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PACIFIC REGIONAL SYNTHESIS FOR

THE STATE OF THE WORLD'S BIODIVERSITY FOR FOOD AND AGRICULTURE

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Foreword

One of the priority areas of FAO's Subregional Office for the Pacific Islands is that "sustainable and climate-smart practices [are] promoted to help build resilient agriculture, fisheries and forestry production systems." As shown in FAO's report on *The State of the World's Biodiversity for Food and Agriculture*, biodiversity plays an important role in increasing the sustainability and resilience of production systems, while improving food security and nutrition, contributing to livelihoods and providing multiple other benefits and ecosystem services.

The synthesis report for the Pacific region draws on reports submitted by ten countries to describe how climate change, economic and market influences, invasive alien species, land-use change, overexploitation and other drivers are affecting the genetic resources, species and ecosystems on which production systems in the region depend. It provides compelling examples from the region of how biodiverse systems can be more productive and more resilient physically and economically when faced with many of the challenges associated with these drivers.

Pacific islands are particularly vulnerable to the loss of marine biodiversity, as fisheries play a much larger role in their economies than in those of most other regions and countries and are a cornerstone of the region's food security. Many biodiversity-friendly management practices built on ecosystem approaches to fisheries and aquaculture, organic agriculture and diversification are increasingly being adopted in the region. Initiatives such as the Global Environment Facility-funded ridge-to-reef projects that have been implemented in 14 Pacific Island countries create opportunities to better integrate the activities of the environment, agriculture, forest, fisheries and aquaculture sectors to improve the conservation and sustainable use of biodiversity for food and agriculture.

While sufficient information is available to confirm that biodiversity is declining in the region, that the region's production systems face many threats and that biodiversity-friendly practices are gaining traction, country reports indicate that many knowledge gaps still need to be addressed. Other needs and priorities identified range from increasing the awareness of all stakeholders to improving cross-sectoral collaboration in the management of biodiversity for food and agriculture.

There is an urgent need to build on the information that has been gathered in this process and intensify efforts to promote the sustainable use and conservation of biodiversity for food and agriculture in the Pacific, including by strengthening collaboration at regional level.

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[1] National Focal Points at the time of preparation and submission of the country reports. For an up-to-date list of National Focal Points for Biodiversity for Food and Agriculture, please consult: http://www.fao.org/cgrfa/overview/nfp/nfp-bfa/en/

About this report

BACKGROUND

This report summarizes the state of biodiversity for food and agriculture in the Pacific region based on the information provided in country reports submitted to FAO as part of the reporting process for the forthcoming report on *The State of the World's Biodiversity for Food and Agriculture*. A first draft, based on six country reports, was prepared as supporting documentation for an informal regional consultation on the state of the Pacific region's biodiversity for food and agriculture held in Nadi, Fiji, 3 to 5 May 2016. The document was later revised based on feedback received from the participants of the informal consultation and on additional country reports (four) and country-report updates received by FAO before September 2016. During the informal consultation, participants also discussed regional needs, priorities and possible actions for the conservation and sustainable use of biodiversity for food and agriculture.[1]

SCOPE

The report addresses the biodiversity for food and agriculture (see working definition below) found in plant, animal, aquatic and forest production systems and the ecosystem services associated with them. It focuses particularly on associated biodiversity (see working definition below) and on species that are sources of wild foods.

WORKING DEFINITIONS

The working definitions of biodiversity for food and agriculture and associated biodiversity used for the purposes of this report (and in the country-reporting process for *The State of the World's Biodiversity for Food and Agriculture*) are described, along with other key concepts, in FAO (2019).

Biodiversity for food and agriculture

Biodiversity for food and agriculture includes the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the ecosystem structures, functions and processes in and around production systems, and that provide food and non-food agricultural products and services. Production systems, as defined for the purposes of this report, include the livestock, crop, fisheries and aquaculture and forest sectors. The diversity found in and around production systems has been managed or influenced by farmers, pastoralists, forest dwellers and fisherfolk over many hundreds of generations and reflects the diversity of both human activities and natural processes. Biodiversity for food and agriculture also encompasses the wild foods of plant, animal and other origin.

Associated biodiversity

Associated biodiversity comprises those species of importance to ecosystem function, for example, through pollination, control of plant, animal and aquatic pests, soil formation and health, water provision and quality, etc., including *inter alia*:

a) micro-organisms (including bacteria, viruses and protists) and fungi in and around production systems of importance to use and production such as mycorrhizal fungi, soil microbes, planktonic microbes and rumen microbes;
b) invertebrates, including insects, spiders, worms, and all other invertebrates that are of importance to crop, animal, fish and forest production in different ways, including as decomposers, pests, pollinators and predators, in and around production systems;

[1] See Annex 2 of *Report of the Informal Regional Consultation on the State of the Near East's and North Africa's Biodiversity for Food and Agriculture* (CGRFA-16/17/Inf.11.5) (FAO, 2016).

c) vertebrates, including amphibians, reptiles, and wild (non-domesticated) birds and mammals, including wild relatives, of importance to crop, animal, fish and forest production as pests, predators, pollinators or in other ways, in and around production systems;
d) wild and cultivated terrestrial and aquatic plants other than crops and crop wild relatives, in and around production areas such as hedge plants, weeds and species present in riparian corridors, rivers, lakes and coastal marine waters that contribute indirectly to production.

Domesticated species may also provide ecosystem services other than provisioning ones and affect crop, animal, fish and forest production in different ways.

Executive summary

WHAT IS BIODIVERSITY FOR FOOD AND AGRICULTURE?

"Biodiversity is the variety of life at genetic, species and ecosystem levels. Biodiversity for food and agriculture (BFA) is, in turn, the subset of biodiversity that contributes in one way or another to agriculture and food production. It includes the domesticated plants and animals raised in crop, livestock, forest and aquaculture systems, harvested forest and aquatic species, the wild relatives of domesticated species, other wild species harvested for food and other products, and what is known as 'associated biodiversity', the vast range of organisms that live in and around food and agricultural production systems, sustaining them and contributing to their output [such as natural enemies of pests, pollinators, soil micro-organisms]. Agriculture is taken here to include crop and livestock production, forestry, fisheries and aquaculture" (FAO, 2019).

ABOUT THIS REPORT

This report summarizes the state of biodiversity for food and agriculture in the Pacific region based on the information provided in country reports submitted to FAO as part of the reporting process for *The State of the World's Biodiversity for Food and Agriculture*. The document was prepared as supporting documentation for an informal regional consultation on the state of the Pacific region's biodiversity for food and agriculture held in Nadi, Fiji, 3 to 5 May 2016.

SUMMARY

All countries in the Pacific region that are members of FAO[1] were invited to submit country reports as contributions to the preparation of the report on *The State of the World's Biodiversity for Food and Agriculture*. The Cook Islands submitted a full country report. Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands and Tonga submitted brief reports.

Excluding Australia and New Zealand (which account for 93.77 percent of the region's total land area), the countries of the Pacific region comprise a diverse range of small islands spread across the world's largest ocean. They support many diverse ecosystems and a high level of biodiversity. The richest and most varied biodiversity tends to be found on high volcanic islands, where there are larger ecosystems and a greater range of habitats. However, the isolation of low-lying islands has often resulted in intense speciation and given rise to levels of endemism that are unique globally.

The area of the western Pacific known as the Coral Triangle has the most extensive coral-reef system and the highest marine diversity in the world. This area, which covers less than 2 percent of the world's oceans, accounts for 76 percent of the world's corals and 37 percent of the world's coral-reef fish species. Two of the region's countries – Papua New Guinea and Solomon Islands – lie within the Coral Triangle.

Papua New Guinea accounts for 5 percent of the world's diversity of animal and plant species, two-thirds of which are endemic. In contrast, Kiribati, a country of 33 atoll islands spanning 3.6 million km^2 of the equatorial central Pacific Ocean, has very poor terrestrial resources but very rich marine resources.

Fisheries play a much larger role in the economies of Pacific Island countries than in those of most other regions and countries and are a cornerstone of the region's food security.

The monitoring of biodiversity for food and agriculture (BFA) in the region is constrained by a lack of resources. Baseline data for many components of BFA have never been collected.

A number of drivers of change and threats to BFA, including associated biodiversity and wild foods, can be identified. Negative pressures exerted by these drivers have, on the whole, increased in recent decades.

[1] Australia, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.

The population of the Pacific region grew from 6 million people in 1990 to approximately 10 million people in 2011, equating to an average annual growth rate of 3.3 percent.[2] On the smaller islands, the majority of the population is often located in coastal areas. As a result of this, coastal habitats and species face ongoing pressures from land-based pollution, exploitation and other stresses. These pressures are further compounded by the effects of climate change and climate variability. The population in many urban areas is increasing at twice the national growth rates, which both increases the scale and concentrates the effects of population growth in these areas. Population growth triggers a number of other drivers of change and threats, including overharvesting of resources (wild foods are particularly at risk and fuelwood harvesting is a major threat to forest and mangrove diversity), insensitive land use associated with residential and (often) touristic development, and pollution (e.g. sediment loading caused by coastal development).

In many countries, the need to produce food for an increasing population has led to reductions in fallow periods and to the use of increasingly steep land (>20 percent slope) for farming. These changes have in turn resulted in a decline in beneficial soil micro-organisms and soil fertility. Urbanization can influence lifestyle aspirations and mean that traditional practices and cultural connections to the land lose their attractiveness. Urbanization also tends to increase reliance on imported foods, which gives rise to a degree of indifference to the land and the biodiversity it supports.

Climate change is threatening the strategic reservoir of genetic resources that can be drawn on and bred from to support climate change adaptation. The recent El Niño has had a devastating effect on agricultural production in many of the region's countries and may have affected the future viability of some varieties. In the Cook Islands, taro was traditionally grown in wetland conditions but now has to be cultivated in raised beds linked to water channels. Countries have reported changes in fruiting patterns of breadfruit, mango and *Citrus* spp. Among the region's forest systems, mangroves and coastal forests are projected to be the most affected by climate change. It is predicted that montane- and cloud-forest ecosystems will contract and that their distributions will shift, moving upslope where this is possible. Damage to montane forests caused by climate change will affect water catchments and harm the region's biodiversity. The threat to associated biodiversity and ecosystem services from invasive species can be exacerbated by changing climate and climatic extremes. For example, cyclone damage can open forest to invasive species, especially climbing weeds such as *Meremia peltata* and *Epipremnum pinnatum*.

Economic and market influences are very strong drivers of change. The pressure to meet market demand has encouraged less sustainable agricultural practices, with subsequent impacts on BFA. People are increasingly collecting or harvesting resources for monetary income rather than solely for local subsistence uses. Mining activities are particularly destructive for ecosystem health and associated biodiversity – the total loss of native forests in Nauru is clear evidence of the impact of uncontrolled mining. Heavy overexploitation of timber resources has caused severe forest degradation in the region, resulting in the loss of native tree species and the biodiversity they support. Siltation caused by logging threatens traditional marine fisheries.

Wild foods are extremely important in the region and make a significant contribution to human health. Despite their importance, there is very little monitoring of their status. If a species that is used as a wild food is monitored, it is usually because of interest in it as a component of biodiversity rather than because of its role as a source of food. Across the region, associated biodiversity, wild foods and BFA as a whole are generally neglected.

Ecosystem health is commonly mentioned in policies and programmes, but mainly in relation to ecosystem services such as the supply of freshwater rather than in relation to its importance to agriculture.

Recently, there has been an increase in ridge-to-reef type projects. For example, GEF-funded ridge-to-reef projects have been implemented in 14 Pacific Island countries. This creates

[2] The figures are from a report (SPREP, 2012a) covering American Samoa, the Cook Islands, the Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, the Marshall Islands, Nauru, New Caledonia, Niue, the Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna Islands.

opportunities to evaluate and monitor associated biodiversity and other components of BFA and their contributions to agriculture. However, unless cross-sectoral collaboration, particularly between the agriculture and the environment sectors, is strengthened, there is a risk that these opportunities will be neglected.

The region identified three key "needs" in terms of where efforts need to be increased in order to improve the assessment and monitoring of BFA, and in particular of associated biodiversity, wild foods and ecosystem services. Lack of human resources and technical capacity in taxonomy and data analysis was seen as the main constraint. Addressing this capacity deficit will require stronger collaboration (country–country, South–South, regional and international) to support capacity building and explore innovative approaches that can help compensate for the limited number of people available for training in the smaller islands. Baseline data on associated biodiversity are lacking. The region needs to prioritize species, production systems and ecosystem services at national and regional levels and to put in place effective knowledge-management systems for storing and sharing data. Finally, policy and institutional support for BFA need to be strengthened, including through the integration of BFA concerns into broader policy instruments and frameworks. The absence of a whole-landscape/cross-sectoral approach often means that different sectors are sending out different and conflicting messages.

Traditional food production in the region was founded on diversity – multicrop/agroforestry-based, rainfed food gardens, with cash crops often integrated into the gardens. Free-range chickens and pigs are an integral part of these traditional systems. Shifting cultivation enabled land to be left fallow for a number of years to support soil health and fertility. Expansion of cash cropping and increasing commercial production (e.g. taro in Fiji and Samoa, squash in Tonga and palm oil in Solomon Islands) have led to more-permanent occupation of land and a resulting decline in diversity-based practices. Population pressure and the drive to supply domestic and export markets have contributed to the increasing use of more intensive agricultural practices.

There is, however, increasing interest in terrestrial and marine diversity-based practices. All countries provided examples of the implementation of such practices. This trend is being fuelled by countries' concerns about environmental degradation, declining crop yields and climate change, as well as by global interest in (and therefore donor support for) ecosystem-based/landscape-level approaches.

Countries identified a number of needs and priorities with respect to the sustainable use of BFA, and associated biodiversity and wild foods in particular. Policies and strategies that support the sustainable use of BFA were identified as a key priority, and cross-sectoral collaboration was seen as crucial to ensuring that the importance of BFA in all sectors is acknowledged. Increased awareness and education for all stakeholders, including decision-makers, researchers, producers and consumers, were also identified as key means of improving understanding of the multifunctionality of agriculture and the interconnectedness of biodiversity, ecosystem functioning and human health. The benefits of diversity-based practices need to be more clearly defined, including by (a) identifying associated biodiversity found within the various production systems, (b) improving knowledge of how management practices and diversity-based interventions influence BFA and (c) improving technical/field knowledge of management practices and diversity-based interventions that contribute to the sustainable use of BFA.

In situ conservation in the region mainly takes the form of protected areas – especially in the case of marine resources. At least 7.5 million people (about 50 percent of the total population) live in coastal areas within 30 km of a coral reef. Mangroves are a vital resource for a wide range of associated biodiversity and wild foods. They play a role in supporting the supply of seafood, protecting coastlines and coastal developments from hazards, improving water quality and providing natural materials used in traditional practices (e.g. dye from mangrove bark used in tapa and to treat textiles, nets and fish traps). Communities have seen significant improvements in fish stocks as a result of the establishment of protected areas. However, monitoring of protected areas and tracking of species are often limited because of resource constraints.

The only examples of *ex situ* conservation of associated biodiversity in the reporting countries are the maintenance of herbarium samples in Papua New Guinea and Solomon Islands. Some of the region's larger countries maintain field genebanks that conserve accessions of important staple food crops such as taro, banana and yam. The Pacific Community Centre for Pacific Crops and Trees (SPC CePaCT) can support Pacific Community member countries in conserving agricultural biodiversity and has established significant collections of the staple food crops of the Pacific.

All countries agreed that needs and priorities with regard to the conservation of BFA, and in particular associated biodiversity and wild food species, are similar to those identified for sustainable use, and that conservation should ideally be linked to use. Identifying conservation needs requires improved monitoring and data gathering. Many countries do not have the necessary skills, let alone the funding to support surveys. Financial resources and taxonomic expertise are therefore priorities. Improving the latter requires capacity building and/or the sharing of skills across the region. Knowledge-management systems need to be put in place so that data and information can be easily accessed and shared.

Knowledge of the links between production, conservation and ecosystem services needs to be widely disseminated. Improving access to information on the sustainable use and conservation of BFA is a priority. For associated biodiversity, and to some extent wild food species, countries agreed that the main priority is to increase awareness among all stakeholders/actors regarding the importance of these components of biodiversity and their contributions to food security and agriculture and therefore to health. Ridge-to-reef, landscape and ecosystem approaches would help to raise awareness through community involvement and at the same time promote conservation and livelihood approaches that support sustainable use and reduce pressures on threatened resources. They would also contribute to capacity building at all levels.

Seven of the reporting countries are Contracting Parties to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), but only three are Parties to the Nagoya Protocol. Countries need capacity building to support accession to both these international conventions. Furthermore, there is a need to integrate the provisions of the Convention on Biological Diversity (CBD) and the ITPGRFA into national policies and plans, supported by suitable legal frameworks, to address local farmers' access to and exchange and sharing of genetic resources, use and management of these resources, farmers' rights, intellectual property, etc.

Across the region, a wide range of policies and programmes has been put in place to support the conservation and sustainable use of BFA. However, the extent to which they address associated biodiversity and wild food is very limited. Some of the more recent climate-change policies and strategies focus on forestry, agriculture, water, livestock, biodiversity and natural ecosystems. Overall, however, existing policies and programmes do little to enhance the roles of BFA, in particular associated biodiversity and wild foods. The increasing popularity of ridge-to-reef projects is a positive sign, but it will be important to ensure that these projects give sufficient priority to BFA, are well targeted and are able to deliver valuable outcomes. Countries agreed on the need either for an overarching policy on BFA or for a mechanism that ensures cross-sectoral policy and programme planning and facilitates the inclusion of BFA concerns.

Training and education are priority needs for the Pacific region. There is a need to recognize the difficulties faced by the smaller islands with regard to human resources. Strengthening collaboration and partnerships – within countries, across the region and with overseas institutes – and the development of alternative approaches/mechanisms that can help to supplement capacity are essential. Capacity development/support is needed in conservation and sustainable-use technologies, including breeding and taxonomic expertise. All countries recognized the need for awareness raising among the general public, including in the school curriculum, so that the importance of BFA, and in particular associated biodiversity, and ecosystem health is recognized. At the policy level, general capacity building is needed to improve understanding of the importance of biodiversity so that its relevance to all sectors is clearly understood and can therefore be

integrated into policy development, including improvements in incentive measures to support policy implementation and compliance.

Overall, knowledge of associated biodiversity (particularly in soils), wild foods and ecosystem functioning is limited. All countries agreed that the main constraint in this field is funding and that the key to optimizing limited resources is to prioritize research needs at national and regional levels. A regional conference on BFA would help in this prioritization process. Areas of research discussed at a regional consultation included soil biodiversity, propagation of wild foods, and identification of indicators for assessment of the status of BFA and improving understanding of "how much" agricultural biodiversity adds to resilience.

Improving the integration of BFA, and in particular associated biodiversity, wild foods and ecosystem services, into regional and international initiatives requires strengthening coordination and information sharing between agencies and initiatives. At the same time, regional and international initiatives must take into account the needs of the region so as to maximize the benefits provided by any integration. Integration must therefore be supported by prioritized and targeted capacity building, innovative capacity-supplementation mechanisms, simple monitoring and evaluation systems, resource support for data gathering, recording, documentation and analysis, and effective and user-friendly knowledge-management systems.

I. Assessment and monitoring of biodiversity for food and agriculture

1.1 REGIONAL CONTEXT

All countries in the Pacific region[1] that are members of the Food and Agriculture Organization of the United Nations (FAO) were invited to submit country reports as contributions to the preparation of the report on *The State of the World's Biodiversity for Food and Agriculture*. Cook Islands submitted a full country report. Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands and Tonga submitted brief reports. Most of the information provided in this regional synthesis was sourced from these reports. Some information was also sourced from FAO's global assessments of plant, animal and forest genetic resources (FAO, 2010a 2014a, 2015a), national biodiversity strategy action plans (NBSAPs) and other relevant literature. The limited information provided on countries that did not submit country reports was obtained from these sources and other relevant documentation.

Table 1. Extent of land, water, agricultural and forest areas in Pacific countries that provided country reports

Country	Land area (1 000 ha)	Territorial waters (1 000 km²) [1]	Agricultural area (1 000 ha)	Forest area (1 000 ha)	Form
Cook Islands	24.0	31.3	1.5	15.1	Volcanic, volcanic and limestone, atoll
Fiji	1 827.4	114.5	428.0	1 000.0	Volcanic, limestone, atoll, mixed
Kiribati	81.0	75.3	34.0	12.2	Atoll, coral island, limestone
Nauru	2.0	1.9	0.4	0.0	Raised coral atoll, limestone
Niue	26.1	3.0	1.4	18.8	Raised coral atoll
Palau	46.5	14.0	0.3	44.5	Volcanic and raised limestone
Papua New Guinea	46 173.9	355.7	11 785.8	34 325.6	Volcanic, limestone, atoll, coral island
Samoa	284.0	10.0	63.0	130.0	Volcanic
Solomon Islands	2 889.6	140.0	108.0	2 092.4	Volcanic, limestone, atoll
Tonga	72.0	37.5	31.0	9.0	Limestone, volcanic, mixed
TOTAL	51 426.5	3 801.0	12 453.4	37 647.6	

[1] Territorial waters data were sourced from SPREP (2012a).
Source: Calculated from FAOSTAT data for 2014.

The countries of the Pacific region are highly diverse in terms of their land area (Table 1). Australia and New Zealand account for 93.77 percent of the total land area, and Australia alone accounts for 90.6 percent. While the Cook Islands, Nauru, Kiribati and Palau, together with Niue, Tokelau, Tuvalu and Wallis and Futuna Islands, account for less than 1 percent of the region's total population, together they have the biggest exclusive economic zone (EEZ) in the world.

