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Climate Change, Agriculture and Forestry in the Pacific

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Key Messages

- The Pacific has an enormous natural capital in terms of soil and forestry resources. The Melanesian countries are generally the most-forested nations in the Pacific: Fiji, Papua New Guinea, the Solomon Islands, and Samoa all have forest cover in excess of 50–80% of their land area. The highest forest covers are found in the Federated States of Micronesia (>90 %), while Papua New Guinea (PNG) has the third largest area of intact tropical forest in the world with 7% of the world's species of plant and terrestrial life forms, while Solomon Islands has the highest concentration of endemic birds on the planet.

- The forests in PNG, but also in Samoa, Solomon Islands, Timur Leste, Tonga and Vanuatu are of global significance in terms of biodiversity and could contribute significantly to global climate change mitigation. However, if these countries could not stop the shrinking of its forest resources by moving towards sustainable logging through improved forest governance and land-use legislation, they will quickly lose critical global ecological and economic assets.

- Up to 35% of gross domestic product (GDP) in resource rich countries such as Papua New Guinea is derived from agriculture and forestry. Between 60–85% of Pacific Islanders, which are nearly 10 million people (with PNG comprising 7.0 million inhabitants), are rural based and live from agriculture, forestry and fisheries. The European Union (EU) is the biggest market for agricultural exports from the Pacific, with 40% of agricultural exports targeting the EU markets (mainly Fijian sugar and PNG palm oil exports).

- Papua New Guinea and Fiji together represent 88.6 % of the land mass, 70% of the GDP and 74.5 % of Pacific Islands Countries and Territories' population.

- The Pacific Islands are one of the world's most vulnerable regions with respect to the impacts of climate change according to the Intergovernmental Panel on Climate Change (IPCC) in its 4th Assessment Report. In the 1990s, the cost of extreme events in the Pacific Island region is estimated to have exceeded US$1 billion.

- The EU is the second largest donor for the Pacific after Australia. The EU's regional programme (€95 million) addresses economic growth and sustainable development in the Pacific through its two focal sectors: regional integration and trade (€45 million); and sustainable management of natural resources and the environment (€40 million). The EU supports applied research and pilot projects to prepare long term strategies for adaptation to climate change.

- The Pacific region represents an important number (12) of seats and votes in the UN and international organizations and often acts as a group with who the EU works at UN level. The 15 Pacific ACP countries are neighboring the South-East Asia region and are part of the wider Asia-Pacific region, whose geopolitical importance is growing.

- The Pacific lacks a regional Science, Technology and Innovation (STI) framework in which the potential of STI in providing solutions to the challenges related to agriculture and forestry in the Pacific is clearly stated and supported.

Key Messages

There is a need:

- for an overarching policy framework that integrates the appropriate environmental and socio-economic measures (chapter "Significance of the Sector"), addresses the vulnerabilities of the sector (chapter "Status of Research") and makes the necessary changes (chapter "Proposed Adaptions and Supporting Policies");

- to embark on a programme of research, development and innovation (chapter 5) that would both inform and facilitate long-term policy development while at the same time produce results that would have an immediate impact on the management of the region;

- to develop a synergistic relationship between policy and programme that would create a positive spiral of mutually supporting activities.

Investments are necessary in:

- Researchers and technicians mobility and cooperation between Pacific countries and also between European and Pacific regions;
- Genetic resources and management of crops and livestock;
- Monitoring and compliance related to crops and forest resources;
- Traditional knowledge & culture;
- Cross-cutting issues (awareness-rising, monitoring, impact assessment);

Expected impacts of investments:

Overall we anticipate that the proposed actions would lead to higher resilience of the Pacific Island countries against internal as well as external threats by

- Improved human talent capacity in key areas of climate change mitigation and adaptation;
- Improved preparedness of smallholder farming communities to the effects of climate change;
- Increased food security by both higher diversity of production and management as well as non-agricultural income options (e.g. fishing, hunting, tourism);
- Creation and improvements on integrated information systems linking into regional and international systems;
- Appropriate policies and strategies for mitigation of effects of climate shocks and other natural disasters, international markets for Pacific produce (including organic produce);
- Social change by Pacific Islanders towards climate change;
- Preserving cultural and ecological diversity by Pacific Islanders.

Significance of the Sector

Natural resources underpin economic growth and the livelihoods and cultural identity of the people in the 19 Pacific Island Countries and Territories (PICTs)[1] which cover a land area of 552,000 km^2. Agriculture, forestry and fisheries have been vital in sustaining livelihoods of peoples of the PICTs. Between 60–85% of its nearly 10 million people are rural based and live from agriculture, forestry and fisheries (SPC, 2004). Agriculture and forestry products make particularly significant contributions to food security, employment, income and foreign exchange earnings in the Pacific (SPC, 2009). In Melanesia, up to 80% of the population is involved in agriculture and forestry on a subsistence or commercial basis. Up to 35% of the GDP in resource rich countries such as Papua New Guinea is derived from agriculture and forestry.

Agriculture and forestry provide vital products for ensuring food security

Climate associated disasters such as tropical cyclones, flash floods, sea-level rise, increased temperatures, droughts and pronounced rainfall variability pose serious constraints on development in the islands. This forces some PICTs to be in "constant mode of recovery" (FAO, 2008). Food availability and people's accessibility to food are among the first to be affected following such disasters which degrade and damage settlement, fertile crop land, native forests and plantations.

These climate change (CC) induced disasters may add to the pressures from global change (GC) drivers. Impacts from GC are mainly due to rapid population growth, increasing impact and competition of international investors such as mining, tourism and other industries, land use demand for growing biofuel products which will exacerbate the vulnerability of many PICTs.

In this GC-CC nested regime, the need to strengthen the resilience of people and ecosystems towards sustainable food security is therefore of paramount importance.

Addressing the challenges of food security by taking into account current and future changes in climate and due to human impacts is critical to reducing poverty and food insecurity (FAO, 2008). Food security assessments carried out in four Pacific countries (Fiji, PNG, Tonga and Vanuatu) by the CGPRT Centre (2000) showed that provincial and household food security are of more serious concern than national food security. Food security systems in rural areas are mainly natural resources based while urban areas are more dependent on imported food processed food, both locally and overseas. For some, for example in PNG, fresh produce is supplied from rural areas to urban markets. According to a study by the University of Copenhagen (2007), in the Solomon Islands, the majority of rural people still lives and depend on subsistence food production and fisheries. A multitude of cultivated plants such as yams (*Dioscorea spp.*), taro (*Colocasia esculenta*) and sweet potatoes (*Ipomoea batata*) and other crops such as bananas (*Musa spp.*) and watermelon (*Citrullus lanatus*) are still part of people's main staple diet. Such is the case in most of the other PICTs. Similarly, products from agro-forestry systems and forests provide Pacific Islanders a significant contribution to food security by harvest of edible nuts, fruits, plants and meat (FAO, 2008). Although these primary sectors are of critical importance to ensuring food security, the dominant realities for most Pacific countries are their limited land area, small populations, distance from markets and poor transportation links, with the exception of Papua New Guinea (CTA, 2011).

Agriculture and forestry products are key sources of employment, income, security and trade

Agriculture, forestry and fisheries sectors are the main opportunities for employment in the Pacific. In Papua New Guinea, 85% of the population is

1 The PICTs include the 15 member countries of the Africa Caribbean Pacific (ACP) Group of the Pacific region and 4 Overseas Countries and Territories (OCT). The ACP countries in the Pacific are Cook Islands, Federate States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea (PNG), Solomon Islands, Timor-Leste, Tonga, Tuvalu, Samoa and Vanuatu. The OCTs in the Pacific region comprise French Polynesia, New Caledonia, Wallis and Futuna, Pitcairn.

employed in the agriculture sector (many in the informal sector) and similar patterns are observable – to a greater or lesser extent – in the other island countries (World Bank, 2008). In Fiji, a total of 46,600 people were engaged in subsistence agriculture with 1,389 people formally employed in the agriculture, forestry and fisheries sectors (Fiji Islands Bureau of Statistics, 2010). In many cases, the development of appropriate infrastructure and market value chains are what's needed for commercialization to take place. Such employment creation is critical for the ever increasing population in the PICTs. For instance, PNG has the highest rate of population growth at 3% per annum, and there are over 50,000 students leaving formal education every year. They go back to the village or migrate to towns and have been the main cause of PNG's social problems (Ware, 2004; McMurray, 2002). In several countries, unemployment, especially youth unemployment is a significant problem, with frustrations leading to crime and sometimes spilling over into civil unrest, as in, for example, the Solomon Islands and Tonga (World Bank, 2008).

Income from agriculture, forestry and fisheries make a significant contribution to the GDP of countries in the Pacific. Incomes from corresponding export revenues are given in Table 1. Relative contribution to GDP by agriculture, forestry and fisheries was highest in PNG (31%), followed by Niue (in 2006), Tonga, Solomon Islands, Fiji, Samoa and Cook Islands.

There are some big estates which grow cash crops such as sugar in Fiji, coffee, palm oil and cocoa in PNG, and cocoa in Vanuatu and the Solomon Islands. Apart from that there are only a few other cash crops pro¬duced in large quantities in the region. Coffee production is stagnating, but palm oil production has grown rapidly (from 32,000 t in 2003 to 446,000 t in 2008). PNG and Fiji dominate agricultural production and trade in the Pacific with PNG being by far the largest agricultural producer (palm oil, coffee, cocoa). In Fiji, sugar accounts for over 30% of agricultural GDP and 40,000 jobs. The relative importance of semi-subsistence agriculture is also important to meet the

Pacific Island Countries and Territories (PICTs)	Total GDP contribution by sectors (agriculture, fisheries, forestry)	Percentage contribution to total GDP	Total GDP by countries	Comments
Papua New Guinea	8,106.90	30.71	26,395.30	in millions of PGK
Fiji	603.80	11.57	5,218.70	in millions of FJ$
Niue	4,913.00	23.92	20,541.00	in thousands of NZ$
Cook Islands	17,114.00	5.11	334,825.00	in thousands of NZ$
Samoa	145.00	9.80	1,480.60	in millions of Tala
Tonga	116.80	14.40	711.40	in millions of pa'anga
Solomon Islands	224.80	53.64	419.10	in millions of SB$
Australia	28,764.00	2.22	1,293,380.00	in millions of AU$
Kiribati	36,022.00	23.33	154,382.00	in thousands of AU$
Nauru	2.80	4.05	69.10	in millions of AU$
New Zealand	9,731.00	5.01	194,420.00	in thousands of NZ$
Palau	11,727.00	5.63	208,162.00	in thousands of US$
Tuvalu	8,037.00	21.88	36,724.00	in thousands of AU$
Republic of Marshall Islands	23,301.00	14.30	162,936.00	in thousands of US$
Vanuatu	12,425.00	19.71	63,024.00	in millions of Vatu
Federated States of Micronesia	0.00	0.00	297.50	in millions of US$
Timor-Leste	116.60	18.57	628.00	in millions of US$

Table 1. The annual export earnings (GDP contributions) from agriculture, forestry, and fisheries for Pacific Island Countries and Territories (PICTs) (2010).

GDP figures are expressed in nominal (current market prices), except for Solomon Islands is expressed in constant price.
For Niue and Timor-Leste, the GDP figures are for 2006 fiscal year due to lack of supplied information for 2010; for Nauru and New Zealand, for 2008 fiscal year as well as for Vanuatu, for 2009 fiscal year, respectively.
For Vanuatu and Federated States of Micronesia, there is no annual official data for sectoral contributions, only provided are the total annual GDP figures.

Country	Product (1)	Product (2)	Product (3)	Product (4)
Fiji	Sugar cane	Rice	Copra	
Papua New Guinea	Coconut	Sweet potatoes	Copra	Coffee
Solomon Islands	Fish	Copra	Palm oil & kernels	Coconut oil
Vanuatu	Coconut	Copra	Bananas	Cocoa
Samoa	Coconut	Copra		
Tonga	Coconut	Copra	Bananas	
Tuvalu	Coconut	Bananas	Copra	
Kiribati	Copra	Seaweed		

Table 2. Main agricultural commodities in the Pacific (Asian Development Bank 2010).

demand of the local and regional tourism industry (CTA, 2011).

Considering agricultural exports, the Pacific exports mainly fats and oils, sugar, cocoa, coffee, tea and spices. The EU is the biggest market for agricultural exports from the Pacific, with 40% of agricultural exports targeting the EU markets. The main agricultural exporters are PNG, Fiji and Vanuatu, with 52%, 27% and 7%, respectively. PNG exports mainly palm oil (45% of agricultural exports), cocoa (17%) and coffee, tea and spices (collectively 18%). Fiji mainly exports sugar (36% of agricultural exports) (CTA, 2011).

Over time, apart from Papua New Guinea and the Solomon Island, the contribution of agriculture to national GDP is declining such as in Fiji, Vanuatu, Tonga, Samoa, Kiribati and Tuvalu. However, compared to many countries in Asia, the trend is less pronounced. In many of the Pacific island countries, a prolonged fall in copra prices is a key contributor to this decline, though in Samoa the taro leaf blight has also seriously affected that crop and its export (FAO, 2011). The principle agricultural commodities in the Pacific are shown in Table 2.

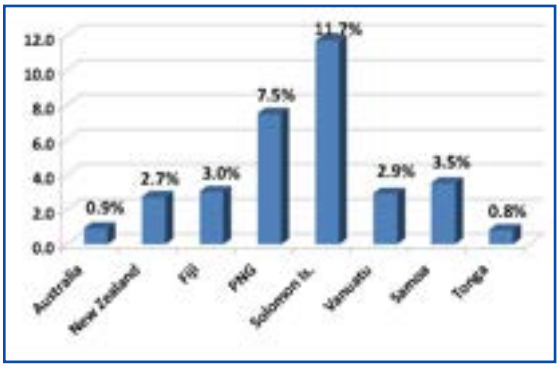

Figure 1. Average percentage contribution of the forestry sector to GDP 1995–2006 (Lebedys, 2008).

