Plant Genetic Resources in the Pacific

Towards regional cooperation in conservation and management

A report based on an
ACIAR − NARI workshop
Lae, Papua New Guinea, 30−31 March 1999

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FORWARD

The Australian Centre for International Agricultural Research has worked in partnership with Papua New Guinea research institutions and government agencies on a program of agricultural research for development since 1983. Some 39 projects have been concluded since that time, the major focus being crop sciences and farming systems. Studies in renewable natural resource economics, policy and planning have underpinned the more technically oriented work in agriculture, forestry and fisheries. This pattern of activity in Papua New Guinea has its parallel in ACIAR's programs with other Pacific Island countries although because of its relative size Papua New Guinea has received more attention. The very smallness of many Pacific countries militates against their ability to enter into viable collaborative research activities on a bilateral basis with Australian partners; hence ACIAR also works closely with the South Pacific Community through its Secretariat in addressing issues of regional significance for the benefit of the countries of the region.

The conservation, improvement and management of crop genetic resources is of particular importance to the Pacific because of its long standing, continuing and primary dependence on agriculture; for example over 85% of Papua New Guinea's people depend on traditional agriculture augmented by cash cropping for their livelihoods. Traditional root crops are fundamental to agriculture − sweet potato, yam, taro, cassava − as are banana, vegetables and sugar cane with the mix of crops employed in various farming systems varying among agro−ecological zones. The one thing most of these crops have in common however is that they are vegetatively propagated and this creates particular problems and challenges for the effective conservation of their germplasm. In situ conservation in farmers' fields of farmer−selected local land races, forms and traditional varieties through the process of growing the crops over many generations (cropping in the Papua New Guinea highlands has a history going back more than four thousand years) combined with the high level of natural biodiversity has led to the situation where that country is a region of global importance for secondary biodiversity particularly for root crops, sugar and banana. In contrast many Pacific Island countries utilise crops with a much narrower genetic base, reflecting their comparatively recent migrations (e.g. New Zealand and parts of Polynesia were settled from the western Pacific within the last two thousand years) accompanied by a narrower suite of crops. Their vulnerability was accentuated by the effective elimination of the staple crop taro from Samoa in the mid 1990s by taro blight caused by Phytophthora colocasiae. However the Pacific remains a centre of secondary biodiversity for coconut, breadfruit and some indigenous fruits and nuts.

Because of the importance of Papua New Guinea as a centre of biodiversity, the threat to that biodiversity by reduced use of some traditional varieties by farmers, the imperative to ensure access to replacement germplasm of crops important to its own farming communities in the face of natural disasters and its capacity for agricultural research relative to its neighbours, the Department of Agriculture and Livestock established comprehensive ex situ genebanks of the major crops. The accessions in these collections included material of interest to its Pacific neighbours and there are duplicate accessions in some of the other national collections. The Department experienced increasing difficulties in managing these collections, particularly in financing their maintenance and regeneration. The situation was exacerbated by the widespread severe drought of the mid 1990s during which many entries in the collections were lost. With the establishment of the National Agricultural Research Institute (NARI) out of the Department's Technical Services Division, responsibility for the genebanks passed to NARI at a time when local resources for the genebanks were stretched to the limit.

One of the critical issues for Papua New Guinea is the extent to which costs of maintaining the ex situ field collections are increased by servicing the needs of the Pacific region over and above the immediate national need. ACIAR therefore established a project to determine the costs of genebank management and the marginal costs associated with undertaking this regional service role. That project became the springboard for the Lae workshop, the subject of this report, as it became apparent that a concerted regional effort was needed for establishing regional cooperation in crop germplasm conservation and management, together with consideration of the policy issues of germplasm transfer and exchange and associated benefit−sharing. ACIAR funded the workshop as a component of the project.

The workshop was designed, organised and facilitated by Dr Padma Lal, ACIAR's Research Program Manager, Agricultural and Natural Resources Economics. She commissioned the papers and worked with several of the authors on content. Dr Lal also prepared the comprehensive synthesis report of the workshop which is the lead paper of these proceedings.

Genetic resources managers and scientists from the Pacific region were most responsive to the opportunity to meet, discuss the issues and plan a positive way forward. Thirty delegates attended representing seven countries of the region, the Secretariat of the Pacific Community (SPC), FAO and the International Plant Genetic Resources Institute (IPGRI).

Genetic resources scientists prepared comprehensive country papers documenting their experience and the issues from their perspective; international and Australian participants provided overview papers with a global context for regional initiatives. A most important outcome of the meeting was a decision to prepare a Pacific strategy paper that would chart the way forward for regional cooperation for plant genetic resources conservation and management. This paper has been prepared by Papua New Guinea, Fiji and SPC, and will be tabled for endorsement at the forthcoming Pacific Heads of Agriculture and Livestock Services (PHALPS) meeting in May 2001.

This publication presents extended abstracts of the papers to the workshop together with the synthesis paper which brings together the issues, the main points of discussion and decisions on the way forward. The complete text of the original papers is available on request from the authors or ACIAR.

The meeting was timely as it followed closely on the heels of other Asia Pacific initiatives for genetic resources conservation under the aegis of FAO and IPGRI. The focus however in these meetings was Asia rather than the Pacific with its unique disabilities and problems. I hope the Lae meeting assisted in redressing the imbalance and, by providing Pacific colleagues with much useful material, will enable them to move forward in a mutually beneficial way in this area so fundamental to human well being underpinning as it does our collective food security.

Ian Bevege
ACIAR
26 February 2001

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1.1 The workshop and its background

1.1.1 Background

Plant and animal genetic resources have generally been regarded as the common heritage of mankind. Free exchange of germplasm has been the norm as it has generally been recognised that no one country has been or can ever be self sufficient in all the genetic resources it requires to meet current and future needs for food and nutrition and forest products. National, regional and international collaboration is essential if the food, medical and other needs of current and future generations are to be met.

Countries throughout the world, including the Pacific island nations, until recently have not hesitated to freely share and exchange plant and animal genetic material obtained from the wild, from farmers' fields or from national collections. Much of this exchange has occurred between communities and between nations. It has been facilitated by personal contacts between farmers exchanging crop seeds and vegetative materials and amongst scientists working on taxonomy or plant improvement programs. Conservation, selection and improvement of key plant characteristics to meet the needs of consumers and producers have been the basic foundation of agricultural development.

This philosophy of free exchange is now under a cloud. Countries are worried about international pharmaceutical companies and commercial seed companies accessing their traditional knowledge to fuel innovation and developments in multimillion dollar industries ranging from agriculture and pharmaceuticals to chemical, paper products, energy and others, without the traditional communities benefiting from such developments (RAFI 1994).

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Pacific, particularly Melanesian, countries are considered to be secondary centres of genetic diversity for many indigenous food crops, with much of the diversity in landraces found in farmers' fields. But genetic diversity in farmers fields is slowly, and in some countries rapidly, being lost due to the breakdown of traditional farming practices in the face of a market economy. With increasing populations and quest for cash income, many of the villagers are concentrating on growing popular varieties, which are easy to grow and provide good financial returns. This together with increased preference for 'western foods' is contributing to farmers not maintaining crop diversity in their fields. In addition valuable biodiversity in the wild is also being eroded through excessive logging and conversion of forest lands for alternative uses such as agriculture or urban development.

Loss of diversity in farmers' fields and the wild is more worrying when past germplasm collections of crop varieties and land races held in ex situ genebanks are also being eroded. The Pacific regional collections are small and scattered. Currently, the whole collection of 8778 accessions in the Pacific region, excluding Australia (123,000) and New Zealand (70,000), represents much less than 1% of the world's 6.2 million accessions (FAO 1998:461), adding weight to the concern about under investment in ex situ conservation by the Pacific nations.

Germplasm conservation activities in the Pacific were, and continue to be, initiated with the assistance of international agencies, focussing on meeting the initial costs of collections, documentation and capital outlay for museum storage facilities. But much of the running costs of maintaining collections have to be met by the respective national governments. National governments, in the presence of more pressing immediate development needs of the rural communities, have not often seen much merit in investing in PGR conservation, particularly when expected payoffs are long term.

The concern about the erosion in genetic diversity and the loss of national collections has been heightened recently when some countries in time of need have had difficulty accessing genetic material for purposes of selecting diseases−free crops from other national and international collections. For example, recently PNG was asked to pay to access their own banana genetic material stored internationally. Furthermore, some Pacific island nations have been unwilling to share their blight−resistant taro genetic material. Taro leaf blight recently devastated the export−based taro industry in Samoa and other countries. This reluctance to share was apparently because there was no mechanism for benefit sharing or for the recipient countries to contribute towards the maintenance of another country's national genebanks.

