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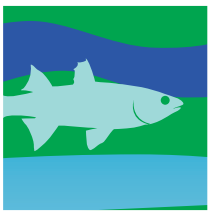

THE STATE OF **PAPAUA NEW GUINEA'S** BIODIVERSITY FOR FOOD AND AGRICULTURE

REPORT ON THE STATE OF BIODIVERSITY FOR FOOD AND AGRICULTURE IN

PAPUA NEW GUINEA

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Compiled by:

Brown Konabe
National Focal Point
Department of Agriculture & Livestock
Port Moresby
Papua New Guinea

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List of Abbreviations

AnGR	Animal Genetic Resources
AqGR	Aquaculture Genetic Resource
BAPNET	Banana Asia and Pacific Network
CBD	Convention on Biological Diversity
CEPA	Conservation and Environment Protection Authority
CePaCT	Centre for Pacific Crops and Trees
CITES	Convention on International Trade on Endangered Species in wild flora and fauna
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security
FGR	Forest Genetic Resource
FRI	Forest Research Institute
GEF	Global Environment Facility
GR	Genetic Resources
INEA	International Network of Edible Aroids
ITPGRFA	International Treaty on Plant Genetic Resource for Food and Agriculture
NARI	National Agriculture Research Institute
NAQIA	National Agriculture Quarantine Inspection Authority
NGO	Non Government Organization
NPAS	National Protected Area System
PAPGREN	Pacific Plant Genetic Resource Network
PDP	Plant Derived Pesticides
PGRFA	Plant Genetic Resource for Food and Agriculture
PGR	Plant Genetic Resources
PITSC	Pacific Islands Tree Seed Centre
PNG	Papua New Guinea
RBG	Royal Botanical Gardens
R&D	Research and Development

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EXECUTIVE SUMMARY

- Papua New Guinea is enriched with biodiversity and accounts for the 5% of the global biodiversity. The number of plant species is estimated to be in the range of 15,000 to 20,000, which represent about 6% of world's flora. For animals, it is estimated that PNG has 150,000 species of insects; 314 species of freshwater fishes (82 endemic); 2800 species of marine fishes; 641 species of amphibians and reptiles (328 endemic); 740 species of birds (77 endemic) and 276 species of mammals (69 endemic).

- The agriculture system is a mixed rain fed cropping system dominated by traditional staples such as sweet potato, taro, banana, yam and sago. Sweet potato is the most dominant system practice by about two million people predominantly in the highlands region. The forestry system is dominated by large areas of rainforest, which are harvested for industrial logging. The fisheries sector is dominated by marine and aquaculture fishery.

- There is a general trend of declining biodiversity in agriculture, forestry and fisheries. The main drivers of these are commercial logging, mining and agriculture activities such as slash and burn and large scale commercial plantations, over-harvesting, over-fishing and use of destructive fishing methods.

- It is very difficult to accurately determine the status of biodiversity for associated biodiversity and wild food species and the changes affecting them due to lack of information and monitoring system.

- The management and diversity based farming techniques that is practiced is dominated by diversification and base broadening practices that is commonly practice on traditional staples such as sweet potato, banana and taro. Introduction of new genetic material for livestock and fish breeds is increasing. NARI has done considerable number of R&D work in the last five years in developing climate change agriculture technologies and broadening genetic base of food crop varieties by bringing in new crop varieties, that are evaluated and release to farmers.

- Conservation of associated biodiversity and wild foods is mostly done in situ in legally protected wild life management areas. Currently, there are 44 existing terrestrial protected areas in PNG.

- PNG is a signatory to international conventions like CBD and ITPGRFA and thus complies with its provisions on access, exchange and benefit sharing. However, these conventions have not been aligned with national legislation and policies and therefore local access, exchange and benefit sharing of local genetic resources and farmer rights issues are yet to be formalize and implement at national level.

- PNG has in place relevant sectoral policies for biodiversity and genetic resources supported by necessary legislations. However, the sectoral policies are disjointed and there is a need for an overarching policy that will unify and integrate the sectoral policies of agriculture, forestry, fisheries, environment and climate change to ensure that the sectoral objectives contribute to the common goals of biodiversity, genetic resource conservation and sustainable use for food and agriculture and have a common cross sectoral management system.

- The most important needs and priority issues that need to be addressed are: the need for an information system to assess and monitor status of biodiversity and genetic

resources; the need to generate and promote suitable diversity based farming practices and management; the need to obtain more information and knowledge on associate biodiversity species in regard to their potential for ecosystem services and suitable conservation strategies and methods; the need to have a unify overarching policy for biodiversity for food and agriculture; and the need to improve manpower and financial capacity for R&D work on biodiversity for food and agriculture.

I. Assessment and monitoring of biodiversity for food and agriculture

1.1 General context

(a) General overview of the country

Papua New Guinea (PNG) is located in the oceanic region north of Australia and east of Indonesia. It occupies the eastern half of the island of New Guinea, where it shared a common land border with Indonesia. PNG has a total land area of 452,868 square kilometers and based on 2011 census, has a population of 7.2 million people and a population growth rate of 3.1%.[1]

PNG is one of the wettest countries in the world with annual rainfall ranging from less than 1000mm to 10,000mm. Annual rainfall of 2500mm-3500mm is common in the largest part of the country. On the other hand, areas like the national capital (Port Moresby) can experience annual rainfall of less than 1000mm. Although rainfall seasonality is experienced in most areas, its occurrence is less prominent. The average temperature is 30-32 degrees Celsius for lowland areas (600-1200m altitude) and 22-25 degrees Celsius for the highlands areas above 1200m altitude.[2]

The PNG landscape is categorized into five basic landforms: mountains and hills; landforms of volcanic origin; plains and plateaus; floodplains; and raised coral reefs and littoral areas. Around half (52%) of the total land area is mountainous and hills; almost 19% is plains or plateaus; 18% is floodplains; and the smaller proportion is made up of volcanic landforms, raised coral reefs & littoral areas.

PNG is endowed with natural resources and has a commodity oriented economy based on exports of gold, copper, oil, gas, timber, fish, coffee, palm oil, cocoa, rubber and copra. The country experienced high economic growth of average of 9% in the last decade driven mainly by the development of multi-billion dollar LNG industry. The economy is dominated by industry and services sectors supported by the agriculture sector which accounts for 39.1%, 33.1% and 27.6% GDP respectively. The economy is currently slowing down due to low world commodity prices of oil and agricultural products.

Despite its importance to the national economy, the agricultural sector is also vital for the livelihood of the 87% of the population in rural areas. It is a source for food security, nutrition, income and employment.

(b) Role of biodiversity for food and agriculture

PNG is one the few countries in the world enriched with biodiversity. Together with the main island of New Guinea, it accounts for the 5% of global diversity of animal and plant species; two-thirds of which are endemic.

The richness of biodiversity in PNG is demonstrated by the presence of number of plant and animal species. The number of plant species is estimated to be in the range of 15,000 to 20,000, which represent about 6% of world's flora. For animals, it is estimated that PNG has 150,000 species of insects; 314 species of freshwater fishes (82 endemic); 2800 species of marine fishes; 641 species of amphibians and reptiles (328 endemic); 740 species of birds (77 endemic) and 276 species of mammals (69 endemic).[3]

[1] Papua New Guinea 2011 National Census Report
[2] Geographic and Climate information is source from Bourke et al (2009) and McAlphine et al (1983).
[3] Animal and Plant Species diversity information is source from Coates (1989) and PNG National Fourth National Report to the Convention on Biological Diversity.

Biodiversity plays an important role in food and agriculture as the genetic resource base for seeds and planting materials of crops and breeds of livestock and fish for different types of crops, livestock and fish which the farmers can use for cultivation and farming to meet their food security, nutritional and socio-economic needs

Plant biodiversity provide rich source of species and varieties for the cultivation of food crops; spice crops and industrial cash crops such as coffee, coconut, palm oil, sugarcane, rubber and tea. Currently, it is estimated that there are about 4000 accessions & varieties of food crops; fruits and nuts, sugarcane, spices, coffee, cocoa, coconut, rubber and tea in existence in PNG.