The Pacific Island region is generally considered to comprise three subregions: Melanesia, Polynesia and Micronesia. The large size of the high islands of Melanesia, along with the prevailing weather conditions, has provided good opportunities for agriculture, fisheries and forestry, and thus

[1] Australia, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.

supported the expansion of human settlements. Rainfall is higher in Melanesia than in the low-lying islands further to the east. However, there are strong spatial variations in rainfall, with windward (usually eastern) slopes typically receiving more rain than the leeward (usually western) slopes. The islands of Polynesia and Micronesia vary greatly in size, but are smaller than those in Melanesia. Atolls (ring reefs formed around a completely submerged peak) are found in all three subregions. In atoll nations, such as Tuvalu and Kiribati, reef islands provide the only habitable areas.

In short, if Australia and New Zealand are excluded, the countries of the Pacific region comprise a diverse range of small islands spread across the world's largest ocean. These islands support many diverse ecosystems and a high level of biodiversity. The richest and most varied biodiversity tends to be found on high volcanic islands, where there are larger ecosystems and a greater range of habitats. However, the isolation of low-lying islands has often resulted in intense speciation and given rise to levels of endemism that are unique globally (McIntyre, 2005).

The Pacific is a centre of diversity and/or origin for a small number of crops. Generally, however, the history of human colonization in the Pacific means that the genetic diversity of the (mostly vegetatively propagated) crops of the region declines markedly from west to east. Traditionally, the Pacific Islands have depended on local staples such as roots and tubers for food and nutritional security.

Papua New Guinea accounts for 5 percent of the global diversity of animal and plant species, two-thirds of which are endemic. The number of plant species represents about 6 percent of the world's flora. Papua New Guinea has a diverse range of species and varieties of cultivated food crops, spice crops and industrial cash crops such as coffee, coconut, palm oil, sugar cane, rubber and tea. It is estimated that there are about 4 000 accessions and varieties of food crops, fruits and nuts, sugar cane, spices, coffee, cocoa, coconut, rubber and tea in Papua New Guinea (Bourke and Harwood, 2009).

Solomon Islands' natural forests are recognized as being of global significance because of their unique vegetation, tropical oceanic forest typology and extremely rich biodiversity. Most rural Solomon Islanders depend on traditional agroforests for subsistence food and livelihood needs (Government of Solomon Islands, 2011). In contrast, Kiribati, a country of 33 atoll islands[2] spanning 3.6 million km^2 of the equatorial central Pacific Ocean, has very poor terrestrial resources, but very rich marine resources (World Bank, 2012a).

Australia's biodiversity developed largely in isolation over many millions of years, making the country one of the most biologically diverse parts of the planet (Government of Australia, 2014). Between 7 and 10 percent of all the world's plant and animal species occur only in Australia (ibid.).

New Zealand's indigenous biodiversity is highly endemic and has been identified as being among the most distinctive in the world (Government of New Zealand, 2014). All the country's frogs and reptiles and over 90 percent of its insects, 80 percent of its vascular plants, 50 percent of its fungi and 25 percent of its birds do not naturally occur anywhere else (ibid.).

The area of the western Pacific known as the Coral Triangle has the most extensive coral-reef system and the highest marine diversity in the world. This area, which covers less than 2 percent of the world's oceans, accounts for 76 percent of the world's corals and 37 percent of the world's coral-reef fish species. Two of the region's countries – Papua New Guinea and Solomon Islands – lie within the Coral Triangle.

Fisheries play a much larger role in the economies of Pacific Island countries than in those of most other regions and countries and are a cornerstone of food security, with average annual consumption of fish (including shellfish) by coastal rural populations ranging from 30 to 118 kg per person in Melanesia, 62 to 115 kg per person in Micronesia and 50 to 146 kg per person in Polynesia. Fish consumption, even in urban centres, usually greatly exceeds the global average of 16 to 18 kg per person per year (Bell Johnson and Hobday, 2011). Most of the benefits that Pacific islanders obtain

[2] The islands have an average elevation of 4 m above mean sea level, while Banaba, the only raised atoll, rises to about 78 m above mean sea level

directly from fisheries (e.g. nutrition and jobs) are provided by coastal aquatic systems. These systems also provide ecosystem services to island countries and the world at large through exports, tourism and provisioning and protective functions. In most coastal communities, women play an important role in obtaining food on a daily basis through shoreline fishing and reef gleaning. They also earn family income through processing fish products and selling them in local markets.

All the Pacific Island countries are located in tropical climate zones. In the Southern Cook Islands there is a difference of 4 °C between the warmest and the coolest months – in June/July temperatures can drop to below 20 °C. In the Northern Cook Islands, as they are closer to the equator, temperatures are fairly constant throughout the year, with an average maximum around 30 °C and an average minimum of around 26 °C.

New Zealand's climate is complex, varying from warm subtropical in the far north to cool temperate in the far south, with severe alpine conditions in mountainous regions (NIWA, 2017). Because of its huge size, Australia has several different climate zones, ranging from tropical in the north to temperate in the south. A substantial proportion of the country's land area is desert or semi-arid (Weather Online, 2017).

The region contains a number of biodiversity hotspots:[3]

- The East Melanesian Islands: This hotspot lies northeast and east of New Guinea and includes the Bismarck and Admiralty Islands, the Solomon Islands and the islands of Vanuatu. Habitats in this hotspot include coastal vegetation, mangrove forests, freshwater swamp forests, lowland rainforests, seasonally dry forests and grasslands, and montane rainforests. Most of the habitats are species-poor in comparison with New Guinea, although they are rich compared to Polynesia–Micronesia, with several tree species dominating (e.g. those in the genera *Terminalia*, *Pometia*, *Agathis* and *Metrosideros*).
- New Zealand: New Zealand is linked biogeographically with New Caledonia via the undersea Norfolk Rise. Both New Zealand and New Caledonia split away from the ancient supercontinent of Gondwanaland at the same time and did not separate from each other until around 40 million years ago. Both the New Zealand and the New Caledonia hotspots are "ancient life-rafts" that have been largely isolated and have evolved unique flora and fauna.
- Polynesia–Micronesia: This hotspot includes all the islands of Micronesia and Polynesia, plus Fiji, scattered across 40 million km² of the Pacific Ocean. Included in this enormous expanse are at least 4 500 islands, representing 11 countries, eight territories, and one state of the United States of America (Hawaii). A wide range of ecosystems are found in this hotspot. There are 12 principal vegetation biomes, the most widespread of which is strand vegetation, which consists of salt-tolerant plants and is found along the shores of most Pacific islands. Other principal vegetation associations include mangroves, coastal wetlands, tropical rainforests, cloud forests, savannahs, open woodlands and shrublands.
- Southwest Australia: The forest, woodlands, shrublands and heath of Southwest Australia are characterized by high levels of endemism among plants and reptiles.

The country-reporting guidelines provided by FAO requested countries to list their production systems in accordance with the categories shown in Table 2. Countries were not familiar with the use of this classification system, which led to some confusion, especially with regard to production systems in sectors that were not the main areas of expertise of the respective national focal points. As a result, countries tended to interpret the various production system categories differently and had difficulties providing information according to the proposed classification (e.g. the extent of the areas covered by each production system). Moreover, countries generally had difficulties accessing information on some sectors. Much of the agriculture in the Pacific Island countries is at subsistence level and production areas are therefore difficult to quantify.

Traditional food production systems in the Pacific are based on agroforestry. The most common system is shifting cultivation or "slash and burn" rainfed gardens associated with

[3] http://www.cepf.net/resources/hotspots/Pages/default.aspx

Table 2. Production systems reported by countries in the Pacific region

Production system	Countries reporting
Livestock grassland-based systems	Cook Islands,[1] Fiji, Nauru, Papua New Guinea, Samoa, Solomon Islands, Tonga
Livestock intensive farming	Papua New Guinea
Livestock landless systems	Fiji, Nauru, Niue, Palau, Tonga, Samoa, Solomon Islands
Naturally regenerated forests	Fiji, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga
Planted forests	Fiji, Kiribati, Niue, Palau, Papua New Guinea, Samoa Solomon Islands, Tonga
Self-recruiting capture fisheries	Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga
Culture-based fisheries	Cook Islands, Fiji, Kiribati, Samoa, Solomon Islands
Fed aquaculture	Fiji, Kiribati, Nauru, Palau, Papua New Guinea, Solomon Islands
Non-fed aquaculture	Cook Islands, Fiji, Kiribati, Nauru, Palau, Papua New Guinea, Solomon Islands, Tonga
Irrigated crops (rice)	Fiji, Solomon Islands
Irrigated crops (non-rice)	Cook Islands, Fiji, Niue, Samoa
Rainfed crops	Cook Islands, Fiji, Nauru, Niue, Palau, Papua New Guinea, Solomon Islands, Tonga
Mixed systems (including agroforestry)	Cook Islands, Fiji, Kiribati, Nauru, Papua New Guinea, Samoa, Solomon Islands, Tonga

[1] All countries are in the tropical climatic zone with the exception of the Cook Islands, where all production systems can also be found in subtropics climate zone.
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

arboriculture of local fruit and nut species. Throughout the region, free-range chickens and pigs are an integral part of self-sufficient production. Larger commercial pig and chicken production systems are only found in Fiji and Papua New Guinea. Irrigated rice is found in a few training institutes and farming communities in Solomon Islands. Rice farming by rural communities in Solomon Islands is a recent initiative aimed at addressing the shortfall in supply caused by increasing demand for rice for local consumption (Government of Solomon Islands, 2010a). In Fiji, rice is produced mostly under schemes involving irrigation systems and well-prepared paddy fields (Fiji Ministry of Agriculture, 2016). Water is provided by large water pumps, gravity effect from dams and siphons that channel water into paddy fields. Vanuatu has a notable beef industry based on smallholder cattle farms and larger holdings. Fiji has a significant dairy and goat industry and a small sheep industry. The integration of the region's agriculture into the global economy commenced with colonization and the production of commodities such as copra, sugar, coffee and cocoa. The development of cash cropping and increasing commercial production (e.g. of taro in Fiji and Samoa, squash in Tonga and palm oil in Solomon Islands) has led to more-permanent occupation of land (Lisson *et al*., 2016; McGregor *et al*., 2016).

1.2 STATUS, TRENDS AND DRIVERS OF CHANGE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

1.2.1 Main drivers of change affecting genetic resources for food and agriculture

The region's environment spans ecosystem types ranging from montane rainforests and cloud forests, closed rainforests and open woodlands to open grass savannahs, mangrove and littoral forests, salt marshes and mudflats, freshwater lakes and streams, coastal marine ecosystems, fringing and barrier reefs and deep-ocean areas.

While there is some overlap in terms of the drivers affecting the various subsectors of food and agriculture and the various components of BFA (e.g. human-induced climate change and population growth) other drivers are more specific (e.g. targeted fisheries operations).

Animal genetic resources for food and agriculture

According to *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture* (SoW-AnGR2) (FAO, 2015a), the cattle population in the Southwest

Pacific region was 3 percent of the total global population in 2012, with the highest numbers in Australia. The region's sheep population was 9 percent of the global total, with the highest numbers in Australia and New Zealand. The number of extinct mammalian breeds reported was six (two cattle, one horse, one pig and two sheep breeds). Despite their small sizes, Pacific Island countries have some of the largest pig and chicken densities in the world. These densities reflect the importance given to livestock keeping and contribute to problems with feed supply and waste management. High livestock and human densities also increase the threat of zoonotic disease outbreaks. The lack of regional small-scale feed manufacturing plants, the high costs of imported feed and cheap poultry imports are holding back the development of the smallholder poultry sector in Pacific countries.

At the time the SoW-AnGR2 was prepared, no up-to-date information was available on the population sizes of the region's avian breeds[4] and therefore their risk statuses could not be determined. In the small Pacific Island countries this lack of population data reflects a lack of resources (funding and human capacity) for monitoring and data collection. Genetic analysis of the region's livestock populations has also been limited. From 2008 to 2011, FAO provided funding for the South West Pacific Animal Genetic Resources Inventory and DNA Characterization Pilot Project, which was implemented in Fiji, Niue, Samoa, Solomon Islands, Tonga and Vanuatu. The country reports submitted for the SoW-AngGR2 from the Southwest Pacific indicated low levels of provision and capacity in all areas of animal genetic resources (AnGR) management.

In the small island countries of the Southwest Pacific, *in situ* conservation programmes for AnGR (livestock), if they exist at all, are in their early stages of development and focus mainly on pigs and chickens. The main activities undertaken within these programmes are awareness raising, promotion of niche markets and breed-related cultural activities. In the case of pigs, there are some community-based conservation programmes.

In Australia[5] and New Zealand, most *in situ* conservation activities for AnGR are implemented by private institutions, with non-governmental organizations (NGOs) playing a key role. These countries have the region's only AnGR genebanks, which are operated by private bodies rather than by the public sector. The Rare Breeds Conservation Society of New Zealand, in collaboration with a private cryostorage facility, maintains a genetic repository at which genetic material from at-risk breeds is stored in the form of semen and embryos.[6] A similar approach is taken in Australia, where breeding organizations and civil society organizations support *ex situ* conservation. *In vitro* programmes in Australia only cover at-risk breeds with commercial potential.[7]

In New Zealand and Australia, breeding programmes focus largely on the development and improvement of a narrow range of species and breeds, with breeders' associations and livestock keepers' cooperatives playing key roles. In the small island countries of the Southwest Pacific, breeding programmes are rare. Those that exist are in their early stages of development. The very small size of many of these countries, and the associated lack of resources, constrains the development of independent breeding programmes. The few breeding programmes mentioned in the country reports[8] are government-driven. Private companies are sometimes involved, but there is little participation on the part of individual breeders. The most commonly reported activities are the importation and distribution of

[4] The analysis of status and trends presented in the SoW-AnGR2 was based on population data drawn from the Domestic Animal Diversity Information System (DAD-IS). Breeds for which no population data were available for any of the 10 years preceding 2014 were deemed to be of unknown risk status.

[5] Australia did not submit a country report as part of the SoW-AnGR2 process. However, it prepared a country report at its own initiative in 2012.

[6] http://www.rarebreeds.co.nz/

[7] Information on conservation and breeding programmes for AnGR (livestock) is drawn largely from the SoW-AnGR2.

[8] This refers to the country reports submitted for the SoW-AnGR2.

exotic breeds to replace locally adapted breeds or for cross-breeding with them; the extent of informal cross-breeding with exotic breeds has not been evaluated or quantified.

In Solomon Islands, the Livestock Strategy 2015–2020 addresses AnGR improvement, conservation and development, with a specific focus on promoting the conservation and development of existing AnGR so as to maintain fitness traits while improving production performance through formal breeding programmes. The government, through the Ministry of Agriculture and Livestock, was planning to import cattle from Vanuatu in 2016 (Saeni, 2016). Cross-bred progeny are known to be in high demand as they offer improved production while maintaining some characteristics that make them tolerant of local environmental conditions and production systems.

Drivers of change/threats to AnGR include:[9]

- Economic and market-related factors: In the island countries, imported meat tends to be cheaper than locally produced meat with regard to quantity. However, the quality of imported meat can be poor, which can negatively affect nutrition. The availability, accessibility and cost of livestock feed can be constraints to local meat production.
- Economic, livelihood or lifestyle factors: Changes in the availability of alternative employment activities outside livestock keeping, changes in the relative attractiveness of livestock keeping in economic terms and/or changes in lifestyle aspirations have diminished the appeal of livestock keeping as a livelihood.
- Climate change: Tropical breeds are better adapted to higher temperatures and less likely than high-yielding animals to suffer from heat stress. This could benefit the conservation and use of indigenous breeds. However, natural disasters such as cyclones and droughts can be very damaging for AnGR. The availability of feed and the prevalence of diseases and parasites can be affected by changes in local ecosystems brought about by climatic events.
- Pests and diseases: Limited diagnostic capacity in the smaller islands is likely to exacerbate any threat from pests and diseases. Some islands (e.g. Niue) have no qualified veterinarians. The impact that climate change will have on pests and diseases remains quite unclear.
- Competition from introduced breeds: The introduction and increased use of exotic breeds and the lack of competitiveness/poor performance of some local breeds, when yield is the main criterion used in selection, is a threat to AnGR.
- Indiscriminate cross-breeding: Indiscriminate cross-breeding is a significant threat to indigenous breeds. In some island countries (e.g. Niue) inbreeding is common because of the small-scale nature of farms and limited gene pool of the animal population.
- Lack of or weak AnGR management policies, programmes or institutions: For example, outdated animal health and production legislation and policies, and general lack of enforcement by the authorities, are significant constraints in the AnGR subsector.
- Changes in technology: Technological developments and changes in access to technologies within the livestock sector (e.g. in the fields of animal health, feeding, housing, reproduction and genetics) are influencing the management of AnGR.

According to the SoW-AnGR2, drivers related to the environment and natural resources stand out in terms of their predicted future increases in impact in the Southwest Pacific. However, in absolute terms, the scores[10] for these drivers were not particularly high relative to other regions. From relatively low levels in the past, the impacts of cultural change, technological change and policy factors were predicted to increase substantially.

[9] Information from country reports, SOW-AnGR2, *Regional report on animal genetic resources: Southwest Pacific* (FAO, 2007) and the author's personal experience.

[10] The country report questionnaire for the SoW-AnGR2 requested countries to score (none, low, medium or high) the past and predicted future impacts of various drivers of change on AnGR and their management.

Plant genetic resources for food and agriculture[11]

The Pacific Island region is a centre of diversity and/or origin for a small number of crops. In general, however, due to the history of human colonization in the region, genetic diversity in the region's (mostly vegetatively propagated) crops declines markedly from west to east. Root and tuber crops are important to food and nutritional security, income generation and cultural identity. The region is a primary centre of diversity for taro (*Colocasia esculenta*), the Pacific gene pool being separate from that found in Southeast Asia (Lebot *et al.*, 2004). Similarly, Micronesia and the atolls are a primary centre of diversity for giant swamp taro (*Cyrtosperma merkusii*). For yams, the picture is more complex; primary and secondary centres are found in the Pacific. Melanesia, for example, is the primary centre of diversity for *D. alata* (Lebot, 2009). Papua New Guinea is a secondary centre of diversity for sweet potato.

In Papua New Guinea and Solomon Islands, many other species are traditional sources of dietary carbohydrates, for example *Amorphophallus campanulatus*, *Tacca leontopetaloides*, sago (*Metroxylon sagum*, *M. bougainvillense* and *M. salomonense*), the Polynesian or Tahitian chestnut (*Inocarpus fagiferus*), *Haplolobus floribundus* and *Corynocarpus* spp. (Government of Papua New Guinea, 1996; Government of Solomon Islands, 1996). Some of these plants are still important food sources in certain areas, but they generally only provide seasonal or occasional food. Leafy vegetables are also important in Papua New Guinea and Solomon Islands – significant diversity is found in *Abelmoschus manihot* (commonly known as aibika, bele, island cabbage or slippery cabbage). In Solomon Islands, leafy vegetables sourced from ferns, climbers, shrubs and trees are often referred to as "cabbage".

Papua New Guinea is a primary centre of diversity for banana. It is home to ten wild-banana species, of which one (*Musa ingens*) is only found in the country. Unique to the Pacific are the Iholena and Maoli-Popo'ulu bananas (the Pacific plantains). The fe'i bananas, belonging to the Australimusa section, are important in the Pacific, particularly in French Polynesia, but significant diversity is found in Solomon Islands (FAO, 2010b).

The Pacific is a primary centre of diversity for breadfruit (*Artocarpus* spp.). Genetic diversity is greatest within cultivars from Melanesia and Micronesia, which are mostly seeded, out-crossing, fertile diploids or hybrids. In contrast, those from Polynesia represent a much narrower genetic base and sterile triploids predominate (Ragone, 2007). The Pacific is also a primary centre of diversity for coconut.

Melanesian countries are rich in fruit-tree and nut-tree diversity. Many of these are multipurpose trees for which people consider other uses more important than the provision of edible fruit. There are minor fruits and berries that are occasionally gathered and others that are eaten in times of scarcity. Multipurpose trees are favoured in traditional agroforestry systems because of their ability to provide many different products, improve overall yield on a piece of land, increase economic security and (due to the relatively permanent nature of trees) improve agricultural sustainability.

There are reports of losses of traditional crop varieties. Importation of "improved" crop varieties can threaten the existence of often lower-yielding, but probably more resilient, landraces. Policies and programmes supporting production for export may favour the cultivation of one or maybe two varieties. Island surveys and community appraisal studies of biodiversity in Kiribati reported declining trends in the subspecies of important traditional food plants such as breadfruit, pandanus, giant swamp taro, native fig and coconut. Tonga reported a decline in the diversity of fruit trees as a result of increased competition for land, especially for commercial farming, and a rise in the population. In Papua New Guinea, logging, mining and intensive agriculture activities also threaten the survival of traditional crop varieties.

[11] Unless otherwise indicated, information sourced from country reports, *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture* (FAO, 2010a) and the author's personal experience.

Conservation and use of plant genetic resources for food and agriculture (PGRFA) across the region is often constrained by a lack of resources – funding and human capacity. The larger countries, such as Papua New Guinea, have prioritized PGRFA. This is partly a reflection of the significant diversity found within their borders. *Ex situ* collections are maintained and breeding and evaluation programmes supported. However, resource constraints mean that these programmes are limited in terms of what they can achieve. The smaller countries are served by the regional genebank, the Centre for Pacific Crops and Trees (CePaCT), hosted by the Pacific Community (SPC) in Suva, Fiji. CePaCT has made good progress since it began in 1998 as the Regional Germplasm Centre. It holds significant collections of the region's important crops, in particular taro and other edible aroids. Through CePaCT, the region can easily access PGRFA from elsewhere in the world, in particular from the International Agriculture Research Centres (IARCs). CePaCT has signed Article 15 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

Almost all plant-based agricultural commodities in Australia come from exotic species. A notable exception is the macadamia nut (*Macadamia integrifolia* and *M. tetraphylla*). The use of exotic plants in Australian agriculture started in the late 1780s, when Europeans first settled in Australia. Endemic Australian plants are used in niche food industries (bush foods) and native grasses are sometimes planted as pastures or grazed in extensive livestock operations as part of the natural flora. However, it is exotic plant species that provide the majority of food consumed domestically and exported (Stoutjesdijk, 2013).

