars and have been in the public domain for a long time and they may not have any potential for commercialization and therefore cannot be protected under the 'patent' protection.

PNG does not have an IPR legislation or law on the protection of biological resources and therefore this has created a lot of confusion and problem when it comes to honor its international obligations or implement the international agreements on accessing and sharing of PGRFAs.

7.2 State of access to genetic resources

At the national front, the promising genetic materials of banana, yam, cassava, aibika, taro and sweet potato from field collections are selected, multiplied and distributed to farmers upon requests. The materials in the collections mostly came from farmer's fields and therefore when they want the materials back, the curators make arrangements to return the materials to them.

Part of the PNG National Germplasm Collection of banana is held in the INIBAP Transit Centre (TC) at the Catholic University Leuven, Belgium and is made available to any international breeding programmes for use. The duplicate collection is held in field gene-bank at Davao Agriculture Research Station in Philippines. The banana germplasm that was collected by IPGRI/QDPI/DAL in the eighties are held under *in vitro* storage at Maroochy Research Station, Nambour, Australia and some promising materials are conserved in field gene-bank at the South Johnston Research Station, North Queensland also in Australia.

No formal exchange of germplasm has taken place between PNG and other countries in the last 10 years after the CBD came into force. There is exchange of germplasm in the country between NARI and farmers and other stakeholders who are involved in food production, but not between PNG and other countries.

7.3 Benefits arising out of the utilization of PGRFA

As discussed in the earlier Sections, PNG is still working on its ABS policy and legislation. At the moment, the PGRFAs are accessed by other gene-banks or R&D organizations through an MTA arrangement and only for research purposes. The benefits come back in from of information made available to enhance the scientific knowledge and capacity and infrastructure developments for scientific enhancement. There is no monetary benefit due to absence of ABS policy and legal framework to facilitate this process.

7.4 Financing PGR activities

The PNG government through an annual NARI budget finances the budget for human resources responsible for PGR activities. Whilst the budget for the PGR Programme projects and activities come from various collaborating national, regional and international organizations. The main collaborators are; Bioversity International, INIBAP/BAPNET, Crop Diversity Trust, SPC/PAPGREN, ACIAR and HarvestPlus. Three collecting expeditions were carried out in the last 10 years and the Japanese and PNG governments through their national Agricultural Research Institutes; NIAS of Japan and NARI of PNG sponsored these expeditions jointly.

7.5 Implementation of Farmers' Rights

There is no national legislation administrating 'Farmers' Rights' law in PNG and therefore the rights of the farmers are not always considered when decisions are made on the access and use of their valuable PGRFAs. This has created a lot of problem with the resource owners and the users of the germplasm. The immediate need is to develop or formulate an appropriate and workable policy and legislation to administer rights of the farmers and resource owners over their genetic resources, their indigenous knowledge on the use of these resources and the traditional practices or processes involved in creating intellectual products from these resources. Once the legislation is developed, mechanisms should be put in place to ensure effective implementation of this law.

CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPMENT



8.1 Contribution to agricultural sustainability

The agricultural productivity of PNG has not been able to keep pace with the average population growth and, therefore, food security is threatened. The production of root and tuber crops has grown at an average rate of 6.3% over a six-year period (1995-2001), much less than the population growth rate of 13.8–15.0% over the same period. The Food and Agriculture Organization (FAO) has identified PNG as one of the countries in the Pacific region as having poor food security status.

The Government is seeking policies to improve agricultural productivity and human nutrition while conserving the genetic resources of crop species via national, regional and international collaboration. The target is to achieve sustainable food production within the framework set at the 1996 World Food Summit in Rome and reaffirmed five years later in the Millennium Development Goals. However, the major challenge faced by PNG is how to address these issues particularly under situations of limited human resource capacity, high costs of living, adverse effects of climate change and increased levels of communicable and lifestyle diseases. The Government agreed to set up a National Agricultural Research Institute (NARI) to be responsible for R&D of food crops, village livestock and alternative food and cash crops and natural resources management. NARI Genetic Resources Programme is responsible for ensuring that all agricultural biodiversity is collected, conserved, properly managed and utilized for the benefit of the country.