About 1,035 different plant species are known to be used for various purposes in PNG. Wildlife plays an important part in traditional diets, supplying the primary intake of proteins and fats in many highland areas and other isolated areas of the country. In coastal areas a wide variety of seafood, including fish, mollusks, and turtles, dominate local diets.

Extensive biodiversity is also found in the marine and aquatic environment in PNG. The country is part of the coral triangle[4], the area of the world's highest known marine biological diversity. Its coral reefs and associated marine habitat are home to about 2800 species of fishes, about 10% of the world total. Almost all reef types found in PNG waters are within fringing and/or barrier reefs, with an estimated area of 40,000 km². In addition, PNG has some of the largest unpolluted tropical freshwater systems in the Asia Pacific region.

The main agriculture, forestry and fisheries farming systems are presented and described in Table 1. The agriculture system is a mixed rain fed cropping system dominated by traditional staples such as sweet potato, taro, banana, yam and sago. Sweet potato is the most dominant system practice by about 2 million people predominantly in the highlands region[5].

Table 1. Production systems present in the country.

Production System	**Indicate if present in the country (Y/N)**	**Description**
Livestock grassland-based systems	Y	Commercial farming of cattle in ranges
Livestock landless systems	N	
Livestock intensive farming	Y	Large scale commercial pig farming in pens
Naturally regenerated forest	Y	It is the most dominant vegetation covering 60% of the country. There are about 278,767 square kilometres of closed canopy rainforest.
Self-recruiting capture fisheries	Y	
Culture based fisheries		See country described systems indicated below
Fed aquaculture	Y	See country described systems indicated below
Non-fed aquaculture	Y	See country described systems indicated below
Irrigated crops (rice)	N	See country described systems indicated below
Irrigated crops (other)	N	

[4] http://www.coraltriangleinitiative.org/
[5] Farming systems information is source from Bourke and Harwood (2009).

Rainfed crops	Y	
Mixed systems (livestock, crop, forest and/or aquatic and fisheries.	Y	All cropping system described under mixed systems are rainfed.
		(a) Sweet potato based system Sweet potato is the dominant crop occupying one third of the garden area. It is practiced by about 2million people from lowlands to the highlands. However, it is a common staple in the Highlands region at altitudes 1200-1800 metres (b) Banana based system Banana is grown as a sole dominant crop or combine with cassava, Chinese taro, sago, sweet potato and yam. Both crops are dominant and intercropped with other crops. The diploid bananas are cultivated in Madang, New Britain, New Ireland, Morobe and Sepik Provinces. The triploid and tetraploids are commonly cultivated in Markham/Ramu valleys and Central Province. This cropping system is practice by about 400,000 people. (c) Taro based system Taro is the dominant crop or taro/yam are dominant crop intercropped with other food crops. This system is predominant in the wet lowland areas of Morobe Province and the atoll islands of Bougainville. It is practice by 90,000 people. (d) Yam based system It is common in inland areas of East Sepik Province, Madang Province and Trobriand Islands of Milne Bay Province. It is practice by about 120,000 people. (e) Sago based system It is common in swamp lowland areas of East Sepik Province, Gulf Province and Manus Province where it is a staple food. It is practice by about 400,000 people. (f) Rain-fed rice farming Small scale upland cultivation of rice using rainfall as the source of water. (g) Pig farming system

		Free range farming of native pigs fed on sweet potato non-marketable, low quality small tubers.~~.~~ Practice mainly in the highlands region.
Commercial marine fisheries	Y	Small-scale fisheries practice by village fishers along the coastal environment, freshwater reaches of larger rivers and swampy lowland areas. It involves using dug-out or motorized banana boats for spear fishing, hand-lining, netting and trapping. Subsistence catch is sold, traded or bartered. Production is estimated at 26,000 tones and is practice by about 250,000 to 500,000 people. Tuna fishing is carried out by license foreign vessels through bilateral or multilateral access arrangements. Shell fishery is based on harvesting of trochus, pearl and green snail shells and is a village-based activity. Lagoon, reef and pelagic fishing are done by small-scale commercial fishers using nets, lines and other fishing methods.
Freshwater aquaculture	Y	Farming of Tilapia, Trout, Perch, Carp, Eels, Catfish and Gourami.
Marine aquaculture	Y	Farming of seaweed, giant clams, crocodile, milkfish, mullet, mussels and prawns.

1.2. State, trends and drivers of change of biodiversity for food and agriculture

The state, trends and drivers of change in biodiversity for food and agriculture is describe below:

(a) Agriculture and Livestock

There is a general trend of declining genetic diversity of all agriculture genetic resources in the country. The main drivers of these are commercial logging, mining and agriculture activities such as slash and burn agriculture and large scale commercial plantations of palm oil.

The country is rich in mineral resources, which is largest source of revenue.

However, mining developments caused destruction of natural habitats and direct poisoning of the ecosystems. An example of this is the dumping of the tailings from the OK Tedi Mine in the Western Province into the Ok Tedi and Fly Rivers systems for two decades, that resulted in the poisoning of about 2000 square kilometers of forest and also depleted fish stocks in the river systems. There is also threat from acid rock drainage that could spill acid water into the river systems, which would lower the pH causing negative change in the ecosystem.

Slash and burn is a common traditional technique practiced mainly by smallholder farmers in the country to clear vegetation for cultivation of crops. However, uncontrolled burning of large areas is destructive to the ecosystem resulting in the loss of biodiversity. A study conducted in the Wanang conservation area along the Ramu river of Madang Province revealed a 20 percent decline in bird species in the secondary forest compared to primary forest after under-going slash and burn for agriculture use[6].

Palm oil is the largest agriculture export earner for the country accounting for about 39% to total agriculture export earnings. However, this has come at a cost of natural habitat destruction and loss of biodiversity due to deforestation of large tract of areas for commercial palm oil production.

(b) Forestry

According to State of the Forest of PNG 2014 Report[7], there were 278,767 square kilometers of closed canopy rainforest in PNG in 2014. Thirteen percent of this forest was logged at least once since 1972 and 4.1% was cleared or logged since 2002. There was change in the country forest over the period 2002-2014 resulting in the 4.1% clearing and logging. The main drivers of this change from 1972 to 2002 were industrial logging accounting for 48% of total change, subsistence agriculture and landslides accounting for 46% and fire accounting for 4% of total change. In contrast, from 2002 to 2014, the main drivers for forest change were due to deforestation and degradation accounting for 81% of total change.

(c) Fisheries and aquaculture

Marine fisheries with regard to reef and pelagic fish and beech-der-mer have declined due to over-harvesting and the use of destructive fishing methods like dynamite fishing. This change is driven by the demand of commercialization.

Marine species biodiversity is also threatened by climate change, habitat destruction and pollution. Climate change could potentially disrupt ocean circulation; changes in the amount and distribution of fish; and change level of salinity, temperature and acidity. Habitats are destroyed by coastal development and sedimentation of coastal waters. Dumping of toxic waste, sewage and sediments into seas are the main pollution threats.

Specific institutions set up their own information system for biodiversity and genetic resources for food and agriculture. Hence, there is absence of a hub or a centralized information system for biodiversity for food and agriculture. There are various databases available in Agricultural Research Institutions on *ex-situ* collections of crop species that are maintained by National Agriculture Research Institute (NARI) for food crops especially

[6] http://news.mongabay.com/2010/12/biodiversity-and-slash-and-burn-agriculture-in-papua-new-guinea

[7] Bryan and Sherman (2015); The State of Forest of Papua New Guinea 2014.

sweet potato, taro, yam, banana, cassava, aibika; Cocoa Coconut Institute for coconut; Ramu Agro Industries for sugarcane; and Forest Research Institute (FRI) maintains some collections on forest genetic resources and the herbarium on plant genetic resources.