A number of native species in Australia are closely related to important agricultural species, including those listed in Annex 1 of the ITPGRFA. For example, one species of *Ipomoea* (*I. polpha* subsp. *latzii*), known as the giant sweet potato, is considered rare and used as a food source by indigenous Australians. The majority of native Australian species relevant to food and agriculture are not threatened and are not the subject of specialized conservation efforts. Should *in situ* conservation be required, both state and national legislation allows for the declaration of threatened (or similar) species status, which gives legislative authority to conservation measures. *Ex situ* conservation is organized and coordinated through a network of plant genetic resource centres (PGRCs), with the focus on grains and forages (Stoutjesdijk, 2013). Australia is a partner in the Millennium Seed Bank Partnership and has established its own Australian Seed Bank Partnership, which involves 14 organizations across the country. The Australian Seed Bank Partnership, through the Atlas of Living Australia, has created an online seed hub[12] with information on the conservation of native-seed accessions in Australia.

New Zealand's indigenous plant flora consists of a fairly small number of species relative to its land area by world standards. However, it includes a high proportion of endemic species. At least 85 percent of the approximately 2 300 indigenous vascular plant species are endemic. There are also considerable numbers of endemic species among the approximately 1 200 indigenous species of mosses, liverworts and hornworts and over 4 000 species of algae. For example, 43 percent of seaweed species are endemic. There are an estimated 3 000 to 4 000 substantial collections of exotic species. Almost 90 percent of these collections contain over 100 different types of organisms and 44 percent have over 1 000 types of organisms.

Drivers of change/threats to PGRFA include:

- Lack of sustainable resources: Monitoring of PGRFA diversity, conservation and use are significantly constrained by limited and unreliable funding and a lack of human capacity and facilities.
- Poor knowledge management: Poor knowledge management is linked to a lack of resources, but the absence of user-friendly and harmonized systems at national and regional levels for recording data adds to the challenges. Poor feedback from PGRFA users is a significant constraint to improving the use of PGRFA.

[12] http://asbp.ala.org.au

- Climate change: Extreme weather events (drought, flooding and cyclones) and longer-term climate variability are and will continue to be a threat to PGRFA.
- Market preferences: The availability of varieties of crops with high market values may lead farmers to opt for these varieties instead of less marketable ones, which may be landraces. Agricultural policies supporting commercial production for export are likely to favour a small number of varieties and more intensive, less environmentally friendly practices.
- Invasive alien species, including pest and disease organisms: Taro leaf blight in Samoa wiped out all the local taro varieties in the country. Climate change is likely to exacerbate the threat from pests and diseases – countries in the Pacific that are currently free from taro leaf blight could be at risk in the future given projected increases in temperature and rainfall.
- Land-use changes: Genetic erosion of PGRFA can be caused by various land-use changes, including the establishment of palm-oil plantations and tourist developments.
- Lack of youth involvement in agriculture: There is a general lack of interest on the part of the younger generation in agricultural activities, compounded by migration of youth from rural to urban areas. Data show high rates of adolescent and youth migration from countries such as the Cook Islands, Samoa and Tonga (UNICEF, 2014).
- Consumer preferences: Changes in lifestyles in the Pacific have been accompanied by a change in eating habits and diet. Rice and flour have now replaced root crops as the most important sources of starch and energy. Despite their poor nutritional value, their cost and convenience make them popular purchases. Limited agroprocessing facilities are a constraint to improving the convenience and ease of use of staple food crops.
- Lack of national strategies or action plans: Lack of appropriate policies, programmes, etc. specifically targeting the management of PGRFA diversity negatively affects the conservation and use of these resources. Even where instruments exist, they can be poorly implemented, which is often linked to a lack of resources. Poorly integrated policies can create conflicts, often to the detriment of PGRFA.
- Poor or ineffective planting material networks (PMNs) can also lead to genetic erosion: Effective PMNs can be useful not only in ensuring a reliable flow of PGRFA to farmers, but also in facilitating the sharing of farmers' varieties and the monitoring of PGRFA in farmers' fields.

Forest genetic resources[13]

The report on *The State of the World's Forest Genetic Resources* (SoW-FGR) (FAO, 2014a) indicates that *ex situ* conservation activities have been conducted for about 60 species in the countries of Oceania that submitted reports: Australia, Cook Islands, Fiji, France (represented by three territories – French Polynesia, New Caledonia and Wallis and Futuna Islands), Papua New Guinea, Solomon Islands and Vanuatu.

The region provides numerous examples of the cultural importance of intraspecific tree diversity. For instance, there are hundreds of named varieties of *Pandanus tectorius*, mostly selected female plants propagated vegetatively. Different varieties are used at different times for food, for different types of leis and in different types of thatched mats and other plaited wares (Thomson, Thaman and Fink 2016). For most people in Kiribati, *P. tectorius* is the ancestral tree from which, according to legend, their progenitors came (Luomala, 1953). In the Pacific Island countries, medicinal value is important and accounts for 8.6 percent of reported uses.

Deforestation is a significant problem in Papua New Guinea and Solomon Islands. The exploitation of Papua New Guinea's forests has accelerated in recent years with the issuing of a total of 5.5 million ha of Special Agriculture and Business Leases (SABLs). Rather than being

[13] Unless otherwise indicated, information sourced from country reports, *The State of the World's Forest Genetic Resources* (FAO, 2014a) and the author's personal experience.

used for agricultural projects, as originally intended, SABLs have been widely used by logging companies (Lang, 2016). The main drivers of deforestation in both countries are commercial logging, agriculture (predominantly expansion of oil-palm plantations), mining and infrastructure developments. In the period between 1990 and 2010, Solomon Islands lost an average of 5 550 ha of forest per year, which is about 4.8 percent of its total forest cover. In 2011, a new forest resources assessment concluded that more than half of the country's primary commercial forest resources had already been logged and that approximately 30 percent (604 000 ha) was left for extraction. Some of the smaller islands still have extensive forest cover. For example, the Niue 2008 Forest Inventory registered 71.8 percent mature dense forests (Government of Niue, 2014).

From 1996 to 2005, the South Pacific Regional Initiative on Forest Genetic Resources (SPRIG) (FAO, 1996) project assisted several countries in the Oceania region with research on conservation and development of their indigenous species. This effort resulted in much greater planting of native species such as *Santalum* species in Fiji and Vanuatu, *Endospermum medullosum* in Vanuatu and *Terminalia richii* in Samoa. Species introductions have to be appropriately managed. For example, the introduction of *Santalum album* into Tonga for a species trial threatened the local species, *S. yasi*, through hybridization and overharvesting. *S. yasi* is found only in Tonga and Fiji.

The Forest and Tree Genetic Resource Conservation, Management and Sustainable Use in Pacific Island Countries and Territories Strategy and Action Plan (SPC, 2007), which represents the collective views of representatives of 14 Pacific Island countries and territories, and other national and international participants, expressed during a workshop in Nadi, Fiji, in June 2007, serves as a framework for planning and implementing the conservation, management and sustainable use of forest and tree genetic resources. In 2011, the SPC developed the Pacific Islands Tree Seed Centre to help research, conserve and disseminate seeds of socio-economically important tree species in the 22 SPC member countries and territories.

Australia has more than 1 000 species conserved *ex situ* in seed banks and field plantings (clonal archives, seed orchards and arboreta). The Australian Seed Bank Partnership,[14] which developed from the Millennium Seed Bank Partnership, has a mission to safeguard Australia's plant populations and communities through a national network of conservation seed banks. This partnership unites the expertise of 14 institutions, including universities, herbaria, botanic gardens, NGOs and environmental agencies. The Threatened Flora Seed Centre of the Western Australian Department of Environment and Conservation (one of the members of the partnership), which was established to safeguard a geographically diverse range of seeds from threatened plant species, has successfully stored seeds from three-quarters of Western Australia's threatened plant species – many of them trees and other woody species. The centre has also reintroduced more than 50 threatened species into the wild. The Commonwealth Scientific and Industrial Research Organisation's (CSIRO's) Australian Tree Seed Centre maintains a national *ex situ* seed collection of more than 900 tree species, while the Southern Tree Breeding Association contributes significantly to *ex situ* conservation through provenance and progeny trials for multiple tree species. Papua New Guinea has a national tree seed centre in Morobe Province, which stores seed for research, reforestation and export.

Only Australia and Papua New Guinea reported data on species under *ex situ* conservation in their country reports for the SoW-FGR. In Australia, well-represented genera and species include eucalypts in the genera *Angophora*, *Corymbia* and *Eucalyptus* (900 species in seed banks and arboreta), *Acacia auriculiformis* (780 accessions in seed banks), *Araucaria cunninghamii* (800 clones and 400 families planted in fields), *Khaya senegalensis* (150 clones and 80 provenances in seed banks) and *Pinus radiata* (916 clones and 772 seed accessions). In Papua New Guinea, 200 field stands containing 107 accessions have been established for five native species (*Acacia crassicarpa, A. mangium, Araucaria cunninghamii, A. hunsteinii* and *Eucalyptus deglupta*) and one exotic species (*Tectona grandis*). Seven clone banks contain 114 clones of these species.

[14] www.seedpartnership.org.au

In Solomon Islands, over 25 tree species are reported to be threatened, including ebony, rosewood, rattan and some palms. Ebony (*Diospyros insularis*) is listed as critically endangered. A newly identified species, *tubi* (*Xanthostemon melanoxylon*), was given some form of legal protection in 2004 because of its limited distribution. The status of many other forest plants in the country is still unknown.

The larger islands, from Papua New Guinea to Fiji, have some of the most extensive and species-rich intact areas of mangroves on Earth, with the mangroves of New Guinea listed as a WWF global ecoregion. There are also limited mangrove populations on many of the atolls and raised limestone islands. Throughout the Pacific, mangroves serve as a critical habitat, spawning ground or nursery for a majority of near-shore fisheries resources and for a wide range of birds, some mammals and saltwater crocodiles (SPREP, 2012a). Mangrove ecosystems provide goods and services that are highly valued by the people of the Pacific. However, this unique ecosystem faces continuing threats from overharvesting, degradation and land reclamation. Key challenges for mangrove management in the Pacific include weak governance, disconnect between formal and traditional management systems, limited baseline information, weakening traditional management, lack of awareness and limited capacity.

The main drivers of change/threats to forest genetic resources (FGR) are:

- Lack of coordination among policies, laws, government departments and sectors: The lack of cross-sectoral collaboration in many countries, linked with increasing pressures from various development activities, is a significant threat to FGR. The growth of the tourism sector (including ecotourism, if not properly managed) and other sectors of industry, particularly with regard to infrastructure development and public utilities, can also be detrimental to forest ecosystems and FGR.
- Lack of, or insufficient, integration of FGR issues into wider national policies and laws: The importance of FGR and the wider forest ecosystem needs to be acknowledged in national policies and legislation.
- High levels of land clearing and deforestation: This is an ever-increasing threat across the Pacific region, driven by a variety of factors including poverty arising from population growth, change in land use as a result of expansion of agriculture and non-agricultural developments, and increasing market demand for timber, other wood products and products such as palm oil.
- Changes to physical and biological environments brought about by factors such as extreme climatic events and indiscriminate burning: Damage from forest fires is often exacerbated by the limited capacity of fire services to control fires, especially on smaller islands or where access is constrained by poor or non-existent infrastructure.
- Lack of resources (trained human resources, infrastructure and finances) to develop, implement and monitor FGR projects.
- General lack of awareness of the importance of conserving and sustainably utilizing FGR among the general public and poor coverage of FGR in school curricula.
- Land-use policies and land-tenure issues that constrain efficient, effective and sustainable management of FGR.
- Overharvesting of high-value species such as sandalwoods and forest products: overharvesting of sandalwood has occurred in Fiji and Tonga.
- Invasive species (including pests and diseases): For example, poplar rust devastated poplar plantations in Australia and New Zealand in the 1970s. More recently Australia's 2 000 plant species in the family *Myrtaceae* have been threatened by *Puccinia psidii* (myrtle rust or guava rust) (Invasive Species Council, 2011). The invasive vine *Merremia peltata* is a problem in the Pacific Islands. The African tulip tree (*Spathodea campanulata*), an evergreen tree native to West Africa, which favours moist habitats and grows best in sheltered tropical areas, is invasive in Fiji, the Cook Islands and Samoa, and is a potential invader in several other tropical locations.

Aquatic genetic resources for food and agriculture

The importance of fish to coastal communities is illustrated by figures presented in *The State of World Fisheries and Aquaculture 2014* (FAO, 2014b) showing that the average annual fish consumption in coastal settlements is close to 120 kg/capita.

While finfish contribute significantly to food security in coastal communities, invertebrate fisheries such as sea cucumbers, mother-of-pearl shell, trochus and pearl oysters provide community-level income streams and contribute to national export revenue. Sea cucumbers are the third most economically important marine export from the Pacific Islands, after tunas and pearls, and are probably worth much more than officially reported (Purcell, Lovatelli and Pakoa, 2014). Strong growth in seaweed farming (mostly *Kappaphycus alvarezii*) for export markets is reported by Solomon Islands. There is seaweed farming in three of the nine provinces (Western, Isabel and Temotu).

In general, the coastal fishery resources of the Pacific Islands are heavily fished and often show signs of overexploitation, especially in areas close to population centres and for fishery products that are in demand in rapidly growing Asian economies. A study on reef fisheries carried out between 2002 and 2009 across 17 Pacific Island countries and territories and 63 sites found that less than one-third of the sites were in good condition and that most sites (54 percent) were in average-to-low or poor condition (Pinca *et al.*, 2010).

Soaring market demand, lack of alternative income streams for fishers and ineffective management have led to overexploitation of resources across the Pacific. In Solomon Islands, overexploitation for both subsistence and commercial use has resulted in severe depletion of several important food and commercial species, including greensnails, blacklip and goldlip shells, coconut crabs, giant clams and sandfish (sea cucumber). Overexploitation of wild stocks has prompted national fishery closures in Papua New Guinea and Solomon Islands within the past five years. Ark shell, bone fish, giant clam, lobster and all species of shark were reported to be declining in density, distribution and size ratios in Kiribati. Some countries, however, reported that effective management plans had been implemented and enforced. For example, Palau reported that bumphead parrotfish and Napoleon wrasse populations were rebounding following a ban on the harvesting of these species.

In New Zealand, the loss and degradation of freshwater ecosystems has been accompanied by the decline of a wide range of freshwater species; there is a continuing decline in indigenous fish species (e.g. eels and whitebait) (Government of New Zealand, 2014). Overharvesting in both the marine and freshwater environments has a range of ecological effects, including the modification or destruction of habitats and removal of large numbers of both target and non-target (bycatch) species (ibid.). Bottom trawling, which impacts benthic habitats including vulnerable marine ecosystems, occurs on 85 222–166 233 km^2 of New Zealand's sea area per annum (from a total of over 4 million km^2) (ibid.).

Declining catches in the fisheries within Australia's EEZ can be partly explained by a reduction in effort and catches following structural adjustment to reduce overcapacity and a ministerial directive in 2005 aimed at stopping overfishing and allowing overfished stocks to rebuild (FAO, 2014b).

The drivers of change/threats to aquatic genetic resources include:[15]

- Overfishing: Increasing population is leading to growing demand. Technical developments are enabling more-effective harvesting of aquatic resources. Traditional methods, which tended to limit harvesting, are no longer used. In addition, resources are increasingly being harvested for monetary income rather than for subsistence use.
- Coastal-zone development: The increasing importance of tourism in many countries is leading to escalating coastal development, which can mean reclamation of land and therefore loss of marine habitats.

[15] Sourced from country reports and references provided in the text.

- Pollution: Sewage and nutrients, garbage dumps located at the sea edge, excessive silt (from deforestation), loss of beaches due to sand mining, oil from boats and industrial wastes (e.g. in Australia from mining) all contribute to pollution in coastal waters. In Palau, major development in the watershed of the Ngerikiil River, which empties into Airai Bay, has resulted in increased sediment loads that have smothered the bay's reefs and caused the collapse of a once-productive fishery.
- Climate change: Global warming is believed to contribute to coral bleaching and ocean acidification in the region. Specialist fish species that depend directly on live coral for food and shelter are likely to experience greater impacts than generalists, i.e. species that can switch to using alternative resources. Overall, significant changes in the species composition of demersal (bottom-dwelling) fish associated with coral are expected (Bell and Taylor, 2015).
- Limited alternative livelihoods: There are limited alternative livelihoods and a general lack of available commercial funding mechanisms to support small-scale community livelihoods and hence reduce impacts on aquatic genetic resources.
- Weak compliance with and enforcement of conservation laws and regulations: In some cases, especially in the smaller islands, this is due to limited capacity to monitor illegal fishing in territorial waters.

Bell *et al.* (2013) concluded that, overall, Pacific Island countries and territories are better-placed than other nations to cope with the effects of climate change on fisheries and aquaculture, and have good potential to adapt in the longer term and seize the benefits from changes in fisheries and aquaculture systems. Impacts on fisheries and aquaculture, such as the movement of tuna from west to east and improved environmental conditions for developing pond aquaculture, are likely to benefit those countries and territories with a greater economic dependence on tuna (FAO, 2014b).

Common drivers of change affecting plant, animal, forest and aquatic genetic resources in the region

Increasing population particularly in the Pacific Island region: The population of the Pacific region grew from 6 million people in 1990 to approximately 10 million people in 2011, equating to an average annual growth rate of 3.3 percent (SPREP, 2012a).[16] On the smaller islands, the population is often located in the coastal area. In Samoa, for example, 70 percent of the population and infrastructure is located within the coastal area and, as a result, coastal habitats and species are under ongoing pressure from land-based pollution, exploitation and other stresses, which are being further compounded by the effects of climate change and climate variability. Populations in many urban areas are growing at twice the national growth rates, both increasing the scale and concentrating the effects of population growth in urban areas (ibid.). Increasing urbanization also leads to a reduction in historical and cultural connections to the environment and to traditional, subsistence (low-impact) practices. Increasing population and growing urban centres favour commercialized food production that targets high yields, often to the detriment of traditional plant and animal varieties.

Increasing consumption of imported food: With urbanization, an increasing reliance on imported foods has created a certain degree of indifference to the land and the biodiversity it supports. Local food traditions help to maintain traditional crop varieties in agricultural production systems. In both urban and rural areas (especially in the smaller islands) lifestyles are becoming more cash-based. Retail food outlets in Pacific island countries are increasingly selling imported, processed foods that are pricing locally produced, healthier foods out of the market and affecting islanders' health.

[16] The figures are from a report covering American Samoa, the Cook Islands, the Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, the Marshall Islands, Nauru, New Caledonia, Niue, the Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna Islands.

Traditional staple foods are often seen as indicating low status – for example, the Karat banana in Pohnpei, Federated States of Micronesia – which means that people are not keen to cultivate them in their gardens (New Agriculturalist, 2008). Imported and processed products, such as rice, bread and noodles, are increasingly replacing traditional staples. Meat products are replacing fish, and sugary products are replacing traditional snacks, such as fruits. This change in diet, accompanied by changes in lifestyles, has seen a surge in obesity and non-communicable diseases. Micronutrient deficiencies are also common in this region – vitamin A deficiency is a significant public-health problem in Kiribati and Papua New Guinea. Many countries are facing the double burden of malnutrition – where undernourished children live in the same household as overweight adults.

Economic and market forces: The pressure to meet market demand has tended to encourage less-sustainable agricultural practices, with subsequent impact on BFA, in particular PGRFA. Some countries noted that traditional hunting and fishing methods, which tend to limit the volume of harvest, are rarely employed today. Moreover, people are increasingly collecting or harvesting resources for monetary income rather than solely for local subsistence uses (Koczberski *et al*., 2006). Tourism is a major source of income in the Pacific Islands. However, increasing visitor numbers put increasing demands on infrastructure, ecosystem services and natural resources. In Fiji, giant clams, triton trumpet shells and decorator urchins are collected for food, but also for the increasing tourism souvenir trade (Whippy-Morris, 2009). In addition, sea cucumbers are gathered for the Asian market and lobsters for local tourism. Based on IUCN data for 2010, Morrison (2013) concluded that tourism was having a negative impact on 15 percent of all the IUCN Red-Listed species in the Pacific region (282 species), with the majority (83 percent) of the affected species being corals. Tourists may prefer western-type foods and thereby influence agricultural production. For example, coleslaw is commonly served in hotels, which encourages farmers to abandon more nutritional, local vegetables such as *Abelmoschus manihot* in favour of white cabbage (*Brassica oleracea*).

Exploitation of natural resources: The most commonly exploited natural resources in the Pacific include deep-sea fisheries, coastal fisheries, timber and natural gas. Tuna is a vital source of revenue for fishing communities. Overfishing will seriously jeopardize this hugely valuable industry, worth more than USD 42 billion (Galland, Rogers and Nickson, 2016), unless countries can agree to catch limits that allow stocks to recover. Five out of the eight tuna species are at risk of extinction as a result of overfishing (IUCN, 2011). Increased interest in mining activities, both onshore and offshore, in many countries (e.g. Papua New Guinea) has the potential to inflict significant damage on biodiversity, as does the continued move away from subsistence lifestyles and farming towards production of commercial crops, including palm oil, and the development of new infrastructure such as roads and wharves. Fuelwood harvesting is a major threat to forest and mangrove diversity. Large-scale unsustainable logging is the single biggest threat to forest genetic resources in Solomon Islands, but expanding palm-oil plantations are also a cause of land clearing. Currently, the only large (15 000 ha) palm-oil estate in the country is in Guadalcanal. However, there are proposals to develop palm-oil plantations in Malaita, which could severely affect the forests there.

Policies: Policies that promote commercial agricultural production mainly for export can be detrimental to plant, animal, forest and aquatic genetic resources, especially if the market dictates genotype preferences. Policies that support the maintenance of these genetic resources are needed, including integrated cross-sectoral planning aimed at ensuring that policies, strategies and action plans are not in conflict with each other. Inadequate monitoring and enforcement of laws and regulations, especially in the forest and fisheries sectors, can lead to the depletion of genetic resources.