The average forestry contribution to GDP gives a broad indication of the importance of forestry within each national economy. Lebedys (2008) calculated this forestry contribution in the period 1995–2006 for many Pacific countries (Figure 1).

As Figure 1 shows, forestry is a major contributor (more than 5%) to GDP in the Solomon Islands and Papua New Guinea, and an important contributor (1–5%) in Samoa, Fiji, Vanuatu and New Zealand.

The forestry contribution to merchandize exports also provides a good indicator of forestry's national economic contribution in terms of earning foreign exchange and supporting the national Balance of Payments (BoP). The Solomon Islands is the most forest-dependent economy in the region, with almost 45 of its national export earnings deriving from forest products. However, the current rate of harvest in the Solomon Islands is not sustainable, leading to a rapid decline of forest area. Pauku (2009) observes: In 2004, around 1 million m^3 of logs were harvested, in contrast with the sustainable harvest level estimated at around only 200,000 m^3. The Forest Management Project (FMP) has recently predicted that the natural forests will be exhausted by 2015. Export earnings from forest products from Papua New Guinea, Vanuatu and Fiji are still significant, but with 5.8%, 3.5%, and 2.9%, respectively, less prominent (FAO, 2009a; CIA, 2009). Major export destinations for forestry exports from Pacific countries are North Asia, Southeast Asia, the Near East, as well as intra-Pacific (Table 3).

Forestry exports to European countries are relatively modest, while trade with Africa and Latin America is negligible. Thus the PICTs are increasingly reducing their exports towards their historical strong partners Australia and New Zealand. For example, New Zealand still imports tropical hardwood

From -> To	East Asia	South East Asia	Pacific	Other Asia	Europe	North America	Total
Fiji	50	26	6,417	35	96	737	23,132
Papua New Guinea	377,110	11,586	12,296	0	892	40	225,826
Solomon Islands	170,479	11,104	3,920	0	153	39	104,926
Vanuatu	0	0	509	0	0	0	3,151

Table 3. Directions of forest exports 2006 (US$ 1,000) (FAO, 2009a).

timbers from Pacific island countries for applications such as outdoor furniture. However, Papua New Guinea and the Solomon Islands export much larger volumes of hardwood logs and sawn timber to Asia, while Japan provides an important market for Fijian woodchips. The United States is an important market for Fiji's mahogany sawn timber.

In most Pacific island countries, forests still constitute a subsistence income, both for people who still live in or near forests, as well as for people who may live and work in more distant urban areas, but retain forest ownership rights elsewhere (FAO, 2011).

Most Pacific countries participate in the World Trade Organization (WTO) and are parties to a variety of multilateral and bilateral trade agreements. Three subregional trade arrangements promote trade among countries within the Pacific:

- **The South Pacific Regional Trade and Economic Cooperation Agreement (SPARTECA)**, established in 1981, governs intra-regional trade between member countries of the Pacific Islands Forum. SPARTECA was to ease import restrictions on goods produced in island countries that are imported into Australia and New Zealand, and to promote economic growth and trade.

- The **Pacific Island Countries Trade Agreement (PICTA)**, established in 2003, is a free-trade agreement among member countries of the Pacific Islands Forum. PICTA is designed to promote regional integration and trade development through creation of a single regional market.

- **The Pacific Agreement on Closer Economic Relations (PACER)** provides a framework for "economic integration of the economies of the Forum members in a way that is fully supportive of sustainable development of the Forum Island Countries and to contribute to their gradual and progressive integration into the international economy".

Furthermore, Pacific ACP (African, Caribbean and Pacific Group of States) countries are presently negotiating an Economic Partnership Agreement with the European Union to cover trade in goods and services, investment and development cooperation (FAO, 2011).

Considering the use of land for agriculture and forestry, there is overall a relatively little competition between the different users in the Pacific. Where land is scarce, such as in the smaller PICTs, agroforestry is the dominant land use. This symbiotic system means that tree crops and agricultural crops are complementary, rather than competing land uses. However, due to raising global needs for high quality palm oil, monocultural oil-palm plantations, especially if they were planted on cleared forest land are increasing in the Pacific.

Such oil-palm plantations have been established, or are planned in Papua New Guinea, the Solomon Islands, Vanuatu and Fiji at larger estates. Considering Papua New Guinea, palm oil is becoming a major crop, which is reputed to produce the world's highest quality. Plantations of palm oil are criticized for negative impacts on biodiversity, soil conservation, water quality and local communities (FAO, 2011).

Forestry is a relatively modest employer in the Pacific countries, with ca. 12,000 persons in Papua New Guinea, 8,000 in the Solomon Islands, 3,000 in Fiji, 1,000 in Samoa and Tonga. However, as a proportion

of the formal labour force, especially in Papua New Guinea and the Solomon Islands, the proportion is significantly higher (Lebedys, 2008). Conversely, most of the people in the PICTs are employed in the agriculture sector (many in the informal sector), e.g. 85% in Papua New Guinea, while the figures are greater or lesser in the other island countries.

Agro-forestry and forestry as climate mitigation and carbon sink

In the current international climate change negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), the important role of forests and trees in reducing the emissions of carbon dioxide is well recognised. Considering the per capita basis, the Pacific is one of the world's most forest-rich areas. The Melanesian countries are generally the most-forested nations in the Pacific: Fiji, Papua New Guinea, the Solomon Islands, and Samoa all have forest cover in excess of 50–80% of their land area. The highest forest covers are found in the Federated States of Micronesia (>90 %). Nonetheless, in some localities forests are under intense population pressures, particularly in the small island countries of Kiribati, Tonga and Tuvalu. The area under forest is shown in Table 4.

The Pacific has been a region of net forest loss during the past 20 years. Papua New Guinea and the Solomon Islands have also lost significant forest area during the past 20 years. Conversely, Fiji, New Zealand and Samoa have increased their forest areas, while forested areas in other countries have remained relatively constant.

Agriculture and forestry provide cost-effective options for reducing greenhouse gas emissions. Forestry resources in larger PICTs represent important carbon sinks. Financing mechanisms for afforestation and reforestation under the Clean Development Mechanism (CDM) and the proposed reduced Emissions from Deforestation and Degradation (REDD) and voluntary markets could assist these countries to increase and maintain these vital carbon stores (SPC, Policy Brief, 7/2009).

	Forest area										
	km²				% of land area				% change per annum		
	1990	2000	2005	2010	1990	2000	2005	2010	90–00	00–05	05–10
Cook Islands	149	155	155	160	62.1	64.6	64.6	66.7	0.4	0.0	0.6
Fiji	9,529	9,804	9,973	10,140	52.2	53.7	54.6	55.5	0.3	0.3	0.3
French Polynesia	550	1,050	1,300	1,550	15.0	28.7	35.5	42.3	6.7	4.4	3.6
Kiribati	122	122	122	120	15.0	15.0	15.0	14.8	0.0	0.0	-0.2
Marshall Islands	126	126	126	130	70.0	70.2	70.2	72.2	0.0	0.0	0.6
Micronesia (F.S.)	637	639	640	640	91.0	91.2	91.4	91.4	0.0	0.0	0.0
New Caledonia	8,390	8,390	8,390	8,390	45.9	45.9	45.9	45.9	0.0	0.0	0.0
Niue	206	196	191	190	79.2	75.4	73.5	73.1	-0.5	-0.5	-0.1
Palau	380	396	403	400	82.6	86.1	87.6	87.0	0.4	0.4	-0.1
Papua New Guinea	315,230	301,330	294,370	287,360	69.6	66.5	65.0	63.4	-0.4	-0.5	-0.5
Samoa	1,300	1,710	1,710	1,710	45.9	60.4	60.4	60.4	2.8	0.0	0.0
Solomon Islands	23,240	22,680	22,410	22,130	83.0	81.0	80.1	79.1	-0.2	-0.2	-0.3
Tonga	90	90	90	90	12.5	12.5	12.5	12.5	0.0	0.0	0.0
Tuvalu	10	10	10	10	33.3	33.3	33.3	33.3	0.0	0.0	0.0
Vanuatu	4,400	4,400	4,400	4,400	36.1	36.1	36.1	36.1	0.0	0.0	0.0

Table 4. Forest area in the Pacific (Economic and social commission for Asia and the Pacific, ESCAP 2011. Statistical Yearbook for Asia and the Pacific 2011. II – Environment).

Note: No data were available for Nauru, Pitcairn, Timor-Leste and Wallis and Futuna.

Agriculture and forestry as globally essential biodiversity pool and cultural heritage

Land management systems across the Pacific support culturally distinctive and widely dispersed human communities (Smith and Jones, 2007) and have the capacity to safeguard natural habitats, increase biodiversity (Manner, 2006) and help to deliver important ecosystem services. They also raise the international profile of the region, earn foreign currency (Yari, 2003) and have potential for satisfying the needs of innovation and economic development. However, they are also vulnerable to the effects of population growth, environmental change, invasive species, epidemics and, critically, the impact of ad hoc short-term policies that ignore cultural resonances and the social and economic value of the ecosystem services provided by the natural environment (sensu Boer and Clark, 2012). Over time, these production systems have been moulded by subtle regional differences and human ingenuity to produce tested baseline models of sustainable management. These interactions have shaped landscapes (Lepofsky et al., 1996; Kirch, 1996) and produced locally adapted crops and stock (Manner, 2008) that have the potential to bolster ecological resilience and improve food security elsewhere in the region. These locally adapted land management systems have drawn their resources almost entirely from the region's otherwise unexploited reservoir of genetic material, which has gene-lines and biologically active molecules that have potential for world markets.

The agricultural and forestry sectors make a significant contribution to the economy of the region. They sustain local communities, deliver ecosystem services that support other sectors of the economy, such as tourism and supply primary products for export (Yari, 2003). The wider environment on which they depend and which has been an active evolutionary template producing rich patterns of farm-based biodiversity also has potential for the commercial exploitation of biologically active molecules (DaSilva et al., 2004).

Between 1997 and 2001, there was an overall increase in visitor arrivals from 646,439 to 662,015 (Pemberton and Kapak, 2003: 13), but between 1980 and 2000 exports of primary products from the region were unstable, deviating from the trend between 30 and 65%, with the greatest variance occurring in countries that rely heavily on a few commodities (Yari, 2003) – probably reflecting fluctuations in supply rather than in demand (Prichard, 1995). In terms of economic development and growth, general trends suggest that there is probably scope for:

- Increasing tourism, but this is likely to be contingent on whether local land management systems and their cultural associations can be encouraged to adapt to and exploit changing circumstances and provide the required infrastructure;

- Increasing export income by diversifying and stabilising production to satisfy existing market demand, and explore new opportunities to develop added-value products and exploit the biodiversity of the region;

- Become actively involved in biotechnology, first to help the region adapt to climate change in terms of intra-island gene transfer, and then to explore commercial links with international markets for the valorisation of the region's biologically active molecules.

Securing this vision within the compass of the prevailing cultural constraints and with the help of world markets will need an ongoing public dialogue facilitated by effective information systems and informed by sound research. As many Pacific islands are for many considered as holiday paradise sites, land use must be shared between farms, forests and scenic places such as resorts or beaches or parks (Figure 2) which contribute fully to the tourism attraction of these countries.

Climate change related disasters leading to severe losses from agriculture and forestry

The Intergovernmental Panel on Climate Change (IPCC) in its 4th Assessment Report in 2007 de-

Figure 2. Threats of sea-level rise to biodiversity in the lagoon and its islets in Anaa atoll in the Tuamotu archipelago French Polynesia (Dr Jean-François Butaud, 20/06/2005).

scribed the Pacific Islands as one of the world's most vulnerable regions with respect to the adverse impacts of climate change (Mimura, 2007). The economic costs associated with natural disasters in the region are already significant. In the 1990s, the cost of extreme events in the Pacific Island region is estimated to have exceeded US$1 billion (Bettencourt and Warrick, 2000). A list of major disasters and the associated costs is shown in Table 5. At the same time as Pacific countries are the most exposed to the effects of climate change, they are the least responsible (Sabatucci, 2012).

Major disaster	Year	Country	Losses	Remarks
Cyclones Ofa and Val	1990/1991	Samoa	US$ 440 million	losses were greater than average annual GDP in recent years
Cyclone Heta	2003/2004	Niue	NZ$37.7 US$30.4 million	losses were ca. 25% of Niue's GDP (McKenzie et al., 2005)
Cyclone Ami	2004	Fiji	FJD 40 million US$22.7	
Cyclone Cuba	2007	PNG	50 million Kina US$25.1	Severe flooding from heavy rains and subsequent heavy and persistent rains caused extensive damage to smallholder agriculture, rural infrastructure and livelihoods in general in all Local Level Governments (LLGs) of the Oro Province of the Northern Province of PNG. At least 153 people were confirmed dead.
Cyclone Gene	2008	Fiji	FJD 45 million US$25.5	The government had to provide food rations worth FJD 1.7 million US$ 0.96 million as a result of damage to agriculture (excluding the sugar industry), infrastructure, utilities and property (Relief Web, 2008).
Droughts	1941 1972 1982 1987 1997	PNG	AUD$30 million food aid (1997) US$31.2	PNG has experienced 26 droughts since 1800 (Mc Rae, 2002). Of these 5 droughts have been recorded as having severe impacts on agricultural productivity and survival and were all induced by El Nino-Southern Oscillation (ENSO). The 1997 drought caused significant disruptions to village food and water supply as well as failure of water supply to towns, mines (causing closures) and disruption to supply of electricity (Bang, Poloma and Allen, 2003). There were severe food and water shortages, with horticulture produce declining by 80% (Allen et al., 1997). Up to 40% of rural people (1.2 million) were suffering from severe food shortage by the end of 1997, which was life threatening (Bourke et al., 2001). The Australian government spent more than AUD$ 30 million delivering food aid to isolated areas of the highlands and low-lying islands affected by drought (AUSAID, 2001). There was significant reduction in exports of tree crops in 1997 compared to 1996. Exports of rubber and tea declined by 35% and 30% respectively, while coffee export declined by 5% (Bang et al., 2003).