In response to this and with the help of international donor agencies such as AusAID, ACIAR and EU−CIRAD, a loose regional project called TaroGen has helped obtain genetic material for research purposes. Many different approaches have been proposed/used, including regional networks, regional projects, loose collaborative agreements, and legally binding contracts stipulating conditions of exchange.

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Pacific island nations have acknowledged the need for a more systematic and regional approach to germplasm conservation and utilisation. In 1997 Pacific Heads of Agriculture and Livestock Programs (PHALPs) adopted the following resolution: 'Conserving genetic diversity is the key to crop performance and thus its neglect could imperil agriculture. Linked to this is the need to protect and utilise plant genetic resources so that there is an equitable sharing of benefits.' The resolution also urged the Pacific leaders 'to put in place in their countries, and through regional cooperation, policies to conserve, protect and best utilise their plant genetic resources'.

1.1.2 Workshop

The ACIAR−NARI workshop at Lae, PNG, in March 1999 addressed the issues mentioned in Section 1.1.1 and then sought to identify specific operational strategies that could be used by the Pacific island nations to develop regional cooperation in collecting, maintaining, sharing and funding the conservation and utilisation of plant genetic resources. The workshop built on an ACIAR project, ANRE 1994/028 'Economics of preserving genetic diversity in PNG in the context of world agriculture' (Kambuou and Godden 2.3.3). The project was implemented following a request of the PNG government facing recurrent budgetary concerns. They were also concerned about the need for national policies regarding ownership of plant genetic rights, sharing of PNG's germplasm, and who should bear the cost of national germplasm conservation since the germplasm is expected to be shared with others in the region and internationally.

The specific objectives of the workshop were:

1. To discuss and confirm the rationale for facilitating a regional approach to the conservation and management of plant genetic resources

2. To identify alternative modalities for, and key elements of, regional cooperation for collecting, conserving/maintaining, sharing, using and funding of plant genetic resources

3. To identify future strategy/ies, including a regional institutional arrangement, to encourage and facilitate the implementation of a regional approach for conservation and management of plant genetic resources

4. To identify roles of international communities, including agencies such as FAO, IARCs, and bilateral donor agencies, such as AusAID, NZODA and ACIAR, and mechanisms by which their activities can be coordinated to meet the needs of the region

5. To develop a Draft Action Plan to facilitate the establishment of a regional institutional mechanism(s) for cooperation in germplasm conservation and management in the Pacific region.

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The 30 workshop participants (see 3.2) were representatives of those countries with significant national collections, representatives of regional collections and organisations such as SPC, key technical experts and representatives from international agencies IPGRI, FAO, ACIAR and AusAID.

The workshop was divided into five technical sessions with invited papers followed by specific session discussion on the following themes (see 3.1 for details):

− status of Pacific plant genetic resources (country reports)
− rationale for regional cooperation
− international developments
− current regional collaboration
− possible solutions and a way forward.

To ensure the discussion did not get bogged down with political differences, political issues related to IPR and farmers' rights, etc were deliberately not discussed, though their relevance for establishing mechanisms for access to germplasm and benefits was noted.

The three−day workshop successfully addressed the first three objectives. The following synthesis (Sections 1.2−1.5) draws out key points from the commissioned papers, other relevant literature and the workshop discussions of the first three objectives. A summary of each of the invited papers follows this synthesis (Sections 2.1.1−2.5.6). Workshop papers are referred to in the text by section number, for example, Kambuou (2.2.1). To request the full text of a workshop paper the reader should contact the paper's author or Padma Lal. (see 3.2 for addresses).

The synthesis has the following structure:

Section 1.2 provides a brief overview of the status of PGR of common interest to the Pacific Island countries and the underlying rationale for their adopting a regional approach to germplasm conservation and utilisation.

Section 1.3 examines the international context of germplasm conservation and its implications for the Pacific island countries.

Section 1.4 discusses existing regional cooperation in plant genetic resource together with lessons that can be drawn from cooperation in other areas.

Section 1.5 outlines key features of alternative models of regional cooperation identified in the last session of the workshop.

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The workshop identified a plan of action (Section 1.5.6) for encouraging the Heads of Pacific Islands to take practical steps towards establishing a PGR conservation and utilisation program in the region. This included the identification of a subcommittee of the representatives from PNG, Fiji and Solomon Islands formed under the direction of SPC to prepare a Draft Strategy Paper on:

− the preferred regional institutional arrangement
− the desired scope of cooperation
− the role of national and international agencies.

1.2 Status of plant genetic resource conservation in the Pacific

Conservation of plant genetic resources in the Pacific takes one of four forms, namely in situ conservation in the wild; in situ conservation in farmers' fields; ex situ conservation in regional or national collections, mainly field genebanks for vegetatively propagated crops; and in vitro genebanks (ex situ conservation in tissue culture). In the last decade or so all categories of PGR conservation have been eroded.

1.2.1 In situ conservation in the wild

Most Pacific islands still retain most of their primary forests, 'rich storehouses for food plant diversity'. The larger islands composed of continental land masses, with Gondwanan inheritance of their flora and fauna, show phenomenal diversity, with a large number of species, genera and families being unique in the world (Lebot et al. 2.5.4). Plantation crops such as coconut, coffee, cocoa, and more recently oil palm, have been the major cause of loss of forest−based genetic diversity in Samoa (Pouono and Semesi 2.2.4), Solomon Islands (Liloqula 2.2.2), Tonga (Taufatafua 2.2.5), PNG (Kambuou 2.2.1) and other countries.

Small islands composed of volcanic material and coral exhibit a high rate of endemism and a very limited diversity of flora and fauna. For future breeding programs and agriculture−based economic developments these small island nations would have no choice but to rely on genetic diversity found elsewhere.

1.2.2 Farmers' fields

While conservation of natural forests in the wild remains as the single most important form of in situ conservation of genetic material, active in situ conservation in farmers' fields is the most common and popular practice throughout the region. Farmers conserve diversity in land races of important staple foods by consciously selecting desired characteristics and material for planting and maintaining them in their fields. In the tropics the traditional

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crops, with the exception of coconut, are maintained vegetatively, including banana, taro, sweet potato, cassava, yam and leafy aibeka. Other crops maintained in farmers' fields or maintained in the wild include many tropical fruits and nuts, many plants of medicinal value and material used for shelter.

While no one knows how much diversity was and is in cultivated species of crops in farmers' fields in the Pacific (Kambuou 2.2.1), it is generally acknowledged that there has been substantial loss of diversity in major indigenous food crops throughout the region. For example, in Papua New Guinea villagers are reluctant to maintain the many land races of crops such as taro, sweet potatoes, aibeka, bananas and cassava, when demands in the urban markets focus on only a few varieties. In some cases, genetic erosion of biodiversity in food crops is considered to be occurring at an alarming rate and in some cases irreversibly (Kambuou 1996).

1.2.3 Ex situ national collections

Pacific islands have germplasm collections of land races and cultivars of major crops collected from farmers' fields or from the wild 'stored' in established national field germplasm banks (Table 1.1). Taro, sweet potato, yam, tannia, cassava and, more recently, kava are the most common crops maintained in ex situ collections throughout the Pacific. Ex situ collections in the region can be traced back to early colonial days when botanical specimens and germplasm were collected, documented and stored in national collections with the help of colonial governments, such as Britain or France. More recently, collections have been made with the assistance of external funding bodies such as the European Union, AusAID, International Plant Genetic Resources Institute (IPGRI), and the United Nations Food and Agricultural Organisation (FAO).

Table 1.1 Commonly maintained crop germplasm in national collections

Vegetatively maintained crops	**Countries where accessions are/were known to be present in ex situ (field) collections**
Aibeka	PNG; Fiji; Tonga
Banana	PNG; Tonga; Samoa; Vanuatu
Cassava	Fiji; Tonga; PNG
Kava	Fiji, PNG; Vanuatu
Sweet potato	Vanuatu; Fiji; Tonga; Samoa; PNG
Tannia	Vanuatu; Fiji; Tonga
Taro	Vanuatu; Fiji, Samoa, Tonga; PNG
Yam	Vanuatu; Fiji; Samoa; Tonga; Solomons; PNG
Sexually maintained crops:	
Coconut	Samoa; Vanuatu; Tonga; Fiji; PNG
Mango	Vanuatu; Fiji
Source: Kambuou (2.2.1) (PNG); Lebot (2.2.6) (Vanuatu), Pouno and Semesi (2.2.4) (Samoa); Taufatafua (2.2.5) (Tonga); Vakabua and Turagakua (2.2.3) (Fiji);.	