Climate change: As conditions change, some varieties and breeds may be abandoned by farmers and livestock keepers, and may be lost forever. Catastrophic extreme-weather events, such as cyclones, floods and droughts, can pose an immediate threat to the survival of breeds and varieties that are raised only in specific small geographical areas.

The recent El Niño has had a devastating effect on agricultural production in many countries and could have affected the future viability of some varieties. In the Cook Islands, taro has traditionally been grown in wetland conditions, but it now has to be cultivated in raised beds linked to water channels. Countries have reported changes in the fruiting patterns of breadfruit, mango and *Citrus* spp.

Studies have indicated that forest-tree populations are unlikely to be able to migrate sufficiently quickly to keep pace with the changing climate (FAO, 2015b). They will therefore have to adapt *in situ*, relying on their phenotypic plasticity and genetic diversity.

Seasonally dry forests and woodlands are at greater risk of increased firing and an associated decline in their capacity to provide useful products and ecosystem services (Thomson and Thaman and Fink 2016). Climate experts in Australia are warning that with rising temperatures, as well as decreasing rainfall in the south, parts of the country have become so dry that the risk of bushfires is rising (Kwek, 2016). The latest report from the Climate Council, *The burning issue: climate change and the Australian bushfire threat* (Hughes and Fenwick, 2015), notes that the length of the fire season increased by almost 19 percent globally between 1978 and 2013, with longer fire seasons reducing opportunities for controlled burning and intensifying pressure on firefighting resources.

Invasive species, pests and diseases: Invasive plants and animals threaten plant, animal, forest and aquatic genetic resources. Several Pacific Island countries have reported the spread of *Merremia peltata*, a very vigorous and fast-growing vine that grows in forest clearings. Land clearing, road construction and other human activities have created more opportunities for the vine to thrive. The smothering effect of this plant is threatening the regeneration of lowland-forest species such as *Terminalia richii* and *Mailkara samoensis* in Samoa (Pouli, Alatimu and Thomson, 2002). In Palau, agriculture on the island of Angaur is no longer possible because of the impact of a population of macaque monkeys descended from animals introduced as pets when the islands were under German rule. Countries such as the Cook Islands where there is a lot of movement of people and goods because of tourism and links with New Zealand are at increased risk from the introduction of new and serious pests and diseases. African tulip tree (*Spathodea campanulata*) is a significant invasive species and is competing with native species in many countries (e.g. Fiji and Samoa). Taro leaf blight disease caused by *Phytophthora colocasiae* wiped out the taro landraces in Samoa.

Land-use change: Land-use change, land clearance, habitat fragmentation, fire and forest conversion can also adversely affect the survival of plant, animal, forest and aquatic genetic resources. Traditional land-tenure systems with poor regulation can lead to individuals maximizing their own benefits until the resource is depleted. Fishing of village inshore marine resources is often unregulated. The right of use (and *de facto* ownership) of village communal land can encourage clearance of forested land merely to stake a claim, with little or no long-term commitment to its development. Coastal development for tourism in many Pacific island countries is a major driver of change, often compounded by land-tenure issues. The Cook Islands Agriculture Census of 2011 showed that only 540 acres (219 ha) of land were utilized for agricultural purpose compared to 2 500 acres (1 012 ha) in 1988.

Resource and knowledge-management constraints: Lack of resources (trained personnel, infrastructure and finance) constrains the development, implementation and monitoring of genetic-resources projects. Non-existent or ineffective knowledge-management systems hinder monitoring and evaluation of genetic resources and restrict access to baseline information that could prove useful in land-use planning.

1.2.2. National information systems

Some countries in the region do maintain databases for PGRFA. For example, Fiji has an informal database in which information on all conserved PGRFA in the country is recorded. However, updating the database is a challenge because of other demands on staff. Countries such as Solomon

Islands and Tonga reported that landing catch and export production recorded by Fisheries Divisions can provide information that might assist in determining changes in marine ecosystems. Generally, information systems in the region tend to be based on wild biodiversity and are therefore more environment-focused and not linked to agricultural production.

The Cook Islands reported on The Cook Islands Biodiversity and Natural Heritage website,[17] which aims to collect and integrate scientific and traditional information on local plants and animals and to preserve this information and make it available to the general public. The Cook Islands multimedia biodiversity database currently contains information on 4 500 existing species, native and introduced, including 2 500 with photographs to aid recognition. The Cook Islands Biodiversity & Ethnobiology Database[18] is a collaborative project between the Centre for Social Anthropology and Computing of the University of Kent (United Kingdom), the Cook Islands Natural Heritage Trust and community groups in the Cook Islands, which aims to support the use of scientific biodiversity data and local ethno-ecological knowledge to improve adaptive strategies for biodiversity management, reporting and monitoring in the Cook Islands in the context of significant demographic and climatic changes and subsequent ecosystem changes.

Papua New Guinea has a Forest Resource Information Management System (PNG- FRIMS) based on a GIS system with remote-sensing technology (PNG Forest Authority, 2015). The country's Conservation and Environment Protection Authority has recently invested resources, through the Kokoda Initiative, to develop a national biodiversity database – and has just taken receipt of more than 100 000 digitized records of plant and animal specimens from Australia. Papua New Guinea has a Plants of Papua New Guinea database.[19] Palau is also developing a biodiversity clearing-house mechanism, which will host a website dedicated to biodiversity information.

In Australia, information systems are being used to bring together and present datasets in a centralized and accessible format. Australia has established the online Atlas of Living Australia,[20] which provides efficient access to data held in biological collections across the country and integrates taxonomic information, collection data, ecological and genetic information with geospatial-analysis tools (Stoutjesdijk, 2013). It has also established the Australian Virtual Herbarium,[21] which links all major Australian herbarium records (ibid.).

There have been some one-off assessments, such as the 2012 IUCN assessment of freshwater fishes, land snails and reptiles in the Pacific Island region. One hundred and sixty-seven species of freshwater fish, 166 species of land snail and 157 species of reptile were evaluated for inclusion in the IUCN Red List of Threatened Species, some of which are very important for ecosystem health (Pippard, 2012).

Generally, any surveying or monitoring activities implemented tend to be project components rather than ongoing activities within national programmes. The Pacific Islands Species Forum held in 2013 recognized that monitoring of Pacific Island species faces a significant number of challenges, not least among which was the region's limited capacity in taxonomic skills and research capabilities (PISF, 2012).

Although soil biodiversity is recognized as being important to the sustainability of agriculture, very few countries mentioned monitoring of soil organisms in and around production systems. The Australia Centre for International Agriculture Research (ACIAR) has been funding a project in the Pacific Islands that analyses the structure of nematode communities and links the results to soil health and management practices. The importance of soil organisms is often referred to when discussing optimum levels of soil nutrients, but the objective in this context is typically to ensure that nutrients are at the appropriate level for the organisms rather than to monitor the presence or abundance of the organisms.

[17] http://cookislands.bishopmuseum.org
[18] http://csac.anthropology.ac.uk/Research/Cibed
[19] http://www.pngplants.org/
[20] http://www.ala.org.au/
[21] http://avh.chah.org.au/

Table 3. Biological control agents used in SPC Biological Control Laboratory projects in the Pacific region and the pest species targeted

Biological control agents	Target pests
Nephaspis dispar Coleoptera: Coccinellidae	*Aleurodicus disperses* Hemiptera:Aleyrodidae
Encarsia haitiensis Hymenoptera: Aphelinidae	*Aleurodicus disperses* Hemiptera: Aleyrodidae
Chilocorus nigritus Coleoptera: Coccinellidae	*Aspidiotus destructor* Hemiptera: Diaspididae
Telsimia nitida Coleoptera: Coccinellidae	*Aspidiotus destructor* Hemiptera: Diaspididae
Cryptognatha nodiceps Coleoptera: Coccinellidae	*Aspidiotus destructor* Hemiptera: Diaspididae
Diadromus collaris Hymenoptera: Ichneumonidae	*Plutella xylostella* Lepidoptera: Yponomeutidae
Heteropsylla spinolusa Hemiptera: Psyllidae	*Mimosa invisa* Mimosaceae
Diadegma semiclausum Hymenoptera: Ichneumonidae	*Plutella xylostella* Lepidoptera: Yponomeutidae

Source: SPC, 2012.

In summary, monitoring programmes covering a broad range of taxonomic groups are in operation in the region. However, data on associated biodiversity are not linked to production systems. Some analysis of trends within production systems could be achieved by linking survey data on biodiversity to spatial information on the distribution of the production systems.

1.2.3. Associated biodiversity species actively managed for the provision of ecosystem services

The components of associated biodiversity most frequently reported as being actively managed include biological control agents, leguminous plants (e.g. *Mucuna pruriens* and *Gliricidia sepium*) used for nutrient cycling, soil organisms used through the application of compost and mulch, honey bees used as pollinators and mangroves used for habitat provisioning.

According to the Pacific Community (SPC, 2012), regional successes in biological control include:

- lantana weed (*Lantana camara*);
- giant sensitive plant (*Mimosa invisa*);
- spiraling whitefly (*Aleurodicus disperses*);
- coconut scale insects (*Aspidiotus destructor*); and
- diamond back moth (*Plutella xylostella*).

Table 3 shows the projects using biological control agents that SPC Biological Control Laboratory has facilitated and coordinated in the region.

Also reported by SPC are:

- control of mile-a-minute (*Mikania micrantha*) in Fiji and Papua New Guinea using the caterpillars *Actinote thalia pyrrha* and the rust fungus *Puccinia spegazzinii*;[22]
- control of spiralling whitefly using *Nephaspis bicolor* and *N. oculata*;[23] and
- control of coconut scale insect using *Telsimia nitita*.[24]

[22] https://lrd.spc.int/mikania-project
[23] https://lrd.spc.int/climate-change-mitigation/spiraling-whitefly
[24] https://lrd.spc.int/our-work/plant-health/entomology/coconut-scale-insect

Table 4. Associated biodiversity species most frequently reported as being actively managed for the provision of ecosystem services in the Pacific region

Species	Ecosystem functions and services in the production system provided by the species	Countries where species is reported
Salvinia weevil (*Cyrtobagous salviniae*)	Pest and disease regulation: management of *Salvinia molesta*	Papua New Guinea
Neohydronomous affinis	Pest and disease regulation: management of water lettuce, *Pistia stratiotes*	Papua New Guinea
Neochetina bruchi and *N. eichorniae*	Pest and disease regulation: management of water hyacinth, *Eichhhornia crassipes*	Papua New Guinea
Stem gall fly (*Cecidochares connexa*)	Pest and disease regulation: management of *Chromolaena odorata*	Papua New Guinea
Puccinia spegazzini pustules	Pest and disease regulation: management of mikania weed, *Mikania micrantha*	Papua New Guinea
Calligrapha pantherina	Pest and disease regulation: management of flannel weed broom stick, *Sida rhombifolia*	Papua New Guinea
Parasitoids of *Asecodes hispinarum*	Pest and disease regulation: control of coconut hispine beetle (*Brontispa longissima*)	Nauru
Fungal pathogens	Pest and disease regulation: for example of *Merremia peltat*a	Palau
Ctenopharyngodon idelle (grass carp)	Introduced into Fiji for aquatic weed control (*Ctenopharyngodon idelle* is a sterile triploid fish and cannot produce viable offspring) in the wild	Fiji
Gambusia affinis (mosquitofish)	Introduced as a mosquito-control agent (it is invasive in some of the waterways)	Fiji
Legumes (for example *Gliricidia sepium*, *Mucuna pruriens*, *Erythrina* spp., *Callindra* spp.)	Nutrient cycling and weed suppression, plus moisture retention in the case of *Mucuna*	Fiji, Kiribati, Niue, Palau, Solomon Islands
Compost and mulching organisms	Soil formation and protection	Kiribati
Mangrove species	Spawning ground for fish and a habitat for other species	Kiribati, Solomon Islands
Sea cucumbers	Detritus feeders that cleanse muddy sediments and recycle nutrients and sediments	Kiribati
Honey bees	Pollinators of many crops and other plant species	Niue
Rarotonga flycatcher (*Pomarea dimidiate*); Rarotonga starling (*Aplonis cinerasreus*); kukupa/fruit dove (*Ptilinopus rarotongensis*); Atiu swiftlet (*Collocalia sawtelli*), and Mangaia kingfisher (*Todiramphus ruficollaris*)	Habitat provisioning (naturally regenerated forests)	Cook Islands
Humpback whale	Habitat provisioning (self-recruiting capture fisheries)	Cook Islands
Vermiculture	Use of a species of earthworm imported from Australia by Grace Road Company for organic rice production in Navua, Fiji. This company, based in the Republic of Korea, is assisting the Fiji agriculture sector with commercial rice farming and in its efforts to achieve self-sufficiency in rice production by 2020	Fiji

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

1.2.4. Wild food species

The consumption of wild food plants makes a significant contribution to human health in the Pacific region. For example, Thaman (1990) lists 60 wild food plants used in Fiji, noting that wild food plants play an important role as emergency foods when extreme climatic events disrupt cultivation. According to Clarke and Thaman (1993):

> *Wild food resources are among the most important products of agroforestry systems, particularly in Melanesia, where extensive stands of primary and secondary forest remain. Most notable among these are a great diversity of wild yams, ferns, fungi, fruits, nuts and leaves and birds, frogs, snakes, grubs, insects, fin fish, eels, freshwater prawns, and other foods that are found in agroforestry zones. Even in grassland areas and on*

atolls, wild yams, ferns, wallabies, kangaroos, birds, edible plants, and crabs constitute wild or emergency food resources.

Table 5 shows the wild food species most frequently reported by countries in the region.

Table 5. Selected wild food species reported by countries in the Pacific region

Wild food species	Countries where species is reported
Terrestrial plant and fungi	
Sago (*Metroxylon sagu, M. salomonense, M. vitiense*)	Fiji, Papua New Guinea
Karuka (*Pandanus brosimos, P. julianettii, P. conoideus*)	Papua New Guinea
Breadfruit (*Artocarpus altilis*)	Kiribati, Papua New Guinea, Nauru, Niue
Polynesian chestnut (*Inocarpus fagifer*)	Fiji, Papua New Guinea, Samoa
Elephant foot yam (*Amorphophallus campanulatus*)/wild yam (*Dioscorea* spp.)	Fiji, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga
Swamp taro (*Cyrtosperma species*)	Fiji, Kiribati, Niue, Solomon Islands
Mangrove species (*Brugiera gymnorhiza*),	Solomon Islands
Fruit trees – mango, coconut, lime, papaya, banana, soursop; bele (*Abelmoschus manihot*), guava	Nauru
Roseapple (Syzigium jambos), bird's nest fern, red strawberry guava (*Psidium cattleianum*), governor's plum (*Flacourtia jangomas*), Java plum (*Syzigium cumini*), guava (*Psidium guajava*)	Cook Islands
Arrowroot (*Tacca* spp.), edible fern (*Asplenium nidus*), coconut, Pacific litchi (*Pometia pinnata*), tropical almond (*Terminalia catappa*), fig (*Ficus scabra*), kolivao (*Syzygium richii*), nonu/Indian mulberry (*Morinda citrifolia*), red read tree, red sandalwood (*Adenanthera pavonina*)	Niue
Edible fern (*ota*) (*Athyrium esculentum*), traditional taro species (*Colocasia esculenta*), wild traditional nuts, fei banana (sei in Fiji), wild bush lemon, wild water cress, blackberry night shade (*Solanum nodiflorun*), spleen amaranthus (*Amaranthus viridis*), wild chili pepper (*Capsicum fruitescens*), wild cape gooseberry (*Physellius peruviana*), kudzu root (*inoka*) (*Pueraria lobota*), wild fungi on trees, swamp cabbage (*Ipomea aquatic*), local guava (*Psidium guajava*), *dawa* (*Pometia pinnata*), Malayan apple, wild taro leaf (*rourou ni wai*) (*Colocasia esculenta*), *sukau* (*Gnetum gnemon*), mountain banana (*sowaqa*) (*Musa troglodytarum*), pursalane pig weed (*Portulaca oleraceae*), two palms – *niu masei* (*Prichardia pacifica*) and *niusawa* (*Veitchia joannis*)	Fiji
Giant taro (*Alocasia macorhizza*), cordyline – green leaf (*Cordyline fruticosa*)	Cook Islands, Niue
Native fig (*Ficus tinctoria*)	Kiribati
Terrestrial animal species	
Deer, tree kangaroo, cassowary, guria pigeon, crocodile, bandicoot, lizard	Papua New Guinea
Wild fowl	Cook Islands, Fiji, Niue, Papua New Guinea
Wild pigeon (*lupe*) (*Ducula pacifica*)	Cook Islands, Niue
Feral pig (*Sus scrofa*)	Cook Islands, Fiji, Niue, Papua New Guinea, Samoa
Longhorn beetle grub (*yavato*) (*Olethrius tyrannus*), green katydid (*Othoptera* spp.), black duck (*Anas superciliosa*), white throated pigeon (*Columba vitiense*)	Fiji
Fruit bat (*Pteropus tonganus*)	Cook Islands, Niue
Bat (*Emballonura semicaudata*), small Indian mongoose	Fiji
Wild honey bee (*Apis mellifera*),	Cook Islands, Niue
Frigate bird (*Fregata minor*), red-tailed tropicbird (*Phaethon rubricauda*)	Cook Islands
Marine and freshwater species	
Pacific shortfin eel (*Anguilla obscura*), Pacific longfin eel (*Anguilla marmorata, A. megastoma*), five-tooth prawn (*Macrobrachium aemulum*), freshwater prawn (*M. lar*), lined sea hare (*Stylocheilus striatus*), seagrapes (*Caulerpa racemose*), seagrape parrotfish (*Leptoscarus vaigiensis*), scribble rabbitfish (*Siganus spinus*), foxtail rabbitfish (*S. argenteus*), marbled grouper (*Epinephelus polyphekadion*), yellowfin goatfish (*Mulloidichthys vanicolensis*), yellowstrip goatfish (*M. flavolineatus*), bigeye scad (*Selar crumenophthalmus*)	Cook Islands
Coconut crab (*Birgus latro*)	Cook Islands, Niue, Palau
Mud-flat cardisoma crab (*Cardisoma carniflex*)	Cook Islands, Kiribati, Niue

Table 5 *Cont'd*

Wild food species	Countries where species is reported
Tuna (*Thunnus albacares, Katsuwonus pelamis, Thunnus alalunga, Gymnosarda unicolor*), wahoo (*Acanthocybium solandri*), marlin (*Tetrapyurus audax*), baracuda (*Sphyraena barracuda*), flying fish (*Cheilopogon unicolor*), mackerel (*Decapterus macarellus*), parrot fish (*Chlorurus microrhinos*), mahimahi (*Coryphaena hippurus*), jobfish (*Aphareus rutilans*), yellow-edged lyretail (*Variola louti*), blotcheye soldierfish (*Myripristis bendti*), black jack (*Caranx lugubris*), brassy chub (*Kyphosus vaigiensis*), honeycomb grouper (*Epinephelus merra*), stocky hawkfish (*Cirrhitus pinnulatus*), lobster (*Panulirus penicillatus*), octopus (*Octopus cyanea*), mottled sally lightfoot crab (*Graspus albolineatus*), silvermouth turban (*Turbo argyrostomus*), ugako – snake-like worm (*Serpulorbis colubrinus*), seaweed (*limu*), toothed stolon (*Caulerpa cupresoides*), coarse seagrape (*Caulerpa racemosa*), sea urchin (*Echinostrephus* spp.), limpets (*Patella flexuosa*), sea cucumber (*Holothuria atra*)	Niue
Rabbit fish (*Siganus canaliculatus*), humphead parrot fish (*Bolbometopon muricatum*), snappers, turtles (*Chelonia mydas, Eretmochelys imbricate*), tuna (*Thunnus albacares*), wahoo (*Acanthocybium solandri*), Napoleon wrasse (*Cheilinus undulates*), goat fish, unicorn fish, surgeon fish (*Paracanthus hepatus*), mangrove crab (*Scylla serrata*), sea cucumber (*Holothuria* spp.), sand clam, grouper (*Plectropomus* spp.).	Palau
Palolo worm (*Palola viridis*)	Fiji, Samoa
Sea grapes (*Caulerpa racemose*), codium (*Codium geppii*), maiden hair (*Hypnea nidifica*)	Fiji
Finfish, shellfish, tilapia, clams, eel, sea vermicelli (eggs of *Dolabella auricularia* – sea hare)	Kiribati

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

In Papua New Guinea, wildlife plays an important part in traditional diets, supplying the primary intake of proteins and fats in many highland areas and other isolated parts of the country. Pelts, plumage and skins are also used.

In Kiribati, the proportion of the population that eats wild food on a regular basis varies between the three island groups (Gilbert, Phoenix and Line) and between wild food species. Fish is a subsistence food and consumed every day by the population. Among the island groups, the Gilbert Islands have the highest proportion of population that uses coastal and marine wild food sources, mainly fish, clams and shellfish, during normal times. However, different regions or districts of the Gilbert Islands also differ in the extent to which wild food is used. For example, in the northern Gilberts 50 to 60 percent of the population consumes land crabs on a regular basis, compared to 10 to 20 percent in the central and southern islands, where land crabs are less abundant. The large size of wild-bird and land-crab populations in the northern islands of the Gilbert group and the Line and Phoenix Islands is thought to be a consequence of the existence of wilderness, marshy natural ponds and an abundance of small uninhabited islets. In these areas, the proportion of wild food in the diet can reach 100 percent, although not on a regular basis. Giant swamp taro and breadfruit are two common staple wild food sources that are widely used by a large proportion of the population throughout Kiribati, but again not on a regular basis. Their use increases in times of emergency and when there are shortages of imported foods, particularly rice.

In Niue, the 2009 agricultural census found that 60 percent of households hunted for coconut crabs and 62 percent engaged in fishing. Taking into account other wild foods not accounted for in the census, it is likely that about 70 percent of the population eat wild food on a regular basis. In Palau, wild food is consumed by an estimated of 80 percent of the population. In the Cook Islands, more than 80 percent of the population in the atolls consumes wild food. However, in the southern islands, the percentage might be as low as 25 percent and decreasing as a result of economic and social structural changes.