Data available would mostly include passport data and in cases of agricultural crops some evaluation data of crop varieties. Generally, there is no system in place that would monitor any components of associated biodiversity. PNG's Conservation and Environment Protection Authority (CEPA) has recently invested resources, through the Kokoda Initiative, to develop a national biodiversity database – and have just taken receipt of more than 100,000 digitized records of plant and animal specimens

There are about one hundred invasive flora and fauna species found in PNG. Measures were taken to control some of the species using bio-control agents indicated in Table 2. Most of these were invasive weed species like free-floating species like *Salvinia, Water hyacinth* and *Water lettuce* and terrestrial weeds like *Mikania* and *Broomstick.*

Table 2: List of associated biodiversity species that are actively managed in the production systems for the provision of ecosystem services.

Associated biodiversity species	Ecosystem functions and services provided by the species in the production system
Salvinia weevil (*Cyrtobagous salviniae*)	For the management of *Salvinia molesta*
Neohydronomous affinis	For the management of water lettuce, *Pistia stratiotes*
Neochetima bruchi and Neochetina eichorniae	For the management of water hyacinth, *Eichhhornia crassipes*
Stem gall fly (*Cecidochares connexa*)	For the management of *Chromolaena odorata*
Puccinia spegazzini pustules	For the management of mikania weed, *Mikania micrantha*
Calligrapha pantherina	For the management of flannel weed broom stick, *Sida rhombifolia*

The wild food species used for food and other uses such as pelt, plumage, skin etc. is presented in Table 3. There is little known or no information about the change in most of the species. It is assumed that the changes are happening caused by destruction of forest for logging but there is no proper assessment and monitoring system in place to monitor this changes. Generally, the main driver of change, were industrial logging, large scale commercial agriculture like Palm Oil plantations and over-hunting which cause destruction to the habitats of these plant and animal species and direct reduction in their population.

Table 3: Wild food species used for food in the country.

Wild food species	**Change in state (2,1,0, -1,-2, NK)**
Sago (*Metroxylon sagu, M. salomonense*)	-1
Breadfruit (*Artocarpus altilis*)	NK
Polynesian Chestnut (*Inocarpus fagifer*)	NK
Elephant foot yam (*Amorphophallus campanulatus*)	NK

Karuka (*Pandanus brosimos, P. julianettii, P. conoideus)*)	NK
Deer	Food, antler, wetland management; NK
Tree kangaroo	Food, pelt, conservation of habitat; NK
Wild fowl	Food, plumage; NK
Cassowary	Food, plumage, cultural value, bone tools; NK
Guria pigeon	Food, plumage; NK
Feral pig	Food, tasks for decoration; NK
Crocodiles	Food, conservation, teeth for decoration; NK
Bandicoot	Food; NK
Lizard	Food, skin; NK

BOX 1. Examples of countermeasures that have been taken in the country to reduce adverse effects of drivers on associated biodiversity, ecosystem services and/or wild foods.

The legal banning of crocodile shooting and hunting of tree kangaroo and their population and habitat conservation and management by government, NGOs and local communities.

1.3 Needs and priorities

The possible needs and priorities are:

(a) Due to lack of baseline information on the status of biodiversity and genetic resources on the main biodiversity, associated biodiversity and wild foods, there is very little information available on the status and extend of changes affecting biodiversity. Hence, there is a need to do a comprehensive field survey to collect this information, which can be used for future assessment and monitoring.

(b) There is a need to develop an information system for the baseline and other relevant information.

(c) Development of knowledge management systems to standardize data collection and monitoring methods, document existing datasets and establish and improve data storage and access.

(d) Conduct research on the role of biodiversity, associated biodiversity and ecosystem services on food and agriculture.

II. Sustainable use and conservation of biodiversity for food and agriculture

2.1 Sustainable use

(a) Management and diversity based practices that support the maintenance and use of biodiversity for food and agriculture in production systems

Table 4 indicates the management and diversity based practices that support the maintenance and use of biodiversity for food and agriculture in production systems in the country. There is a range of management and diversity based practices used such as diversification; use of pest and diseases resistant/tolerant varieties; base broadening and domestication. There is no or probably little change in the current varietal diversification of sweet potato and banana systems but introduction of new crop species and genetic material is common and increasing in the production systems for both flora and fauna species. Base broadening

through germplasm collection of crops genetic material is threatened by lack of resources to manage and maintain collections, which results in the loss of varieties.

Table 4: Management and diversity based practices that support the maintenance and use of biodiversity for food and agriculture in production systems.

Production system	**Management/ diversity based practice**	**Trends in the application of the practice over the past ten years**
Rain-fed sweet potato	Diversification: Cultivating early, mid and late maturing sweet potato cultivars	0
Rain-fed banana	Diversification: Various genetic groups (AAA, AAB, ABB) are cultivated for cooking and eating. Cooking banana are cultivated for early, mid and late maturing. A group is a perennial food crop	0
Rain-fed taro production system	Pest & Disease Management/Base Broadening: Use of pest/disease resistant/tolerant cultivars of taro.	increasing
Taro and sweet potato systems	Diversification Introduction of new varieties of taro and sweet potato	increasing
Traditional mixed systems	Diversification Introduction of new crops eg rice	increasing
Sweet potato and taro systems	Base broadening: Introduction of genetic diversity from international gene banks for use in local breeding programmes	increasing
Forest systems	Domestication: Domestication of edible nut species eg *Canarium indicum*	increasing
Small livestock systems	Diversification: Some limited diversification with introduction of new livestock species into mixed sytems (eg goats, ducks) or different breeds of poultry	Some increase
Marine and aquaculture systems	Base broadening: Introduction of new genetic material and fish species	increasing
All staple crop systems	Base Broadening-*Institutional managed (Ex-situ field collection)*	*Conservation & maintenance of ex-situ field collection is challenging when faced with limited resources and extreme climatic conditions such as drought, flood water, excessive soil moisture etc. Each year we tend to lose genetic materials from the field ex-situ collection. No back up collection under in-vitro storage in country to replace those genetic materials that are being lost in field gene-banks.* *Over the past ten years generally, a good of number accessions have been lost from most ex-situ National collections and also an increase in cassava collection and Lowland sweet potato collection due to new accessions/cultivars being collected.* • *Banana (musa spp) accessions reduced from 230*

		to 217, which is 5.65% loss over the ten years or 0.565% loss per annum. • *Aibika (A.manihot) accessions reduced from 93 to 43, which is 53.8% loss over the ten years or 5.3% loss per annum.* • *Yam (Dioscorea spp) accessions reduced from 348 to 96 accessions, which is 72.4% loss over the ten years or 7.2 % loss per annum.* • *Cassava (M.esculenta) has increased from 77 to 112, which is 45.5 % increase over the ten years, or 4.5% increase per annum.* • *Taro (C.esculenta) accessions have reduced from 859 to 425, which is 50.5% loss over the ten years or 5% loss per annum.* • *Sweet potato (I.batatas) Highlands collection- accessions reduced from 1161 down to 717, which is 38.2% loss over the ten years, or3.8% loss per annum. Lowland collection – increase in accessions from 103 to 160, which is 53% loss over the ten years, or 11% loss per annum*

BOX 2. Successful program or project that has been undertaken in the country to support one of the practices listed in Table 4.

1) NARI has implemented in the past 5 years an EU funded project titled 'Generation and adaptation of improved agricultural technologies to mitigate climate change-imposed risks to food production within vulnerable smallholder farming communities in Western Pacific countries'. Using a participatory approach, participating communities determined their needs for agricultural interventions that would help them better adapt to the effects of global Climate Change in relation to their production systems. A major implemented strategy was the diversification of production systems with new crop species and crop varieties to shorten the period were food supply is scarce due to unfavorable season or weather and broaden the genetic diversity of crop species for better resilience to climatic variability. The project also introduced new livestock species (ducks, goats), livestock production systems (aquaculture and duck-fish integration), management practices for livestock production.