Table 5. Major disasters in the Pacific and their associated losses in specific countries.

International, EU, Regional and National Policy Frameworks

International agreements, memberships and private investments

Most Pacific countries are signatories to **agreements that relate directly to forestry**. These include

- Convention on Biological Diversity (CBD) (ratification)
- United Nations Framework Convention on Climate Change (UNFCCC) (ratification)
- Kyoto Protocol (ratification)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (ratification by all except Kiribati, Tonga, Tuvalu)
- Ramsar Convention (ratification by all except Kiribati, Solomon Islands, Tonga, Tuvalu, Vanuatu),
- World Heritage Convention (ratification by all except Tuvalu)

Most Pacific countries are members in **global international and intergovernmental organizations** including

- Food and Agriculture Organization of the United Nations (FAO)
- Asia Pacific Forest Commission (APFC)
- International Tropical Timber Organization (TTO) (membership by all except Kiribati, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu).
- Alliance of Small Island States (AOSIS)
- G-77 coalition of developing nations
- With these memberships and coalitions, PICTs seek new political partnerships, such as south-south alliances and emphasize their joint interests in international negotiations.

Concerning international commitments, the **Ambo Declaration** was adopted by Fiji, Kiribati, Maldives, Marshall Islands, Solomon Islands and Tonga together with Japan, New Zealand, Australia, Brazil, China, Cuba at the 2010 Tarawa Climate Change Conference. This Declaration calls for more and immediate action to be undertaken to address the causes and adverse impacts of climate change. The Declaration was slated to be a non-legally-binding agreement between the nations to present at the larger international climate change summit, the 16th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun, Mexico in 2010.

Of relevance to this study, the Ambo Declaration recognizes that climate change is one of the greatest challenges of our time and that there is an urgent need for more and immediate action to be undertaken to address the causes and adverse impacts of climate change.

The Declaration underlies the concern over loss and degradation of biodiversity and its impact on human livelihood and welfare, in particular, in the most vulnerable states in the frontline, and also concern over the emissions added by land degradation. It calls on developed country parties to give priority support to the capacity building and technology transfer needs and priorities of the developing country parties, in particular that of the most vulnerable states to enhance their ability to contribute to the rapid reduction and mitigation of global emissions and to adapt to the adverse impacts of climate change, and further supported by transfer of environmentally sound technologies on mitigation and adaptation (SPC, 2011).

The **Pacific Alliance Leaders Meeting (PALM)**, established by Japan in 1997, is a forum between the government of Japan and leaders in the Pacific islands region. Since its foundation, PALM has become an important venue of dialogue between Japan and Pacific island nations for issues such as development aid and climate change. In 2009, Japanese and Pacific Leaders adopted the Hokkaido Declaration which would facilitate the achievement of the objectives of the Pacific Plan. The main of themes of relevance to S&T in agriculture and forestry outlined in this Declaration include: environment and climate change; bolstering food security, development of agriculture.

The **Millennium Development Goals (MDGs)** were adopted by 192 world leaders, including Pacific island Leaders following the 2000 United Nations (UN) Millennium Summit. Among the eight key Millennium Development Goals (MDGs) these ones referring to agriculture and forestry are (7) to ensure environmental sustainability; and (8) develop a global partnership for development. The themes emanating from these MDGs directly concern environment (deforestation, biodiversity, climate change).

The **Mauritius Strategy**, adopted by 129 Member States in Mauritius in 2005, including Pacific island Leaders, is a Programme of Action for Sustainable Development centred on the specific needs of Small Island Developing States (SIDS). The Programme of Action reflected in the Mauritius Strategy is a blueprint for SIDS and the international community to address national and regional sustainable development in SIDS that takes into account the economic, social and environmental aspects that are the pillars of the holistic and integrated approach to sustainable development. The Mauritius Strategy, organised in twenty chapters, addresses all important elements covering the sustainable development of SIDS, as well as actions that should be taken in specific strategic sectors. In relation to S&T agricultural and forestry research for development, the Mauritius Strategy includes references to continuing to strengthen S&T collaboration through North-South and South-South cooperation, as well as noting the importance of facilitating research into new products and maximising the use of existing SIDS' resources.

The most important OECD members' donors for environmental issues are Australia, New Zealand, Japan, European Commission, Germany, and France. Besides, international agencies also provide assistance to forestry programmes in Pacific Island Countries including FAO, ITTO, UNDP, the World Bank, and ADB. The Global Environment Facility (GEF) is currently providing funding for several forestry projects within the framework of the Pacific Alliance for Sustainability (PAS) programme.

Current GEF PAS forestry projects include

- Improving the representativeness of Papua New Guinea's terrestrial protected area system
- Conserving Fiji's biodiversity via an integrated system of protected areas
- Sustainable management of forest resources on Savaii Island (Samoa)
- Sustainable management and conservation of forests in Vanuatu
- Sustainable use and management of Niue's forest resources.

International private sector investments in forestry are increasingly encouraged by Pacific Island states, e.g. according to Fiji's Forest Policy Statement 2007 "The development of joint ventures for logging, forest management, and timber processing between incorporated landowner groups and both domestic and foreign investment partners will be strongly encouraged (p. 44). Establish a favorable investment climate and coordination mechanisms to promote efficient, profitable and internationally competitive forest industries (p. 47). The Government will encourage expanded value-added processing of timber by both large-scale processing plants and portable sawmills. Foreign investment priorities will be for high technology, capital intensive, value-added processes and for the establishment of commercial plantations on land already cleared (p. 48) (Government of the Republic of the Fiji Islands, 2007; SPC, 2011).

EU-Pacific policy frameworks

The EU is the second largest donor in the Pacific after Australia and has a long-standing cooperation with the Pacific ACP countries in the framework of the ACP/EU Partnership Agreement and reaffirms its ambition of strengthening the partnership between the European Union and the Pacific region. The EU-Pacific partnership has developed and deepened in different strategies and initiatives.
The **Cotonou Agreement**, signed in 2000 until 2020, is a treaty between the EU and 79 African, Caribbean and Pacific Group of States (ACP) countries. The Cotonou Agreement is a comprehensive development, trade and aid partnership, setting out the framework for the EU's relationship with ACP countries. This Agreement is aimed at the reduction and eventual eradication of poverty while contributing to sustainable development and to the gradual integration of ACP countries into the world economy. In its structure, the Agreement encompasses three pillars for the relationship between EU and ACP countries: (1) a political dialogue between ACP countries and the EU; (2) the development of a new trade regime, called Economic Partnership Agreements; and (3) the development aid co-operation. In various articles, the Cotonou Agreement follows the appeal of the **Libreville Declaration**. The Libreville Declaration, adopted in 1997 by the 78 ACP

countries, aimed to improve the development co-operation between ACP countries and the EU by placing "greater emphasis on the development of our human resources, on enhanced access to science and technology, especially on information technology and the financing of research relevant to our socio-economic development". Article 23j of the Cotonou Agreement states for instance that the co-operation should support the 'development of scientific, technological and research infrastructure and services, including the enhancement, transfer and absorption of new technologies'. Article 33b aims to improve the 'capacity to analyze, plan, formulate and implement policies, in particular in the economic, social, environmental research, science and technology and innovative fields'.

Other areas mentioned in the Cotonou Agreement on which S&T research opportunities in agriculture and forestry can be based appear under the co-operation strategies and include: social sector development (through nutrition, food supply, regional co-operation (in environment, education and training, research and technological development); environment and natural resources (includes issues of scientific and technical human and institutional capacity building, forests, biodiversity, soils, protection of ecosystems, drought and deforestation, sustainable tourism, climate change).

In 2006 the EU agreed on a **'Strategy for the Pacific'** to focus on specific, selected priorities where the Pacific has significant needs for which Europe has indisputable comparative advantages. The overall emphasis is on a blue-green economy for growth and on improved political dialogue. Key issues to be addressed in this partnership among others are the "socio-economic and environmental challenges through more efficient, better coordinated and more focused development cooperation, giving priority to sustainable development and sustainable use of natural resources. The Council moreover recalls the existing EU agreements with the Pacific and draws attention to the close links with some Member States through the overseas territories of France (French Polynesia, New Caledonia, Wallis and Futuna) and of the United Kingdom (Pitcairn)" The Council notes the particular challenges of sound sustainable development in the Pacific and the vulnerability to natural disasters. Willing to support sustainable development in the Pacific, the EU will help countries protect their biodiversity, including dealing with climate change and rising sea levels and addressing diminishing fish-stock and coral bleaching.

The Council furthermore emphasizes its readiness to support Pacific countries in land use, land and natural resources management, the fight against land degradation, illegal logging and deforestation, and making ecological and sustainable use of renewable energy resources […]. In line with the Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan for the ACP countries the Commission proposes a regional approach, building national and regional capacity to monitor and support FLEGT partnership agreements. **Research cooperation could be followed up under the European Union's Research Framework Programmes.**

Moreover, the Council stresses the need to strengthen Disaster Risk Reduction including through the Pacific Tsunami Early Warning System and France, Australia and New Zealand (FRANZ) agreement. Information and communication technologies in the form of surveillance and control systems for logging and for facilitating communication could be used for supporting the resource management and disaster preparedness activities.

The Council underlines the importance of ensuring that policies fully support the MDGs and the principles outlined in the Paris Declaration on Aid Effectiveness of March 2005. The Council recognises the importance of working closely with all other donors active in the region, as well as with multilateral institutions, such as UN organisations, the Asian Development Bank and the World Bank, in an effort to improve donor coordination and harmonisation and alignment to recipient country systems. In this context, the existing relations with Australia and New Zealand should be further strengthened (Council of the European Union, 2006).

The EU (EC DG RTD-INCO) strongly supports the international cooperation in science and technology between the EU and the Pacific. The three-year INCO-NET Coordination Action, **PACE-NET** which started in April 2010 with the support of the EC has the main goals to 1) strengthen bi-regional sustainable dialogue on Science and Technology between Europe and the Pacific on global and regional priorities of mutual importance; 2) identify research

partnership projects that will address those priorities; and 3) raise awareness of the critical importance of the Pacific region to global sustainability and the vulnerability of its island countries.

In 2010 the EU and the Pacific signed a **'Joint Pacific-EU Initiative on Climate Change'**, aiming at attracting EU Member States' attention to the region and mobilizing a fair share of international Climate Change funding. […] The initiative aims to ensure that a fair share of international climate change funding goes to Pacific countries. The Commission is leading the EU's efforts to support the Pacific Islands to tackle climate change effects, with an overall dedicated envelope of €90 million over 2008–2013.

The Commission is leading the EU's efforts in development cooperation with the Pacific, with more than €600 million made available for 2008–2013. In addition, the EU dedicates €70.49 million for the Pacific Overseas Countries and Territories on the same period in the framework of the EU-OCT (Overseas Countries and Territories) association. Addressing climate change has been one of the priorities of the last few years, with €90 million for programmes at country and regional level. They notably focus on adaptation measures, sustainable management of natural resources, renewable energy and disaster preparedness. […]

At the regional level, the EU programmes support strategic actions on adaptation by strengthening capacity building, community engagement and encouraging applied research. Also, the European Development Fund finances climate change related programmes. For example, renewable energy is the main sector of activity for EU actions in Federate States of Micronesia, Kiribati, Marshall Islands, Niue, Nauru, Palau, and Tonga. The objective is to promote renewable energy and energy efficiency that will help reduce dependency on fossil fuels […].

The "INTEGRE" project developed by Wallis and Futuna, New Caledonia, French Polynesia and Pitcairn, the Pacific Overseas Countries and Territories associated with the EU, with a budget of € 12 million focuses on actions in the areas of protection of the environment and the management of natural resources and island ecosystems, with an overall objective relating to adaptation to climate change. The project will reinforce regional cooperation in these areas by the means of implementing in the Overseas Countries and Territories projects carried out in Pacific States. This will notably allow networking between them. This project will be co-managed with the Secretariat of the Pacific Community (Europe Press Releases Rapid, 2010).

The EU supports applied research and pilot projects to prepare long term strategies for adaptation to climate change. The University of South Pacific will conduct community adaptation projects (including mangrove replanting, reforestation of watershed areas, introduction of drought/salt resistant cultivars, soil retention measures, etc.) train students in the science of climate change both at formal academic level (45 postgraduate diplomas, 25 Masters scholarships, 5 PhD scholarships) and also to work with communities on climate change adaptation (300 certified trainers).

In 2012 the Joint Communication to the European Parliament, the Council, the European Economic and social committee and the Committee of the Regions was made **"Towards a renewed EU-Pacific development Partnership"** (European Commission, 2012). This Joint Communication focused on the development aspects of EU relations and stresses the need to promote coherence between development, climate action and other EU policies, such as trade, environment, fisheries, research, on the one hand, and human rights and democracy support on the other. Among the recommendations of action the Joint Communication stressed the need "The EU should continue involving civil society, local authorities, the private sector and the research community in its cooperation in the region, by supporting regional networking and Pacific-EU partnerships and by promoting public interest and debate in Europe on issues of common concern for the Pacific Islands Countries and Territories and people".