Consumption of wild marine seaweeds is very common in Fiji, and a majority of the population eats sea grapes, maiden hair (*lumi*) and other edible seaweeds. Edible fern, or *ota*, is regarded as a delicacy by more than 50 percent of the population, and this is reflected in the quantity sold in municipal markets. This plant is now consumed on a daily basis rather than only on Fridays and Saturdays as in the past. Some is exported vacuum-packed to overseas markets, and demand is high

from Fiji nationals residing in overseas in New Zealand, Australia, Canada, the United States of America and various Pacific Island countries.

Capture-based fisheries contribute substantially to local subsistence and market economies in the Pacific Islands. Fish protein constitutes around 30 percent of the Micronesian diet and 15 percent of the Polynesian diet. These averages "hide" specific localities within regions (and countries) where fish protein is a far more important dietary constituent (Bell *et al.*, 2009). The countries that depend most on fish for food rely primarily on catches from the wild. Overharvesting is a significant threat to coastal and marine wild food species such as coconut crab and certain fish species.

Cook Islands reported a wild food species conservation and management programme undertaken by the Ministry of Marine Resources (MMR) on the island of Aitutaki. The programme started in the 1980s in response to the drastic decline of the population of the clam *Tridachna gigas* in the lagoon and on reef flats. Spawning, using broodstock from the wild, and nurturing of immature clams are conducted in the hatchery on the island. When the immature clams reach 10 cm in length they are introduced into the wild.

1.2.5. Status and trends and drivers of change of associated biodiversity, ecosystem services and wild food resources

The status and trends of associated biodiversity of relevance to food and agriculture are less systematically monitored than those of animal, aquatic, forest and plant genetic resources, especially in the Pacific Islands. Any funding support for associated biodiversity would be likely to be obtained through environment-focused projects rather than those focused on agriculture and food security. Lack of monitoring capacity is a significant constraint to the monitoring of BFA. In an effort to develop a methodology that can be utilized even with limited capacity, the Belau National Museum, in cooperation with the Palau Conservation Society and the Palau International Coral Reef Centre, has recently completed preliminary studies aimed at identifying bird species that could be used to indicate near-shore environmental quality and ecosystem health.

In 2012, as noted above, IUCN conducted an assessment of freshwater fish, land snails and reptiles in the Pacific Island region. These organisms are extremely important in maintaining general ecosystem health: land snails play a vital role in nutrient cycling, especially of calcium; reptiles can take on the role of predator or prey and often act as seed dispersers; and freshwater fish recycle nutrients, purify water and provide an important food source for many Pacific Islanders. Land snails were found to be the most highly threatened group, with 70 percent of the assessed species threatened: half of all threatened species were listed as Critically Endangered, with many, including *Aaadonta angaurana* from Angaur island in Palau and *Lauopa mbalavuana* from Vanua Balavu in Fiji, qualifying as Possibly Extinct, as no live or dead shells had been found in recent times. Almost 20 percent of reptiles were found to be threatened, with species such as the Fijian banded iguana, *Brachylophus bulabula*, being affected by invasive mammals and plants and by habitat degradation. Many fish species (40 percent) were listed as "Data Deficient", meaning that their conservation status cannot be evaluated (Pippard, 2012). Although these species are known to be important for ecosystem health, their actual roles and the impact of their decline and extinction on the ecosystem are not known.

Ridge-to-reef/ecosystem-based projects are on the increase in the Pacific Island region, but are mainly associated with climate change rather than with monitoring or improving the status and health of associated biodiversity that contributes to food production.

Land use: Human population growth is having a pronounced impact on land use in the Pacific Island region. In the Cook Islands, growing demands for concrete for the building industry on the main island have led to increased mining of sand. Open mines are back-filled with soils with relatively high nutrient levels, which can then affect the marine environment and the organisms it supports. Tourism and residential development, especially in coastal environments, are major drivers of land-use change. Natural wetlands in the Cook Islands, commonly used for taro

cultivation, are being reclaimed for residential and tourist accommodation. These natural wetlands act as a filtration system for soil particles and nutrients from higher elevations or forested and agricultural areas during floods and heavy downpours. The loss of these areas increases the flow and deposition of sediments and nutrients in the marine ecosystem. Habitat destruction, driven by the expansion of aquaculture or agriculture or by urban or coastal development, is one of the primary threats to mangrove species.

Changes in land use can directly impact coral reefs or (in the case of coastal development and human-induced changes to watersheds) lead to increased sediment loading. Terrestrial sediment run-off and deposition on coral reefs can significantly affect coral health by blocking light and inhibiting photosynthesis, by smothering and abrading coral and by triggering increases in macroalgae. Coral reefs vital for sustaining fisheries (spawning grounds for fish) and for buffering waves and protecting coastlines from storm damage are already stressed by warming temperatures and ocean acidification.

Industrial/commercial practices: Mining activities in Papua New Guinea and other parts of Melanesia are particularly destructive for ecosystem health and associated biodiversity. For example, Swales (undated) reports that the Fly River system in Western Province, Papua New Guinea – the largest river in the country and home to the most diverse freshwater fish fauna in Australasia, local artisanal/subsistence fisheries and a limited commercial fishery – has experienced significant reductions in fish catches. Contributing factors are believed to include river-bed aggradation, elevated levels of total suspended solids and other mine-related environmental changes, such as elevated levels of dissolved and particulate copper (ibid.). Nauru's Fifth National Report to the Convention on Biological Diversity notes that "the impacts of a hundred years of phosphate mining has brought almost total loss of native forests including flora and fauna that have once covered 80 percent of lands on the central plateau of our island" (Government of Nauru, 2014). In Solomon Islands, forest degradation is among the most severe in the region; heavy overexploitation of timber resources is resulting in the loss of native tree species and the biodiversity they support. Logging around the country's Marovo Lagoon has been so intense that siltation threatens traditional marine fisheries (Forests Monitor, 2006).

Invasive species: There are several reports from countries regarding the impact of invasive species on terrestrial and marine biodiversity. Judging by their impacts on red crabs (*Gecarcoidea natalis*) on Christmas Island (Kiritimati), yellow crazy ants (*Anoplolepis gracilipes*) are potentially a growing threat to land crabs, including the coconut crab (used as a wild food). Fiji's coral reefs are affected by crown-of-thorns sea-stars and *Drupella* snails, which from time to time reach high population densities and can consume large amounts of live coral (Chin *et al.*, 2011). Cyclone damage can open up the forest for invasive species, especially climbing weeds such as *Meremia peltata* and *Epipremnum pinnatum*. *Acacia mangium* and *A. crassicarpa* were introduced some 25 years ago to the islands of Mangaia, Atiu and Mauke (Cook Islands) with the aim of providing a wood supply for power generation. The trees were not used for wood supply and as a result have invaded many agricultural areas and are thriving well in the makatea[25] forest. The trees are a threat to some important species in the makatea environment, including the plant *Alyxia stellata* (*maire*), which is used for lei making, an important livelihood activity in the islands.

More than 30 000 plant species have been introduced into New Zealand, 2 500 of which have become established in the wild (Government of New Zealand, 2014). Invasive weeds reportedly threaten native biodiversity in terrestrial, marine and freshwater systems, both by directly competing with and excluding native species and indirectly by altering ecosystem processes and functions (ibid). Examples include invasive macrofungal weeds that can compete with native fungi, for example the invasive fly agaric mushroom (*Amanita muscaria*) in beech forests (ibid.).

[25] Raised limestone substrate.

Unsustainable use of resources: Overfishing in in-shore areas will continue to be a major threat to the integrity and sustainability of coastal resources and coral reefs. The underlying drivers are the combined effects of population growth, the open-access nature of coastal fisheries resources and the growing demands of an increasingly cash-based lifestyle in rural communities. In Kiribati, a high proportion of the population is concentrated in Tarawa and Kiritimati, which leads to overexploitation or overharvesting of some wild food species, such as lobster, shellfish and bonefish, in these areas. Species groups of clam, bêche-de-mer and lobster have been overexploited and are reported to have declined in Abaiang and Kiritimati.

Overharvesting of animals regarded as local delicacies is a threat to coconut crabs (*Birgus latro*), wild pigeons and flying foxes. The problem is exacerbated by population pressure, inadequate policies and (where relevant policies exist) poor enforcement of policies, often due to human-resource constraints.

Agricultural intensification is a major driver of change affecting associated biodiversity and ecosystem properties in agricultural landscapes. Many farmers understand the important role of associated biodiversity such as soil micro-organisms, but unfortunately there is a general lack of knowledge regarding how farming practices such as soil cultivation, removal and burning of trees and organic matter, and abusive use of pesticides and fertilizers (occurring particularly in monoculture vegetable production systems) affect BFA. The need to produce food for an increasing population in many countries has led to reduced fallow periods and to farming on increasingly steep lands (slopes of more than 20 percent), resulting in a loss of beneficial soil micro-organisms and soil fertility. Unsustainable agricultural practices negatively affect BFA, associated biodiversity and ecosystem health.

Climate change was highlighted by several countries as a major threat to BFA in terrestrial, inland-water and coastal ecosystems. The emphasis on commercial production, along with other factors such as population pressures and limited land availability, has generally meant that the vital contributions that micro-organism and invertebrate genetic resources make to agriculture and food production (creation and maintenance of soils, pollination, biological control of pests, etc.) are neglected. Climate change, including changes to temperature and moisture regimes and to atmospheric CO_2 levels, is likely to affect these organisms and their capacities to provide ecosystem services. A recent study on the vulnerability of agriculture in the Pacific (Taylor *et al.,* 2016) reviewed a number of studies on the impact of climate change on soil organisms. It notes, for example, (citing Pritchard, 2011) that studies have shown that increasing CO_2 levels are associated with a shift from fungal-dominated to bacterial-dominated soil food webs and with promotion of mycorrhizal and nitrogen-fixing relationships but also that increasing precipitation generally favours the fungal component of the soil food web, which could mean increases in soil-borne fungal diseases. It further notes (citing Staddon, Heinemeyer and Fitter, 2002; Wardle, 2002; Pritchard, 2011) that the effects of warming are highly variable and have only been investigated over relatively short periods, with some studies suggesting that warming will favour a shift from a bacterial-driven to a fungal-driven food web and some that effects will be most significant on larger soil organisms such as surface-dwelling earthworms.

Lisson *et al.* (2016) note that three of Fiji's native bee species have only been found above 800 m, with one other species widespread below this elevation. They further note that the "current climate predictions are likely to have contrasting impacts on different species. The lower-elevation species that responded positively to the warming climate that followed the last glacial maximum may continue to persist at lower elevations as they appear to be generalist pollinators. However, those species found at higher elevations and which are already comprised of very small populations with lower genetic diversity, are likely to be heavily affected by a warmer climate. Their current restriction to very high elevations raises the possibility that, if mean temperatures continue to increase, they may be unable to persist by retreating to even higher habitats. As pollinators, this

has broader implications for the plant species they interact with and may disrupt angiosperm reproduction in these habitats."

With regard to the effects of climate change on the region's forests, Thomson, Thaman and Fink (2016) note, *inter alia*, that:

- mangroves and coastal forests will be the most-affected forest systems in the region and are likely to need more regular replanting with species that are fast growing and easily established, such as *Hibiscus tiliaceus* and *Pandanus tectorius*;
- forests in riverine situations will be more at risk from flash flooding; and
- montane- and cloud-forest ecosystems are expected to contract and have altered distributions as a result of higher temperature (moving upslope where this is possible).

Damage to montane forests will, in turn, adversely affect water catchment (ibid.). The main negative effects on trees planted outside forests and agroforests will be on those planted close to the sea (within 1 to 2 m of normal high tide) or in areas susceptible to prolonged drought and wildfires (ibid).

Loss of traditional knowledge: Knowledge of the biodiversity in their surrounding habitat was once central to the survival of Pacific Island communities, and community members who held this knowledge were valued. However, this respect for biodiversity is reported to have diminished. Traditional knowledge is being lost with the loss of community elders and there is little documentation of such knowledge. Traditional farming knowledge is also being lost because the younger generation is not interested in farming and/or in consuming traditional food. In the Cook Islands, this is more of a problem in the southern islands, but it is also extending rapidly to the northern atoll islands, which as a result of increased sea and air services are now receiving more processed products.

Impact of fisheries and deep-sea mining on marine flora and fauna: Bottom-trawl fisheries have been a major factor in damaging seabed communities, particularly in biogenic habitats, such as coral reefs, and relatively stable habitats in deeper waters (Van Denderen *et al.*, 2015). In shallow waters that are frequently exposed to natural perturbations by tidal currents or storms, bottom trawling has less impact (Diesing, Stephens and Aldridge, 2013). Considerable damage to deep-water coral communities has been recorded on seamounts near Australia and New Zealand (DSCC, 2017). Deep-sea mining (DSM) is a significant threat in the region. Annual demand for rare-earth elements leapt from 30 000 tonnes in the 1980s to 120 000 tonnes in 2010; this is higher than the world's current annual (terrestrial) production of 112 000 tonnes and hence provides a major motivation for making DSM a viable industry as soon as possible (ibid.). A DSM project was scheduled to begin in 2018 in the Bismarck Sea, 30 km offshore from New Britain Island (Papua New Guinea) at a depth of 1 600 m (Judd, 2016). If successful, this project is likely to be the first of many DSM projects in the Pacific Islands region (ibid.).

1.3. NEEDS AND PRIORITIES

The needs and priorities in terms of the assessment and monitoring of biodiversity for food and agriculture discussed below were identified in the country reports and during the regional consultation.

Gaps in information and knowledge

All countries recognized that in order to monitor components of associated biodiversity within production systems, baseline data on associated biodiversity for each production system are required and that once baselines have been established continuous or systematic monitoring is necessary in order to detect changes. At present, such data are virtually non-existent. All that can be done is to assign associated biodiversity an assumed status of "healthy" or "not healthy" on the

Box 1. Countermeasures taken to reduce adverse effects of drivers on associated biodiversity, ecosystem services and/or wild foods: examples from Palau and Solomon Islands

The Palau Protected Areas Network (PAN)[1] is a nationwide network of terrestrial and marine protected areas that aims to protect areas of significant biodiversity, important habitats and other valuable resources that are essential to the future social, cultural, economic and environmental stability and health of Palau. To date, there are 13 PAN sites (including single and networked sites). These sites have management plans that guide conservation and natural resource management efforts within their borders and are implemented by site conservation officers employed in the states in which the sites are located. All of these managed sites have goals and objectives related to biodiversity conservation. The marine sites provide protection for valuable pelagic resources, allowing them to grow larger, become more abundant and generate higher reproductive output. This benefits fishing within and around Palau and protects biodiversity by reducing bycatch of a wide range of species critical to ecosystem function.

The Arnavons Community Marine Conservation Area (ACMCA),[2] Solomon Islands, was founded in 1995. Since then, the Arnavons have experienced a remarkable recovery. The number of hawksbill-turtle nests laid annually in the Arnavons has doubled and biological surveys show that other species, such as giant clams and trochus, are also thriving. In 2008, the ACMCA won the Equator Prize at the World Conservation Congress in Barcelona, earning recognition for its efforts to alleviate poverty through conservation. The ACMCA has nurtured an appreciation of biodiversity in general and stimulated interest in activities such as sustainable agriculture and beekeeping. Best practices encouraged in the ACMCA benefit associated biodiversity and ecosystem health.

Sources: Adapted from the country reports of Palau and Solomon Islands.

[1] http://www.palaupanfund.org/
[2] http://www.nature.org/ourinitiatives/regions/asiaandthepacific/solomonislands/placesweprotect/arnavon-islands.xml

basis of the general health of the respective ecosystem (assuming that the latter is subject to some assessment).

Assessment and monitoring are constrained by the lack of attention given to knowledge-management systems. There is a need to improve and simplify the collection and documentation of information. Five countries (45 percent) highlighted the need for a knowledge-management system that will enable easy access to information so that it can be readily shared and analysed. This would also help minimize duplication of activities by different projects.

The need to strengthen data collection on wild foods was highlighted by two countries. Such data would enable countries to ascertain which foods are threatened, endangered, rare, extinct, cultivated, abandoned, underutilized and so forth. Data were reported to be needed on the production and consumption trends of wild food resources at the household, island and country levels. The inclusion of wild foods in the next agricultural census was proposed by one country.

Increasing research on the role of BFA was identified at the regional consultation as being important for generating baseline data and knowledge in general and for raising awareness. Research would also help to identify priority species, production systems or ecosystem services within each sector at national and regional levels.

Capacity or resource limitations

Lack of human resources (numbers and capacity) was identified as a constraint in all the islands, but particularly in the smaller islands. Individual staff members often have numerous responsibilities

and many new projects do not account for staffing constraints. Technical capacity can also be limiting, especially in the area of taxonomy. There is also a lack of capacity in the analysis of survey data. Lack of capacity is exacerbated by a lack of cross-sectoral sharing of skills, especially between the environmental and the agriculture sectors.

The large number of treaties and conventions pertaining to biodiversity provide important financial, technical and political support for domestic work. However, the agreements in themselves are constraints to the assessment and monitoring of BFA, in that each has its own reporting and administrative obligations. These obligations place significant demands on small countries with limited human and institutional resources. An active coordinating mechanism that brings stakeholders together to share information pertaining to the various agreements and efficient and effective knowledge-management systems to facilitate information access and sharing would facilitate the assessment and monitoring of BFA.

For the smaller islands, linkages with regional agencies and/or overseas institutes with the relevant expertise should be utilized to strengthen the assessment and monitoring of BFA. Promoting community-based conservation programmes would help not only with conservation but also with monitoring. Shortages of human resources will always be a constraint in the smaller islands and various different approaches will need to be employed to address the problem. Country-to-country arrangements need to be strengthened at the subregional and regional levels.

All countries recognized the importance of strengthening awareness regarding the importance of BFA and increasing knowledge of how BFA links to agricultural productivity, food security and livelihoods. At the regional consultation, countries proposed that knowledge about native species, associated biodiversity and their uses should be integrated into school and university curricula.

Policy and institutional constraints

Political and institutional support for protecting biodiversity needs to be strengthened, particularly through appropriate legislation that covers all types of biodiversity. BFA is linked to water resources, land resources, waste management, food security, culture and many other development issues. However, it is not consistently mainstreamed in national sustainable-development strategies. The enforcement of regulations on biodiversity also needs to be strengthened. For example, the awareness and capacity of quarantine and border controls with respect to biodiversity and introduced species are limited.

Integrated water, land and coastal policy and strategic-plan development (whole landscape) is essential to ensuring that environmental and biodiversity priorities are considered along with development pressures and that all sectors are sending out the same message. The responsibilities of national and regional agencies need to be more-clearly defined. Collaboration needs to be strengthened, so that data collected by one sector are shared with other sectors where they may be of value. Poor monitoring and evaluation deprives decision-makers of the data that they need in order to formulate and revise policy.

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

2.1. SUSTAINABLE USE

2.1.1. Management practices supporting the maintenance and use of biodiversity for food and agriculture

Table 6. Reported trends in the adoption of selected management practices and approaches in the Pacific region

Practice or approach	Production system(s)	Countries reporting	Reported trends in adoption
Agroforestry	Rainfed crops, mixed	Cook Islands, Kiribati, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga	Overall increase
Bush fallowing or shifting cultivation	Rainfed crops, mixed	Tonga	Increase in number of farms, but decrease in length of fallow
Conservation agriculture	Irrigated crops (non-rice), rainfed crops	Cook Islands, Kiribati, Palau	Overall increase
Conservation hatcheries	Self-recruiting capture fisheries, fed aquaculture, non-fed aquaculture	Kiribati, Palau	Increasing
Diversification – broadening the genetic base	Livestock systems, livestock grassland, planted forests, marine and aquaculture, irrigated crops (non-rice), rainfed crops, mixed	Cook Islands, Fiji, Kiribati, Palau, Papua New Guinea, Samoa	Overall increase
Ecosystem approach to aquaculture	Culture-based fisheries, fed aquaculture	Kiribati	Increasing
Ecosystem approach to capture fisheries	Self-recruiting capture fisheries	Cook Islands, Kiribati, Palau	Increasing
Enrichment planting	Mixed	Cook Islands	Not known
Establishment of enclosures	Self-recruiting capture fisheries	Solomon Islands	Recently introduced – too early to comment on trend
Home gardens	Irrigated crops (non-rice), rainfed crops, mixed	Cook Islands, Kiribati, Nauru, Palau, Tonga	Overall increase
Integrated crop management practices	Rainfed crops	Solomon Islands	Decreasing
Integrated multitrophic aquaculture	Fed aquaculture	Kiribati	Increasing
Integrated pest management	Naturally regenerated forests, irrigated crops (non-rice), rainfed crops, mixed	Cook Islands, Fiji, Kiribati, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga	Overall increase
Integrated plant nutrient management	Livestock grassland-based, self-recruiting capture fisheries, irrigated crops (non-rice), rainfed crops, mixed	Cook Islands, Nauru, Palau	Overall increase
Integration of livestock with aquaculture	Livestock landless	Fiji (tilapia with chickens and ducks), Solomon Islands	Fiji – practised on most aquaculture farms for the last 10 years Solomon Islands – recently introduced – too early to comment on trend
Integration of rice production with aquaculture	Rice production	Fiji	Not common, but implemented on very small scale by a few farmers

Table 6 *Cont'd*

Practice or approach	Production system(s)	Countries reporting	Reported trends in adoption
Landscape management	Livestock landless, naturally regenerated forests, planted forests, non-fed aquaculture, rainfed crops, vegetable production	Kiribati, Cook Islands, Niue, Palau, Samoa	Overall increase
Low external input agriculture	Rainfed crops	Cook Islands, Palau	Overall increase
Maintenance and conservation of different tree species	Naturally regenerated forests	Solomon Islands	Recently introduced – too early to comment on trend
Organic agriculture	Livestock landless, rainfed crops, mixed	Cook Islands, Fiji, Kiribati, Niue, Palau, Papua New Guinea Samoa, Tonga	Overall increase
Pollination management	Naturally regenerated forests	Cook Islands	Not known
Restoration practices	Naturally regenerated forests, planted forests, self-recruiting capture fisheries, culture-based fisheries	Cook Islands, Kiribati	Increasing or not known
Sustainable soil management practices	Livestock landless, planted forests, irrigated crops (non-rice), rainfed crops, mixed	Cook Islands, Fiji, Kiribati, Niue, Palau, Papua New Guinea, Samoa	Overall increase

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

Box 2. Examples of programmes supporting biodiversity-based and biodiversity-friendly management practices in the Pacific region

Region-wide: The Pacific Organic and Ethical Trade Community (POETCom)[1] is a not-for-profit membership organization. Membership comprises representatives from 14 Pacific Island countries and territories, including farmers' organizations, non-governmental organizations, private-sector organizations and research institutions. POETCom has established a regional certification scheme that aims "to 'grow' the organic and ethical trade movement and contribute to a productive, resilient, sustainable and healthy Pacific Islands region." Products that successfully pass the Pacific Organic Standard certification process can carry the Organic Pasifika certification mark, which provides an organic guarantee to buyers. Countries that have developed or are developing organic markets include Cook Islands, Fiji, Kiribati, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands and Tonga.