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External agencies and expertise, with the help of local scientists and farmers, were responsible for collecting the material from the wild or from farmers' fields and morphologically describing (characterising) it using descriptor lists developed by IPGRI. Some of the accessions have been assessed for their agronomic potential by national scientists with the assistance of international experts. Characteristics assessed include yield and variants that contribute to yield such as hand/bunch, number of suckers and size of tubers, pest and disease scores and general performance under different growing conditions. Such passport information, characterisation and preliminary evaluation data are recorded in field notes and in office files, and more recently with the introduction of computers some electronic records are also maintained.

Maintaining ex situ collections of germplasm that can only be conserved in vegetative form is an expensive activity requiring consistent effort throughout the crop cycle. Four general types of activities (Table 1.2) are conducted to maintain the collections: land preparation, planting and replanting, crop maintenance, and harvesting, all of which require extensive resources. In particular extra resources are required for irrigation facilities during dry seasons and during sudden out−breaks of diseases and pests. Sufficient labour is needed to relocate germplasm collections to safer grounds in times of natural disasters such as floods.

Although detailed information of the costs of such vegetatively maintained genebanks is not available, limited evidence from PNG suggests the fixed cost, i.e. the unavoidable cost of establishing and running the facility, is the principle cost (Kambuou and Godden 2.3.3). For crops such as aibika, banana, sweet potato and taro fixed costs accounted for about 75% of the total cost. The total costs per accession change markedly where there is a substantial increase in the number of accessions owing to economies of scale. For example, the average cost of maintaining taro field germplasm decreased by about 35% when the number of accessions increased from 316 to 580. On the other hand the average cost of sweet potato increased almost four fold when the number of accessions fell from 435 to 110 (Kambuou and Godden 2.3.3). Obviously significant economies of scale can

Table 1.2. Activities involved in maintaining field genebanks for vegetatively propagated crops

Land preparation	Slashing, ploughing, harrowing, and field markings at the beginning of a cycle
Planting	If plant material deteriorates it is discarded or rescued and replanted later; if discarded, infilling and plant material transplanted from old gardens
Crop Maintenance	Weeding by hand or machine; application of fertiliser, insecticides and fungicides; irrigation
Harvesting	Harvesting and recording and labelling at the end of reproduction cycle.

Source: Kambuou (2.2.1) (PNG); Lebot (2.2.6) (Vanuatu), Pouno and Semesi (2.2.4) (Samoa); Taufatafua (2.2.5) (Tonga); Vakabua and Turagakua (2.2.3) (Fiji);.

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be achieved by increasing the size of national collections or adopting a regional approach in maintaining collections.

Typically, in countries like PNG, budgetary constraints result in activities like germplasm collection and storage being given a low priority. As a consequence staff struggle for resources to adequately maintain collections and in times of calamity − drought, floods, insect attack and/or disease outbreak − collections can be devastated for lack of resources. Added to these problems is the high turnover of trained staff, resulting in untrained staff often being left in charge of field collections, sometimes leading to a mix up of labelling or a mismapping of accessions in the field (Kambuou 2.2.1).

After the end of economic optimism of the 1980s, most international donors shifted their funding approach away from capital grants to projects. This meant that where once international agencies were prepared to invest on a long−term basis in facilities and encourage national collections to be established, now funding is restricted to specific projects and minimal resources are available to meet operating expenses. Consequently, once a project's funding ceases, countries are left to find resources for germplasm conservation from their own recurrent budget. As a result all national collections in the region have suffered losses over time.

Kambuou (2.2.1) estimates that PNG lost over half of its germplasm collections due to inadequate funding and high turnover of trained staff. She also expects the current trend of inadequate funding to continue in PNG, and perhaps in other PICs, and genetic erosion to continue unless some major actions are taken in the region as a whole.

Even where collections were maintained, intensive studies and appropriate utilisation of genetic material have been limited by insufficient staff trained in appropriate disciplines, limited research facilities, changes in research policies or personnel. Lebot et al.(2.5.4) observe that breeding programs in the region have produced few results. The experiences throughout the region suggest that many countries may not be in a position to maintain, let alone utilise, much of the plant genetic resources so painfully collected and conserved over time.

1.2.4 Regional and international collections

Recently, because of the major losses from national collections, there have been a number of initiatives taken by international agencies to support re−collection of germplasm of major food crops as part of regional programs. By storing them in regional institutions, it is hoped that these collections will have a better fate. However, the issue of finding the annual budget to meet ongoing costs of their maintenance remains.

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Over the last decade or so, much international effort has targeted regional collections for crops which are of significant importance either as subsistence food or ceremonial value, or as export crops (Table 1.3).

Table 1.3. Key crops and major regional collections

Crops	Project and location of formally recognised regional collections	Major funding source
Taro	· TaroGen − Secretariat of the Pacific Community, Suva, Fiji (field collections plus collections in other countries as duplicates) · SPC Regional Germplasm Centre (tissue culture) · EU−Pacific Regional Agricultural Programme (EU−PRAP) University of the South Pacific (tissue culture)	· AusAID, ACIAR, EU
	· National Botanical Garden , Maui, Hawaii	· USA
Sweet Potato	· PNG Germplasm Collections · SPC Regional Germplasm Centre (tissue culture) Fiji	· Various international agencies, including, AusAID, EU, FAO, IPGRI
Yam	· Secretariat of the Pacific Community, Suva, Fiji (field collections) · EU−Pacific Regional Agricultural Programme (EU−PRAP) University of the South Pacific (tissue culture) Samoa	· EU− CIRAD
	· National Botanical Garden , Maui, Hawaii	· USA
Banana	· PNG, Laloki	· Various international support
	· International Network for the Improvement of Banana and Plantain (INIBAP), Belgium	· INIBAP
Coconut	· COGENT − The International Coconut Network in Madang, PNG	· IPGRI, AusAID, FAO

Source: Sivan (2.2.7); Kambuou (2.2.1); Ovasuru and Batugal (2.5.2)

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1.2.5 In vitro genebanks

Regional collections have been encouraged by international donors to take advantage of recent high−tech developments in germplasm conservation technologies. The advent of in vitro (literally meaning 'in glass') techniques has encouraged the use of tissue culture and cryopreservation−based genebanks for key vegetatively propagated crops (yam, taro, cassava, sweet potato and banana), or for crops whose seeds cannot be stored (coconut). A large number of accessions can thus be stored in a small space cost effectively after initial capital−intensive investment has been made.

The EU−funded PRAP regional tissue culture laboratory in Western Samoa has cultures of taro, yam, sweet potato and banana collected from various islands in the region. SPC, as part of the TaroGen project, has tissue culture collections of taro germplasm collected under funding from AusAID and ACIAR. The tissue culture is expected to be expanded into in vitro collections of taro plantlets and as cryopreserved shoot tips (Sivan 2.5.1).

Many crop species grown in the Pacific are stored in vitro by national and international institutions throughout the world. Such techniques, however, are capital intensive and depend on a secure electricity supply. The techniques also rely on sophisticated preservation, storage and maintenance techniques and highly trained staff (Ashmore 2.4.2). Despite this, evidence from elsewhere in the world suggests that in vitro conservation can cost much less and be more secure than conservation in field genebanks (Taylor 2.5.5) and can be invaluable for storing and distributing disease−free plants (Ashmore 2.4.2).

1.2.6 Indigenous fruits, nuts and vegetables

For indigenous fruits and nuts there appear to be no organised collections nor is there any significant commercial production at present. Although most countries report a number of varieties of major indigenous nuts and fruits, such as canarium, terminalia, Tahitian chestnut, candle nut and betel nut, little is known about the extent of genetic variation found in the region (Sivan 2.2.7). Extent of variation in indigenous vegetables, such as aibeka or bele, kangkong, coastal pitpit also is not known. Countries such as PNG, Vanuatu, Solomon Islands and Fiji have a great diversity of many of these crops.

The level of duplication in existing germplasm collections is not known but may be high. There is a need to consolidate the different national, regional and international collections creating at least one regional set of germplasm for each Pacific crop which could be regarded as a base collection, and one or more working collections in reserve. Consolidation will require the use of standardised methods of description as well as central databases and regional catalogues, and in some cases DNA fingerprinting. This will help rationalise germplasm

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holdings and provide a basis for comparison of germplasm held within the region or internationally.

1.2.7 Concluding remarks − reasons for adopting regional cooperation

Reasons for adopting a collective Pacific regional approach to germplasm conservation and utilisation discussed in this Section include the following cultural, technical, economic and operational ones:

· common heritage of the Pacific Islanders and commonality of purpose;
· common set of crops used for subsistence, cultural and ceremonial purposes;
· common constraints of limited resources and the need for sophisticated and capital−intensive conservation technologies;
· common problems of disease, drought, floods and limited personnel to adequately maintain national collections;
· limited financial resources, lack of sophisticated laboratory facilities and inadequate discipline−based national staff to effectively utilise PGR;
· potential gains to be had from economies of scale in collective PGR genebanks and in their utilisation;
· potential to rationalise collections based on complementarity rather than duplication; and
· strengthen collective self−reliance in the region for conservation, management and utilisation of PGR.