2) NARI is a partner organization in the International Network for Edible Aroids. Through a multi-national project involving more than 20 partner organizations from Europe, Pacific, Asia, Africa and Central America, fifty Taro (*Colocasia esculenta*) accessions from a diverse genetic background (Japan, Thailand, Indonesia, Malaysia, Hawaii, Vietnam, Samoa) were introduced, evaluated together with local varieties and 30 of the best performing accessions (local and exotic) were made available to farming communities in Madang, Eastern Highlands and Morobe communities for their own assessment and selection of preferred varieties. Participating farmers appreciated the opportunity to access new taro varieties and in most communities, they decided to keep all accessions for further assessments in coming seasons.

(b) Examples where biodiversity per se or its lack had a direct effect on productivity; food security and nutrition; rural livelihoods; ecosystem services; sustainability; resilience; or sustainable intensification. These are provided below:

(i) The current National Agriculture Quarantine Inspection Authority (NAQIA) regulations restrict the sourcing of imported breeding stock to Australia or New Zealand and for poultry currently to New Zealand only. This means that it is not possible to replace breeding material of Asian origin unless, as is the case with buffalo, the material is present in Australia. It also means that access to genetic resources adapted to the tropics is limited to what is currently in PNG or again available in Australia. Hence this reinforces the need to take seriously suggestions concerning the characterisation, conservation and utilisation of native pigs and chickens, Javanese Zebu cattle, Priangan sheep and PNG goats.

(ii) In early 2015, aibika farmers at Brown River Community, Central Province, lost most of their aibika varieties through flood and they were supplied with aibika planting materials for different aibika accessions/cultivars from the aibika germplasm collection maintained by NARI to restock as well as increase the genetic base.

(iii) NARI supplied planting materials of cassava, sweet potato, taro, yam and others to Cyclone Guba affected communities in Oro Province.

(iv) NARI is supplying a range of planting materials (sweet potato, corn seed, rice seed, cassava etc.) to communities who lost their crops and planting materials during the extended severe drought caused by the current El Nino effect.

(c) Examples whereby biodiversity for food and agriculture also contributed to cope with climate change, invasive alien species, and natural or human-made disasters.

The examples of these are indicated in Table 5.

Table 5: Examples whereby the use of biodiversity for food and agriculture contributed to cope with climate change, invasive alien species, and natural or human-made disasters

Objective	**Description**
Use of BFA to adapt to and mitigate climate change	*Crop germplasm accessions identified as tolerant to salinity (taro, cassava), drought (cassava, bananas, aibika) and flood (taro, banana) in ex-situ collections are being distributed to farmers. This is really proving useful in sustaining food security during the current (2015-2016) National Drought where 40% of the 7.5 million people are affected to category 4 and 5 levels.*
Use of BFA to manage the spread of/control invasive alien species	*As part of associated biodiversity reared and distributed bio-control agents for invasive weeds, used research formulated plant derived pesticides to control insect pests, use and promote natural insect repellent plants. Examples of biocontrol of invasive weeds species in PNG are presented in Table 2.*
Use of BFA to prevent natural or human-made disasters and/or reduce their effects on livelihoods, food security and nutrition	*Whenever there is an unexpected extreme climatic condition, the PGR materials from the national germplasm collection are being rescued for safely duplication in nurseries. PGR materials collected from natural environmental conditions such as flood prone area, drought, excessive soil moisture, saline etc. are identified and safely duplicated under in-vitro storage at Centre for Pacific Crops and Trees (CePaCT), Fiji regional tissue culture laboratory for future use*

PNG government has undertaken measures such as protection of biodiversity areas. This has resulted in the protection of fourthy four existing terrestrial areas using International Union for the Conservation of Nature and Natural Resources categories. These protected areas account for 1.6% of the total land area. A further 398 areas have been identified for protection, which will increase the total protected areas to 16.8%.

d) Ecosystem/landscape/seascape approaches that have improved the management and use of biodiversity for food and agriculture in the country.

(i) Ridge-to-Reef Project[8]

PNG is part of Pacific Islands Regional Global Environment Facility (GEF) funded program called "Ridge-to-Reef program, which has the goal of maintaining and enhancing ecosystems goods and services through integrated management of land, water, forest, coastal and marine resources to contribute to poverty alleviation, sustainable livelihood and climate change resilience.

The objective of Ridge-to-Reef program in PNG is to strengthen national and local capacities to effectively manage the national system of protected areas and address threats to biodiversity and ecosystem functions in these areas. The project has two components: Management capabilities of the PNG state to support and oversee protected area management and Strengthening the capacity of the State and local communities to cooperatively manage protected area sites.

These two components will focus on enhancing the capacity of CEPA in policy formulation and management of protected areas and also strengthen capacity of CEPA, stakeholders and local communities to effectively managed protected areas like YUS[9] and Torricelli[10] Mountain Range landscapes.

(ii) Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)[11].

The Project was funded by Asian Development Bank and co-financed by GEF, Cooperation and Integration fund and Australian Government. It was implemented in five Countries: PNG, Solomon Islands, Timor-Leste, Fiji and Vanuatu from 2011 to 2014.

The aim of the project is to strengthen the capabilities of national and local institutions in sustainable coastal and marine resource management and enable coastal communities to apply best practices in ecosystem-based fishery management and climate change adaptation.

In PNG, the target area was Kimbe Bay located in West New Britain Province, which is provides the habitat of some of the most ecologically significant shallow and deep water marine habitats in the Coral Triangle. More than 60 percent of the Indo-Pacific coral species and more than 860 species of fish are found in this 9800 square kilometres area.

The diverse ecosystems of Kimbe Bay which consist of coral reef, mangrove, sea grass, oceanic and sea mount habitats demand specific technical and institutional interventions to manage these diverse interconnected ecosystems. Hence, a multi-stakeholder approach is also required to manage the interventions.

(e) Examples of activities undertaken to maintain and use traditional knowledge of associated biodiversity and wild foods

A number of activities have been undertaken to maintain and use traditional knowledge of

[8] https://sustainbledevelopment.un.org/partnership/?=7315
[9] http:www.conservation.org/NewsRoom/pressrelease/page/papuanewguinea
[10] http://www.tenkile.com/about.html
[11] http://www.coraltraingleinitiative.org/news/multi-stakeholder-approach-empowering-coastal

associated biodiversity and wild foods. The examples are listed below:

(i) Traditionally, farmers use natural insect repelling plants such as ginger, lemon grass, chili and even floral plants like marigold. NARI also developed formulas for using these plants as a 'Plant Derived Pesticides' (PDP) and trains many rural farmers on the use of PDP.

(ii) In the rural areas farmers bring in wild crop relatives from their natural habitats and domesticate them in their gardens. For example, 'Tulip' (*Gnetum genum*) a leafy delicacy in most PNG dishes, is *commonly grown in* the backyard and food gardens in mostly coastal communities).

(iii) Certain cultural practices also help in building up genetic biodiversity of food crops, in particular, when a bride leaves her parents' home village to join the family of her bridegroom (which can be a nearby village, or a very far place) she usually goes with food crops seeds or seedlings presented by her parents and relatives during the wedding. In this way new food stock cultivars and the knowledge of cultivating them is spread from one community to another. This practice also naturally enhances duplication of genetic materials for 'safe keeping' because if her parents lose a particular variety they can go and get it from her.

(f) Possible needs and priorities

The possible needs and priorities in terms of the sustainable use of biodiversity for food and agriculture, and in particular of associated biodiversity and wild foods are outlined below:

(a) The use of management and diversity based farming practices to promote sustainable use and maintenance of biodiversity is limited by poor capacity in local manpower and finance to support the necessary Research and Development (R&D) work. Research scientist and technicians need to be trained in plant and animal breeding and proper facilities for genetic research need to be established.

(b) There is need for the custodians of germplasm collections to put highest priority to the management and upkeep of ex situ collections to avoid l~~o~~osing varieties and accessions. Crop varieties are being lost on Research stations because of lack of funding to manage and maintain the collections.

(c) There is a need to develop suitable biosecurity protocols to facilitate the imports of genetic materials from other countries to broaden genetic base.

(d) Identification of associated biodiversity found within different production systems.

(e) Better knowledge on how management practices and diversity-based interventions influence biodiversity for food and agriculture.