Papua New Guinea: A five-year project, funded by the European Union and implemented by the National Agriculture Research Institute, used a participatory approach to help communities determine their needs with regard to climate change adaptation. A major focus was the diversification of production systems with new crop species and crop varieties. The aim of the diversification was to shorten the period when food supply is scarce because of the season or because of unfavourable weather and to broaden the genetic diversity of crop species for better resilience to climatic variability. The project also introduced new livestock species (ducks and goats), livestock production systems (aquaculture and duck–fish integration) and livestock-management practices.[2]

Tonga and Nauru: Tonga Health's "Give me Five Programme"[3] focuses on home gardening, encouraging householders to grow fruit and vegetables for consumption for good health. The programme promotes the planting of diverse fruit trees at the household level, in combination with various types of introduced and local vegetables. Nauru had a similar programme – "Grow and Green" – that promoted the planting of local fruit trees in communities, with the aim of improving food security and soil fertility and building local capacity in tree planting.

Sources: SPC 2015a and the country reports of Nauru, Papua New Guinea and Tonga.

[1] http://www.organicpasifika.com/poetcom
[2] https://euardproject.wordpress.com/about
[3] http://www.tongahealth.org

2.1.2. Diversity and productivity, food security and nutrition, rural livelihoods, ecosystem services, sustainability, resilience and sustainable intensification

There are numerous examples of how a lack of diversity has resulted in significant food-security issues and/or ecosystem damage. There are also examples of the huge role that diversity plays in strengthening food security and improving nutritional and environmental health. Some examples are given below, but there are many more. It is also far easier to see the impact of lack of diversity than the benefits of diversity – these often go unseen and unrecorded. Limited human and financial resources are a constraint to conducting diversity impact studies.

Lack of diversity

Fiji: With increasing demand for taro overseas, traditional shifting cultivation practices changed to more intensive monocropping systems favouring a single variety of taro for the specialized market. The traditional slash-and-burn system gave way to systemic herbicide-based land clearing and fertilizer was used to obtain maximum yields from a limited agricultural land area. In 1994, there were 23 000 ha of arable land in Taveuni. The area under cultivation remains the same today. However, the number of taro growers has increased, leading to repeated cultivation of the same area of land. Nutrient loss through crop harvest and topsoil erosion has led to significant yield losses. The export industry requires taro corms to be between 1 kg and 3 kg, but currently about 40 percent of the produce is below the minimum standard.

Kiribati: Only one variety of breadfruit (the bukiraro variety) is commonly and widely grown on Butaritari Island, where it is a main staple food. Because of the susceptibility of this variety to anthracnose, an outbreak of this disease in 2002 caused breadfruit yield to fall by approximately 70 percent. Rural livelihoods, food security, resilience and the productivity of breadfruit trees were all directly affected.

Nauru: Years of phosphate mining severely degraded the environment of Nauru and had a detrimental effect on biodiversity. The impact of the lack of local food production and therefore use of BFA is evident from the level of type 2 diabetes and obesity in the country – Nauru has the highest rates of type 2 diabetes in the world, with 40 percent of its inhabitants affected by the condition. Moreover, 71 percent of the population is obese and 97 percent of men are overweight; the figure is only marginally smaller for women (Wood, 2015). The history of diabetes in Nauru closely parallels the rise and fall of the country's economic wealth from phosphate mining over the second half of the twentieth century (Colagiuri and Thu Win Tin, 2009). The people of Nauru used to eat a low-fat diet of fish and native fruit and vegetables and lived a relatively physically active life (ibid.). However, by the 1970s Nauru had become one of the wealthiest countries in the world, and with this wealth and associated lifestyle changes came one of the highest rates of diabetes in the world (ibid.).

Samoa: Export demand for taro in the late 1980s and early 1990s led to the establishment of a production system that relied on one variety of taro, i.e. a monocropping system. The variety used was susceptible to *Phytophthora colocasiae* (taro leaf blight), which wiped out taro production in Samoa, with huge implications for food and nutritional security. A significant export market was lost and has only recently been revived thanks to investment in a breeding programme for over ten years. Not only was taro the country's most important export crop, it was the traditional staple and taro leaves provided the main green leafy vegetable in Samoa – a vital source of vitamins and minerals.

Tonga: Squash production started in 1987 and peaked in 1993 (when total production reached 18 499 tonnes). It had a heavy toll on soil fertility, biodiversity and many ecosystem services. Large areas of land were cleared and the importation of fertilizers and pesticides soared.

Benefits of diversity

Kiribati: Food and income security are strengthened through the use of an integrated system of farming milkfish, sandfish sea cucumber and seaweed. Seaweed and sandfish sea cucumber provide an income and milkfish provides food at times when weather conditions prevent fishing.

Niue: Tamakautoga and Vaiea Vegetable Garden Projects are initiatives that use diversity in vegetable production to demonstrate how families can work together to supply vegetables for home consumption and as an avenue for families in the community to earn income by selling their produce.

Palau: More than a hundred varieties of taro are grown in Palau, and traditionally Palauans grow a wide range of taro varieties in any given taro patch, thereby reducing vulnerability to pest and disease attack and strengthening climate resilience. When Samoa lost all its taro to taro leaf blight disease in the early 1990s, Palau was able to provide varieties with tolerance to taro leaf blight.

Papua New Guinea: Çrop diversity is used to enhance the resilience of food production systems, especially to drought and salinity. Tolerance of these abiotic stresses has been identified in local varieties, and planting material from these varieties has been distributed to farmers. This approach proved to be successful in sustaining food security during the 2015–2016 National Drought, when 40 percent of the country's 7.5 million people were affected to category 4 and 5 levels.

Table 7. Examples of use of biodiversity for food and agriculture to cope with climate change, invasive alien species or natural or human-made disasters in the Pacific region

Objective	Countries	Description
Use of BFA to adapt to and mitigate climate change	Cook Islands, Fiji, Kiribati, Nauru, Palau, Papua New Guinea, Samoa, Tonga	- Use of salt-tolerant taro varieties. - Diversification of root crops and rice varieties. - Diversification in food gardens. - Selection and evaluation of Fiji coconut tall populations. - The majority of countries have a national strategy in place for adaptation to climate change. Most of these strategies embed the conservation and efficient utilization of BFA. The emphasis is mainly on the diversification of crops and trees to support adaptation. - The GEF-funded ridge-to-reef projects in 14 Pacific Island countries have as their goal "to maintain and enhance Pacific Island countries' ecosystem goods and services (provisioning, regulating, supporting and cultural) through integrated approaches to land, water, forest, biodiversity and coastal resource management that contribute to poverty reduction, sustainable livelihoods and climate resilience." - Base-broadening of marine species, for example introduction of resistant species of sea cucumber that can cope with high temperatures.
Use of BFA to manage the spread/control of invasive alien species	Cook Islands, Fiji, Kiribati, Palau, Papua New Guinea, Niue, Samoa, Solomon Islands	- There are quite a few cases in which BFA has been used to slow the spread of invasive alien species. Examples include biological control of *Chromolaena odorata* (Siam weed) with the gallfly *Cecidochares connexa*, control of *Mimosa diplotricha* (giant sensitive plant) using the psyllid insect *Heteropsylla spinulosa* and use of pasture species (*Setaria*) to control a common invasive sedge (Navua sedge)
Use of BFA to prevent natural or human-made disasters and/or reduce their effects on livelihoods, food security and nutrition	Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu	- Mangrove planting in Kiribati: 37 000 seedlings planted – funded by Kiribati Adaptation Programme Phase 11 (World Bank, 2011).
	Papua New Guinea	- The Mangrove Rehabilitation for Sustainably-Managed Healthy Forests (MARSH) Project in aims to build capacity and strengthen sustainable mangrove management at the local and national levels (IUCN, 2012b).
	Fiji, Samoa, Solomon Islands, Tonga, Vanuatu	- Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (MESCAL) is a regional project that is being implemented in and under the guidance of the International Union for Conservation of Nature. Activities focus on the protection of mangrove ecosystems and have included improvement of baseline knowledge on the biological, economic, social and cultural aspects of mangrove resources (IUCN, 2012a).
	Fiji, Niue, Papua New Guinea	- Distribution of crops and varieties after natural disasters – usually sweet potato varieties best suited to "difficult" conditions

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

2.1.3. Ecosystem, landscape and seascape approaches[26]

GEF-funded Ridge-to-Reef projects are being implemented in 14 countries[27] with the goal of maintaining and enhancing ecosystem goods and services (provisioning, regulating, supporting and cultural) through integrated approaches to land, water, forest, biodiversity and coastal-resource management that contribute to poverty reduction, sustainable livelihoods and climate resilience. For example, a project in Tonga is seeking to conserve the ecosystem services of the Fanga'uta Lagoon Catchment on Tongatapu – the objective of the project is to conserve the ecosystem services of the Fanga'uta Lagoon through an integrated land, water and coastal management approach and thereby protect livelihoods and food production and enhance climate resilience. The objective of the Fiji project is to preserve biodiversity and ecosystem services, sequester carbon, improve climate resilience and sustain livelihoods through ridge-to-reef management of priority watersheds in the two main islands of Fiji.

The Island Biodiversity project, implemented in the Cook Islands, Nauru, Tonga and Tuvalu, was a three-year initiative under which countries and their local communities developed and strengthened management actions supporting threatened species and ecosystems and the sustainable use of natural resources (SPREP, 2012b). The project promoted activities that used an integrated ecosystem-based management approach that emphasized the connectivity between systems (e.g. between land and sea and people) (ibid.).

Marine and Coastal Biodiversity Management in the Pacific Island States and Atolls (MACBIO):[28] Implemented in Fiji, Kiribati, Solomon Islands, Tonga and Vanuatu (2013–2018), the project aimed to showcase best practices for the management of MPAs (including payments for environmental services), and to use exemplary areas to demonstrate the ensuing benefits.

Coral Triangle Initiative:[29] The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI–CFF), formed in 2007, is a multilateral partnership between the six Coral Triangle countries (including Papua New Guinea and Solomon Islands). CTI-CFF was established to address the urgent threats facing the coastal and marine resources of one of the most biologically diverse and ecologically rich regions on Earth.

Kiribati: In 2006 Kiribati established the massive Phoenix Island Protected Area (PIPA),[30] covering 408 250 km2. The country adopted formal regulations for PIPA in 2008 and more than doubled the original size of the protected area. PIPA became a UNESCO World Heritage Site in 2010. Closing PIPA to commercial fishing provides an opportunity for tuna populations in and around Kiribati's waters to regenerate.

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[26] The ecosystem approach concept is generally understood to encompass the management of human activities, based on the best understanding of the ecological interactions and processes, so as to ensure that ecosystems structure and functions are sustained for the benefit of present and future generations. Ecosystem approaches include the Convention on Biological Diversity's Ecosystem Approach, Integrated Land Use Planning, Integrated Water Resource Management, Sustainable Forest management, Code of Conduct for Responsible Fisheries, Ecosystem Approach to Fisheries management, etc. According to the World Bank, "a landscape approach" means "taking both a geographical and socio-economic approach to managing the land, water and forest resources that form the foundation – the natural capital – for meeting our goals of food security and inclusive green growth. … By taking into account the inter-actions between these core elements of natural capital and the ecosystem services they produce, rather than considering them in isolation from one another, we are better able to maximize productivity, improve livelihoods, and reduce negative environmental impacts" (World Bank, 2012b).

[27] Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.

[28] http://macbio-pacific.info

[29] http://www.coraltriangleinitiative.org

[30] http://www.phoenixislands.org

Niue: The establishment of a marine protected area (MPA) at Beveridge Reef recognizes the link that is thought to exist between the Reef and mainland Niue. Beveridge Reef serves as a source of recruitment for clams and other marine species that make up Niue's coral reefs.

Palau: The Ngardok Nature reserve[31] is the first designated Ramsar Wetland Site of importance in the region. Lake Ngardok is the largest natural lake in Micronesia. The traditional leaders of Melekeok established the Ngardok Nature Reserve to protect the watershed from degradation. The special qualities of the lake and integrity of the forests above the lake are critical to preserving water quality.

Papua New Guinea: Kimbe Bay's rich marine biodiversity is at risk from local threats such as overfishing, sedimentation, pollution and increasing human populations. Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific Project (Phase II)[32] is building on coastal management work in Kimbe Bay, with a focus on managing land-based threats and identifying livelihood opportunities through ecologically sustainable economic development, and extending ecosystem-based coastal fisheries management in Manus Island.

Samoa: The Togitogiga Catchment is WANI's (IUCN Water and Nature Initiative)[33] selected demonstration project in Samoa (IUCN, 2010). Located on the eastern Upolu Island, Togitogiga is the main source of water supply for downstream communities and has a unique biodiversity. It is also well known for recreational significance as part of the Togitogiga National Park. This catchment area has become significantly degraded as a result of increasing population and development pressures, soil erosion, sedimentation and water pollution. The project aims to develop and implement a watershed management plan that creates a balance between anthropogenic demands on the catchment and biodiversity conservation.

2.1.4. Traditional knowledge of associated biodiversity and wild foods

The following examples of activities undertaken in the region to maintain and use traditional knowledge of associated biodiversity and wild foods were reported by countries.

Ra'ui, or traditional bans, have been a resource-management and governance system in the Cook Islands for centuries. Ra'ui may be total bans on access to an area or bans on particular marine resources. They may be permanent, but more frequently they tend to be periodic or temporary. The use of Ra'ui declined in the 1970s in the main and most developed island, Rarotonga. However, the late 1990s saw a revival of the Ra'ui system and Ra'ui were reinstated in six different lagoon areas around Rarotonga. Most communities see the Ra'ui as a way of replenishing stock. When needed, the village can harvest according to a predetermined quota per household. There is a growing recognition of the benefits that Ra'ui can provide to tourism.

A similar system exists in Palau. Bul is a traditional way of conserving certain marine species during times of low availability. Bul involves the Council of Chiefs placing reef areas off limits to fishing during known fish-spawning and feeding periods. This traditional "ban" respects vulnerabilities in the ecosystem while ensuring sufficient numbers of fish are available to catch during other times of the year. The bul system has become the basis for Palau's network of protected areas and its new Protected Area Network law.

Fiji: The Taukei Affairs Board and National Archives document traditional knowledge and the Ministry of Agriculture and Ministry of Information documents traditional farming systems. Mass media – mostly television – are used to publicize and promote the use of traditional knowledge in

[31] http://www.palaupanfund.org/ngardok.html
[32] https://www.adb.org/projects/43427-012/main
[33] http://www.waterandnature.org/initiatives/water-and-nature-initiative

food systems. The village system also helps to pass on traditional knowledge, for example on the hunting of wild pigs and traditional cultivation of yams and other crops.

Kiribati: Linking traditional uses and culture to present-day needs for energy is encouraging the sustainable use of *Pandanus* spp., which are important for mat weaving and for the production of traditional dancing skirts. A project is promoting the use of firewood from pandanus in efficient stoves and at the same time reinforcing the cultural importance of pandanus for mats and traditional dress. The efficient stoves reduce smoke inhalation and the quantity of pandanus required. The pandanus trees also provide food (fruit) and herbal medicine. The project encourages the replanting of pandanus to ensure a secure supply to satisfy all needs.

Niue: The local processing of arrowroot starch for food is an ongoing traditional practice. The arrowroot (*Tacca* spp.) is an annual crop that grows in the wild and is harvested during April and May of each year. The starch is processed to make local dessert dishes such as *nane* (local pudding) and *pitako* (local bread). The traditional methods of processing arrowroot are still very strong among the Niuean people.

Papua New Guinea: Certain cultural practices help build up the genetic biodiversity of food crops. For example, when a bride leaves her parents' home village to join the family of her bridegroom, she usually takes seeds or seedlings of food crops presented by her parents and relatives during the wedding. In this way, new varieties of crops and knowledge of how to cultivate them are spread from one community to another. This practice also works to strengthen the conservation of genetic materials through duplication. Farmers in Papua New Guinea use natural insect-repelling plants such as ginger, lemon grass, chilli and even floral plants such as marigold. The National Agriculture Research Institute has developed formulas for using these plants as "plant derived pesticides" (PDPs) and provides training for many rural farmers on the use of PDPs.

Solomon Islands: With specific reference to traditional knowledge, the Solomon Islands Nasinol Policy Framework blong KALSA (SPC and Government of Solomon Islands, 2012) states that as "a culture thriving predominantly on oral tradition, much of the country's wealth of traditional knowledge risks being lost over time due to lack of research and documentation." The framework addresses intellectual property rights in traditional knowledge, stating that "the rights of customary owners of traditional knowledge must be protected through legal and non-legal measures" (ibid.). It also addresses the commercialization of traditional knowledge and the issue of individual versus collective ownership of intellectual property rights and states that "customary owners and communities should benefit equally and equitably from the use of their cultural resources. Similarly, traditional knowledge to which no individual claim can be proved must be treated as the *common heritage* of tribes, communities, islands, or cultural and linguistic groups" (ibid.).

2.1.5. Needs and priorities

The needs and priorities in terms of the sustainable use of biodiversity for food and agriculture, and in particular of associated biodiversity and wild foods identified in the country reports and at the regional consultation, addressed four areas: linking associated biodiversity and production systems; policy support and enabling environment; traditional knowledge; and data, information and information sharing.

A key priority for countries is that national policies and strategies support the sustainable use of BFA. Cross-sectoral collaboration with regard to policies, strategies and action plans is vital to ensure that the importance of BFA to all sectors is acknowledged. Land-management policies, especially those addressing long-lease sale of large areas of land, should limit production practices that are likely to be detrimental to associated biodiversity and ecosystem health. Papua New

Guinea highlighted the importance of policies that support base-broadening/diversification efforts, where appropriate.

Increased awareness and education for all stakeholders, including decision-makers, researchers, producers and consumers, is needed in order to highlight the multifunctionality of agriculture and the interconnectedness of biodiversity, ecosystem functioning and human health. With reference to the latter, increased efforts are needed to raise awareness of the connection between poor diet and nutrition (generally imported food) and significant health problems and to nurture linkages between health, agriculture, biodiversity and climate change adaptation and mitigation. The solution to all the challenges is the same – again this highlights the importance of effective cross-sectoral collaboration.

The benefits of diversity-based practices need to be more clearly defined. Therefore, there is a need to expand knowledge of these benefits through relevant research and effective outreach, including: (a) identification of associated biodiversity found within different production systems; (b) improving knowledge of how management practices and diversity-based interventions influence BFA; and (c) improving knowledge of (technical/field) management practices and diversity-based interventions that support the sustainable use of BFA.

The importance of promoting the benefits of diversity-based practices also highlights the need to improve knowledge-management systems and the documentation and sharing of information. A significant volume of research output is not documented, partly because of limited human-resource capacity, but also because insufficient importance is allocated to documentation. "Stories" of how traditional knowledge can strengthen the sustainable use of BFA should also be recorded and promoted. Nauru reported on the outcomes of the Nauru BIORAP, which prioritized working with local communities to sustainably utilize marine and terrestrial resources – this approach facilitates the targeting of needs such as awareness, education and traditional knowledge (McKenna, Butler and Wheatley, 2015).

Six countries identified certification systems, such as organic certification, as an important mechanism for encouraging sustainable practices in production systems. Market creation for products or services provided by ecological agriculture may be important in ensuring long-term adoption of sustainable practices, substituting public financial support after an initial phase.

2.2. CONSERVATION

2.2.1. *In situ* conservation

The region has a significant number of protected areas and marine sanctuaries that support *in situ* conservation. Protected areas are a recognized mechanism for protecting species and preventing the loss of habitat. They enable relatively large areas of land and sea and the biodiversity associated with them to be protected. Many of the MPAs include coral reefs and mangroves. At least 7.5 million people in the Pacific Islands live in coastal areas within 30 km of a coral reef, about 50 percent of the total population (Burke *et al.*, 2011). Pacific Islanders value mangroves as a resource for a wide range of associated biodiversity and wild foods, including their role in supporting seafood important to local diets, protecting coastlines and development from coastal hazards, supporting good water quality and providing natural materials used in traditional practices such as dye from mangrove bark used in tapa and to treat textiles, nets, and fish traps (Gilman *et al.*, 2006). Monitoring protected areas and tracking species are, however, often constrained by a lack of resources.

Cook Islands: Bird species are protected in the Takitumu Conservation Area, Rarotonga, the inland Makatea forest, Mangaia, and the Makatea forest, Atiu – naturally regenerated forest areas. There is also a whale sanctuary (2.2 million km^2), which supports self-recruiting capture fisheries.