1.3. International context of germplasm conservation

Although exchange of germplasm between regional genebanks in different countries has been common in the past, there is a growing tendency to restrict access to them in the light of recent developments in intellectual property rights (IPR), farmers' rights and breeders' rights. The issue of equitable share of benefits between countries supplying the genetic material and those using plant genetic resources is at the core of many debates, agreements and conventions.

There is an array of international regimes that deal directly or indirectly with issues related to plant genetic resources. Measures introduced over the last three decades address access to PGR, biological conservation in general, international trade and property rights. They have provided mixed signals to countries supplying germplasm to individuals, countries or commercial entities and international and regional research organisations hoping to access the resources. Property rights over genetic resources expressed in several international

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arrangements and protocols range from open access systems at one extreme to legally binding restrictive and exclusive protocols under intellectual property regimes at the other extreme.

1.3.1 International undertaking on plant genetic resources

There are two categories of international regimes defining access to plant genetic resources and benefit−sharing from the use of germplasm. The 1983 FAO International Undertaking on Plant Genetic Resources (IUPGR) and 1993 Convention on Biological Diversity (CBD), as Bevege discusses in his paper (Section 2.4.1), are the two main international regimes that oblige countries to share their genetic resources. The non−binding FAO agreement recognised the universally accepted principle that plant genetic resources are a heritage of mankind and consequently should be available without restrictions. It codified the international open access system.

Such free exchanges have been the foundation of modern agriculture. Before the biotechnology revolution agricultural technology development and dissemination were largely in the public domain and patents and plant variety protection were generally not a major issue. This is destined to change to be largely in the private sector. Consequently many processes and products are expected to be patented and protected (Miller 1995:112). Developing countries are particularly concerned about this when many cases have been reported of their plant genetic materials having produced significant benefits to developed countries and large commercial companies, with little or no return to the developing countries.

The widely publicised patenting of the Indian neem tree is a classic illustration of this. For centuries locals have used products extracted from the neem plant for medicine, contraception, toiletries, fuel, and insecticide. India never patented these products. Since 1985, US and Japanese firms have taken out dozens of US patents for a variety of neem compounds. Patenting of neem plants has affected local Indian farmers who are now having to compete for neem seeds. The seed price has increased from R.300/t to in excess of R.8000/t. This incident has caused considerable concern amongst farmers and scientists throughout the world, particularly since the Uruguay Round of GATT sought to standardise IPR under TRIPS. The issue of patents under WTO/TRIPS is at the core of the debate over benefit sharing.

1.3.2 Trade related aspects of intellectual property rights

The World Trade Organisation (WTO) and Trade Related Aspects of Intellectual Property Rights (TRIPS) are two of the products of the Uruguay Round of negotiations, which had as a primary goal the increase in flow of resources,

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including capital between countries in the context of global trade liberalisation. Recognising intellectual property rights over products and processes is the foundation of the basic market mechanism underpinning trade liberalisation.

Many states do not allow living organisms to be patented but since the USA in 1980 allowed extension of utility patent protection to living organisms, many countries have followed suit and registered patents over PGR. Patenting of the Indian neem tree and basmati rice are recent examples. To take advantage of patent laws under WTO/TRIPS, countries would need to develop, file and defend their patents over their PGR. As these have to be done in each country separately, not many countries, despite being members of WTO, are likely to have adequate resources to successfully do so. It is believed that the poorest countries will be disadvantaged when it comes to developing, filing and defending patents and this trend could throw up yet another obstacle to creating their own intellectual property, leaving them further and perhaps permanently behind the rest of the world.

Beside the moral arguments over patenting of life forms, the issue of restricted access to patentable genetically modified materials (GMOs) has also become a significant one. Patentability of GMOs itself is a subject of discussion under the International Convention for the Protection of New Varieties of Plant (UPOV). Under UPOV (1991 amendments) member states are expected to grant and protect breeders' rights at the national level for plant varieties which are new, distinct, uniform and stable. However, while IPR mechanisms are used to protect the products of biotechnology from unapproved use, these are seldom applicable to inputs, including genetic materials improved by farmers. The concept of farmers' rights was created as a complement to plant breeders' rights in order to promote 'a more equitable relationship between providers and users of germplasm by creating the basis for farmers to share the benefits derived from germplasm they have developed and conserved over generations'. The debate over plant breeder's rights and farmers' rights continues.

TRIPS and UPOV are at odds with the provisions of the Undertaking (IUPGR) and the Convention on Biological Diversity (CBD).

1.3.3 Convention on Biological Diversity

The legally binding Convention on Biological Diversity covers the general themes of conservation of biological diversity, sustainable use of its components and the fair and equitable sharing of benefits arising from the use of genetic resources.

The CBD recognises states' sovereign rights over their genetic resources and attempts to create a new relationship between the providers and users of biological resources. The basic idea behind the CBD is sharing of benefits derived from the use of genetic material in exchange for access to that material.

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The CBD can be seen in part as a wide endorsement of the cessation of open access in exchange for a system providing some remuneration.

In the context of the CBD, the Undertaking (IUPGR) has been renegotiated to clarify many issues including:

· nations have sovereign rights over their plant genetic resources (this subordinated the original common heritage principle);
· farmers and breeders have discretion to make their genetic breeding lines and breeding material available to others;
· plant breeders rights are not incompatible with the Undertaking;
· states may impose restrictions on free exchange of PGR as necessary for it to conform to its national and international obligations; and
· free access does not mean access free of charge.

Parties to the Undertaking developed the Global Plan of Action (FAO 1996), which identified advantages for collaboration between countries on a regional basis. Regional and international collaboration cannot, however, be achieved in today's environment without an agreed system of benefit sharing being developed.

Further information on IUPGR, CBD, CGIAR and other international agreements and voluntary arrangements of importance in conservation and use of PGR were presented in the workshop papers by Bevege (2.4.1), Virchow and Anishetty (2.4.3) and CGIAR (2.4.4). Other literature of relevance includes Miller (1995), Lesser (1998) and FAO (1996).

1.3.4 Benefit sharing

Much of the interest of the developing countries in access to germplasm is underpinned by the desire to derive benefits from their genetic resources. Controlling access to genetic resources provides the countries with the primary advantage in ensuring they benefit from its use. Benefit sharing could take one of two forms: payment for existing or expected benefits, or compensation for the utilisation of PGR (Virchow 1998). While the former, in terms of appropriate royalty payments, is the focus of much interest, it is very difficult to determine since it is only really known after the event. TRIPS represents this notion of 'benefit sharing' by developing some kind of protection system for genetic resources.

The CBD and the FAO Global System recognise compensatory benefit sharing. As a minimum, countries would require compensation for access to PGR as recognition of past conservation efforts and to meet the costs of future conservation. Terms of access could be negotiated either as part of bilateral

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contracts, or material transfer agreements, between suppliers and users. Material Transfer Agreements (MTA) are used when the owners of the materials are known and willing to provide permission at least conditionally (Boland and Thomson, 2.5.3 and 3.3). Simple MTAs would allow research use only and contain very basic aspects of a description of the material; a statement that research use is permitted, prohibiting commercialisation without additional agreements; and prohibiting distribution to third parties (see Taylor 2.5.5). Alternatively, MTAs can be complex agreements which also includes clauses about limited use of the material for only certain types of research; requirements of notification prior to publicising an invention using the material; reasonable access to research data and payment of royalty.

Such binding agreements may not always be necessary. In some cases, simple standardised, but voluntary, agreements contained in the Codes of Conduct specifying obligations may be sufficient (Boland and Thomson 2.5.3 and 3.4).

1.3.5 Concluding remarks − national imperatives of international developments

Many different international regimes influence individual state responsibilities, roles and obligations in regard to access to and equitable sharing of benefits from plant genetic resources. The critical one is the binding Convention on Biological Diversity (CBD) which stipulates in Article 6 that each of the contracting parties, including many Pacific island states:

· develop or adapt existing national strategies, plans and programs for the conservation and sustainable use of biological diversity; and
· integrate the conservation and sustainable use into relevant sectoral or cross sectoral plans, programs and policies.

This, together with obligations under the Undertaking (IUPGR) and the Global Plan of Action (GPA), obliges countries to cooperate on a regional basis, including to share in PGR conservation and promote the exchange of genetic material and information and promote collaborative research and capacity enhancement. Although not legally binding, the Global Plan of Action does oblige many of the Pacific island countries, certainly the larger countries which are members of FAO and have participated in many PGR programs, to conform with these conditions.