8.2 Contribution to food security

One way of addressing food security is through enhancing capacity in collection, conservation and utilization of invaluable diverse PGRFAs that can contribute to sustaining food and nutritional security of the local communities. Many times critics from outside PNG describe rural communities in certain parts of the country as having “food security” problems. In actual fact, when you look at the situation closely, you will begin to see that it is not “food security” problem, but mostly “nutritional security” problem. Rural households in PNG have sufficient food to eat, but often eating one kind of food, basically the main ‘carbohydrate’ foods like the roots and tubers. They often lack ‘protein’ in the diets and do not eat fruits as part of the balanced meals.

Producing and consuming more local food crops will not only enhance nutritional status of the populations but will also contribute to addressing the lifestyle and communicable diseases and empowering the local people to generate cash for sustaining their cost of living.

8.3 Contribution to economic development

Agrarian economies like PNG in the Pacific region, have not achieved the level of growth that can pull large proportion of their citizens out of poverty and hunger. Poverty is widespread in Western Pacific countries including PNG, Solomon Islands (SI) and Vanuatu; totaling a population of 6.7 million. In PNG about 40 per cent of the population is earning less than \$1 a day. PNG is predominantly an agricultural country and therefore agriculture remains the main sector in providing employment and income for over 80 percent of the population. However, agricultural growth and per capita income of the country is growing at less than one per cent rate, whereas the population is growing at an average rate of

2.7 percent/annum. Therefore, livelihood and income security is threatened. To help farming households emerge from poverty, the R&D institutions need to generate and deliver new farm technologies and promote linking of small farmers to markets.

PNG is rich in invaluable plant genetic resources (PGR) and is a 'home' to many root & tuber crops, green leafy vegetables and fruit & nut species. However, much of this biodiversity is depleting in the absence of appropriate conservation policies and strategies and because of increased urbanization, deforestation, plantation crop expansions, mining projects and the adverse effect of climate change. This is a serious concern, especially with respect to food crop diversity, and requires an immediate attention, as the crops in question are directly responsible for the livelihoods of the vast majority of the people. Coupled with the loss of biodiversity is the lack of knowledge in how to utilize existing genetic resources to improve agricultural productivity so as to sustain growing populations. Therefore the immediate need is to build adequate capacity in both human resources and scientific infrastructure to ensure that PGRFAs are effectively and sustainably conserved, managed and utilized.

8.4 Contribution to poverty alleviation

The population of PNG is growing at an average rate of 2.7% per annum. More than 80 percent of the workforce is engaged in subsistence agricultural production. However, the increase in per capita agricultural production achieved over the last 6-year period (1995-2001) has been marginal or nearly stagnant. The production of major staple food crops like roots and tubers grew at an average of 6.3% over the same period, which is much less than the population growth of 13.8-15.0 per cent during the same period. The challenge of producing sufficient food for the rapidly growing population remains a serious problem. At the same time yields of major food crop species like taro declined by 16.3% due to problems with pests and diseases, soil fertility and effects of climate change.

Poverty in PNG is reflected in difficulties of meeting basic needs of adequate shelter and health care. Poor health care can be contributed by water and sanitation problem, poor nutrition and limited purchasing power. About 40% of the 6.3 million people in PNG earn less than \$1 a day. With limited purchasing power compounded with high cost of living, the local communities are faced with challenges of sustaining their household needs and requirements. Communicable diseases of malaria and tuberculosis and lifestyle diseases and related problems like diabetes, kidney and heart problems are common with HIV/AIDS ravaging PNG at the moment. All these issues together with the effect of climate change have placed a challenge for the agricultural R&D institutions in the country to effectively utilize their limited resources to address these issues.

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