Regional policy frameworks

At a regional level there are several policy frameworks with relevance to agriculture and forestry and related science.

The **Pacific Plan for strengthening regional cooperation and integration** (The Pacific Plan) was adopted by all 16 member countries of the Pacific Island Forum towards regionalization in economic growth, sustainable development, good governance and security for Pacific countries, thus offers an opportunity to foster EU-Pacific relations. The Pacific Plan does not make specific reference to S&T research. However, the pillar relating to sus-

tainable development is the most relevant to S&T research as it provides the context for research opportunities.

The strategic objectives underlined within this pillar include: reduced poverty; improved natural resource and environmental management with initiatives in sustainable development, […] adaptation and mitigation in climate change and disaster management, biodiversity and environmental protection; improved education and training; and recognized and protected cultural values, identities and traditional knowledge.

One of the region's key priorities is the facilitation of international financing for sustainable development, biodiversity and environmental protection and to counter the effects of climate change in

the Pacific. The Pacific Plan requested the SPC to develop a new agriculture and forestry initiative, including atoll agriculture, under the Pacific Plan's sustainable development pillar, to be considered and approved, noting resource requirements and implications, by the PPAC in 2008; Furthermore, it requested SPC and the Forum Secretariat to jointly develop National Sustainable Development Strategies (NSDS)-based agriculture and forestry policies, plans of action and budgeting processes, in collaboration with national governments, seeking technical and financial support from regional agencies and development partners as required (Pacific Islands Forum Secretariat, 2007).

The **Pacific Island Regional Framework for Action on Climate Change 2006–2015 (PIFACC)** aims to ensure that Pacific island peoples and communities build their capacity to be resilient to the risks and impacts of climate change with the key objective to deliver on the expected outcomes under the following six principles: (1) implementing adaptation measures; (2) governance and decision-making; (3) improving our understanding of climate change; (4) education, training and awareness; (5) contributing to global greenhouse gas reduction; and (6) partnerships and cooperation. The Action Plan for the implementation of PIFACC has identified the key areas that will be impacted by climate change as: food security and agriculture and other areas. Sectors of importance to the sustainable development of PICTs such as land-based resources, biodiversity are also considered under this Action 20 Plan. Moreover, the recommendations made under the principles 3, 4 and 6 in the Action Plan are of relevance to S&T research (SPC, 2012).

- Principle 3: to increase capacity for climate change and health research in the Pacific; and to improve regional and international collaboration in this regard.

- Principle 4: to develop and maintain regional expertise for research and development focused on climate change, climate variability and sea level rise; develop a directory of regional and national organisations and individuals, with a view to build active networks in the implementation of climate change activities and to increase the capacity of regional educational and research institutions; and to coordinate the collection and dissemination of information, advice, training, networking and linkages to ongoing research in Council of Regional Organisations in the Pacific (CROP), at the University of the South Pacific (USP) and other tertiary institutions, through the Clearing House Mechanism.

- Principle 6: to promote joint climate change projects between international organisations, education and research institutions and PICTs."

The PIFACC is supporting the following PICTS (American Samoa, Federated States of Micronesia, French Polynesia, Guam, Cook Islands, Kiribati, Marshal Islands, New Caledonia, Niue, Norfolk Islands, Northern Marianas, Palau, Pitcairn Islands, Solomon Islands, Tokelau, Tonga, Samoa, Papua New Guinea, Tuvalu, Fiji and Vanuatu) in implementing key strategic priorities in the area of climate change including, where relevant, their National Adaptation Programmes for Action (NAPA), National Communications to the United Nations Framework Convention on Climate Change (UNFCCC), and other relevant national strategies, polices and plans (SPC, 2011).

The Action Strategy for Nature Conservation in the Pacific Islands Region 2008–2012 was developed in 2002 at the 7th Pacific Islands Conference on Nature Conservation and Protected Areas and endorsed by SPREP's member countries. This Action Strategy has received broad acceptance of all key stakeholders in the region (national governments, regional organizations, non government organisations, church groups, and donors) and now represents the WSSD Type II Partnership Initiative on mainstreaming conservation which was identified as a priority by Pacific island Leaders in 2002. The Action Strategy highlights the priority concerns for conservation in the Pacific region, and outlines a roadmap for achieving the key goals. It centers on the following three 30-year goals: (1) environmental including conservation of biodiversity and natural environment; (2) economic - nature conservation and sustainable resource use; and (3) social – peoples, governments, and institutions in the Pacific involved in sustainable and equitable natural resources use activities and the following key focus areas: (1) ensure conservation has a development context that recognises, respects and supports sustainable livelihoods and community development aspirations; (2) identify, conserve and sustainably manage priority sites, habitats and ecosystems; (3) protect and recover threatened species and species of ecological, cultural and economic significance; and (4) manage threats to biodiversity, especially climate change. These focus areas are drawn from common priorities identified in Pacific Island National Biodiversity Strategies and Action Plans (NBSAPs) that were developed by 22 PICTs, presenting the key goals and actions that these nations feel are necessary to safeguard their biological diversity. Of relevance to agriculture and forestry S&T, the following common themes have been identified in the NBSAPs: endangered species; invasive species; ecosystem management; genetic resource use; agro-biodiversity; ecological social and economic development; waste management; human resources and institutional development; mainstreaming biodiversity conservation; securing and enhancing traditional knowledge; addressing pollution; and education and awareness (SPC, 2011).

National policy frameworks

Countries of the Pacific have policies to guide their efforts in developing their agriculture and forestry sectors to provide improved food security and incomes for sustainable livelihoods. Examples include

- The Pohnpei State Agriculture Strategic Action Plan (2011–2015 for the Federated States of Micronesia
- Guam State-wide Forest Resource Assessment and Resource Strategy 2010 -2015
- Solomon Islands National Agriculture and Livestock Sector Policy (2009-2014)
- PNG National Agriculture Development Plan (2007–2016)
- PNG National Forest Development Plan (1991)
- Fiji Agriculture Strategic Development Plan (2010-2012)
- Fiji Forest Policy (2007)
- Fiji Agriculture Policy (2008)
- Vanuatu Forest Plan (2011)
- Samoa Agriculture Strategic Plan (2008)
- Tonga National Forest Policy (2008).

Most PICTs have a Climate Change office. In collaboration with these offices, steps must now be taken to develop policies that cover the necessary areas of adaptations and mitigations.

However, corruption is a major problem to execute such plans and policies, especially where forestry has been an important industry and a major source of revenues. Corruption facilitates the illegal harvesting and removal of timber, and associated trade; it reduces government revenues from royalties and taxes; it may suppress prices for legal timber; where endemic, it raises transaction costs through the need for additional procedural auditing as well as costs of graft payments; it repels investors looking for safe havens for their funds; and it undermines confidence in governments and their forestry agencies Elges (FAO, 2009b).

Forest research in the PICTs is carried out in a range of forest research providers, including universities, private sector firms (forestry companies and consulting agencies) and cross-sectoral agencies. For example in Papua New Guinea, the

Forest Research Institute (PNGFRI) operates as a directorate of the PNG Forest Authority. PNGFRI provides forest-related research services based on collaboration with users in government, industry and communities.

Key subregional forest research priorities in the Pacific (incl. Australia and New Zealand) include after FAO (2011):

- Strengthening efficient, value-added, integrated processing;
- Development of efficient, small-sized processing plants (Pacific islands);
- Reconstituted wood products – composites and polymers;
- Wood substituting for less environmentally friendly products;
- Wood products as a carbon store;
- Bioenergy and second generation biofuels;
- Biotechnology;
- Tree improvement and tree breeding;
- Biosecurity, forest health and forest fires; and
- Building sciences.

Agriculture and forestry research and development programmes of institutions and initiatives for the Pacific Islands

The major academic and science institutions, regional and civil society organizations based in the Pacific islands and those based in Australia and New Zealand with strategic focus on the Pacific island region, as well as initiatives, foundations and cooperation for development programmes with contributions to agricultural and forestry S&T research for development as identified by SPC (2011) are listed below:

Academic institutions

- The Australian National University (ANU) – ANU's College of Asia and the Pacific (CAP) – Research School of Pacific and Asian Studies (RSPAS) – The Pacific Centre
- University of the South Pacific (USP) – Institute of Research, Extension and Training in Agriculture (in Samoa)
- University of Guam (UoG) – Western Pacific Tropical Research Center
- University of Papua New Guinea (UPNG) – UPNG Remote Sensing Centre
- University of French Polynesia (Université de la Polynésie Française, UPF)
- National University of Samoa (NUS)

Science institutions

- Commonwealth Scientific and Industrial Research Organisation (CSIRO) – "research for development" role in connection with the Australian Centre of International Agricultural Research (ACIAR) and Australian Agency for International Development (AusAID)
- Landcare Research (New Zealand)
- New Zealand Forest Research Institute Limited (SCION)
- The Institute of New Caledonian Agriculture (Institut Agronomique néo-Calédonien, IAC)
- The Papua New Guinea National Agricultural Research Institute (NARI)
- The French Agricultural Research Centre for International Development (Centre de Coopération Internationale en Recherche Agronomique pour le Développeme (CIRAD))
- The Institute of Research for Development (Institut de Recherche pour le Développement (IRD), – Noumea IRD Centre (in New Caledonia)
- Forest Research Institute of Papua New Guinea (PNGFRI)

Regional inter-governmental organizations with capacity building and research services

- Secretariat of the Pacific Community (SPC) – Land Resources Division (LRD),
- South Pacific Applied Geoscience Commission (SOPAC)
- South Pacific Regional Environment Programme (SPREP)
- The Pacific Islands Forum Secretaria (PIFS)

Civil society organizations contributing to S&T

- Hawaii Agriculture Research Center (HARC)
- The Observatory of Environment in New Caledonia (L'Observatoire de l'Environnement en Nouvelle-Calédonie; OEIL)
- The Papua New Guinea Cocoa and Coconut Research Institute (CCRI)
- The Papua New Guinea Institute of Biological Research (PNGIBR)
- The Papua New Guinea Oil Palm Research Association (OPRA)
- The Research and Conservation Foundation of Papua New Papua (RCF)

Initiatives and foundations contributing to S&T

- Observatory in the South Pacific for the environment and terrestrial and marine biodiversity (Grand Observatoire de l'environnement et de la biodiversité terrestre et marine du Pacifique Sud (GOPS)

- The Pacific Island Roundtable for Nature Conservation
- The Australia and Pacific Science Foundation (APSF)
- The French Facility for the Environment (Fond Français pour l'Environnement; FFEM)
- The Pacific Fund (Fonds Pacifique)
- Global Climate Change Alliance (GCCA)
- Global Island Partnership (GLISPA)
- Joint Pacific-EU Imitative on Climate Change
- Global Environment Facility (GEF)
- Island Biodiversity Programme of Work

Cooperation for Development Programmes of Donor Agencies - Bilateral Aid Agencies contributing to S&T

- Australia: Australian Agency for International Development (AusAID) - Australian Centre for International Agricultural Research (ACIAR) – AusAID-CSIRO´s Research for Development Alliance
- France: Directorate-General for Development and International Cooperation - French Development Agency (Agence Française de Développement; AFD)
- Japan: Japan International Co-operation Agency (JICA) - JICA Research Institute
- Korea: The Korea International Co-operation Agency (KOICA)
- New Zealand: New Zealand Aid (NZAID) - Pacific Strategic 2007 – 2015 Framework - International Development Research Fund (IDRF)
- United States of America: United States Agency for International Development (USAID) – Millennium Challenge Corporation (MCC)
- Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) – Coping with climate change in the Pacific island region programme for environmental protection and resource conservation
- China/Taiwan: Regional Development Assistance fund

Cooperation for Development Programmes of Donor Agencies - Mulilateral Aid Agencies contributing to S&T

- Asian Development Bank (ADB): Strategy 2020 – ADB's Pacific Approach, 2010-2014 - Country Partnership Strategy
- European Union (EU): World's biggest aid donor – DG for EuropeAid Development and Cooperation (DEVCO) – European External Action Service (EEAS): EU Strategy for the Pacific – European Development Fund (EDF) – ACP Caribbean and Pacific Research Programme for Sustainable Development – ACP Science and Technology Programme
- United Nations (UN) Agencies
  - UN Development Assistance Framework for the Pacific sub-region (UNDAF) Food and Agriculture Organisation (FAO)
  - United Nations Development Programme (UNDP)
  - The Pacific Operations Centre of UNESCAP (EPOC)
  - United Nations Educational, Scientific and Cultural Organisation (UNESCO): Recognizes that scientific knowledge is an essential driver for social and economic development in the Pacific and strongly advocates the involvement of research activities across its programmes
  - United Nations Environment Programme (UNEP)

Status of Research on the Vulnerability of the Sector

The absence of an ecologically coherent policy framework for the sustainable management of biodiversity in relation to food and livestock production (sensu Boer and Clarke, 2012) means that the research agenda is poorly placed to:

- Identify and elucidate causal processes at work in the environment and deal with conflicting pressures facing the region as it promotes and responds to change;

- Address the relationship between local biotic resources and the development of land man- The abThesence of an ecologically coherent policy framework for the sustainable management of biodiversity in relation to food and livestock production (sensu Boer and Clarke, 2012) means that the research agenda is poorly placed to:

- Identify and elucidate causal processes at work in the environment and deal with conflicting pressures facing the region as it promotes and responds to change;
- Address the relationship between local biotic resources and the development of land management systems and cultural patterns as a basis for monitoring change, adapting to new situations and exploiting new opportunities;
- Explore economic opportunities offered by the region's bio diverse ecosystems;
- Align national and international research agendas to the needs of the region;
- Broker mutually multi sector investment deals with the commercial sector and attract investment from the commercial sector;
- Engage and interact with local communities and civil society organisations.