Finding the right balance between allowing access to PGR and ensuring those supplying the PGR receive appropriate benefits will be a challenge for PICs. Collective actions will put PICs in a better position to take advantage of recent international developments such as CBD, IUPGR, WTO/TRIPS and UPOV than if they were to act independently. But to do so in a cost−effective and an

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optimum fashion they need to take collective decisions to establish regional institutional arrangements reflecting an agreed principle of mutual benefits, reciprocity and subsidiarity in establishing cooperative partnership for PGR in the Pacific. Each country would also need to introduce appropriate legislation that will enable it to use instruments such as MTAs and Codes of Conduct to provide access to its resources and equitably share in the benefits derived from their PGR.

For the region as a whole, collaboration will encourage:

· access to international information systems on PGR in IARCs, FAO and other already established regional institutions
· development of a regional PGR using SPC and IPGRI, and links to international information systems
· development of capacity to negotiate with commercial companies the best terms and conditions of access to PGR
· development of capacity for bilateral and multilateral arrangements within the international framework and with partners within the region and external to it
· development of a harmonised policy and legislative basis for PGR management and use consistent with various international regimes to which PICs are party
· identification of how the region can cost−effectively participate in international arrangements

Such regional cooperation will help individual countries to:

· strengthen their plant genetic resources for food and agriculture programs
· avoid unnecessary duplication of activities within the same region or sub region
· share in PGR conservation and promote the exchange of genetic material
· exchange information, experiences and technology related to conservation and utilisation
· promote collaborative research
· promote the evaluation and utilisation of conserved material
· identify and promote opportunities for collaboration in training and capacity enhancement
· formulate proposals for regional projects
· develop strengths in negotiating, and obtain best terms and conditions for allowing access to their PGR.

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Once the Undertaking (IUPGR) is harmonised with the CBD there should be an agreed position about the issue of international exchange of germplasm, including benefit sharing. This should help countries overcome IPR related problems likely to be encountered because countries are members of the WTO and TRIPS which provide protection of plant varieties by either patents or effective sui generis systems or some combination of both. However, countries would need to develop national patent laws consistent with these international regimes and have sufficient resources to defend their rights. Not many PICs are likely to be in a position to gain much from PGR under TRIPS. Their best bet will be to develop strong collaborative mechanisms under the CBD and the Undertaking.

1.4. Regional initiatives in the Pacific

To be truly regional, an initiative must benefit two or more countries, address common needs or problems and be linked to, or complement, national programs. Regional initiatives in plant genetic resource conservation could be developed as informal arrangements or formalised under some regional convention or internationally−driven arrangement.

1.4.1 Fear of external threat

One reason for developing regional initiatives is the fear of a common outside threat, as in the case of kava. In the wake of patenting of the neem plant in the USA and the potential competition from newly established kava plantations in Central America using material originally sourced from the Pacific region, the Kava Council was formed after a symposium organised by the Pacific Forum Secretariat. Kava is potentially a big industry for all the participating countries including the Federated States of Micronesia, Fiji, Samoa, Tonga and Vanuatu. For some countries kava promises to become the main source of export earnings. Recently 'vast quantities' of kava have been sold to foreign pharmaceutical companies for production of herbal sedatives sold in USA and Australia as 'calming kava pills'.

The Council agreed to pursue collaborative measures around 'recognition of kava chromotypes, chemotypes and genotypes in an effort to protect Pacific rights to kava on a global scale'; however, how the Council will implement this is unclear. It is not clear either, whether individual countries can protect their varieties since they do not have plant variety protection laws and no Pacific island country is a member of UPOV.

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1.4.2 Economic losses

Actual economic losses due to an outbreak of taro leaf blight in American Samoa and Samoa, formerly Western Samoa, led to the establishment of a regional R&D project with funding from external donors. The effect of leaf blight was devastating for these two countries. In Samoa, within two years the number of farmers had declined from 'thousands' to only 200 (Pouono and Semesi, 2.2.4). Western Samoa's export of taro dropped from a high of 9.5 million talas in 1993 to just under 200,000 talas a year later. The Samoan experience issued a grave warning to all other taro producing countries in the region. When American Samoa and Samoa needed to access varieties for selection for leaf blight resistance, they had to look elsewhere since their national germplasm collections did not have resistance.

Regionally, the ex situ collections did not have a great deal of diversity owing to major losses through diseases, lack of staff, costs of maintenance and drought. The collections in PNG and Solomon Islands, where there has been taro leaf blight for more than 50 years, have some blight resistance but not enough to develop new commercial varieties. With assistance from AusAID and ACIAR and technical input from IPGRI and SPC, the TaroGen project is re−collecting taro germplasm from throughout the Pacific Islands. TANSAO (Taro Network for South East Asian and Oceania) is assisting with the collection of germplasm in PNG and Southeast Asia, while Agricultural Development for the American Pacific (ADAP) is seeking funds for collecting in Micronesia.

1.4.3 Confluence of interest

Regional cooperation may also be brought about by a confluence of interests of researchers, national government agencies and external donors. This has led, for example, to the establishment of a project−based forest network, SPRIG and the yam network, SPYN.

The South Pacific Regional Initiative on Forest Genetic Resources (SPRIG) is funded by AusAID. Boland and Thomson (2.5.3) note that the SPRIG project is aimed at encouraging in situ and ex situ conservation strategies for priority indigenous tree species, and encouraging tree improvement, capacity enhancement and institutional strengthening. This project came about as a result of discussions between the Australian and South Pacific Representative on the FAO Panel of Experts on Forest Genetic Resources and personnel from several Forestry Departments in the South Pacific. The main issue identified during those discussions was the high level of erosion of forest genetic resources due to logging and clearing for agricultural purposes.

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South Pacific Yam Network (SPYN) was, as noted by Lebot et al. (2.5.4), initiated with the help of funding from the European Union and involved participating Melanesian countries, New Caledonia, Vanuatu, Fiji, Solomon Islands and Papua New Guinea, and yam pathologists from SPC, the University of Reading and the Natural Resources Institute, UK. This Network was established largely because of the concern by researchers and heads of agricultural agencies about declining supply of yam, often falling short of demand, and a declining yam production due to high labour costs and diseases. The desire to increase yam yield and the strong belief about the large potential for increased commercial exploitation, particularly in the light of the high socioeconomic value of yams as ceremonial crops, led to the regional initiative. The EU−CIRAD funded SPYN was formed with the intention of collecting and utilising yam germplasm to develop appropriate cultivars which had regular and consistent tuber shape and disease resistant tubers. Key yam collections are expected to cover PNG, Solomon Islands, Vanuatu and Fiji. Similar interests have also led to the implementation of the EU−funded Pacific Regional Agricultural Program (PRAP) focussing on sweet potato collections for preservation in tissue culture in Samoa and SPC.

International agencies such as FAO and IPGRI, consistent with the International Network of Ex situ Collection included in the revised Undertaking, have also encouraged crop−specific regional networks in the Asia Pacific region. TANSAO (taro) and COGENT (coconut) are two such networks. Pacific countries have thus rallied together to cooperate on a regional basis when immediate economic well−being was at stake or national resources have been threatened with exploitation. Such regional cooperation in germplasm collections has, however, generally been ad hoc and piece meal, just as in other parts of the world (Lesser 1998: 14−21).

1.4.4 Instruments of cooperation

To give practical effect to cooperation in germplasm conservation, the region has employed a variety of instruments. One is the voluntary instrument based on FAO's Code of Conduct used in the TaroGen and SPRIG projects. Codes of Conduct represent nothing more than guides for countries to follow and incur moral obligation rather than being legally binding. For example, the use of a collection permit may impose financial/technical obligations, restrictions on distribution or use of germplasm, and the requirement to provide duplicate sets of collected material to countries where the collections are made.

For the exchange of germplasm under the EU−funded Pacific Regional Agricultural Program, a Germplasm Acquisition Agreement (GAA) was used, allowing research use only and prohibiting distribution to third parties.

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A much looser agreement can be found in a Memorandum of Understanding between two parties. A MOU was signed in 1984 to encourage cooperation between two forest projects supported by external agencies, UNDP/FAO South Pacific Forestry Development Program and GTZ Regional Forest Project.

The choice of instrument depends on how urgently cooperation needs to be implemented and how many unresolved issues are outstanding. The TaroGen project opted for the Code of Conduct as a practical expedient to get the project underway.