(f) Better technical and field knowledge on management practices and diversity-based interventions that support sustainable use of biodiversity for food and agriculture

(g) Use of traditional knowledge supporting the sustainable use of BFA

2.2. Conservation

(a) Status of *in situ* conservation of associated biodiversity and wild food species

(i) National Level

Virtually all of the associated biodiversity and wild food species lives in their natural habitats in the wild or in protected wildlife management and conservation areas. Examples are:

1) The YUS National Conservation area in Morobe Province, established in 2009, covers 76,000 hectares of tropical rainforest to conserved species of Eastern Long-beaked Echidnaand, Matsie's tree kangaroos, New Guinea Pademelon, Leatherback sea turtle and Wahnes's bird of paradise. It is funded by Rainforest Trust and managed by a local partner called "Tree Kangaroo Conservation Program.

2) Virarata National Park in Central Province for the *regginae species* of bird of paradise in Central Province.

3) The Wanang[12] Conservation Area in Madang Province, which covers 10,000 hectares and provide protection to species flora and fresh water fish, cassowaries and wild pigs.

4) Marine protected areas like the Karkum[13] Conservation Area in Madang Province that protect and conserve turtle, dugong, whales and dolphin species.

(ii) Sub-Regional/Regional Level

The Framework for Nature Conservation and Protected Areas in the Pacific Islands region, 2014-2020[14] will provide guidance for the region on key priorities for biodiversity conservation and ecosystem management with clear linkages to NBSAPs and the Aichi Biodiversity targets. Strategic goal "C" is 'to improve the status of biodiversity by safeguarding ecosystems, species and diversity

The Coral Triangle Initiative: The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF)[15] is a multilateral partnership of six countries formed in 2007 to address the urgent threats facing the coastal and marine resources of one of the most biologically diverse and ecologically rich regions on earth. It is defined by its extremely high marine biodiversity. Over one hundred million people living in its coastal zones use this biodiversity to support their livelihoods. Papua New Guinea and Solomon Islands are the two PICs' partners in this initiative.

(b) Status of *ex situ* conservation of associated biodiversity and wild food species

(i) National Level

There is very little information with regard to the *ex situ* conservation of associated biodiversity and wild food species. A small collection of PNG orchids species is maintained by Port Moresby Nature Park in the National Capital.

The National Herbarium in Lae, which was established in 1946, holds 350,000 plant

[12] http://baloun.entu.cas.cz/png/wanang/
[13] http://bionesian.blogspot.com/2010/09/turtle-conservation-in-papuanewguinea
[14] https://www.sprep.org/publications/framework-areas-in-the-pacific-islands-region-2014-2020
[15] http://www.coraltriangleinitiative.org/

samples and is probably the largest in the South Pacific. The plant samples were collected in PNG, Island of New Guinea, Solomon Islands and other parts of the world. The Herbarium holds more than 251 various plant families, 169 families of dicotyledons, 47 families of monocotyledons, 26,000 specimens of pteridopytes, which includes 130 fern families and more than 150 families of lichens and liverworts.

A lot of food crop cultivars are still in the farmer's field, and crop wild relatives are in their natural habits. There is little knowledge about what is present in the country. Management of *ex-situ* collections is difficult and accessions are lost regularly due to inherent problems of such collections (environment, un-favorable weather events, human error and negligence etc.).

(ii) Sub-regional/Regional level

The Royal Botanic Gardens (RBG) Kew has signed a 10-year agreement to work with the SPC in supporting and implementing plant conservation activities in the Pacific region. Initially Kew will cooperate with SPC's Pacific Island Tree Seed Centre (PITSC) to conduct seed conservation activities in Fiji.

The SPC Centre for Pacific Crops and Trees can support SPC member countries in conserving agricultural biodiversity.

The Fiji Herbarium at the University of the South Pacific houses more than 50,000 vascular plant specimens in the main collection. It also has a wet collection of plant parts, bryophytes and algae from the Pacific region. The Herbarium serves as a very important resource in matters pertaining to the taxonomy, conservation and ecology of plants, forestry, land use planning, economic plants and weed problems in the region.

(c) The possible priorities and needs include:

i. There is lack of information on in situ and ex situ strategies and methods for associated biodiversity and wild foods for food and agriculture. Hence, there is a need to do more R &D work on this subject.

ii. There is a need to carry out field collections and genetic studies of wild foods and associate biodiversity species useful for food and agriculture. This should lead also to the creation of an information system for the same.

iii. There is need to develop capacity (skills, competencies of personnel; facilities including tissue-culture, herbarium, cryopreservation, DNA-fingerprinting and barcoding; information systems)

iv. Better knowledge on the linkage between production, conservation and ecosystem services

v. Understanding of how ecosystem approaches can contribute to the conservation of biodiversity for food and agriculture

vi. Access to information on the sustainable conservation of biodiversity for food and agriculture

vii. Better knowledge on conservation techniques (*in situ* and *ex situ*) with emphasis on *in*

situ for biodiversity for food and agriculture.

viii. Develop appropriate conservation strategies

ix. Policy support for the conservation of biodiversity for food and agriculture

2.3 Access and exchange

(a) Main measures in the country (i) regulating access to; and (ii) ensuring the fair and equitable sharing of benefits arising from the utilization of biodiversity for food and agriculture (BFA).

PNG is signatory to the CBD and ITPGRFA and therefore comply with their provisions with regard to access, exchange and benefit sharing of genetic resources, which are described in Table 6. However, these conventions have not been translated into national policies, plans and regulations to enable proper use, management, access, farmer rights and sharing of benefits for genetic resources at national level.

Table 6. Description of the main measures in the country (i) regulating access to; and (ii) ensuring the fair and equitable sharing of benefits arising from the utilization of biodiversity for food and agriculture (BFA).

Components of BFA	**Description of measures governing access to BFA**	**Description of measures regulating the fair and equitable sharing of benefits arising from the utilization of BFA**
Genetic resources		
PGRFA	PNG is a member country of CBD[1] and ITPGRFA[2] . PNG has not signed and ratified accessions to the Nagoya protocol that would cover all other Biodiversity	Through ITPGRFA, benefits are shared in an equitable way. However, the shipment of PGRFA requires regulation concerning its pathogen status and database maintenance.
AnGR	Covered under CBD but not other treaty	Use and sharing of benefits of AnGR is not regulated in any way at national level
FGR	Covered under CBD and partly CITES[3]	PNG has signed the MTA with SPC regarding access to and exchange of FGR material (seeds)
AqGR	Covered under CBD and partly CITES	
Associated biodiversity		
Micro-organisms	Covered under CBD and partly CITES	
Invertebrates	Covered under CBD and partly CITES	
Vertebrates	Covered under CBD and partly CITES	
Plants	Covered under CBD and partly CITES	
Wild foods		

[1]Convention of Biological Diversity; [2]International Treaty on Plant Genetic Resources for Food and Agriculture; [3]Convention on International Trade on Endangered Species in wild Flora and Fauna

(b) The possible needs and priorities in terms of the policies and regulations governing the access to and ensuring the fair and equitable sharing of benefits arising from the utilization of biodiversity for food and agriculture, and in particular of associated biodiversity.

The possible need and priorities are outlined below:

i. There is a need to align national laws and regulations to the provisions of CBD and

ITPGRFA to address local farmers access, exchange and sharing of genetic resources and its use and management, farmer rights, IP etc.

ii. PNG need to sign and ratify the Nagoya Protocol that governs access benefit sharing of Biodiversity.

III. Policies, institutions and capacity

3.1 Policies, programmes, institutions and other stakeholders

(a) Relevant policies and programmes the country has adopted and is implementing to support the conservation and sustainable use of biodiversity for food and agriculture, and associated biodiversity and wild foods

PNG have relevant policies for conservation and sustainable use of biodiversity and genetic resources. The policies are based on the country fourth goal the national constitution and its directive principles, which states "*Papua New Guinea natural resources and environment should be conserved and used for collective benefit for all and should be replenished for future generations*".