Fiji: Farmers are conserving a wild yam species (*Dioscorea bulbifera*) known as "Bulou" in its natural habitat. Efforts are being made to conserve this species due to its importance to food

security and diversity. Other conservation efforts include *in situ*/on-farm conservation of Fiji dwarf coconuts or "Niu Leka" (unique to Fiji) and *in situ* conservation of edible fern (*Diplazium esculentum* and *D. proliferum*). Efforts have been made to domesticate this fern. However, they failed due to its very specific cultivation requirements.

Locally managed marine areas (LMMA) are found in 143 of Fiji's 410 *i-qoliqoli*[34] areas, with 415 tabu (no-take) areas covering over 960 km^2. The first LMMA site, established in 1997, covered 24 ha and was set aside for clams. In 2002, this project was awarded the Equator Prize, which recognizes sustainable development solutions and resilient communities. A socio-economic impact study in 2005 reported a 130 percent increase in household income for 600 people. The Navakavu LMMA site in Fiji has received support from the local community because they have observed a positive change in the fish stock, an increase in abundance and size of fish and invertebrates, restoration of corals and a general comeback of marine life (CBD, 2008).

Kiribati: Phoenix Island Protected Area (PIPA)[35] is a national initiative supported by international partners aimed at conserving the rich marine and terrestrial diversity of the Phoenix Islands. In 2010, it became a World Heritage Site. The area serves as a genebank for restocking fish species that are declining and threatened in the Gilbert Island group. Maintaining a healthy ecosystem that supports good fish stocks is essential for food security and economic development in Kiribati.

Niue: Niue has two terrestrial conservation and protected areas – Huvalu Conservation Area (IUCN Category VI) and Hakupu Heritage and Cultural Park (IUCN Category III). Anono Marine Reserve, formerly known as Namoui (IUCN Category VI), is an MPA.

Palau: The Palau National Marine Sanctuary Act[36] establishes one of the world's largest protected areas of ocean. The sanctuary will fully protect about 80 percent of the nation's maritime territory, a higher percentage than in any other country. Full protection means that no extractive activities such as fishing or mining can take place. The reserve covers 500 000 km^2. Palau has also established the first Shark Sanctuary, covering roughly 600 000 km^2. The sanctuary protects over 135 western Pacific shark species, as well as rays – species that are vital to the balance of the ocean's ecosystems.

Papua New Guinea: Papua New Guinea has a vast number of protected areas, and the government's commitment to these areas is reflected in the Papua New Guinea policy on Protected Areas (Government of Papua New Guinea, 2014). The policy covers national protected areas, including national parks, marine sanctuaries, national heritage areas and special management areas, which will be gazetted under national legislation; and regional protected areas, including community conservation areas and locally managed marine areas, which will be gazetted through provincial government legislation. The YUS (Yopno, Uruwa and Som rivers) National Conservation area in Morobe Province, established in 2009, covers 76 000 hectares of tropical rainforest to conserve a number of species and is considered a prime example of a successful protected area in Papua New Guinea. In wildlife management areas (IUCN Category VI), local communities voluntarily agree to certain controls on the exploitation of wild food, instituting measures such as establishing royalties for the taking of deer, duck and fish by outsiders, hunting restrictions, such as forbidding all but traditional hunting methods, the use of shotguns and the use of dogs, prohibiting the collection of crocodile eggs, fishing restrictions, such as forbidding the use of commercially manufactured nets, hurricane lamps and fish poisons, and restrictions on logging (McNeely, 1995).

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[34] An *i-qoliqoli* is a customary fishing ground that extends from the high-tide water mark along the shoreline to the outermost reef crest (i.e. it can be either a fringing or a barrier reef). Hence, an *i-qoliqoli* may consist of the following biophysical features: shoreline with mudflats and/or beaches; mangrove ecosystem, fringing reef system, lagoon and barrier reef system. (Korovulavula *et al.*, 2008)

[35] http://www.phoenixislands.org

[36] Palau National Marine Sanctuary Act (RPPL No. 9-49 of 2015) (available at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC152765).

Samoa: MPAs are large, community-based, multiple-use areas governed by a number of villages (9 villages in the case of Safata, and 11 villages for Aleipata).

Solomon Islands: MPAs such as Arnavon Islands and the Tetepare Island.[37] The whole of Tetepare Island is protected from commercial resource extraction, but low levels of artisanal resource use by local villagers are allowed in some areas. Additionally, a 13 km-long MPA was established to provide a protected nursery ground for marine species. Communities in the Arnavon Islands depend on the marine environment for their livelihoods, including fishing, sea-cucumber harvesting, trochus-shell collection (for making buttons) and seaweed farming. The establishment of the MPA in 1995 empowered local people to improve their lives through managing the resources (wild food) they depend on and ensuring a healthy ecosystem to sustain these resources (CBD, 2008).

Species and groups of species that are being conserved in situ *and conservation objective(s)*
Data on species and groups of species being conserved are limited – reflecting resource constraints:

- Cook Islands: Rarotonga flycatcher (*Pomarea dimidiate*), Rarotonga starling (*Aplonis cinerasreus*), Cook Islands fruit dove (*Ptilinopus rarotongensis*), Mangaia kingfisher (*Todiramphus ruficollaris*), Cook Islands reed warbler (*Acrocephalus kerearako*) and Atiu swiftlet (*Collocalia sawtelli*). The conservation objective is to increase and maintain the populations of the species.
- Fiji: wild yam, dwarf coconuts and edible ferns (*Diplazium esculentum* and *D. proliferum*) and clams.
- Kiribati: PIPA – wild birds, sharks, crabs, tuna, corals and other marine and terrestrial species are protected and conserved.
- Niue: pigeons and flying foxes are protected and the capture and use of the uga-coconut crab is regulated.
- Palau: more than 1 300 species of fish and 700 species of coral are found in the protected area and over 135 western Pacific shark species in the shark sanctuary.
- Papua New Guinea: species of eastern long-beaked echidna and Matsie's tree kangaroos, New Guinea pademelon, leatherback sea turtle and Wahnes's bird of paradise are being monitored.
- Solomon Islands: Tetepare Island – monitoring programmes have been established for turtles, seagrass, coconut crabs, reef check, forest, fish and trochus.

Existing subregional/regional in situ *conservation initiative(s)*
The Framework for Nature Conservation and Protected Areas in the Pacific Islands Region 2014–2020 (SPREP, 2014) provides 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 goal of the GEF-PAS Integrated Island Biodiversity project is "to conserve ecosystems, species and genetic diversity in the Pacific region." The project is focusing on improved systems and processes, including resource assessment and monitoring, legislation and capacity and awareness building. Countries involved include Cook Islands, Nauru, Tonga and Tuvalu.

Marine and Coastal Biodiversity Management in the Pacific Island Countries (MACBIO)[38] is being implemented in Fiji, Kiribati, Solomon Islands, Tonga and Vanuatu (2013–2018).

The Micronesia Challenge[39] is a commitment by the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, Guam and the Commonwealth of the

[37] http://www.tetepare.org
[38] http://macbio-pacific.info
[39] http://www.micronesiachallenge.org

Northern Marianas Islands to preserve the natural resources that are crucial to the survival of Pacific traditions, cultures and livelihoods. The Challenge represents more than 20 percent of the Pacific Island region and 5 percent of the largest ocean in the world. The overall goal of the Challenge is to effectively conserve at least 30 percent of the near-shore marine resources and 20 percent of the terrestrial resources across Micronesia by 2020.

The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF)[40] is a multilateral partnership of six countries formed in 2007 to address the urgent threats facing the coastal and marine resources of the Coral Triangle, which is one of the most biologically diverse and ecologically rich regions on Earth and is defined by its extremely high marine biodiversity. Over 100 million people living in its coastal zones use this biodiversity to support their livelihoods. Papua New Guinea and Solomon Islands are the two Pacific Island country partners in this initiative.

The Dugong and Seagrass Conservation Project[41] aims to enhance the conservation of dugongs (*Dugong dugon*) and their associated seagrass ecosystems in eight countries in the Indo-Pacific region, including Solomon Islands and Vanuatu. The project works with 32 local communities and is the first coordinated global effort to conserve dugongs and their seagrass habitats. The project aims to mobilize community participation and ownership of dugong and seagrass conservation, focusing on introducing sustainable fisheries practices and innovative financial incentives, establishing locally managed marine protected areas (LMMPAs), and mainstreaming dugong and seagrass conservation priorities into national and regional policies and planning.

The GEF-funded Forestry and Protected Area Management Project (FPAM)[42] in Fiji, Niue, Samoa and Vanuatu is designed to strengthen the capacity of these countries to arrest the continuing loss and degradation of their native forests and at the same time to sustainably improve the livelihoods of rural populations who depend on biodiversity.

In 2012, the BirdLife Pacific Partnership[43] started a new four-year European Union-funded regional invasive-species programme, which seeks to reduce the spread and the environmental and socio-economic impact of invasive alien species by supporting the eradication and control of invasive alien species and enhancing biosecurity in the Cook Islands, Fiji, Palau, Samoa, French Polynesia and New Caledonia (Birdlife International, 2012).[44]

2.2.2. *Ex situ* conservation

There are no examples of *ex situ* conservation of associated biodiversity in the region, except for herbarium samples in Papua New Guinea and Solomon Islands. The Government of Solomon Islands currently runs the National Herbarium and Botanical Gardens,[45] while the herbarium at the University of the South Pacific, Fiji, maintains 25 000 other specimens from Solomon Islands. Collaboration between the Government of Solomon Islands and Taiwan's National Museum of Natural Science and Dr Cecilia Koo Botanic Conservation Centre is supporting capacity building in the conservation of the country's plant resources.

The National Herbarium in Lae, Papua New Guinea,[46] which was established in 1946, holds 350 000 plant samples and is probably the largest in the South Pacific. The plant samples were collected in Papua New Guinea, on the Island of New Guinea, in Solomon Islands and in 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 pteridophytes, which include 130 fern families, and more than 150 families of lichens and liverworts.

[40] http://www.coraltriangleinitiative.org
[41] http://www.dugongconservation.org
[42] https://www.thegef.org/project/pas-forestry-and-protected-area-management
[43] http://www.birdlife.org/pacific/partnership/about-us-pacific-partnership
[44] http://www.birdlife.org/pacific/news/birdlife-pacific-invasive-species-programme
[45] http://www.pacificherbaria.org/collections/misc/collprofiles.php?collid=18
[46] http://www.pngplants.org

In Solomon Islands, the Nasinol Local Kaikai Framework (Government of the Solomon Islands, 2014) encourages the production of local food crops, and therefore promotes the conservation and utilization of these resources.

In Tonga, the initiative taken by a private business, 'Ene'io Enterprise Ltd, to establish a 22 acre (8.9 ha) botanical garden for the purpose of providing ecotour services to the community and visitors to Vava'u stands out as a model for public awareness raising, but also contributes to *in situ* conservation.

Several countries have genebanks that maintain accessions of important staple food crops such as taro, banana and yam. Papua New Guinea has relatively large collections of these crops in genebanks, reflecting the diversity found in the country. Wild foods are only conserved in community and household gardens for food security. Fiji has *ex situ* collections of wild yams and the traditional nut *Barringtonia edulis* and is also considering *ex situ* conservation of feral pigs and wild chickens because of their inherent resilience to climate change.

Existing subregional/regional ex situ *conservation initiatives*

The EU-funded Enhanced Food Security through Preservation and Improvement of Genetic Diversity of Sweet Potato and Aibika Project is a collaborative research project between the National Agriculture Research Institute of Papua New Guinea and the Ministry of Agriculture and Livestock of Solomon Islands.

The Royal Botanic Gardens Kew (United Kingdom) has signed a ten-year agreement to work with the SPC in supporting and implementing plant conservation activities in the Pacific region (RBG Kew, 2014). Kew will cooperate with SPC's Pacific Island Tree Seed Centre to conduct seed conservation activities in Fiji (ibid.).

The SPC Centre for Pacific Crops and Trees[47] supports SPC member countries in conserving agricultural biodiversity and has established significant collections of the staple food crops of the Pacific.

The Fiji Herbarium at the University of the South Pacific[48] 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.

2.2.3. Needs and priorities

All countries felt that needs and priorities in terms of the conservation of BFA, and in particular associated biodiversity and wild food species, are similar to those identified for sustainable use and that conservation should ideally be linked to use. For associated biodiversity, and to some extent wild food species, the main priority is to increase the awareness of all stakeholders/actors regarding the importance of these resources and the role they play in food security and agriculture, and therefore health.

All countries agreed that there is a need to generate and disseminate knowledge on linkages between production, conservation and ecosystem services and that improving access to information relevant to the sustainable use and conservation of BFA is a priority. More research and analysis are required in order to better understand countries' BFA conservation needs and determine how best to improve the monitoring and evaluation of conservation outcomes. Palau reported on how ant functional groups can be used as bio-indicators for monitoring the health of its forest ecosystems and thereby help in determining conservation needs.

All countries agreed that relevant policies at national and sectoral levels should be assessed to ensure that they adequately address BFA conservation and do not have a negative impact on

[47] http://lrd.spc.int/the-centre-for-pacific-crops-and-trees-cepact
[48] http://www.usp.ac.fj/index.php?id=ias_herbarium0

BFA. Ensuring that development activities do not threaten areas of high conservation potential requires close coordination and collaboration between sectors. Samoa emphasized the need for close coordination between the agriculture and environment sectors, as this will help to ensure that planned expansion in agriculture does not have a negative impact on sensitive habitats such as catchment areas, riparian strips, slopes prone to erosion and slips, and areas earmarked for biodiversity conservation. Tonga, drawing on the results of the Vava'u BIORAP study (Atherton, McKenna and Wheatley, 2014), reported that there is a need to improve regulation and enforcement of regulations related to conservation areas such as national parks in order to protect the associated biodiversity and wild foods found in these areas. Management strategies should address the spread of invasive species such as *Merremia peltata*.

Palau highlighted the need to promote increased use of ridge-to-reef, landscape and ecosystem approaches. These holistic approaches raise awareness through community involvement and promote conservation and livelihood approaches that support sustainable use and reduce pressures on threatened resources. They support capacity building at all levels, including at community level – thereby enabling communities to become informed partners in land-use planning. Australia, in its Fifth National Report to the Convention on Biological Diversity (Government of Australia, 2014), reported that focusing on landscape-scale and ecosystem approaches to conservation and habitat protection, including by building the connectivity of fragmented ecosystems, has proved to be a useful way of improving conservation outcomes.

All countries agreed that determining conservation needs requires improved monitoring and data gathering. However, many countries do not have the relevant skills, let alone the funding to do this. Access both to financial resources and to taxonomic expertise thus needs to be improved, the latter requiring improvements to capacity building and/or sharing of skills across the region. Linked to the need to improve monitoring and data collection is the need to strengthen knowledge management so that data and information can be easily accessed and shared.

All countries agreed that capacity building, whether at national, subregional or regional level, is needed in order to support the development of *in situ* and *ex situ* conservation strategies, including priority setting and the development of conversation technologies. Capacity limitations mean that there is a need to take a rational approach to determining "who does what and where." The presence of several regional agencies already involved in conservation means that the region is well placed to develop a regional approach to addressing identified priorities. *In situ* conservation offers the advantage of allowing natural selection to act. This cannot be recreated *ex situ*, but if habitat destruction is inevitable then priority species often need to be taken into *ex situ* conservation before they become extinct *in situ*. *Ex situ* strategies also provide the opportunity to study the biology of the conserved species and to understand threats to their survival species, thus allowing the development of more effective programmes to support their future viability.

2.3. ACCESS AND EXCHANGE

Table 8. Reported measures regulating access and benefit-sharing for biodiversity for food and agriculture in the Pacific region

Components of BFA	Description of measures governing access to BFA and ensuring the fair and equitable sharing of benefits arising from its use	Countries
Genetic resources		
PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) Contracting Parties to the ITPGRFA make plant genetic resources for food and agriculture available within the framework of the Treaty's Multilateral System. Parties wishing to provide and receive material under the Multilateral System use the Standard Material Transfer Agreement.	Contracting parties: Australia, Cook Islands, Fiji, Kiribati, Marshall Islands, Palau, Papua New Guinea, Samoa, Tonga, Tuvalu

Table 8 *Cont'd*

Components of BFA	Description of measures governing access to BFA and ensuring the fair and equitable sharing of benefits arising from its use	Countries
Genetic resources that are covered by the Convention on Biological Diversity and related traditional knowledge	The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol) The Nagoya Protocol, which entered into force on 12 October 2014, provides a legal framework for the effective implementation of the fair and equitable sharing of benefits arising out of the utilization of genetic resources.	Parties: Fiji, Marshall Islands, Micronesia (Federated States of), Samoa, Palau, Tuvalu, Vanuatu
Forest genetic resources	Material Transfer Agreement with the Pacific Community (SPC) on access to and exchange of forest genetic resources Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)	Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu Contracting parties: Australia, Fiji, New Zealand, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu
Plants	ABS is included in the Environment Management and Conservation Bill 2015. The basic requirement is that proper consent is developed between the Samoa Government (provider) and the researcher (user) through the signing of the Letter of Agreement or the Prior Informed Consent and the Mutually Agreed Terms (Country report of Samoa).	Samoa
Native genetic resources	"The Australian Government manages the regulatory and policy framework for access to native genetic resources in Commonwealth areas and sharing the benefits arising from their use. The purpose of the framework is to facilitate access to genetic resources and provide legal certainty for researchers and innovators, while also ensuring sustainable use of biological resources and obtaining tangible benefits for Australia and the conservation of biodiversity." (Government of Australia, 2014).	Australia
Associated biodiversity		
Micro-organisms	The Government of Fiji, the University of the South Pacific and Smith Kline Beecham have established bioprospecting agreements for marine organisms (Aalbersberg *et al.,* 1997)	
Invertebrates	Any research into marine organisms would likely be in collaboration with the University of the South Pacific, which is the regional agency with expertise in this area.	

Notes: Measures facilitating access to the different components of biodiversity for food and agriculture usually vary according to the intended use of the resource (e.g. any use, research and development, commercial use). Examples of possible measures include requiring prior informed consent (PIC), sharing benefits based on mutually agreed terms (MAT) and having special arrangements in place for access to resources held by indigenous peoples and local communities. Lists of countries are correct as of November 2019. Up-to-date lists of Parties to the Nagoya Protocol. ITPGRFA and CITES can be found, respectively, at https://www.cbd.int/abs/nagoya-protocol/signatories/default.shtml, http://www.fao.org/plant-treaty/countries/membership/en and https://www.cites.org/eng/disc/parties/chronolo.php?order=field_country_official_name&sort=asc.

Palau is one of the most thoroughly sampled countries in the world for anti-cancer drugs from shallow-marine-water organisms. The Palau-based Coral Reef Research Foundation (CCRF)[49] works only for the National Cancer Institute of the United States of America, which has state-of-the art agreements in place to protect the rights of the countries in which it works. Palau requires legislation to ensure that all researchers follow the same model and procedures.

2.3.1. Needs and priorities

In terms of the policies and regulations governing 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, capacity building/awareness raising regarding the ITPGRFA and the Nagoya Protocol is needed in all countries, including support to countries wishing to formulate/revise national laws and regulations on access to and use of genetic resources, especially with respect to the implementation of the Nagoya Protocol. Some countries emphasized the need

[49] http://www.coralreefresearchfoundation.org

for clarification on the documentation of traditional knowledge so as to encourage the sharing and use of this knowledge.

There is a need to localize the provisions of the CBD and the ITPGRFA in national policies and plans, supported by suitable legal frameworks, to address local farmers' access, exchange and sharing of genetic resources, the use and management of these resources, farmer rights, intellectual property, etc.

Samoa entered into an access and benefit-sharing agreement with the United States of America regarding access to and use of the local plant *mamala* (*Homolanthus nutans*). Various lessons were learned from this initiative, namely:

- clarification is needed regarding risks and timelines communicated to potential beneficiaries;
- the extent to which cooperation and transboundary benefit-sharing are necessary and will occur is likely to be something that the parties will resolve among themselves through regional agreements or through further negotiations at the Intergovernmental Committees of the Nagoya Protocol (ICNP);
- the question of synthetic analogues needs to be addressed – should there be benefit-sharing?

III. Policies, institutions and capacity

3.1. POLICIES, PROGRAMMES, INSTITUTIONS AND STAKEHOLDERS

3.1.1. Policies and programmes

Most countries mentioned a range of national policies, legal frameworks and action plans addressing the conservation and sustainable use of animal, aquatic, forest and plant genetic resources. Relevant laws and regulations are often laid down in specific acts (forest acts, marine fisheries acts, freshwater fisheries acts, etc.). Some fisheries' strategies acknowledge the importance of community-based resource management to sustain and secure inshore fisheries and aquatic resources. Examples include the Solomon Islands National Strategy for the Management of Inshore Fisheries and Marine Resources (Government of Solomon Islands, 2010b).

Most countries have environmental legislation that requires environmental impact assessments. Policies and legislation have also been put in place to address the management of protected areas or areas where special measures need to be taken to conserve biodiversity and the regulation of bioprospecting, research and related matters. Examples include Solomon Islands' Protected Areas Act (2010)[50] and Protected Areas Regulation (2012)[51] and Papua New Guinea's Policy on Protected Areas (2014).[52]

Codes of harvesting practice were reported by Niue and Tonga. In Niue, the Code of Harvesting Practice for the Indigenous Forests (Niue Division of Forestry, 2004) provides practical and rational guidelines to all those involved in forest harvesting, with the aim of reducing forest damage and improving forest yields. The Code sets out best practices covering both environmental and operational matters and specifies uniform safety standards and prescriptions that must be adhered to in any forest harvesting operation.

Some countries (e.g. Papua New Guinea and Tonga) also have agriculture-sector plans that address biodiversity. Similarly, sustainable-development strategies and national-development strategies often acknowledge the importance of biodiversity and ecosystem health in food security and sustainable livelihoods, for example those in Nauru and Solomon Islands

All countries have developed NBSAPs. Some have tried to mainstream biodiversity considerations into sustainable development and environment policies and action plans. For example, the Cook Islands has attempted to do this by incorporating its NBSAP into the National Environment Strategic Action Framework (NESAF) and subsequently including the NESAF in the National Sustainable Development Plan. These efforts have not, however, translated into on-the-ground mainstreaming of biodiversity concerns.