A Material Transfer Agreement is a bilateral contractual agreement between countries which have signed the Convention on Biological Diversity, thereby making a commitment to 'the fair and equitable sharing of benefits arising out of the utilisation of genetic resources' on mutually agreed terms. Nearly all PICs have signed the CBD (FAO 1998:461) under which MTA's would be formulated. The use of MTAs has been strongly advocated in the Pacific Region by Taylor (2.5.5) and by Boland and Thomson (2.5.3) who drew attention to the MTA used by CSIRO's Australian Tree Seed Centre for germplasm leaving Australia (3.3).

In Pacific island countries there is an ongoing debate about access to indigenous plants in the wild which have potential commercial use for pharmaceutical products. Complex MTAs may be required involving three parties: the user, the collector and those who may have contributed to the identification of a commercial product (Downes et al. 1993). The draft MTA proposed for PICs (through PHALPS) covers access to germplasm resources both for research and for commercialisation and generation of profit.

While non−legal instruments have been employed in the past, these are not likely to be adequate to serve the needs of germplasm conservation and management in future. It has been the experience of other regional organisations that more binding instruments are needed.

1.4.5 Regional cooperation in the Pacific

Many regional cooperation arrangements have been established in the Pacific region as discussed by Sutherland (2.5.6). Table 1.4 shows the different rationales, establishment mechanisms and instruments used in creating these regional organisations.

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Table 1.4 Regional organisations promoting cooperation in the South Pacific			
Regional organisation	Rationale for establishment	Establishment mechanism	Instruments used
Pacific Forum	Common concerns about trade and practical development problems	Annual Heads of Government Meeting in 1971	No formal/legal agreement; however, Forum Secretariat (ForSec) was established under a formal agreement, 1973
Secretariat to the Pacific Community (SPC) formerly South Pacific Commission	To promote economic and social welfare in the South Pacific region	Metropolitan countries administering various Pacific colonies and territories	Canberra Agreement, 1947
Forum Fisheries Agency (FFA)	To assist member countries in the exercise of their sovereign rights over their living marine resources in the context of the Law of the Sea	South Pacific Forum Annual Meeting	South Pacific Forum Fisheries Agency Convention, 1979
South Pacific Regional Environment Program (SPREP)	To promote cooperation in the South Pacific region and to provide assistance in order to protect and improve its environment and to ensure sustainable development for present and future generations	Environment workshop organised by the Coordinating Group of ForSec, UNEP and SPC	SPREP Agreement, 1982; SPREP became an autonomous organisation in 1991

The nature of the instrument used to establish an organisation determines the modality for cooperation. The region has in general adopted a combination of modalities for cooperation, all recognising the sovereign rights of nation states. They range from informal understandings and ad hoc collaboration through to jointly implemented projects and programs.

The Pacific Forum, the premier regional organisation, was formed in 1971 without a formal/legal establishing agreement. It comprises the Heads of member countries. In 1973 however, a Forum Secretariat was established under a formal agreement. Unlike other regional agencies, which are concerned with service delivery, the Forum's main concerns are regional, political and economic policies. The Forum Secretariat provides the Forum with policy analysis and advice.

The Secretariat to the Pacific Community (SPC) is primarily a technical/advisory organisation and its technical programs in agriculture, fisheries, health, nutrition, rural technology, etc. assist rural areas at the grassroots level.

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The governing body of the SPC is the Conference of Members at Ministerial level, with the Secretariat to the Pacific Community acting as the implementing body.

The Forum Fisheries Agency (FFA) is acclaimed as a successful example of regional cooperation. The Agency was established in 1979 against the backdrop of international negotiations leading to the declaration of the 200 mile exclusion zone. Seeing the increased threat of foreign fishing vessels taking their tuna, the FFA developed a regional strategy to effectively patrol the increased areas of waters under their jurisdiction. The FFA governing body comprises Ministerial level representatives or senior government officials often from either the Ministry of Foreign Affairs or Fisheries Department.

Less binding Regional Agreements, such as the South Pacific Regional Environment Agreement of 1982, have also been used 'to promote cooperation' and to 'provide assistance …to protect and improve' environment and ensure sustainable development in the region. SPREP is governed by the annual Intergovernmental Meeting of Senior Officials. Once every five years, a SPREP Ministerial Meeting sets broad policy direction.

Since natural systems do not know jurisdictional boundaries it is understandable to find that there are some jurisdictional overlaps between agencies. Concerns about duplication of effort and proliferation of regional organisations led to the establishment of a South Pacific Organisations Coordinating Committee (SPOCC) in 1989. The Secretariat for SPOCC is provided by the Pacific Forum (ForSec).

1.4.6 Funding of regional activities

All regional agencies have fairly similar funding and budgetary arrangements comprising core and non−core income (Table 1.5). All agencies rely on donor contributions for a large part of their activities; with SPREP having the largest proportion of funds coming from external (non−core) sources (92%) and SPC having the lowest (47%).

Table 1.5 Percentage core and non−core budget of each agency in 1997

Agency	%Core	% Non−core	Total budget (Aus $ million)
FFA	40	60	11.0
SPC	53	47	22.2
SPREP	8	92	12.0
Forum	17	80	11.0

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The Pacific island countries' contributions to these regional agencies varied from less than 1% for SPREP to 11% for FFA. The larger local contribution for FFA reflects the importance of tuna fisheries as a source of revenue for many Pacific island nations. They see an immediate payoff for their investment in FFA technical support, vessel monitoring, etc.

Non−core budget of the regional organisations relies on both bilateral and multilateral contributions. The key player in bilateral funding is Australia followed closely by New Zealand. Other bilateral donors include Japan, the European Union, USA and Canada. International agencies, including UN bodies ADB and World Bank, contribute relatively small amounts to the regional agencies. Only SPREP receives most of its funding from international bodies such as UNDP/UNEP.

A large proportion of non−core funding for germplasm conservation has come from bilateral sources such as Australia (AusAID and ACIAR), the European Union and multilateral agencies such as UNDP, FAO, IPGRI, with some funds made available by agencies such as CIRAD and IPGRI/FAO. Most of this funding has been project−based.

In other parts of the world funding mechanisms have been found to be one of the most crucial elements of regional collaboration. Member country contributions to regional germplasm networks vary from meeting a large proportion of the budget to contributing only a small proportion of the budget. Virchow and Anishetty (2.4.3) record how, in the Caribbean, setting up of the Caribbean Committee of Management of PGR without establishing a funding mechanism limited its activities considerably.

Given the current heavy reliance of regional organisations on non−core funding, the funding structure for any new regional institution for germplasm conservation would need to be carefully planned This is even more important considering that, according to the results of the ACIAR project in PNG, fixed costs for germplasm maintenance in field collections accounts for over 70% of total costs (Kambuou and Godden 2.3.3).

Germplasm conservation requires long term commitment as well as long term investment in capacity enhancement. At the same time, short term project−based funding is required for discrete activities, including those aimed at specific crop improvement.

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1.4.7 Concluding remarks − four paths to regional cooperation

Generally speaking, four broad paths to regional cooperation can be seen in the Pacific: political, evolutionary, project regionalisation, and ancillary paths.

Path 1: Political. The political path establishes cooperation by political decision. After this process, which can be very prolonged, countries are likely to have long term commitment, including financial commitment. Such long term commitment will be sustained if the benefits are perceived to be fairly and equitably shared. Key regional institutions, such as SPC, Pacific Forum and the Forum Fisheries Agency, were all established through these means, using legal instruments.

Path 2: Evolutionary. On the evolutionary path a new organisation emerges out of an existing one. SPREP is such an agency, having begun life as a project within the SPC (then known as the South Pacific Commission). With growing international attention to the environment and international donors interested in funding environmental projects in the Pacific, SPREP evolved into a fully−fledged, autonomous organisation.

Path 3: Regionalisation of projects. The transfer of freestanding projects implemented by external agencies to an existing regional organisation is a path to the establishment of a regional institutional arrangement. The regional 'home' then assumes responsibility for implementation of the activity across the region. For example the South Pacific Aquaculture Development Project (SPADP), which began as an FAO project in the Pacific under Japanese funding, was to be transferred by the end of 1999 to SPC as a separate regional activity.

Path 4: Ancillary path. This path is a catch−all to capture the numerous collaborations at the practical/technical, project/program level which emerge on a needs/ad hoc basis under the umbrella of, or in association with, existing regional organisations in the normal course of their work. Many ACIAR and AusAID projects dealing with a single issue or crop fall under this category. Example are SPRIG and TaroGen, although for them to be effective some form of formal agreement was needed.

As already mentioned regional cooperation is facilitated by the South Pacific Organisation Coordinating Committee. SPOCC was established without any legislation, as a compromise between a single regional organisation that had responsibilities for managing all resources and having different organisations operating independently under their respective legislation. SPOCC is an established part of regional practice, helping avoid unproductive competition for scarce aid resources thereby encouraging more effective utilisation of foreign aid. SPOCC considers key initiatives that cut across two or more regional organisations and makes recommendations for consideration by respective governing bodies.