The PNG Protected area policy support the development of a National Protected Area System (NPAS) and guide the stakeholders involved in biodiversity conservation to harmonize their efforts in an effective manner to develop and manage the protected areas. This policy is supported by legislations such as the Fauna Protection and Control Act 1966 and the Conservation Areas Act 1980. Other relevant legislations are the Crocodile Trade Act 1982 and the International Trade Act 1982.

Conservation and sustainable use of biodiversity is also well captured in the PNG Vision 2050 as its fifth Pillar –Environment Sustainability and Climate Change. This pillar aim to enhance conservation of biodiversity from its current level to 7% of the world biodiversity; establish a total of 20 national reserves, wilderness areas and national parks; and establish at least one million hectares of marine protected areas.

Conservation of biodiversity and genetic resource is also captured in national agriculture policies such as National Agriculture Development Plan 2007-2016 and National Food Security Policy 2000-2010.

(b) Strengths and weaknesses of the policies and programmes mentioned above and their level of implementation

Various sectoral organizations mandated in agriculture, forestry, fisheries, environment and climate change have their own biodiversity policies with varying details and coverage on the key issues of biodiversity. Some of the sectoral policies failed to adequately captured important issues on biodiversity, genetic conservation and sustainable use.

An example of this is the lack of detail coverage of biodiversity and genetic resources in the two agricultural policies afore-mentioned. The subject is only briefly mentioned in the objectives or the activities sections of the policy and failed to capture in detail important issues like conservation strategies and methods, assessment and monitoring, data collection, sustainable management, access and exchange, farmer rights and capacity building.

The specific sectoral biodiversity policies afore-mentioned are disjointed, uncoordinated and not properly implemented and monitored. Hence, there is a need of an overarching policy to unify and integrate the sectoral policies on biodiversity. The overarching policy must set the

direction and adequately captured the core technical issues of biodiversity and the management system of the policy as well. This will ensure that the overarching national biodiversity policy will have shared vision, objectives and goals and it will have a common cross sectoral management system to ensure effective coordination of planning, implementation, monitoring and reporting.

Conservation of biodiversity and genetic resources work in PNG is done by national government, International and Local Non-Government Organizations (NGOs). The Conservation Environment Protection Agency (CEPA), which was previously the Department of Environment and Conservation, is responsible for the overall policy on conservation of biodiversity and genetic resources. The main research work on biodiversity and genetic resource is done FRI and NARI supported by the country's two Universities- University of PNG and PNG University of Technology.

The major international NGOs actively involved in conservation of biodiversity are Conservation International; The Binatang Research Centre; Wildlife Conservation Society; World Wildlife Fund; and The Nature Conservancy. The local NGOs are Partners with Melanesians (Oro Province and Karimui); Research and Conservation Foundation of PNG (Crater Mountain); Tenkile Conservation Alliance (Sandaun Province) and PNG Institute of Biological Research. Other local organizations with active conservation programs are Conservation Melanesia; Melanesian Environment Foundation; Village Development Trust and Pacific Heritage Foundation.

The NPAS approach also allow for full local community participation in the conservation of biodiversity in the local protected wildlife management area.

BOX 3. Three examples to highlight how stakeholder groups in the country, such as groups or associations of farmers, forest dwellers, fisher folk and livestock keepers, NGOs or other civil society organizations, have actively contributed to the improved sustainable use and/or conservation of biodiversity for food and agriculture and the maintenance of ecosystem services.

The Torricelli Mountain Wildlife Management area is situated in the range of Sandaun Province. It is the habitat of unique species of tree kangaroos and cuscus. The Tenkile Conservation Alliance in collaboration with traditional landowners operates this wildlife management area.

The Tonda Wildlife Management Area in Western Province was established in 1975. It is listed as wetland, which provides habitat for 250 species of birds. It is managed by WWF in collaboration with local landowners and Kakadu National Park of Australia.

The Crater Mountain Wildlife Management Area in Eastern Highlands, Chimbu and Gulf Province managed by Research and Conservation Foundation in collaboration with traditional landowners.

(c) Example of Successful inter-ministerial cooperation in the area of conservation and sustainable use of BFA

A possible example is "The Bismarck Sustainable Development Planning Process". The Primary objectives are to:

1) To take conservation and sustainable development efforts in Papua New Guinea (PNG) to scale.
2) To assist PNG to meet its International Commitments, particularly (1) Convention on Biodiversity and (2) Millennium Declaration – MDG 1 and 7.
3) To empower Provincial Governments and develop a process that strengthens effective

conservation and sustainable development efforts

4) To embed sustainable development and effective conservation as an integral part of the development planning process in PNG and
5) To ensure the effective consideration of climate change mitigation and adaptation.

The participants/stakeholders are: Provincial Planners from 12 Provincial Governments across the Bismarck Study Area, The Nature Conservancy Melanesia Team and Representatives from: The Department of Environment and Conservation, National Planning, National Fisheries, Mining, and Provincial and Local Level Government Affairs.

(d) Possible needs and priorities

The possible needs and priorities in terms of policies, programmes and institutions governing biodiversity for food and agriculture, and in particular associated biodiversity and wild food species are outlined below:

i. There is a need to develop an overarching national biodiversity and genetic resource policy, which should link with agriculture, forestry, fisheries, environment and climate change policies on biodiversity and genetic resources. This national policy should also establish cross sectoral management, implementation and coordination mechanism of the policy.

ii. Since biodiversity and genetic resources play a vital role in food and agriculture, there is a need to consider formulating a specialized biodiversity and genetic resource policy food and agriculture. This policy will be inclusive and will capture important international and national issues that affect biodiversity and genetic resources for food and agriculture.

iii. There is a need to review existing policies and its implementation in relation to their impact on sustainable use of biodiversity for food and agriculture.

iv. There is a need to strengthen capacity and engage relevant stakeholders for implementation existing policies.

3.2 Capacity

(a) Priority training and education needs for the conservation and sustainable use of associated biodiversity and describe possible constraints

i. Training of scientist and technicians on the principles of plant and animal breeding and field genetic diversity studies.

ii. Advance training for scientist on molecular level genetics in areas of DNA finger printing, barcoding, tissue culture etc.

iii. Advance training for technicians on in situ and ex situ conservation methods, characterization of genetic materials and data collection.

iv. Better knowledge of native species and associated biodiversity and their uses and benefits in relation to ecosystem services.

(b) Priority research needs to strengthen the conservation and sustainable use of associated biodiversity, wild foods and ecosystem services and possible constraints

i. Involvement of a wide range of stakeholders in research on biodiversity for food and agriculture in project design, planning, implementation, monitoring and reporting.

ii. Strengthen capacity for funding and research on the role of biodiversity for food and agriculture for production systems and ecosystems services.

iii. Promote regional and international cooperation on research

IV. Regional cooperation

4.1 Regional initiatives the country is involved with to conserve and use biodiversity for food and agriculture

(a) Regional policies and programmes that embed the conservation and/or use of biodiversity for food and agriculture, and in particular associated biodiversity, wild food species and ecosystem services.

The regional policies and programs which the country is engaged in for the conservation and use of biodiversity for food and agriculture is described in Table 7. PNG has been involved in a number of regional and international programs with international genetic resource centers for conservation of genetic resources of crops like banana, aibika, sweet potato and edible aroids and a number of regional policies and plans to conserve genetic resources and promote sustainable management of land, water, forest, coastal and marine resources to maintain biodiversity and sustainable livelihoods.

Table 7. Description of relevant regional policies and programmes that embed the conservation and/or use of biodiversity for food and agriculture, and in particular associated biodiversity, wild food species and ecosystem services.