This means that the research base for agroecology and agroforestry will remain a largely fragmented and uncoordinated enterprise unable to inform strategic policy and ill equipped to deal with socio-economic and environmental challenges such as sea level rise and increase of soil salinity in ocean-near cropping systems, El Niño induced droughts and La Niña induced Floods (ENSO) and including those posed by pressures to increase production beyond sustainable limits.

Vulnerability and climate change impact on agriculture and forestry

The Fourth Assessment Report of the IPCC (IPCC AR4) Working Group II (2007) identifies small island states as being among the most vulnerable countries of the world to the adverse impacts of climate change. Hay et al. (2003) in discussing the Pacific's observed climate noted that compared to earlier historical records during the twentieth century, the southern Pacific had experienced a significantly drier and warmer climate (by 15% and 0.8°C, respectively). The Central Equatorial Pacific is facing more intensive rain (about 30%) and a similarly hotter climate (0.6°C), and sea surface temperatures in both areas have increased by about 0.4°C. These conditions are linked to an increased frequency of El Niño episodes since the 1970s (without alternating La Niña events). Other studies show that climate projections for the South Pacific indicate warming of 0.8 to 1.8°C and precipitation changes that range from -8 to +7 percent by mid-century (Ruosteenoja et al., 2003). By the end of the century, projected warming is 1.0 to 3.1°C and precipitation changes range from -14 to +14 percent. Projections of globally averaged sea-level rise range from 0.18 m to 0.58 m in 2090–2099 relative to 1980–1999; while tropical cyclones are likely to become more intense, have higher peak wind speeds, and bring heavier rainfall (IPCC, 2007). Thus, it is clear that the small island countries of the Pacific in the warmer latitudes standing to lose the most.

Recent studies in the southern Pacific region show that the annual and seasonal ocean surface and island air temperatures have increased by 0.6 to 1.0 °C since 1910 (SPC, 2012). Analyses of trends in extreme daily rainfall and temperature for the period 1961 to 2003 show significant increases in the annual number of hot days and warm nights, with significant decreases in the annual number of cool days and cold nights. Sea-level rise, inundation, seawater intrusion into freshwater lenses, soil salinisation and decline in water supply are very likely to adversely impact coastal agriculture. Away from the coast, changes in extremes (e.g., flooding and drought, cyclones) are likely to have a negative effect on agricultural production (SPC, 2012).

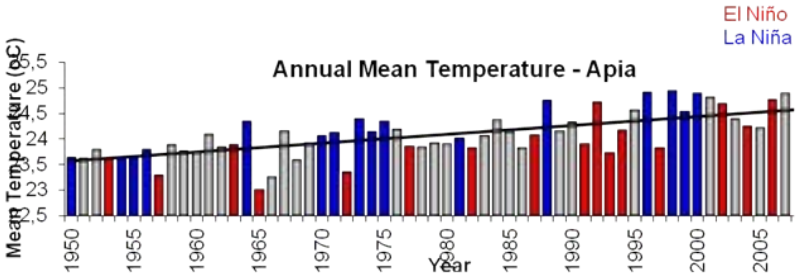

Figure 3. Annual mean temperature development in Apia, Samoa between 1950–2005 (Australian Bureau of Meteorology and CSIRO, 2011).

According to Pacific Climate Change Science Program (PCCSP), the likely future changes would be warmer weather, generally wetter, with heavier rainfall, slightly more humid and less sunny, fewer tropical cyclones, but more intense, more sea level rise and more ocean acidification (Cambers, 2012).

Changes in temperature

Pacific island annual temperature trend range between 0.1°C-0.2°C/decade (1960–2009) (Figure 3). All locations in the Pacific are warming up (Australian Bureau of Meteorology and CSIRO, 2011).

Changes in rainfall and extreme events

Rainfall across the region has increased and decreased in response to natural climate variability. As shown below; over the past 50 years, rainfall totals increased to the north east of the South Pacific Convergence Zone and declined to the south.

The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems.

In the Pacific, about 70% of the gross cropped area is geographically located so as to benefit from rains in the summer season (November–April) (FAO, 2008). Production is, therefore, heavily dependent on the seasonal rainfall. Climate change predictions for the region suggest prolonged variations from the normal rainfall which can be devastating to agriculture.

Sea-level rise

Sea-level rise in the PCCSP region is likely to be similar to the global average. As shown in Figure 7 below, by 2090 sea rise will be as follows: 17-46 cm (B1), 20-58 cm (A1B) and 21-60 cm (A2).

Tropical cyclones

Accordingly to PCCSP, 2010, tropical cyclone numbers are likely to decline in the Pacific Ocean over the 21st century, however severity will increase. Many simulations with fine resolution models (downscaling) show an increase in the proportion of the most severe cyclones.

Effects of climate change on agriculture and forestry

IPCC (2007) has projected that changes in temperature, rainfall patterns (Table 6), sea level and the intensity of extreme weather events such as cyclones will have the following effects:

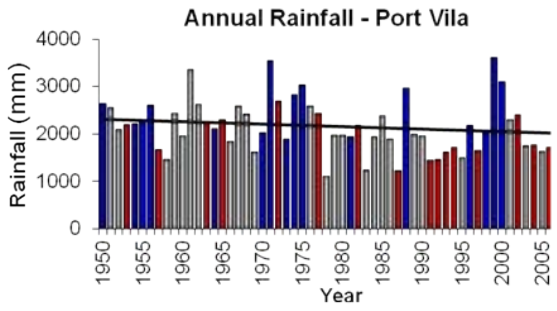

Figure 4. Rainfall over Port Vila, Vanuatu between 1950–2005 (Australian Bureau of Meteorology and CSIRO, 2011).

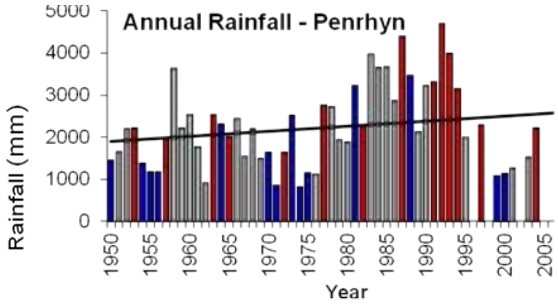

Figure 5. Rainfall over Penrhyn, Cook Islands between 1950–2005 (Australian Bureau of Meteorology and CSIRO, 2011).

- Affect the type of crops that can be grown and reduce agricultural yields due to greater heat stress, more frequent and intense drought conditions or water logging, increased flooding of river catchments and more soil erosion;
- Favor the establishment and spread of new pests and disease vectors, further threatening the production of crops and livestock;
- Result in loss of productive land due to increased coastal erosion and contamination of groundwater by saltwater intrusion;
- Further erode biological diversity and disrupt ecosystem services vital to food security, such as pollination and soil enrichment;
- Alter the function and species composition of forests, affecting their ability to provide important ecosystem services such as water cycle regulation, maintenance of soil fertility and conservation of biodiversity;
- Increase saltwater intrusion in atolls, further limiting what can be grown in these environments and exacerbating existing threats to food security.

Many people living in the Pacific islands and Timor-Leste report their climate is already changing. Representatives from PCCSP partner countries described their communities' experiences of climate change during a PCCSP workshop held in 2010 including:

- Shifts in seasonal patterns of rainfall and tropical cyclone tracks
- More frequent and more intense rainfall causing flooding and mudslides
- More frequent and longer droughts
- More hot days
- Sea-level rise leading to increased coastal erosion and risks to important crops such as taro through salt water contaminating freshwater supplies
- Coral bleaching

Others said higher temperatures were increasing the yields of some crops. For example, grapefruit is now found year-round in Samoa, and in Vanuatu coconut trees are bearing more fruit (PCCSP, 2010).

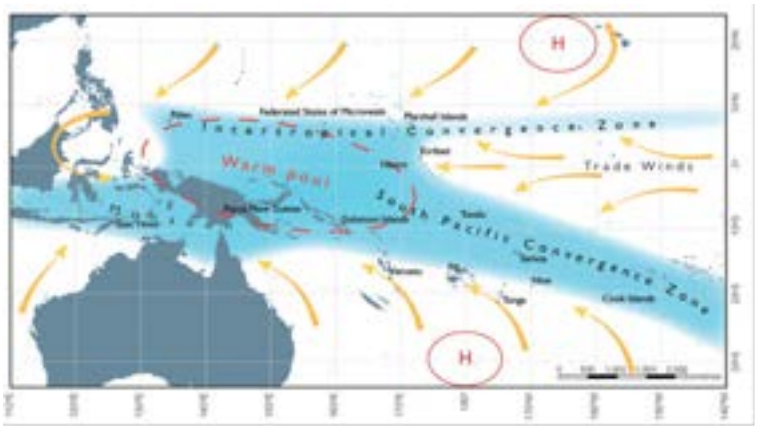

Figure 6. The average positions of the climate features in November to April (Australian Bureau of Meteorology and CSIRO, 2011).

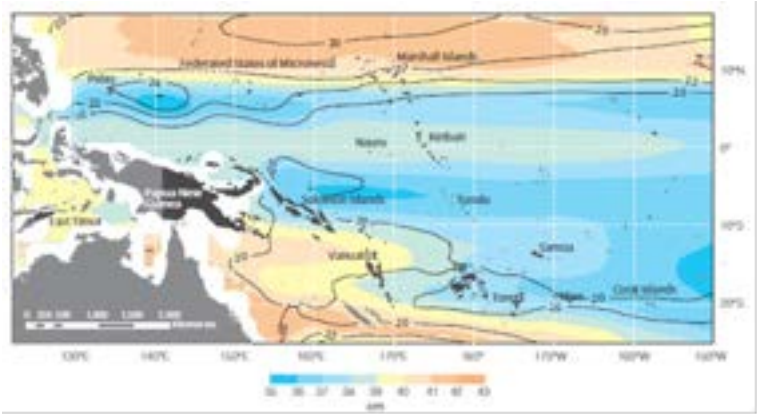

Figure 7. Sea-level projections (in cm) for the A1B (medium) emissions scenario in the PCCSP region for 2061–2100 relative to 1981–2000 (Australian Bureau of Meteorology and CSIRO, 2011).

Air temperature	2010–2039	2040–2069	2040–2069
Northern Pacific (°C)	0.49–1.13	0.81–2.48	1.00–4.17
Southern Pacific (°C)	0.45–0.82	0.80–1.79	0.99–3.11
Rainfall			
Northern Pacific (%)	6.3 to +9.1	–19.2 to +21.3	2.7 to +25.8
Southern Pacific (%)	3.9 to +3.4	–8.23 to +6.7	–14.0 to +14.6

Table 6. Projected increases in surface air temperature (°C) and changes in rainfall by region (%), relative to the 1961–1990 period (IPCC 4th Assessment Report – Table 16.1 and 16.2).

Proposed Adaptations and Supporting Policies

Across the Pacific region, there is an ongoing need to maintain a resilient and productive environment that can support sustainable levels of human exploitation, deliver ecosystem services and reinforce social cohesion. Traditionally, this been achieved through the continuing evolution of locally adapted cultural strategies that not only assured a degree of food security in difficult times (Muliagatele, 2007: 52) but also added to the range of local crops, stock, products and services, effectively increasing ecological resilience. The unintended development of this positive spiral depended upon local communities being able to manage change by maximising production within sustainable limits over short temporal and spatial scales, in a way that avoided large scale system collapse.

Given the projected climatic and demographic change (FAO, 2008) and the suspected threshold-breaching pressures facing the region, this naturally evolved relationship between people and the land is unlikely to remain tenable in the absence of a concerted effort to mobilise the necessary resources and order these within coherent policy framework that is able to:

- Establish the diagnostic value of traditional management systems and their role as baseline models for innovation and development;
- Integrate ecological concerns and the value of ecosystems services into all spatial and economic plans (sensu Hindmarch et al., 2006);
- Ensure that social, economic and environmental plans and policies for the region are subject to evidence-based strategic impact assessment and periodic review involving local communities and civil society organisations;
- Institute intelligence and information systems capable of encouraging social inclusion (sensu, FCMM, 2000; UNESCO, 2002), the involvement of multi-level stakeholders and supporting the development and implementation of locally appropriate solutions;
- Build capacity in science and legislation that will help Pacific islanders to develop policies and land management techniques that will optimise the sustainable use of their natural resources.

Unbalanced competing demands of land use by local communities and rich landowners (farms, resorts…) constitutes a huge frame to optimise the sharing benefit of natural resources adding the less attraction of agricultural activity domain by younger generations who are more and more focussing on urban life.

This section will consider adaptations necessary to sustain income generation and food security of the people of PICTs and also present the relevant supporting policies.

Adaptation strategies

Adaptations required to sustain food security of smallholder farmers

The performance of agriculture and forest systems under stress depends on both their inherent genetic capacity and the integrity of the ecosystem in which these systems are managed (SPC, 2009). Adaptation strategies must combine development of improved crop varieties and animal breeds with the integrated management of natural resources

needed to sustain their productivity and ensure they continue to provide the vital services needed by people and the environment.