Under its Green Growth Framework (Government of Fiji, 2014), Fiji as committed itself to integrating green growth into its development efforts as a means of addressing the key challenges facing the country, namely:

- vulnerability to external shocks, including climate change and financial crises;
- high dependence on imported fossil fuels;
- declining terrestrial and marine biodiversity due to unsustainable land management and coral-reef degradation; and
- provision of urban infrastructure and services.

The Framework's Thematic Area 3 specifically addresses "sustainable island and ocean resources."

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[50] Protected Areas Act 2010 (Act No. 4 of 2010) (available at http://www.fao.org/faolex/results/details/en/c/LEX-FAOC094186).

[51] Protected Areas Regulation 2012 (Legal Notice No 12 of 2012) (available at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC148113).

[52] Papua New Guinea Policy on Protected Areas (available at http://www.pg.undp.org/content/dam/papua_new_guinea/docs/environment%20and%20energy/DEC%20signed%20PNG%20Protected%20Areas%20Policy-lowrespgs.pdf).

Some countries have cultural policies. Examples include the Kiribati Cultural Policy, which focuses on conserving high cultural value sites (terrestrial or marine) or islands. These locations have wild food species and ecosystems that are important for food and agriculture.

Some climate change policies and strategies focus on forestry, agriculture, water, livestock, biodiversity and natural ecosystems. The Republic of Nauru Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt) (Government of Nauru, 2015) identifies environmental damage and rehabilitation and preserving the natural environment and biodiversity as crucial cross-cutting issues.

Papua New Guinea has a number of policies that address the conservation and sustainable use of the country's wealth of biodiversity. Conservation and sustainable use are well captured in the fifth pillar, "Environment Sustainability and Climate Change", of the Papua New Guinea Vision 2050 (Government of Papua New Guinea, 2009). This pillar aims to enhance conservation of biodiversity from its current level to 7 percent of the world biodiversity, establish a total of 20 national reserves, wilderness areas and national parks, and establish at least 1 million ha of marine protected areas.

Palau won the 2012 Future Policy Gold Award, selected from 31 policies submitted from 22 countries; the country is recognized for its policies that engage local communities and traditional management systems for natural resources (SPREP, 2012c).

Regional and subregional programmes/frameworks/initiatives

Regional and subregional programmes/frameworks/initiatives are discussed above and include: ridge-to-reef, marine protected areas, protected areas networks, the Micronesia Challenge, GEF Pacific Alliance for Sustainability Island Biodiversity Project, MACBIO, the Framework for Nature Conservation and Protected Areas in the Pacific Islands Region and the Pacific Islands Marine Species Programme.

REDD+:[53] The Regional Policy Framework (SPC, 2013) endorsed by Ministers of Agriculture and Forestry in 2012 aims to provide strategic oversight with respect to options for the development of national REDD+ programmes in Fiji, Papua New Guinea, Solomon Islands and Vanuatu. The policy aims to support a "no-regrets" approach to national REDD+ programmes, aligned with current and anticipated international REDD+ mechanisms. The policy also proposes a regional approach to REDD+ to support collaboration on REDD+ initiatives across the Pacific region.

Weaknesses

Biodiversity is seen as an environmental issue and this can mean that it is not considered by other sectors because it is an "environmental issue". This silo approach makes monitoring and evaluation difficult. As reported from Papua New Guinea, the national policies on biodiversity and conservation formulated by Conservation Environment Protection Agency (CEPA) do not align and harmonize well with policies in sectors such as agriculture, forests, fisheries and climate change. This makes coordination and implementation of activities difficult. There is therefore a need for an overarching policy on biodiversity and genetic resources that is inclusive and addresses all relevant sectors. Further, there is insufficient recognition of the importance of BFA, associated biodiversity and wild foods in agriculture-sector plans and food-security policies/strategies/programmes.

A lack of monitoring and evaluation, along with poor knowledge management, means that there is a lack of data to support evidence-based decisions. Lessons learned from policies and programmes are not documented and not shared with the wider community and development partners and donors. As a consequence of this lack of documentation and reporting, countries often find that projects are implementing activities that have failed in the past. This is common across the

[53] Reducing emissions from deforestation and forest degradation plus (+) conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks.

majority of the countries in the Pacific Island region. Documentation is rarely considered a priority or funded adequately in project planning and budget allocation.

Resource constraints often lead to weak implementation of policies and programmes. The lack of funding available for research on biodiversity is related to the accessibility of GEF funding. In most, if not all, countries, the departments of environment are responsible for this funding. Access can be a challenge for other sectors, such as agriculture.

Strengths

- Policies in the region are increasingly being developed with wide stakeholder and community participation and raise awareness of BFA-related issues.
- Some countries recognized the strengths of ridge-to-reef programmes because of their significance to community involvement and empowerment.
- Some policies aim to promote cross-sectoral connections, for example Nauru's Climate Change Adaptation and Disaster Risk Management Framework (RONAdapt); however, efforts to meet these objectives are often hampered by a lack of sufficient funding.
- Policies provide a framework for donor interventions and provide guidelines that support harmonized implementation of interventions.

Box 3. Contributions of stakeholder groups to the sustainable management of biodiversity for food and agriculture: examples from Fiji, Niue and Tonga

Fiji: The Korolevu-i-wai district traditional fishing ground (qoliqoli) spans 6 km2 and encompasses four adjacent villages, with a tourism resort situated in the middle, as well as mangroves, seagrass beds and coral reefs. It is home to mangrove crabs, clams, octopuses, lobsters, sea urchins, trochus and reef fish such as emperors, parrotfish, grouper and mullet. The threats to this area include destructive fishing methods (specifically, undersized nets for fishing, poison fishing using derris root and breaking/overturning corals and rocks to catch octopus), coral harvesting, pollution and coral trampling by tourists. The Korolevu-i-wai community has established a mutually beneficial relationship with the owners of a beach tourist resort. In return for making the fishing ground available to the resort for low-impact tourism activities, the community receives substantial financial and technical assistance. The locally managed marine protected area management committee launched a coral-farming project along reefs adjacent to the resort and visitors to the resort can now take part in a "reef walk" (a tour along a carefully marked path through the reef) to appreciate the marine environment and view the coral racks (Bonito, Simpson and Waqairagata, 2011).

Niue: The Niue Island Organic Farmers Association (NIOFA)[1] was developed by Niue farmers with support from the country's government. NIOFA's main focus is on promoting the concept of organic farming. It was formed in 2000 by a handful of dedicated farmers passionate about adopting and promoting organic farming as the way forward for the agriculture sector of Niue.

Tonga: Vava'u Vanilla Growers Association – the vanilla plantations of over 300 vanilla growers on the island of Vava'u have been (as of 2015) certified organic. The preparation and audit process for this certification took three years. Vanilla growers were trained and grounded in good management practices such as "no pesticides" and organic mulching, which helps to protect the environment and associated biodiversity.

Sources: Adapted from the country reports of Fiji, Niue and Tonga.

[1] http://www.organicpasifika.com/poetcom/for-farmers-and-growers/members/niue-island-organic-farmers-association/

3.1.2. Interministerial cooperation

Various countries reported examples of successful interministerial cooperation in the area of conservation and sustainable use of biodiversity for food and agriculture. Some (e.g. Kiribati and Tonga) mentioned NBSAP development as an example of interministerial cooperation, at least in the planning process. Similarly, climate change and disaster-reduction policies and frameworks and the development of ridge-to-reef projects also engage all ministries in the planning process. However, the tendency seems to be that there is cooperation at the planning stage but that, for a number of reasons, this breaks down at the implementation stage.

Nauru: The Republic of Nauru Climate Change Adaptation and Disaster Risk Management Framework (RONAdapt) was developed over five years to set out an overall framework for managing risks to sustainable development. It involved extensive consultation and review by all government sectors, civil society and the general public in Nauru.

Palau: Best-management plans have been designed to promote the implementation of best-management practices (BMPs) and thereby increase sustainability. The BMPs include both generally accepted management solutions and Palau-specific practices based on traditional knowledge of the local environment. They involve cooperation between the agricultural, environment, tourism, finance and other sectors.

Papua New Guinea: The Bismarck Sustainable Development Planning Process involved participation from provincial planners from 12 provincial governments across the Bismarck Study Area, the Nature Conservancy Melanesia Team and representatives from the Departments of Environment and Conservation, National Planning, National Fisheries, Mining and Provincial and Local Level Government Affairs.

3.1.3. Needs and priorities

All countries, both in their reports and at the regional consultation, prioritized a review of current policies and programmes to ensure that BFA is acknowledged, achievable goals set and policies harmonized. Policies targeting food and agriculture should recognize the importance of associated biodiversity, ecosystem health and wild foods, and put in place strategies and action plans to promote conservation and use.

All the countries at the regional consultation agreed that policies and programmes needed to connect the various sectors and that establishing a cross-sectoral working group would facilitate the development of cross-sectoral policies and programmes. Papua New Guinea prioritized the need to develop an overarching national biodiversity and genetic resources policy that would link with agriculture, forestry, fisheries, environment and climate change policies on biodiversity and genetic resources. This national policy should also establish a management, implementation and coordination mechanism, which could take the form of a biodiversity steering committee, whose responsibilities would include effective coordination and facilitation of biodiversity data updates. There should be a national focal point for BFA.

All countries agreed that a lack of quantitative data and analysis is a major hindrance to developing effective evidence-based policies. For example, Tonga proposed that wild foods should be included in its next Household and Income Survey and Agricultural Census. Without more and improved data and data analysis, agencies are severely limited in their ability to design, implement and monitor the effectiveness of policies and programmes. Effective monitoring and evaluation frameworks should be put in place and should take into account the capacity constraints that exist in many countries. Some effort to harmonize these frameworks across policies would be useful.

3.2. CAPACITY

3.2.1. Training and education needs

Training and education needs related to the conservation and sustainable use of associated biodiversity and constraints to addressing them were reported by countries.

Anecdotal observations can provide valuable information for shaping policy decisions. However, systematic, quantitative data are necessary in order to improve the quality of environmental management. Some progress has been made in filling some data gaps through research supported by partnerships between governments, NGOs and the private sector. However, considerable capacity development is needed in order to establish and maintain ongoing data collection, monitoring, reporting and analysis systems. Capacity within relevant ministries needs to be assessed and training conducted to address gaps identified. All countries agreed on the need for capacity development, which would have to target a range of stakeholders and – as proposed in Samoa's country report – use a range of approaches to maximize outreach. Nauru emphasized the importance of the community approach, in particular to rejuvenate and strengthen traditional environmental knowledge systems that were once an integral part of Nauruans' connection to the land and the sea. At the policy level, there is a need for general capacity building to improve understanding of the importance of biodiversity to all sectors. This will promote its integration into policy development, including improvements in incentive measures to support policy implementation and compliance. Kiribati and Tonga identified the need for training in biodiversity (including BFA) valuation, so that the value of BFA to various sectors can be realized and arguments for prioritization in policies and programmes can be justified economically.

All countries highlighted a lack of capacity in conservation and sustainable-use technologies, including those related to breeding and taxonomy. Some countries (e.g. Fiji and Papua New Guinea) highlighted the need to train scientists in molecular genetics. Generally, countries lack expertise in *in situ* and on-farm conservation of BFA – only Papua New Guinea has some experience – and generally there is limited capacity in biotechnology and poor awareness of potential impacts of biotechnological products on the environment. It is important to identify key expertise in these fields and share it across the region. Strengthening partnerships between countries and regional and international organizations will facilitate capacity building.

Pacific-region countries that are parties to the ITPGRFA and the Nagoya Protocol are listed in Table 8. The reports from some countries that are/were not parties to these instruments acknowledged the need for consultation and capacity building to support ratification. Countries that had ratified these or other international instruments prioritized the need to review national laws and regulations to ensure compliance with them and for more information to be made available on benefits and obligations. All countries agreed that the use of traditional knowledge under the ITPGRFA and the Nagoya Protocol required clarification. At the regional consultation, countries identified the need for guidelines and mechanisms to assist them in access/exchange activities.

All countries recognized the need for awareness raising among the general public on the importance of BFA, in particular associated biodiversity, and ecosystem health. This could be achieved through social media, radio programmes, etc. Inclusion of BFA issues, including the interconnectedness of biodiversity, in school curricula would help to raise awareness among the general public and counter trends (especially among youth) that "see" environmental issues as "uncool".

Tonga prioritized the need for regular reporting and information sharing on BFA as an important component of capacity building. Samoa suggested that a regional database through which countries can share information and expertise should be established.

Constraints to developing capacity

- There is a lack of funding for training and to support trained individuals in national and regional systems. After training overseas, there tends to be poor support and integration into national systems – often due to funding constraints.
- Capacity related to the conservation and sustainable use of associated biodiversity is not seen as a priority across all sectors.
- There is a lack of mentoring in national and regional systems once training has been carried out.
- Poor knowledge management weakens ongoing capacity development.

3.2.2. Research needs

Countries reported a number of research needs related to the conservation and sustainable use of associated biodiversity, wild foods and ecosystem services and constraints to addressing them. Overall, knowledge of associated biodiversity (particularly in soils) and ecosystem functioning is very limited. All countries agreed that the main constraint in this area is funding. The key to optimizing limited resources would therefore be to prioritize research needs at national and regional levels. At the regional consultation, countries agreed that a regional conference on BFA should be organized. The following priorities were identified in the country reports:

- Existing projects should be reviewed to assess whether BFA-related research or data collection could be easily included without significant funding implications. This review should be done prior to any prioritization process.
- There is a need for research prioritization at country level. However, any needs common to several countries should, if possible, be addressed at regional level. The following research areas were identified:
  - Pollinators: Very little is known about pollinators in the Pacific Islands region. Some research was carried out in 2011/2012, which looked at the species in a few of the islands, but little is known about their habitat requirements and specificities.
  - Soil biodiversity: Research is needed into how different agricultural practices affect the soil-organism community and how this in turn affects soil health and fertility. Some farmers are saying that their crops are not responding in a positive way to fertilizer application, which may be a consequence of the demise of soil micro-organisms. More research needs is needed on soil micro-organisms, organic-matter decomposition and cultivation practices.
- Research institutions from various sectors should establish a common strategy, as part of more general improvements to coordination processes.
- There is a need to better understand the level of agricultural biodiversity that adds resilience (in particular to climate change) to agricultural production systems, from home gardens to larger-scale enterprises.
- There is a need to better understand the limitations of payment for ecosystem services schemes and how their levels of adoption could be improved.
- Research is needed into the propagation and conservation of endangered wild foods.
- There is a need to identify indicators that can be used to assess various aspects of associated biodiversity, ecosystem health, etc. (e.g. nematode-community analysis for soil ecosystems).
- Countries where tourism has potential to affect ecosystem health and associated biodiversity identified the need to conduct carrying-capacity studies for expanded tourism.
- Short-term consultancies/attachments for research into wild food and ecosystems services are needed, as countries generally do not have capacity to carry out research in these areas.
- Improved collaboration between research agencies (regional and international) to support research is needed.
- Documentation and knowledge management in general need to be strengthened.

Constraints

Generally, limited resources are a constraint to research on the conservation and sustainable use of BFA and in particular associated biodiversity and wild foods. Traditionally, any activities in this area would be the responsibility of the individual sectors. For example, any plant-based research would be carried out by the agriculture sector and any marine-based work would be the responsibility of the fisheries sector. This sector-specific approach is a constraint.

IV. Regional and international cooperation

4.1. MAJOR REGIONAL INITIATIVES TO CONSERVE AND USE BIODIVERSITY FOR FOOD AND AGRICULTURE

Table 9. Reported regional and international initiatives addressing the conservation and/or use of biodiversity for food and agriculture in the Pacific region

Regional policies and programmes	Description	Countries/territories involved
Pacific Plan (Pacific Islands Forum Secretariat, 2007)	In 2005, Pacific Forum leaders agreed to the development of a "Pacific Plan" to "enhance and stimulate economic growth, sustainable development, good governance and security for Pacific countries through regionalism." The Plan's Strategic Objective No. 5 refers to "improved natural resource management and environmental management", with initiatives being promoted in the fields of sustainable development, fisheries, forestry, coastal waters, waste management, energy, freshwater management, biodiversity and climate change."	16 Pacific Islands Forum Secretariat countries: Australia, Cook Islands, Fiji, Kiribati, Micronesia (Federated States of), Nauru, New Zealand, Niue, Palau, Papua New Guinea, Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
The Framework for Nature Conservation and Protected Areas in the Pacific Islands Region, 2014–2020 (SPREP, 2014)	The Framework will provide guidance for the region on key priorities for biodiversity conservation and ecosystem management, with clear linkages to National Biodiversity Strategies and Action Plans and the Aichi Biodiversity Targets. Strategic Goal C is "to improve the status of biodiversity by safeguarding ecosystems, species and diversity."	South Pacific Regional Environment Programme (SPREP) countries: American Samoa, Australia, Cook Islands, Fiji, France, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, United Kingdom, United States of America, Vanuatu, Wallis and Futuna Islands
Pacific Islands Regional Marine Species Programme 2013–2017 (SPREP, 2012d)	A regional strategy for cooperative conservation and management of dugongs, marine turtles, whales and dolphins in the Pacific Region. Dugongs, turtles, whales, dolphins and other large marine species play a significant ecological role in the functioning of coastal and oceanic habitats and systems. They are widely regarded as flagship species for Pacific marine ecosystems. Therefore, the continuing health of populations of these marine animals is essential to maintaining a healthy Pacific Ocean.	SPREP countries – as above
A New Song for Coastal Fisheries: Pathways to Change (SPC, 2015b).	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 Community (SPC) member Pacific Island countries and territories: American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands – plus Australia, France, New Zealand and the United States of America (four of the founding countries).
Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action (PIROP) (SPC, 2005)	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 also 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.	SPC member Pacific Island countries and territories – as above

Table 9 *Cont'd*

Regional policies and programmes	Description	Countries/territories involved
Regional Strategic Plan on the Conservation, Management and Sustainable Utilization of Forests and Trees Genetic Resources in the Pacific (SPC, 2007)	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 is the establishment of a regional tree seed centre.	SPC member Pacific Island countries and territories – as above
Pacific Ridge-to-Reef Program (http://www.pacific-r2r.org/)	The goal of the programme is to maintain and enhance Pacific Island countries' ecosystem goods and services (provisioning, regulating, supporting and cultural) through integrated approaches to land, water, forest, biodiversity and coastal resource management that contribute to poverty reduction, sustainable livelihoods and climate resilience.	14 Pacific Island countries
Pacific Regional Action Plan on Sustainable Water Management (SOPAC and ADB, 2003).	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.	SPC member Pacific Island countries and territories – as above
Pacific Agriculture for Plant Genetic Resources Network (PAPGREN) (http://lrd.spc.int/the-pacific-plant-genetic-resources-network-papgren)	Regional network that addresses the conservation and use of Pacific plant genetic resources	All SPC member countries and territories
International Network of Edible Aroids (INEA) (http://www.ediblearoids.org/)	Aims to increase (base broaden) the genetic diversity of edible aroids through conservation, use and dissemination of genetic diversity	Papua New Guinea, Samoa, Vanuatu and SPC (Centre for Pacific Crops and Trees)

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019) and websites of the respective organizations, instruments and initiatives.

4.2. NEEDS AND PRIORITIES

At the regional level

As with national programmes, programmes implemented by regional agencies also tend to be within thematic areas. Even if the same regional agency covers different themes linked to BFA, such as agriculture and fisheries, there is limited collaboration and planning of integrated projects and approaches. This is, in part, a consequence of human-resource capacity issues, in that staff skills and expertise tend to focus on one thematic area. Another issue is that donor funds are often restricted to specific themes. However, with the increase in the use of ridge-to-reef type approaches, this is likely to change – or, if not likely, should change. Basically, there is an urgent need for improved coordination between agencies and improved coordination and information sharing between initiatives.

The needs and priorities identified at the regional consultation are as follows:

- development of a regional framework for BFA, which would:
  - o clarify the roles of different agencies and develop a mechanism (possibly a steering committee) to improve coordination and collaboration;
  - o identify a contact person within each agency with responsibility for BFA;
  - o improve monitoring, evaluation, reporting and documentation through the development of a knowledge-management system to ensure information is shared across initiatives; and
  - o improve national to regional data collecting and reporting mechanisms and put systems in place to support countries;

- greater integration in policy planning, with a ridge-to-reef/ecosystem/landscape approach;
- improvement of the utilization of regional programmes/initiatives for capacity building; and
- establishment of a regional coordination post – possibly based in FAO.

At the international level

Lack of human resources is a significant constraint in the region. Opportunities for building capacity at the national and regional levels through international initiatives need to be explored.

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The Pacific Regional Synthesis for *The State of the World's Biodiversity for Food and Agriculture* summarizes the state of biodiversity for food and agriculture in the region, based largely on information provided in ten country reports submitted to FAO as part of the reporting process for the report on *The State of the World's Biodiversity for Food and Agriculture*.

Biodiversity for food and agriculture is the diversity of plants, animals and micro-organisms at genetic, species and ecosystem levels present in and around crop, livestock, forest and aquatic production systems. It is essential to the structure, functions and processes of these systems, to livelihoods and food security, and to the supply of a wide range of ecosystem services. It has been managed or influenced by farmers, livestock keepers, forest dwellers, fish farmers and fisherfolk for hundreds of generations.

The report was originally prepared as supporting documentation for an informal regional consultation on the state of the Pacific region's biodiversity for food and agriculture, held in Nadi, Fiji, in May 2016. It was later revised based on feedback received from the participants of the informal consultation. It provides a description of the drivers of change affecting the region's biodiversity for food and agriculture and of its current status and trends. It also discusses the state of efforts to promote the sustainable use and conservation of biodiversity for food and agriculture in the region, including through the development of supporting policies, legal frameworks, institutions and capacities.

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