Regional policies and programmes	**Description**
Conservation of PGR *in vitro* at CePaCT (Centre for Pacific Crops and Trees) at SPC[16]	Germplasms are maintained at CePaCT tissue culture laboratory.
Genotyping by sequencing (GBS) of aibika and sweet potato at National Taiwan University	Aibika and sweet potato lines preserved in PNG are being analyzed by a most recent genotyping technology.
PAPGREN[17]	Pacific Plant Genetic Resource Network – regional network that looks after the conservation and use of Pacific Plant Genetic Resources
BAPNET[18]	Banana Asia and Pacific Network – regional network that also considers the conservation and use of Banana genetic resources in the region
INEA[19]	International Network of Edible Aroids – aims at increasing the genetic diversity of edible aroids through conservation, use and dissemination of genetic diversity of edible aroids
Pacific Plan[20]	Pacific Forum leaders agreed to the development of a 'Pacific Plan' with the goal to "Enhance and stimulate economic growth, sustainable development, good governance and security for Pacific countries through regionalism. The Plan has reference to 'Improved Natural Resource Management and Environmental Management' in the plans Strategic Objective no. 5, with

[16] http://www.lrd.spc.int/the-centre-for-pacific-crops-and-trees-cepact
[17] http://www.lrd.spc.int/the-centre-for-pacific-crops-and-trees-cepact
[18] http://www.promusa.org/BAPNET
[19] http://www.ediblearoids.org
[20] http://www.pacificdisaster.net/pdnadmin/data/original/PIFS_2008_T

	initiatives being promoted in: sustainable development, fisheries, forestry, coastal waters, waste management, energy, freshwater management, biodiversity and climate change.
The Framework for Nature Conservation and Protected Areas in the Pacific Islands region, 2014-2020[21]	The Framework will provide guidance for the region on key priorities for biodiversity conservation and ecosystem management with clear linkages to NBSAPs and the Aichi Biodiversity targets. Strategic goal C is 'to improve the status of biodiversity by safeguarding ecosystems, species and diversity
Pacific Islands Regional Marine Species Programme 2013-2017[22]	A regional strategy for cooperative conservation and management of dugongs, marine turtles, whales and dolphins in the Pacific Region. Other marine species of conservation concern will be added as the need arise.
A New Song for Coastal Fisheries: Pathways to Change[23]	In March 2015, regional Pacific stakeholders and Governments engaged in collaborative planning to establish a new direction in the management of Coastal Fisheries. A New Song for Coastal Fisheries: Pathways to Change calls for a "...new and innovative approach to dealing with declines in coastal fisheries resources and related ecosystems". The paper makes five recommendations designed to strengthen community-based ecosystem approaches to fisheries management (CEAFM) across the region by adopting a capacity development approach as an integrated strategy, to develop capacity in CEAFM in information, management, monitoring and enforcement functions, from community to national government.
Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action (PIROP)[24]	The Pacific Islands Regional Ocean Policy is a policy for all the islands of the Pacific: it has been adopted by the leaders of all Pacific Island countries through the Pacific Islands Forum and is additionally supported by all Pacific Island territories. The Policy underscores the continuing importance of ocean and coastal resources and environments to the region's nations, communities and individuals. Central to the policy is the belief that ocean, coastal and island ecosystems contain high biological diversity that has sustained the lives of Pacific Island communities since first settlement and that it is vital to reduce the negative impacts of human activities and implement measures that protect and conserve biodiversity. It is important that biodiversity protection be pursued in a way that is compatible with community control of resources, and not unduly restrictive of social and economic development, particularly at the community level
Regional Strategic Plan on the Conservation, Management and Sustainable Utilization of Forests and Trees Genetic Resources in the Pacific[25]	Regional Strategic Plan on the Conservation, Management and Sustainable Utilization of Forests and Trees Genetic Resources in the Pacific approved in 2008 by Ministers and Heads of Agriculture and Forestry - serves as the framework for planning and implementing the conservation, management and sustainable use of forest and tree genetic resources with the PICT. One major recommendation from that Regional Strategy and Action Plan is the establishment of the regional tree seed center
Pacific Ridge-to-Reef Program[26]	Goal of the programme is to maintain and enhance Pacific Island countries' ecosystem goods and services (provisioning, regulating, supporting and
Pacific Regional Action Plan on Sustainable Water Management[27]	One of the three key messages is: Implement strategies to improve the management of water resources, and surface and groundwater catchments (watersheds) for the benefit of all sectors including local communities, development interests, and the environment.

4.2 Needs and priorities

There is a need to utilize these international programs to enhance international and regional collaboration focusing on capacity building for national scientists and technicians in area of plant and animal breeding and genetic molecular level studies such as DNA-finger printing, barcoding, cryopreservation and tissue culture.

[21] Same source as footnote 14
[22] https://www.sprep.org/papcific-silands-regional-marine-species-program
[23] http://www.spc.int/coastalfisheries
[24] http://forumsec.org/resources/uploads/attachments/documents
[25] http://www.fao.org/forestry/27929
[26] Source same as footnote 8
[27] http://www.pacificwater.org/userfiles/Pacific

V. Synthesis of needs and priorities[28]

The possible needs and priorities and actions to be undertaken are presented in Table 8. The common needs and priorities issues are summarized below:

1) There is lack of information system for the collection of baseline information and periodic data on the conservation of biodiversity, associated biodiversity and wild food species for food and agriculture under different production systems. Hence, there is also lack of proper assessment and monitoring system.

2) Sustainable use of biodiversity for food and agriculture is limited by poor capacity in manpower and finance to conduct and support suitable R&D work for the generation and promotion of suitable diversity based farming practices to maintain biodiversity. Hence, there is still insufficient knowledge about appropriate biodiversity based practices and technologies and their performance under different production systems and environmental conditions.

3) There is insufficient knowledge on associated biodiversity species and their potential with regard to the provision of ecosystem services to maintain and sustain biodiversity under different production systems. Furthermore, there is also lack of information on suitable conservation strategies and methods for associated biodiversity species. Hence, there is a need for more R&D work on these areas to ensure that suitable associated biodiversity species are identified, utilize and properly conserved to maintain and sustain biodiversity for food and agriculture.

4) There is a need to obtain more knowledge about conservation strategies and methods under ex situ and in situ conditions for both conventional species and associated biodiversity species but particularly for the latter due to little or no information at all. More information is required for the performance of ex situ and ex situ methods under different production systems and ecological conditions to ensure that appropriate conservation strategies and methods are utilize and local capacity building measures are also undertaken to implement and sustain the conservation efforts.

5) Formal access and exchange of genetic resources, its uses and recognition of farmer rights at national level is stalled by lack of national legislation to activate the provisions of access and exchange of genetic resources stipulated in the international conventions of CBD and ITPGRFA. Hence, there is a need to set up or align relevant existing national legislation with these international conventions.

6) Individual organizations of agriculture, forestry, fisheries, environment and climate change have their own specific policies on biodiversity and genetic resources. Hence, there is poor coordination and management of policies amongst the organizations. There is a need to have a unified overarching national policy on biodiversity and genetic resources to integrate the same sectoral policies of these organizations. The unified policy would also have a cross-sectoral management system to ensure that the implementation of the policy is properly managed and coordinated.

7) There is poor capacity to undertake R&D work on conservation of biodiversity, associate biodiversity and wild food species. Hence, there is need to train scientist and technicians to undertake R&D in areas of tissue culture, DNA finger printing,

[28] Additional information on needs and priorities provided in Table 8, were obtained from the informal Regional Consultation on the State of the Pacific Region's Biodiversity for Food and Agriculture, Nadi, Fiji, 3-5 March 2016.

barcoding and field collection and characterization of genetic materials. The capacity can also be enhanced through regional and international cooperation.

Table 8. List of the country's needs and priorities, and possible actions to be undertaken, to conserve and use biodiversity for food and agriculture.