All stakeholders will have to work together to raise awareness of the impacts that could result from the magnitude of changes projected under current climate scenarios for the Pacific. Diversifying production systems and building on traditional practices will be crucial in enhancing community resilience. Some of the main adaptations required include:

- Collection, evaluation and distribution of crop and tree varieties and livestock breeds that can tolerate climatic extremes (drought, heat-stress, salinity);
- Development and promotion of farming systems more suited to changing environmental conditions, such as traditional agro-forestry systems;
- Promotion of sustainable land and forestry management (including strong enforcements of reforestation in logging areas) and land-use planning to minimize the projected impacts of climate change on agriculture and forestry, such as more regular inundation and soil erosion.
- International market development for organic produce of agriculture from the Pacific as a way of improving productivity of subsistence farming, greater carbon sequestration (reduced forest clearing for new gardens) and improved income earning opportunities. (PNG NARI, 2012).

The effects of Climate Change (CC) in the Pacific are most notably irregular weather patterns, increasing frequency and severity of ENSO induced events and effects of rising sea levels and increasing temperature. The severity and frequency of El Nino and El Nina is expected to increase, increased salinity and frequent natural disasters (cyclones, tsunamis, landslides).

This means that technological adaptations need to be focused on developing appropriate simple irrigation technologies for smallholder production under deficit soil water conditions) or developing drought tolerant varieties of staple crops (sweet potato, cassava, taro, yam and banana) of the Pacific. For excess moisture conditions, appropriate cultural methods need to be developed. We need to also develop crop varieties resistant to saline soils and develop crop varieties that can grow and produce under a temperature increase of 1°C.

Current research and development projects on adaptation and mitigation

Across the Pacific there are projects being implemented in each country to develop agricultural crop varieties, technologies and production systems which will enable rural smallholder farmers to cope under Climate Change. Measurable long-term impact in farming communities in terms of their food security, income generation and overall well-being in the face of CC will require a long-term commitment by the government and donors moving away from project-based to strategic programmatic support with an active involvement of national organizations.

The PNG National Agricultural Research Institute (NARI) currently runs 10 CC projects, 4 of which are funded by the European Union. One Project (Agricultural Research and Development Project on Climate Change) covers PNG, Solomon Islands and Vanuatu (Western Pacific) and aims to select, pilot and out-scale varieties of sweet potato having tolerance to both deficient and excess moisture and saline soil conditions as wells as improving food buffering through crops / livestock diversification.

- Agricultural Research and Development Project on Climate Change in PNG, Solomon Islands and Vanuatu (EU funded);
- Adapting clonally propagated crops to climatic and commercial changes (Taro Improvement Project) (EU funded);
- In-house Food Security through Preservation and Improvement of Genetic Diversity of Sweet Potato & Aibika (slippery cabbage)in Papua New Guinea & Solomon Islands (EU funded);
- Enhancing Productivity of land and labor through a Small Scale Mechanization for Subsistence Farmers in PNG & Solomon Islands (EU funded);
- Taro evaluation in PNG for drought and salt tolerance (SPC funded);

- Seeds for Needs (Anonymous Donor);
- Multiplication and downstream processing of NARI cassava preparing for climate change (AUSAID);
- Promotion of diversified (cash/food crops and livestock) integrated production system and strategies for income earning opportunities and food security in remote farming communities in Pomio district of ENBP (AUSAID);
- Drought Preparedness Project (PNG Gov);
- Oro Rehabilitation Project (Cyclone Guba) (PNG Gov and AUSAID).

Regional projects

Furthermore, across the Pacific, there are four regional projects which are implemented covering several countries. These projects include crop diversity, and natural resource management, including irrigation, as coping strategies for farmers. They are:

- **International Climate Change Adaptation Initiative Phase I (AusAID funded)**
  The objective of this project is to increase crop diversity as a mechanism to assist farmers in managing climate change. Crops developed will be available to all countries of the Pacific. The planned outputs for this project are the establishment and development of the climate-ready collection, development of screening methods for drought and salt tolerance for swamp taro, assessment of the impact of increased carbon dioxide concentration on major Pacific crops (i.e. cassava, sweet potato and taro), and improved agro-biodiversity.

The Centre for Pacific Crops and Trees in SPC Fiji is establishing a "climate-ready" collection consisting of crops and varieties with desired "climate-ready" traits, such as drought, salt, high temperature, waterlogging tolerance. These crops/varieties are being sourced locally through collecting from the countries with the support of national partners. The focal points of the Pacific Plant Genetic Resources Network are assisting in identifying the target crops/varieties. Once collected this material must be established in tissue culture and virus tested before it can be distributed to any other country.

- **Vegetation and land cover mapping and improving food security for building resilience to a changing climate project (USAID funded)**
  This project emphasizes on whole of land-resources management based approach and not just crop diversity. The project is implemented in Fiji, Kiribati and Solomon Islands and established base-line data and climate field schools in Solomon Islands. It has involved participatory rural appraisals, considering all thematic areas of land resources division in SPC.

- **Pacific Adaptation to Climate Change Project (PACC) funded by GEF and AusAID, implemented by UNDP and SPREP**
  The PACC Project is designed to promote climate change adaptation as a key pre-requisite to sustainable development in Pacific Island countries. The objective of this project is to enhance the capacity of 14 participating countries to adapt to climate change and climate variability, in selected key development sectors. The three major components are Coastal Zone Management, Food Production and Food Security and Water. The Coastal Zone Management is carried out in the Cook Islands, FSM, Samoa, and Vanuatu. The Food Production and Food Security is implemented in Fiji, Palau, PNG, and Solomon Islands; and the Water component is carried out in Marshall Is., Nauru, Niue, Tokelau, Tuvalu, and Tonga.

  The three planned project outputs are:
  - Strengthened the institutional framework, policies and plans and the capacity of key national government and community decisions makers to take climate change risks into key decisions;
  - Measures to reduce vulnerability in coastal food security and water management demonstrated and implemented;
  - Communication, sharing of lessons learnt and technical backstopping support enabled among project partners.

- **Climate Change and Food Security**
  The objective of this project was to measure

the impact of crop diversity in terms of economic returns through a benefit –cost analysis. There were two case studies done in Samoa and Vanuatu using different approaches to conservation/crop improvement and disaster management.

- The case study of taro leaf blight in Samoa (ex-post assessment) revealed that regional and national germplasm collections was utilized to develop TLB resistant varieties as a climate change adaptation strategy. The study demonstrates how crop conservation utilising regional genebank coupled with an in-country breeding and distribution program provides a basis for an effective response to a biological disaster.
- The case study (ex-ante assessment) in Vanuatu showed that broadening the genetic base of root crops is a proactive climate change adaptation strategy ('genetic insurance' to manage disasters). The study demonstrates a proactive approach where crop conservation, (ex situ and in situ) is used to enhance the diversity of the gene pool – providing the farmers with 'genetic insurance' to manage climatic variability and future biological disasters.

The findings are that for Samoa, there are large quantifiable economic benefits that far outweigh costs. There is a Benefit/Cost ratio of 10.5 – 12.5 (i.e. the benefits are 10-12x higher than the cost) for Samoa. Today, Samoa would be producing virtually no taro had there not been public investment in the taro germplasm development programme. The Fugalei Market Surveys indicate around 500 tonnes of taro now sold annually. The total consumption of all types (Colocasia, Xanthosoma and Alocasia) is now in the order of 18,000 tonnes. Half of this is Estimated to be Colocasia.

The findings in Vanuatu is that the benefits are yet to be realized and thus more difficult to quantify. There is need for farmers to have access to genetic diversity and systems by which diversity can be used and evaluated to provide farmers with a range of options to deal with the variables of climate change. Providing diversity is not a one-off solution – the nature of climate change demands ongoing existence regional germplasm centre operating as a hub. This requires substantial long term funding.

Income through REDD+ as mitigation strategy

As mitigation strategy the Forests of the Pacific provides cost-effective options for reducing greenhouse gas emissions (SPC, 2012). Forestry resources in larger PICTs represent important carbon sinks. Financing mechanisms for afforestation/reforestation under the Clean Development Mechanism (CDM) and the proposed Reduced Emissions from Deforestation and Degradation (REDD) and voluntary markets could assist these countries to increase and maintain these vital carbon stores. However, there are challenges in accessing carbon financing. Generating sufficient carbon credits to overcome the significant transaction costs is difficult in small countries. Mechanisms also need to be established for resource owners to receive the intended benefits. Sustainable land management practices, including reduced tillage, agro-forestry systems and organic production can also increase both above and below ground carbon reserves. Currently, SPC is implementing a decision by the Pacific Heads of Forestry at their technical meeting in 2011 to develop a regional policy framework to guide the implementation of REDD+.

The 2009–2015 PNG Forestry and Climate Change Framework for Action can be used as a guide for the development of the Pacific Regional Policy Framework on REDD+ (Gowae, 2012). The vision is for Pacific Island people, their forests, environment and livelihoods to be resilient to the risks and impacts of climate change. The goal is to ensure that Pacific people build their capacity to ensure payments for their environment and forest services and be resilient to the risks and impacts of climate change through implementing adaptation measures; contributing to mitigation of greenhouse gas emissions; improving decision-making and good governance; improving understanding of climate change its effects; promoting education and awareness; and developing and strengthening partnerships and cooperation.

Supporting policies

Based on assessments by SPC, through the Land Resources Division the following Policy themes are recommended (SPC, 2009). They are:

- Encourage diversification within agriculture and forestry by promoting the use of a wide range of crop, tree and livestock species and varieties within different production systems.
- Increase awareness among stakeholders at all levels of the likely effects of climate change on agriculture and forestry, and the adaptations needed to maintain the benefits of these sectors.
- Support climate-change driven research and development in the agriculture and forestry sectors and facilitate the sharing of information.
- Implement flexible land use and agriculture and forestry practices that can respond effectively to the uncertainties of climate change; including Agro-Forestry.
- The Pacific countries should promote and coordinate cost effective measures to reduce GHG emissions, through SFM, afforestation and reforestation under clean development mechanism (AR/CDM), including increased energy efficiency, with the use of wood biomass as the energy source and increased use of appropriate low carbon and renewable wood energy technologies (Gowae, 2012).

- Establish monitoring and evaluation systems to determine the success of adaptation strategies.
- An additional policy intervention can be development of international market for organic produce of agriculture from the Pacific as a way of improving productivity of subsistence farming, greater carbon sequestration (reduced forest clearing for new gardens) and improved income earning opportunities (PNG NARI, 2012).

The diversifications of these policies will not only help the agriculture and forestry sectors adapt to climate change, it would also make them more resilient to economic shocks.

Furthermore, the PNG National Agricultural Research Institute has recommended the following four Policy interventions:

- Improving human talent capacity in key areas of CC mitigation and adaptation:
  - capacity in research, science and technology with focus on CC modelling and predictions, CC policy research and development, CC mitigation research, weather forecasting, early warning system and other CC related disciplines and focus areas)
  - capacity in disaster response planning and management

- Improving the preparedness of smallholder farming communities to the effects of CC involving:
  - research on locally appropriate and effective CC adaptation measures and identification of best-practice in a local context
  - effective linkage CC adaptation interventions into mainstream public agricultural research and extension services
  - working with communities in implementation of interventions using participatory pathways and consultative processes and improving farmers capacity to absorb and adopt improved knowledge and technologies for CC adaptation and mitigation
  - appropriate Infrastructure development (i.e. water dams for irrigation covering large areas vulnerable to drought).
  - improving institutional arrangements and policy environment to enable broader adoption of CC intervention strategies and measures
  - increased knowledge of best practices and access to innovation by available extension services, farming communities and other stakeholders

- Creation and improvements on integrated information systems linking into regional and international systems
  - investment in regular monitoring of land use, food production, climate, the environment, human health
  - iIntegration of biophysical and socioeconomic information systems and development of mechanisms to utilize them

as decision-support systems for policy makers, researchers, private sector and producers

- Improving the enabling environment
  - cross-sectoral development plans mainstreaming CC adaptation and mitigation
  - appropriate policies and strategies for mitigation of effects of climate shocks and other natural disasters (emergency food reserves, safety nets for most vulnerable communities etc).

Research, Development and Innovation Areas Needing Action in the Pacific

A number of high level studies have drawn attention to the need for a coherent overarching policy framework for the Pacific region (Boer and Clarke, 2012; Yari, 2003; Miles, 2009; Muliagatele, 2007); however, limited local social and institutional know-how and low levels of technological awareness is likely to slow its development, creating uncertainty for the research agenda. Nevertheless, in the short to medium term, rather than simply react to problems as they present themselves, it would make sense to target research investment to areas that would both inform the development of the broader policy framework while addressing credible areas of pressing concern across the region.

Overall this requires more investment in researchers and technicians mobility and cooperation between Pacific countries and also between European and Pacific regions for a better exchange of knowledge, technology, capacity building and mutual learning and innovation generation.

In the context of perceived difficulties with the existing policy framework and the need to adopt new core principles, the vulnerability of the sector due to lack of research engagement and the need for policy adaptations, areas for positive action could include:

Genetic resources and management (GRM) of crops and livestock

The most important factors in GRM are a reliable database, effective resource conservation strategies, the ability to exploit and innovative management and further development and innovation.

Genetic resources and management database

Land management systems are vulnerable to population growth, environmental change, invasive species, epidemics and, critically, the impact of ad hoc short-term policies that ignore cultural resonances and the social and economic value of the ecosystem services provided by the natural environment (sensu Boer and Clark, 2012).