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1.5 Critical issues and future options for regional PGR conservation

With the general consensus amongst national leaders, researchers and external aid agencies about the need for a regional approach to genetic resource conservation in the Pacific, the challenge facing the island nations is how to implement this. The workshop, while discussing the many international developments which the region needs to take into account, identified those operational issues most important for a regional system of PGR conservation and management.

In this Section, key issues raised in various papers and at the workshop are summarised. They can be divided into national and regional considerations. The national issues are those that national governments will collectively need to address for their own national action in the context of cooperation with other countries. The regional issues are those that governments will need to address in the context of any regional institution agree on by PICs.

Any proposal for a regional collaborative arrangement for PGR conservation and management should cover at least the following issues:

· what should be the scope of biodiversity conservation?
· what mandate is envisaged for the regional body?
· who will be involved and why?
· what institutional arrangements, instruments and forms of cooperation and implementation arrangements will be needed?
· what are the resource implications and planned funding arrangements?

More specifically, if the region decides to have a Regional Genebank Centre, the following would need to be clearly defined:

· what are the roles and responsibilities of the regional organisation?
· what will be the role of the regional genebanks vis a vis national collections?
· should the regional genebanks serve as base and or working collections and/or serve as backup to national collections?
· should the regional genebank complement national collections?

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1.5.1 Nature of cooperation

Cooperation in the Pacific needs to go beyond the current informal, project−based collaboration if the region is to be proactive and adopt a systematic and harmonised approach to PGR conservation and utilisation for the mutual benefit of the region.

Within the context of mutual benefit, reciprocity and subsidiarity in establishing cooperative partnerships for PGR activities, the region needs to decide on the degree of formalisation desirable, the nature of specific institutional arrangements, and mechanisms for policy formulation. One approach would be the creation of a regional plant genetic resource conservation organisation, including a Regional Genebank Centre, where all PGR−related activities are centralised in one or more countries. Another approach would be to establish additional crop−specific networks similar to TaroGen, SPRIG, SPYN, etc.

A single regional germplasm conservation body is not likely to be acceptable, as it will be seen as the creation of yet another organisation in a region which already has a plethora of regional bodies and particularly at a time when the PICs have been trying to consolidate various regional activities to better coordinate and harmonise initiatives of common interest.

A network is defined as 'a group of people or organisations or countries who agree to share information and other resources so that each derives greater benefit than had the resources been used in any other way' (Riley 2.3.1). It can vary from the simplest form of informal interaction on common topics (Riley's network type 'a' Fig. 2.1) to complex networks with varying degrees of transfer of resources, information and funds between countries and the central 'hub' (Riley types 'b', 'c', 'd' Fig. 2.1).

The crop−specific networks such as TaroGen, SPYN and SPRIG could be replicated for other crops but when one considers the number of crops that may need to be covered, this could be totally unmanageable. In the past many networks were set up as a result of the confluence of the interest of national agricultural agencies, international and national researchers and international funding agencies. With many of these project−based networks there is no guarantee of funding after each project is completed. A network such as COGENT has a better basis of funding with resources being provided through IPGRI. COGENT could serve as an example of a regional network where the general priorities for the utilisation of germplasm are coordinated by a steering committee comprising member country coordinators. National governments identify designated coconut germplasm to be placed in the regional genebank where they are stored under agreed conditions and freely exchanged with bona fide users, and no intellectual property rights are to be taken out on the accessions. Similar arrangements have been proposed for the other crops, possibly under the proposed Pacific Regional PGR Network (Riley 2.3.1).

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In addition there are several different FAO/ IPGRI−based networks (see Virchow and Anishetty 2.4.3 and CGIAR 2.4.4). These include 'loose' arrangements with different levels of autonomy and different degrees of financial commitment from member countries.

A model that may suit the needs of the Pacific region is the Southern Africa Development Cooperation (SADC) Plant Genetic Resources Centre (SPGRC), established within the framework of the Southern Africa Development Cooperation in Agriculture and Natural Resources Research and Training (SACCAR). In order to conserve indigenous plant genetic resources within the region, and to provide training and promote germplasm collection, characterisation, documentation and utilisation, SPGRC established:

· a regional plant genetic resources centre in Lusaka, Zambia; and
· a network of national plant genetic resources centres in each SADC member state.

SACCAR oversees crop−specific networks that aim to develop locally adapted improved crop varieties through research and training. Nordic countries provide most of the funding, with member countries providing less than 10% of the Centre's resources. There are many other regional networks which have enjoyed varying degrees of success (see Virchow and Anishetty 2.4.3).

1.5.2 Options for cooperation

For the Pacific Region, the workshop identified four different options for cooperation as summarised in the following list which outlines institutional arrangements, scope of cooperation, the respective role of the national and regional agencies, and possible funding mechanisms.

Option 1: Informal Regional Interaction. Countries interact on an informal basis to discuss common problems and share information and data of common interest (Riley's network type 'a' and elements of RECSEA). Such a network could have a rotating chair and a secretariat. The countries set their own priorities, identify national activities and each country would meet its own costs.

Option 2: Formal Network. There would be a secretariat as the regional focal point or 'hub' and a regional coordinator. With such an arrangement, it would then be possible to identify regional priorities and a program of activities using national priorities as the starting point (Riley's network type 'b' and elements of ECP/GR).

Option 3: Regional Cooperation with a Regional Genebank Centre. The Regional Genebank would backstop national collections, which would serve as

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working collections. In addition specific crop networks would be maintained (elements of SPGRC).

Option 4: Regional Cooperation. Option 4 differs from Option 3 in that some national collections would also act as regional ex situ collections. The national collections would focus on key crops of importance to the individual countries and should be based on ex situ field collections and farmers' fields. The Regional Genebank would focus on ex situ conservation of crops of high regional priorities using technologies such as tissue culture and cryopreservation. In addition, under this option crop−specific technical networks will also be maintained. This option closely resembles the Southern African model of Plant Genetic Resources Centre (SPGRC).

1.5.3 Preferred strategy

The workshop agreed that Option 4 (of the 4 options considered) was the preferred strategy for regional germplasm collaboration in the Pacific, under the umbrella of the South Pacific Organisations Coordinating Committee (SPOCC). Operationally, a two−tiered model is proposed of regional and national activities, supported by crop−specific technical network (Fig. 1.1).

1.5.3.1 SPOCC Germplasm Conservation Working Group (Tier 1, Regional)

The workshop proposed that a SPOCC Germplasm Conservation Working Group be established with National Germplasm Coordinators from each country acting as members. The Working Group will act as the technical committee. SPC will act as the secretariat with the assistance of a Regional Coordinator for Germplasm Conservation. The Working Group will identify regional priorities for consideration and endorsement by the Forum. These priorities will be based on national priorities identified at the Tier 2 level in collaboration with relevant stakeholders in each country.

The key principles guiding the activities of the SPOCC Germplasm Conservation Working Group will include (drawing on FAO 1998 and papers presented at this workshop):

· strengthen conservation of national plant genetic resources for food and agriculture programs
· identify key target crops for conservation and management of plant genetic resources
· coordinate funding activities and manage donor support
· avoid unnecessary duplication of activities in countries within the same region or sub region

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· exchange information, experiences and technology related to conservation and utilisation
· promote collaborative research
· coordinate research within regions
· identify and promote opportunities for collaboration in training and capacity enhancement
· formulate proposals for regional projects
· share in PGR conservation and promote the exchange of genetic material
· develop harmonised characterisation, evaluation and documentation of all PGR
· develop harmonised regulation of access and exchange of genetic resources
· assist develop harmonised national quarantine requirements
· help develop standardised and harmonised legal and semi legal instruments for regional cooperation of both in situ and ex situ conservation
· help develop harmonised patent laws

1.5.3.2 National PGR Programs (Tier 2, National)

The National Programs identify national priorities which form the basis of the regional priorities. The responsibilities of the national program, as outlined in the Global Plan of Action, will include:

· develop national policies and strategies in consultation with relevant stakeholders
· provide basic building blocks for regional and international collaboration
· coordinate national activities involving all stakeholders to promote linkages

1.5.3.3 Networks

Individual crop−specific networks will implement all activities related to conservation, utilisation and management of particular crops by:

· collection, characterisation, preliminary evaluation
· harmonised sharing of individual plant genetic resources
· conservation of genetic resources
· identifying priorities for plant improvement needs
· undertaking plant improvements
· harmonised characterisation, evaluation and documentation for the crop

SYNTHESIS

Any institutional arrangement established in the Pacific to coordinate and/or manage regional cooperation in conservation, use and management of any plant resources will need to cover these three categories of activities (regional, national, networks).