Priority Areas	Needs and Priorities	Possible actions to be undertaken
1. Assessment and Monitoring	Due to lack of baseline information on the status of biodiversity and genetic resources on the main biodiversity, associated biodiversity and wild foods, there is very little information available on the status and extend of changes affecting biodiversity. Hence, there is a need to do a comprehensive field survey to collect this information, which can be used for future assessment and monitoring.	Conduct field survey
	There is a need to develop an information system for the baseline and other relevant information.	Develop an information system
	Development of knowledge management systems. to standardize data collection and monitoring methods, document existing datasets and establish and improve data storage and access.	Standardize data collection and monitoring methods, document existing datasets and establish and improve data storage and access.
	Conduct research on the role of biodiversity, associated biodiversity and ecosystem services on food and agriculture.	-Strengthen capacity for funding and research -Identify at national and regional levels priority species and their ecosystem use and services. -Enhance collaboration between international and regional research organizations including national focal points and stakeholders.
2.1 Sustainable Use	The use of management and diversity based farming practices to promote sustainable use and maintenance of biodiversity is limited by poor capacity in local manpower and finance to support the necessary R&D work. Research scientist and technicians need to be trained in plant and animal breeding and proper facilities for genetic research need to be established.	Conduct suitable training for scientist and technicians and establish proper R&D facilities
	There is need for the custodians of germplasm collections to put highest priority to the management and upkeep of ex situ collections to avoid losing varieties and	Provide funding support for management and maintenance of germplasms collections

	accessions. Crop varieties are being lost on Research stations because of lack of funding to manage and maintain the collections.	
	There is a need to develop suitable biosecurity protocols to facilitate the imports of genetic materials from other countries to broaden genetic base.	Develop bilateral/multilateral biosecurity protocols
	Identification of associated biodiversity found within different production systems.	Study associated biodiversity which will require collaboration at international, regional, and national levels to facilitate information sharing and research
	Better technical and field knowledge on management practices and diversity-based interventions that support sustainable use of biodiversity for food and agriculture	Collate and disseminate information and knowledge on the various practices and interventions and provide training for farmers, fishers, etc.
	Better knowledge on how management practices and diversity-based interventions influence biodiversity for food and agriculture.	Study impact of specific management practices on biodiversity in different agricultural systems and at different locations and disseminate information to all relevant organizations
	Use of traditional knowledge supporting the sustainable use of biodiversity in food and agriculture.	Promote the use of traditional knowledge through documentation and sharing of the knowledge between countries
2.2 Conservation	There is lack of information on in situ and ex situ strategies and methods for associated biodiversity and wild foods for food and agriculture. Hence, there is a need to do more R &D work on this subject.	Invest and conduct R&D work on associated biodiversity and wild foods in situ and ex situ conservation methods.
	There is a need to carry out field collections and genetic studies of wild foods and associate biodiversity species useful for food and agriculture. This should lead also to the creation of an information system for the same.	Conduct field collections of associate biodiversity and wild food species useful for food and agriculture
	There is need to develop capacity (skills, competencies of personnel; facilities including tissue-culture, herbarium, cryopreservation, DNA-fingerprinting and barcoding; information systems)	Conduct post graduate advance training.
	Better knowledge on the linkage between production, conservation	Explore opportunities for using native species to strengthen

	and ecosystem services	ecosystem service and biodiversity for food and agriculture
	Understanding of how ecosystem approaches can contribute to the conservation of biodiversity for food and agriculture	Evaluate ecosystem approaches and engage existing projects to contribute to information pool
	Access to information on the sustainable conservation of biodiversity for food and agriculture	Develop/adapt knowledge management systems at national and regional levels
	Better knowledge on conservation techniques (*in situ* and *ex situ*) with emphasis on *in situ* BFA	Collate knowledge on both *in situ* and *ex situ* conservation practices, and address capacity needs Conduct community training and awareness-raising regarding value of biodiversity for food and agriculture
	Develop appropriate conservation strategies	Develop a rational conservation strategy for BFA addressing resource constraints, in particular funding and capacity of existing facilities Strengthen conservation capacity of the Pacific genebanks (e.g. SPC CePaCT)
	Policy support for the conservation of biodiversity for food and agriculture	Review existing policies, including their implementation, as to their coverage of and possible (negative or positive) impact on conservation of biodiversity for food and agriculture
2.3 Access and Exchange	There is a need to align national laws and regulations to the provisions of CBD and ITPGRFA focusing on local farmers access, exchange and sharing of genetic resources and its use and management, farmer rights, IP etc.	Formulate local policies on access and exchange of genetic materials
	PNG need to sign and ratify the Nagoya Protocol that governs access benefit sharing of Biodiversity.	Advise suitable Ministries to sign and ratify the Nagoya Protocol
3.1 Policies, Programs and Institutions	There is a need to develop an overarching national biodiversity and genetic resource policy, which should link with agriculture, forestry, fisheries, environment and climate change policies on biodiversity and genetic resources. This national policy should also establish the management, implementation and coordination mechanism of the policy.	Formulate an overarching National Biodiversity and Genetic Resource Policy
	Since biodiversity and genetic resources play a vital role in food and agriculture, there is a need to consider formulating a specialized biodiversity and genetic resource policy food and agriculture. This policy will be inclusive and will	Formulate a specialize policy on biodiversity and genetic resource for food and agriculture.

	capture important international and national issues that affect biodiversity and genetic resources for food and agriculture.	
	There is a need to review existing policies and their impacts on sustainable use of biodiversity for food and agriculture.	Review existing policies, including their implementation, as to their coverage of and possible (negative or positive) impact on sustainable use of biodiversity for food and agriculture
	There is a need to strengthen capacity and engage relevant stakeholders for implementation of existing policies.	-Strengthen capacity at the national and local level to implement policies -Engage and empower communities in the development and implementation of relevant policies
3.2 Capacity (Training & Education Priorities & Needs)	Training of scientist and technicians on the principles of plant and animal breeding and field genetic diversity studies.	Conduct training
	Advance training for scientist on molecular level genetics in areas of DNA finger printing, barcoding, tissue culture etc.	Conduct training
	Advance training for technicians on in situ and ex situ conservation methods, characterization of genetic materials and data collection.	Conduct training
Capacity (Research Priorities & Needs)	Involvement of a wide range of stakeholders in research on biodiversity for food and agriculture	Involve all relevant stakeholders in project design/planning, implementation, monitoring and reporting
	Regional and international cooperation on research	Regional conference on BFA supported by regional and international organizations
4. Regional and International Cooperation	There is a need to utilize these international programs to enhance capacity building for national scientists and technicians in area of plant and animal breeding and genetic molecular level studies such as DNA-finger printing, barcoding, cryopreservation and tissue culture.	Liaise with international organizations to conduct training for local scientist and technicians through work attachments or post graduate research studies.
	Enhanced regional and international collaboration	Improve coordinating mechanism(s) between regional agencies Establish systems for sharing knowledge and resources amongst the agencies Consider establishing a regional coordination post, possibly based in FAO

VI. Conclusions and Way forward

PNG is one of the few places in the world that is rich in biodiversity for food and agriculture. However, the status of biodiversity is not fully known due to lack of formal information system to assess and monitor the current situation and the changes that is affecting the biodiversity.

Biodiversity in PNG is threatened by the destruction of habitats cause by industrial logging and large scale commercial agriculture; climate change, pollution; over-harvesting; over-fishing; use of destructive fishing methods and commercial interest of focusing on a narrow range of genetic diversity. Genetic erosion is also occurring on ex situ due to limited resources to manage and maintain field germplasm collections.

Although there are sectoral policies of biodiversity in place, these policies are disjointed, uncoordinated and not properly implemented and monitored. Hence, there is a need to formulate a unified national overarching policy on biodiversity that will integrate the policies of relevant sectors such as agriculture, forestry, fisheries, environment and climate change. These will ensure that the policy will have shared vision, objectives and goals and will also have a common cross sectoral management system to properly coordinate the implementation and monitoring of the policy.

In moving forward, there is a need for the following:

(i) There is need for an overarching national policy conservation of biodiversity that would unify the same policies of relevant sectors such as agriculture, forestry, fisheries, environment and climate change.

(ii) There is a need to establish a formal information system for biodiversity, associated biodiversity and wild foods.

(iii) There is a need to align the provisions of CBD and ITPGRFA with national legislation, policies and plans.

(iv) PNG is yet to sign and ratify the Nagoya Protocol. It need to do this to support and strengthen the CBD and ITPGRFA.

(v) There is a need to invest in capacity building for local human resources to enhance their capability to undertake policy formulation, collection of information, monitoring and evaluation and R&D work on biodiversity for food and agriculture.

VII. References

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