In this respect research is needed on

- Mapping and evaluation of traditional land management systems and locally adapted crops and stock and their interaction with natural systems as well as biology and distributions of native and invasive alien species combining both in-situ with remote sensing methods;
- Mapping and evaluation of traditional knowledge, strategies, land tenure issues (May, 2006), cultural practices and community aspirations;
- Mapping and evaluation of opportunities for sustainable innovation, development and marketing within the context of locally-adapted land management systems and established cultural preferences;
- Mapping and evaluation of endemic biodiversity in relation to its potential for economic development within a world market;
- Determining the threats to genetic material;
- Developing access and benefit sharing schemes for the genetic information;
- Developing the concept and structure of a central publicly accessible database for the Pacific to capture the information on the genetic material, stocks, environment, and threats;

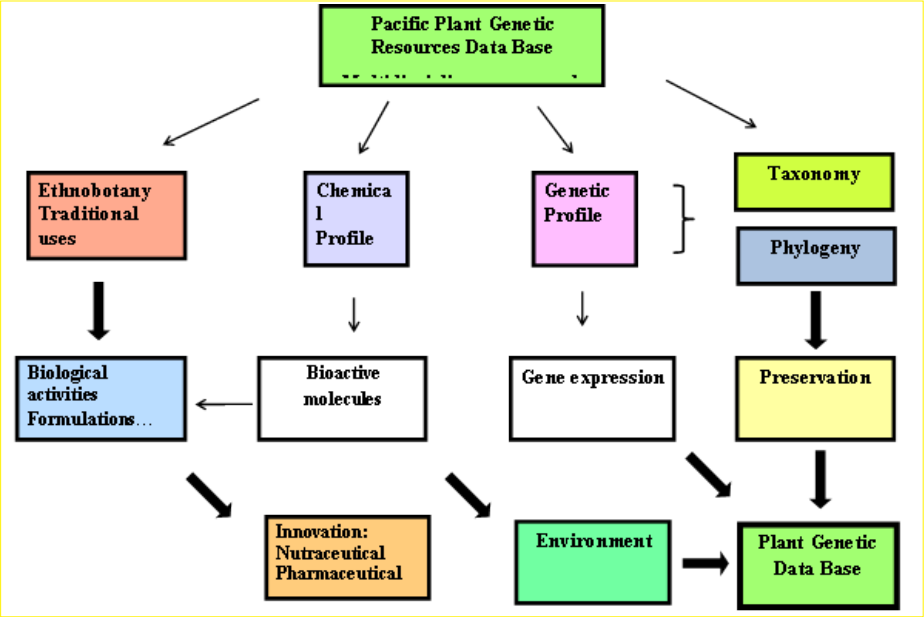

Figure 8. Multi-disciplinary approach aiming at establishing a global data base on Pacific plant genetic resources.

- Developing methodologies for database development and the networking and real-time exchange of information.

Development is needed on

- Mapping, evaluation and development of the region's capacity building needs for adapting to and exploiting climatic and global change;
- Mapping of institutions, multi-level stakeholders, civil society organisations and potential commercial investors that have a shared interest in sustainable development;
- Building technical capacity to set-up the computer and web-based infrastructure for the database (built from in situ collected data, remote-sensing or web search) which gather inventory of all existing data and completed by lacking ones in Pacific region regarding genetic resources (traditional land management systems and land tenure issues, locally adapted crops and stock and their ecology, phytogeography and marketing, endemic biodiversity);
- Building human capacity towards training respective institutional staff as well as students on identifying the reservoir and the geo-location of the genetic material;
- Exploring strategies for enhancing social inclusion, political engagement, policy development and commercial investment;
- Increasing the public awareness within and outside the region on the importance of the identification of the genetic material, their values and threats.

Innovation is needed on

- Building networks of existing data bases to store and share for real-time exchanges;
- Developing decentralized web-services to allow both information entry and information retrieval from the Pacific Island countries;
- Developing products and services for marketing the information from the databases;
- Developing web-based trade services for agricultural and forestry products at global markets.

Genetic resource conservation

Increasing pressures on the region's production systems have disturbed the balance between people and the land, compromising water supplies (Miles, 2009) and threatening the basis of production. Problems have been addressed within an inadequate regulatory framework that has capacity problems (Boer and Clarke, 2012). This situation has had a number of effects on the development of an effective system of environmental governance. Importantly, it has frustrated the development of an ecologically relevant research agenda for the Pacific. Against this background, shifting demographics and pressures to adapt to environmental change and ensure food and material security continue to grow (Boer and Clarke, 2012), along with the realisation that there are practical limits to levels of sustainable human exploitation of the natural environment that vary with locality, and that in places are reaching critical thresholds (sensu Hindmarch, 2011). Balancing these tensions and successfully

managing the necessary change will depend upon a structured flow of locally relevant scientific information supported by a high-level political acceptance.

In this respect research is needed on

- Addressing the immediate and long-term needs of innovation, development in the Pacific and their connections with environmental protection towards developing an ecologically relevant research framework for the Pacific;
- Supporting an evidence-based approach to the development, monitoring and enforcement of local and strategic policies;
- Analysing and identifying the limits to production that vary with locality and reflect local conditions and patterns of biodiversity in order to maintain ecosystem resilience and productive capacity;

- Assessing and ranking the catalogued environmental capital, and that of the underpinning ecosystems, as both an indicator of unsustainable or socially unacceptable change and as evolutionary active templates for adaptive and innovative technologies able to support sustainable and inclusive growth and maintain the resilience of the natural environment and its evolutionary processes;
- Development of credible baseline rules for adapting to climate change and delivering sustainable management solutions across the Pacific region on the basis of the identified nature of these management systems and their relationship with their underpinning ecosystems.

Development is needed on

- Ensuring a high level of public understanding of critical issues, options for change and their relevance human well being in resource conservation;
- Policy measures designed to promote sustainable and inclusive growth will therefore need to be regionally appropriate, informed by local cultural and aesthetic resonances and supported by a comprehensive evidence-base that takes an ecosystem perspective;
- Embedding these core principles in a reformed policy framework for the region will be central to the development of an effective ecologically-sound and sustainable approach to balancing the relationship between human exploitation of renewable resources and maintaining the long-term resilience of pacific ecosystems and their local communities.

Innovation is needed on

- Developing a coherent science infrastructure with derived products and services that are not only capable of developing and implementing locally-appropriate, sustainable solutions, but also able to monitor, enforce and review policies in cooperation with local communities and civil society organisations, and in line with good governance.

Exploitation and innovative management of genetic resources

The wider environment on which agricultural and forestry sectors depend and which has been an active evolutionary template producing rich patterns of farm-based biodiversity also has potential for the commercial exploitation of biologically active molecules (DaSilva et al., 2004).

In this respect research is needed on

- Developing, testing access and benefit sharing schemes for using genetic information from agriculture and forestry sectors;
- Characterizing the unique local land management systems and their cultural associations with respect to their values for tourists and jointly with local communities develop, test

and monitor concepts of community- and eco-friendly tourism.

Development is needed on

- Supporting an ongoing public dialogue facilitated by effective information systems and informed by sound research to secure the vision of a fair access and benefit scheme to the genetic resources within the compass of the prevailing cultural constraints and with the help of world markets;
- Increasing tourism by encouraging local land management systems and their cultural associations to adapt to and exploit changing circumstances and provide the required infrastructure.

Innovation is needed on

- Diversifying and stabilising production to satisfy existing market demand, and explore new opportunities to develop added-value products and exploit the biodiversity of the region to finally increasing export income;
- Developing biotechnology products to help the region adapt to climate change in terms of intra-island gene transfer, and then to explore commercial links with international markets for the valorisation of the region's biologically active molecules.

Monitoring and compliance

Agriculture and forests are integral parts of Pacific livelihoods. Subsistence agriculture plays a large role in many rural areas in ensuring food security. Increasing population adds pressure, dividing small agricultural plots even further and over–using the land. Natural forests are reduced, clear-felling for food production, and selectively logging protection forests for the better quality logs. For many families, the only money they can earn arises from cash agricultural crops destined for the local market or export.

The Pacific has much biodiversity, with many important and unique genetic resources both in the form of its cultivated crops and in its diverse forest ecosystems. The challenge of developing and maintaining sustainable and resilient agricultural and forest systems is impacted both by local capacity issues such as soil loss and degradation, exotic pests and diseases, increasing reliance on mono-cultures, and by globalization factors, such as market access, eco-verification, energy prices and bio-fuel demand.

Climate change is exacerbating existing climate variability, increasing the risk of extreme weather conditions and climatic events such as cyclones, floods and droughts. Climate change and rising sea levels reduce the habitability of coastal villages and farms and may make entire islands uninhabitable. Its effect on the remaining tropical forests is uncertain, perhaps reducing existing bio-diversity or changing the between species competitive nature within a mixed species forest. Climate change may affect species tolerance, growth rates, mortality and seed production.

Pacific Islands' plant communities have one other key characteristic: the islands are small in area (except PNG). Thus in a spatial sense, vegetation change due to climate change could occur more rapidly than elsewhere, with plant species and communities having "no-where to go".

Much of the effects of future climate change on plants is unknown and requires research specific to the Pacific Island countries. Investment in science and technology that enables climatic changes to be tracked is needed.

Assessment and monitoring

The total area of crops and forests in the Pacific is not large (excluding PNG), but neither the countries themselves nor the agricultural and forest areas are a homogenous group. The cultural and information requirements of each nation country must be taken into consideration. This can make monitoring of the estimated 500 ha of exotic forests in Tonga planted for timber, profitability and an alternative to native forest exploitation, very expensive per hectare when compared to the National Forest Inventory costs of larger, developed countries.

Without good quality crop and forest resource data, effective policy cannot be formulated, nor can strategic and tactical planning occur, nor the effectiveness of operations assessed. Accurate (unbiased), statistically precise and geographically specific monitoring of crops, forecasting and assessment of yields, as well monitoring of forests, their extent and biodiversity, is necessary to report on any agriculture and forest change, while the methods to do so requires research, given the nature of small island nations scattered over a large ocean with fragmented landscapes.

To implement national agricultural and forest inventories specific to each individual pacific island country

is likely to be prohibitively expensive. Crop monitoring, yield forecasting and forest measurement methods and sampling systems used elsewhere cannot be directly implemented without some modification. There are opportunities to conduct the science, the research and the development to devise, test and implement integrated national crop and forest information systems that are linked regionally and internationally. This integrated but individual set of systems for the Pacific as a whole needs to be affordable, implementable by the people of the Pacific, and robust through the long time span of forests.

The requirements of any crop monitoring, yield forecasting and forest monitoring system for the Pacific Island Countries are to:

- Provide baseline data;
- Monitor Land Use and Land Use Change;
- Comply with and meet the needs of REDD+;
- Verify that forests are "well managed", for international certification;
- Monitor the readiness of smallholder farming communities to the effects of Climate Change, assessing those effects and the results of any assistance for ameliorative action.

In this respect research is needed on

- Establishing baseline data in crop production, forestry and related sectors and maintaining the collection of latest information on sea level rise, deforestation and forest degradation;
- Statistics, biometrics, mensuration, geo-spatial analysis;
- Social impact assessment;
- Environmental monitoring techniques;
- Database design, and analysis techniques applied to PIC.

This research will lead to devise or improve

- Sampling Methodologies;
- Data collection techniques;
- Statistical and spatial analysis;
- Integration and promulgation.

Development is needed on

- Assessing the cultural and information requirements of each nation country concerning crop production, forests and climate change;
- Sustaining and upgrading existing crop and forest monitoring systems;
- Assisting in the implementation of national crop and forest inventories specific to each individual pacific island;
- Enhancing PICs human resource capacity for generating, analyzing and managing climate, crop and forestry related long-term data sets;
- Translating climate change science into applicable information products through user friendly materials and tools to inform the agricultural and forestry decision making process at all levels.

Innovation is needed on

- Developing integrated national crop and forest information systems that are linked regionally and internationally;
- Innovative collaborative projects which promote partnerships and cooperation to provide an enabling environment as an essential part of Pacific efforts to improve its people's resilience to the adverse effects of climate change in the forestry and agriculture sectors;
- A regional coordinating body should define the timeline, a set of expected outcomes and responsibilities for achievement of each research, development and innovation principle within the timeframe. This requires an individual country coordination body that should coordinate the implementation of the framework through the appropriate sector and country policies and strategies that are mutually reinforcing.

Traditional knowledge and culture

Research is needed on

- Establishing a regional research network on traditional knowledge and culture;
- Identify and test appropriate traditional knowledge which can be integrated into contemporary production systems. For instance, in Yap Islands (Federated States of Micronesia), the most dominant production system is the agro-forestry system consisting of mixed cropping of taro, wetland cultivation of giant swamp taro and mixed tree gardening (Young-Uhk, 1999);
- Analyze advantages and disadvantages of a production system that combines traditional and

contemporary knowledge using a list of criteria such as nutrition, simplicity of techniques, the need to reduce dependency, and income generation (Moengangongo, 1983). Other factors that need to be considered are availability of manpower, skill required and social importance and community acceptance level;
- Understanding the role of Christian missionaries and their impact on traditional systems in the design of traditionally and contemporary combined systems (Milner, 1984).

Development is needed on
- A template of merging traditional agricultural knowledge into contemporary production systems need to be developed. For example developing a mathematical model in which all important factors can be considered. When it comes to social matters, there is always a clash between Western ideas and the Pacific way. For example the clash between competition (Western) and co-operation (Pacific) or profit (Western) versus people (Pacific) (Boe, 1984). Sensitiveness to such difference in value systems need to be taken into consideration at the development stage;
- The diminishing area of rainforest requires urgent attention in traditional knowledge and culture research. In Samoa, the cry to save the rainforest was raised up by an ex-Peace Corps Arthur Whistler when he lamented the following sad story – "Samoans have exploited the forests for centuries, but always in an environmentally sound way. But because of changes in cultures and values, the species of the rainforest have slowly been forgotten, as children no longer venture into the forest with their fathers to learn the names of the trees. Samoans have been keepers of this knowledge for close to three millennia, but today the trees and the people have become strangers to each other" (Whistler, 2004). The importance of the forest to the Pacific people was further highlighted by Sir George G.D. Lepping, the Governor General of Solomon Islands in 1989 in which he stated that " ...the forest is also a valuable resource in everyday life, and provide the setting and materials that form the very basis of our culture" (Henderson & Hancock, 2000).

Innovation is needed on
- Indigenous food storage systems using pit storage, fermentation, drying, baking and household methods (Parkinson, 1983) especially during times of natural disasters and surpluses;
- Sequential planting and harvesting of root crops to ensure a readily available source of fresh root crops for household consumption (Moengangongo, 1983);
- Proper packaging and marketing of 'million dollar' plants like sandalwood oil (Santalum austrocaledonicum & S. yasi) for cosmetics and perfumery and the national beverage kava (Piper methysticum).

Cross-cutting issues (awareness-rising, monitoring, impact assessment)

For an informed sustainable and environmentally-friendly exploitation of various land resources, research linked with capacity development is required in the following sub-areas (SPC, 2011):

- Improving technologies, equipment and knowledge on the prospection and sustainable management of land and forestry;
- Promoting eco-friendly sustainable development and growth of agriculture and forestry activities in areas of genetics, breeding, production efficiency, forest hydrology and soil sustainability;
- Developing manufacturing and storage technologies for high value-added products;
- Studying the impact, adaptation and mitigation of living resources to climate change;
- Improving conservation of land environmental resources through informed management; and
- Monitoring the impacts of exploitation on the

sustainability of the resource, the environment and the biodiversity.

Food security in the Pacific can be increased, inter alia, through improving food (crop, livestock, poultry and aquaculture) productivity. This can be bought about through research on:

- improving nutrients, fertilizers and veterinary drug residues;
- improving resistance to pests and diseases;
- improving resistance to drought; salinity and temperature extremes resulting from climate change;
- raising nutritional value of the crop;
- improving breeding techniques and cultivation practices;
- reducing post-harvest loss; and
- agricultural biotechnology (genetic engineering), all in an environmentally and socially sustainable manner.

Investments Required in Research, Development and Innovation

Because of their leading status in the industries of the Pacific Island Countries, productivity increases in agriculture, fisheries and forestry are likely to have more effect on the welfare of the islanders than increases in other industries. In a study on the benefits of long term R&D investments in New Zealand agriculture, Hall and Scobie (2006) demonstrated that the average rate of agricultural productivity growth in New Zealand over the 75 years between 1926 and 2001 was 1.8%.

There is a significant positive relationship between domestic knowledge and productivity growth. Investment in New Zealand domestic R&D generated an annual rate of return of 17%. At the same time they stressed the importance of knowledge imported from overseas, estimating that perhaps half of the increase in agricultural technology was generated abroad and imported. It was not sufficient to rely entirely on foreign research, as a domestic research capability is necessary to discover, process and adapt science originating abroad to localise it and capture its benefits for the domestic economy.

Hellstrom et al. (1998), discussing the financing of forest research, argue that the dominant source must be that from public funding. This is despite the pressure over the last 15 or so years to reduce public expenditure and to increase the productivity of research results through improved interaction between scientists and users or industry. Any increase in the proportion of privately sourced research funding must narrow the orientation and direction of that research when, particularly for issues of climate change, the major problems are not those of the market economy. Forest management especially is very long term and requires a long term commitment if the benefits of earlier research is not to be lost. This is especially true of the Pacific Island Countries, with relatively low levels of industry outside of the primary sector. Neither do these countries have the wealthy charitable foundations present in developed countries (e.g. the Ford foundation funded the early work towards the development of certification standards towards “well managed forests”).

The Pacific Island Countries are developing nations that urgently require research that will directly benefit their populations, that is to say, applied research with clear links to existing problems and implementation pathways.

Universities have weaker links to users than Government departments. With the academic pressure to publish in peer reviewed international science journals, they are more likely to support a high proportion of pure and basic science in their research mix. This science is important to underpin applied research, but will be insufficient by itself.

One proposal is to achieve a funding balance between applied research and development carried out within a ministry or department that solves practical local problems (for example those noted

by extension officers) with research funding of doctorial and post doctoral candidates at universities. This would imply that overseas aid funding to that end would support science capability and resources rather than projects in government organisations, with the opposite true at universities where staff have tenure and PhD scholarships are required.

The New Zealand Crown Research Institute Task Force (2010) commented on the crown research institutes which play an important role in the nation's economic development. They recommended key performance indicators be developed to include

1. technology transfer success,
2. financial viability and accountability,
3. international and national research collaboration targets.

These performance indicators would be relevant to any developing nation's research programme.

Investment Strategies for Bridging the Research, Development and Innovation Needs of the Sector

Issues surrounding the long term welfare of the region's natural ecosystems and their dependent farming systems are likely to become increasingly interconnected. As human demands inexorably edge up towards limiting thresholds, adaptive strategies will need to become more inclusive in order to build in the necessary checks and balances and attract community support and commercial investment. There will also need to be progressively closer scientific scrutiny of development options in terms of their long-term social, economic and environmental impacts.

Bridging the needs of research, innovation and development and resolving conflict will depend on a commitment to an open rolling programme of information collection and exchange supported by an effective system of information technology and an active network of institutions, multi-level stakeholders, civil society organisations and potential commercial investors.

There will also need to be a long-term commitment by government and donors to moving away from project-based to strategic programmatic support. This will need the active involvement of national organizations such as NARI (PNG), Universities (UPNG), government ministries and departments and numerous NGOs in collaborative, partnership and net-working arrangements in implementing such programmes and activities.

An investment strategy able to secure these broad aims and deliver solid results will need to be:

a. Inclusive and multi facetted, so that it captures institutional and commercial investment at international and regional scales while involving local entrepreneurs;
b. Stratified so that the needs of different socio-economic layers (regional, local, commercial, institutional etc) can be addressed separately within the same framework;
c. Phased so that it can gain momentum and have time to become self sustaining through a combination of commercial investment and local support;
d. Encompass the idea of variable geometry, where elements of the strategy are allowed to move at different rates, depending on circumstances;

e. Supported by up-front investment in strategic enabling measures such as the development of information networks and the accumulation of key data sets

An obvious starting point would be to invest in key enabling measures (chapter "Research, Development and Innovation Areas Needing Action").

These could include a number of mutually supporting activities that would have an immediate public impact:

- Strengthen existing research teams by providing them with the financial resources to build broader partnerships to complete priority tasks where the existing teams do not have the necessary capacity [many PICTs have limited national capacity, investments are needed to develop and support the technical and scientific teams required to assist PICTs with the necessary research, development and innovation];
- Establish an interdisciplinary project aimed at characterising ecosystems and the associated biodiversity in terms of their relevance to cultural and economic development;
- Reinforce, adapt and extend existing civil, commercial, institutional and scientific information and data exchange networks to meet broad strategic objectives.

Expected Impacts of Investments

There are two mutually supportive ideas that emerge from this report. There is a need:

a. for an overarching policy framework that integrates the appropriate environmental and socio-economic measures (chapter "Significance of the Sector"), addresses the vulnerabilities of the sector (chapter "Status of Research on the Vulnerability") and makes the necessary changes (chapter "Proposed Adaptations and Supporting Policies").
b. to embark on a programme of research, development and innovation (chapter "Research, Development and Innovation Areas Needing Action") that would both inform and facilitate long-term policy development while at the same time produce results that would have an immediate impact on the management of the region.
c. to develop a synergistic relationship between policy (a) and programme (b) that would create a positive spiral of mutually supporting activities.

Operating together, these would lead to changes and impacts that would:

- Reduce the likelihood of formulating contradictory or perverse policies;
- Promote evidence-based environmental governance;
- Improve inclusiveness and the public understanding of about the connections between climate variability and agriculture crop productions and the environment;
- Increase the profile of the region on the world stage;
- Bolster market confidence and increase investment;
- Help generate new sources of income;
- Improve local livelihood (food security and sustainable resource management);
- Protect ecological processes that underpin production;
- integrate economic value of externalities in the form of ecosystem services into national regional and local plans;
- Deliver, within a short timescale, practical, usable results that will support policy coherence and social inclusion;
- Develop innovative strategies for preserving cultural and ecological diversity.

Overall we anticipate that the proposed actions would lead to higher resilience of the Pacific Island countries against internal as well as external threats by

- Improved human talent capacity in key areas of CC mitigation and adaptation;

- Improved preparedness of smallholder farming communities to the effects of CC;
- Increased food security by both higher diversity of production and management as well as non-agricultural income options (e.g. fishing, hunting, tourism);
- Creation and improvements on integrated information systems linking into regional and international systems;
- Improved enabling environment (appropriate policies and strategies for mitigation of effects of climate shocks and other natural disasters, International Markets for Pacific Produce; including organic produce);
- Social change by Pacific Islanders towards CC;
- Preserving cultural and ecological diversity by Pacific Islanders.

Risks

This policy brief on agriculture and forestry in the Pacific highlights the significance of the sector, examines its policy context and catalogues its vulnerabilities. It also reviews its policy needs, along with those of research and development and investment. Then it considers the required investment strategies and the expected impact of investment.

The picture that emerges from this policy brief is that of a diverse region of scattered vulnerable ecosystems and communities threatened by global process and demographic change that is largely beyond its control, and where the ability to respond to change is compromised by lack of information, limited communication, poor coordination and lack of human capacity.

Against this background, the likely risks for the region of not developing a coherent, information-based policy framework along with the necessary capacity building and structural investment and, implementation programmes are legion, but in the context of the policy brief, they can be brought into focus by considering the consequences of not delivering the expected impacts set out. These are summarized in Table 7.

Impact	Risks
Policy framework Development of a locally-relevant policy context for the region (sensu Boer and Clarke, 2012; Yari, 2003; Miles, 2009; Muliagatele, 2007) and counter the current tendency to respond to symptoms rather than causes.	**Lack of policy coherency** Continuing lack of coordination between local, regional, national and the international policy, dialogue and compromising the timely delivery of locally-relevant economic, environmental and social programmes.
Programme of research, development and innovation Programme addressing local needs, exploiting investment opportunities, and advancing enabling measures that would support local teams, inform policy development and have an immediate impact on priority areas of concern.	**Uncoordinated, less effective programmes** Limiting the development of a coordinated implementation programme driven by and informing long-term policy development, limiting the delivery of practical results that would have an immediate impact on the region and its communities.
Policy-Programme dialogue Dialogue fostering a constructive spiral in which programme informs policy and policy supports the development, financing and locally appropriate implementation programmes.	**Hampering policy-programme interactions** Lack of interaction would frustrate long-term policy development, compromise the development of implementation programmes and deter inward investment.

Table 7a. Risks associated with a failure to implement the recommendations set out in the PACE-NET Climate Change, Agriculture and Forestry in the Pacific policy brief. Section 1: Expected impact of the overarching policy measures and the risks associated with their not being implemented.

Risks
Increased likelihood of formulating contradictory or perverse policies that erode social and ecological resilience and frustrate an evidence-based approach to environmental governance.
Difficulty developing policies to support the ecological processes that underpin production integrate the economic value of 'externalities' (ecosystem services) into national regional and local plans.
Reduced capacity of policy to respond in a timely, coordinated and appropriate way to the effects of climate shocks, natural disasters and market fluctuations by reinforcing locally distinctive production systems (including organic produce) and developing adaptive cropping techniques.
Threatening local livelihood (food security and sustainable resource management) and reducing preparedness of smallholder farming communities to the effects of Climate Change.
Neglecting locally adapted production systems (including organic production) and failing to invest appropriately into adaptive cropping techniques, as well as missing opportunities to maximise sustainable non-agricultural income (e.g. fishing, hunting, tourism).
Undermining the public understanding about the links between climate variability, crop productions and the stability of the environment and its human communities and limit social inclusion.
Missing opportunities to increase the profile of the region on the world stage and restricting its ability to bolster market confidence and increase investment and generate new sources of income.
Limiting the regions ability to valorise the region's biological resources in a structured way that would benefit the world community and local communities.
Failing to buffer the effects Climate Change on Pacific Island cultural ecological and social diversity and reduce the capacity of local communities to anticipate and respond effectively to the effects of Climate Change.

Table 7b. Risks associated with a failure to implement the recommendations set out in the PACE-NET Climate Change, Agriculture and Forestry in the Pacific policy brief. Section 2: Risks associated with failing to implement provisions set out in policy brief chapters on proposed adaptations and supporting policies, areas needing action, investment needs and strategies (including the overarching policy and programme measures summarised in section one of this table).

Proposed Steps for a Mid-Term Implementation

The proposed investment strategies and key enabling measures outlined in the chapter on investment strategies need to implemented to show impact based on a step-wise approach with a mid to long-term schedule. An example for steps in such a schedule is shown in Table 8.

After consultation with more stakeholders on the overall concept and implementation steps, this broad indication of actions should be refined and corresponding actors assigned (e.g. in the form of a detailed Gant chart).

Strategic elements	Tasks (developed within the context of a broader strategy	Year 1	Year 2	Year 3	Year 4	Year 5
Adapt existing information and data exchange systems	Research and evaluate Adapt and integrate Extend, develop and implement.	→	→	→	→	→
Strengthen existing research teams and networks	Research and evaluate Adapt and integrate Extend, develop and implement.	→	→	→	→	→
Establish multidisciplinary projects to characterise key ecosystems and their cultural resonances	Research and evaluate Adapt and integrate Extend, develop and implement.	→	→	→	→	→
Develop and implement the main strategic programme	Strategic elements inform the development of the main strategy and are substantially integrated with it by Year 3.	→	→	→	→	→

Table 8. Schematic program for mid-term implementation, focussing on strategic investment measures and their integration into the main programme.

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