Figure 1.1. Preferred model for regional germplasm collaboration. In addition to the activities in Tier 1 (Regional) and Tier 2 (National) there would be crop−specific technical networks. National priorities form the basis of regional priorities.

1.5.4 Capacity enhancement

Appropriate capacity enhancement for effective PGR conservation needs to be considered in developing any regional framework at both national and regional levels. Since there is a high mobility of trained staff in the region, a long−term training program may be needed to sustain the level of capacity required to maintain and effectively utilise national and/or regional genebanks. Depending on the relationship between the Regional Genebanks and the national collections, amongst the issues to be considered at the outset are:

· the nature of training needed at the individual country level
· the minimum commonality in the level of expertise available to all countries
· extent of training required in sophisticated techniques
· access to regional and national level PGR−related information and databases

Figure 1.1

SYNTHESIS

1.5.5 Funding mechanism for regional PGR conservation

Experience from other regional institutions in the Pacific and elsewhere in the world suggests that the issue of who and how to fund national and regional PGR conservation is one of the most important ones to be addressed if a sustainable regional cooperation is to be realised. Specific issues to be addressed include:

· What is the appropriate balance of contributions from the Pacific island nations vis a vis international agencies?
· What formulae should be used to decide on contributions from individual island states?
· What role can international (bilateral or multilateral) agencies play?

As in the case of other regional organisations, where a member country contributes substantively, it is in a better position to determine the regional organisation's priorities and work program.

The Pacific island nations obviously can not resolve the funding issue by themselves. They need to discuss and negotiate with international funding agencies formulae−based funding as has FFA and SPC. There are many different funding models in the region depending on the extent of external funds and level of commitment of the island nations. External donor contributions for SPREP accounts for 92% of funds, whereas the SPC has the lowest non−core contribution from external donors (47%), principally Australia and New Zealand. As discussed earlier, experience from the other organisation in the region suggests that unless member countries fully embrace the relevance of a regional organisation and are prepared to contribute their own funds to meet the day to day operational costs of the new organisation, any regional body may not be effective in meeting the short or long term PGR conservation needs of the region.

1.5.6 Conclusion and the way forward

The Pacific leaders recognised the importance of developing a regional approach to germplasm conservation and utilisation when, in 1997, they adopted the following resolution: 'Conserving genetic diversity is the key to crop performance and thus its neglect could imperil agriculture. Linked to this is the need to protect and utilise plant genetic resources so there is an equitable sharing of benefits'. The resolution also urged the Pacific leaders 'to put in place in their countries, and through regional cooperation, policies to conserve, protect and best utilise their plant genetic resources'.

The workshop concluded that the region as a whole has to develop and put in place a mechanism for germplasm conservation that is acceptable to all, in the

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Pacific way. Such a system of sharing, caring, resourcing and utilisation of regional and national collections of plant genetic resources must be found within the context of national institutional regimes, and preferably consistent with international regimes.

The major outcome of the workshop was a preferred model for regional germplasm conservation in the Pacific. Having considered a wide range of relevant issues, the workshop agreed that the preferred model was a combination of regional and national activities, supported by crop−specific technical networks.

A Regional Genebank would focus on ex situ conservation of crops of high regional priority using advanced technologies such as tissue culture and cryopreservation. Some national collections would also act as regional ex situ collections. The national collections would focus on ex situ field collections and farmers' fields. Collaboration would be under the umbrella of the South Pacific Organisations Coordinating Committee (SPOCC) and facilitated by the Secretariat to the Pacific Community (SPC).

Operationally this is not an easy task, and the issues to be considered are numerous. The workshop agreed that a strategy paper needed to be developed to facilitate the establishment of a collaborative mechanism to begin implementing the model developed by the workshop. Amongst the many issues to be addressed in the strategy paper and any future policy documents are the issues summarised in the first part of Section 1.5. The strategy paper would be for consideration by the Pacific Heads of Agriculture and Livestock Programs (PHALPs), before it is submitted to the Pacific Forum. The paper was to be developed by a subcommittee comprising representatives from PNG, Fiji and Solomon Islands and was to be championed by the SPC.

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2. ABSTRACTS OF PAPERS PRESENTED AT THE WORKSHOP

2.1 Opening session

2.1.1 Introduction to the workshop

Padma Lal 1 and Rosa Kambuou 2

Refer to section 1.1

1. ACIAR, Canberra, Australia (present address: National Centre for Development Studies, Australian National University, Canberra)
2. National Agricultural Research Institute, Laloki, Papua New Guinea

2.2 STATUS OF PACIFIC PLANT GENETIC RESOURCES (COUNTRY PAPERS)

2.2.1 Status of plant genetic resources conservation and use in Papua New Guinea

Rosa Kambuou 1

A great diversity of landraces of important staple indigenous food crops is still being maintained in farmers' fields in Papua New Guinea but this diversity is rapidly being eroded with the breakdown of traditional farming systems. A narrowing genetic base is leaving crops more vulnerable to attacks by pests and diseases and environmental stresses.

Ex situ collections by the Department of Agriculture and Livestock of genetically different strains of five important food crops, namely banana, cassava, yam, aibika and sweet potato were held initially at the Dry Lowlands Research Programme site at Laloki but drought destroyed the yam collection and severely affected the other collections. The sweet potato collection was transferred to the Wet Lowlands Islands Research Programme site at Keravat where it is maintained under the Pacific Region Agriculture Programme (PRAP). The highlands sweet potato germplasm is maintained at the Highlands Research Programme site at Aiyura. The National Taro Collection is located at the Wet Lowlands Mainland Research Programme site at Bubia. Germplasm of indigenous fruits and nut species and minor leafy vegetables of the country is currently being maintained at Keravat. Collections are planted in single rows of 10 plants per accession, except sweet potato which is planted in mounds, ridges or flats with 10 cuttings per station. Maintenance of these collections is a labour−intensive task involving proper labelling, frequent weeding, mounding of earth around the bases of the plants, irrigation and, where necessary, addition of fertilisers and pesticides. Crops like bananas have to be propped, especially in windy areas, and yams require staking during the growing period.

Field collections currently maintained ex situ include: lowland sweet potato (844 at Keravat), highland sweet potato (1444 at Aiyura), taro (580 at Bubia), banana (298 at Laloki), aibika (76 at Laloki), cassava (74 at Laloki), yam (63 at Bubia), fruits and nut tree species (11 indigenous and seven introduced species at Keravat) and eight species of minor indigenous leafy vegetables (48 at Keravat).

COUNTRY PAPERS

Accessions are morphologically described using the Descriptor Lists developed by the International Plant Genetic Resources Institute. The National Banana Germplasm Collection is characterised according to the descriptor list developed by the International Network in Banana and Plantains. Not all germplasm collections are yet properly documented. Cassava and aibika national collections are fully characterised and the banana collection has been partially characterised. There is an urgent need to develop a standardised system of documentation for use by genebank curators.

Most of the accessions in the national germplasm collections have had a preliminary evaluation for agronomic potential. A total of 17 accessions are currently being evaluated at Keravat and another 54 at Aiyura. Three farmer cultivars of taro from East New Britain found to be resistant to taro leaf blight have been included in the breeding program. Material selected by preliminary evaluation is tested in replicated plots for a number of seasons, and at different locations, before they are released to farmers. Twenty three (23) accessions of bananas have been put through formal varietal testing trials at Laloki, resulting in the release of 10 high yielding cultivars to farmers, and evaluation trials of 20 aibika and 20 cassava accessions resulted in the release of 10 cultivars of each to farmers. Twelve elite lines of taro from the breeding program are being evaluated for their agronomic potential at Bubia and other selected sites, while, at Keravat, 93 selected cultivars of sweet potato are currently being multiplied by PRAP for distribution to farmers.

The major diseases observed in field germplasm collections include: taro leaf blight and the virus diseases of alomoe and bobone of taro, sigatoka disease complex of banana, anthracnose of yam, virus and mycoplasma−like diseases of sweet potato in dry areas and cercospora leaf spot of cassava. The main insect pests observed in the collections include: taro beetle, taro plant hopper, taro hawkmoth, banana skipper or leaf roller, banana weevil borer, sweet potato weevil and sweet potato hawkmoth, aibika flea beetle, and fruit flies, the major pests of a wide range of tropical fruits. Susceptible accessions are at high risk of being lost from field collections if control measures are not taken. Even when well tended, field collections are not safe from natural disasters and sometimes theft. Of the initial collection of 600 taro accessions, 423 yams, 78 cassava, 142 aibika, 13 sago cultivars, 1453 highlands sweet potatoes and another 1044 lowlands accessions and over 500 accessions of bananas in ex situ field collections at various research locations in the country, over half have been lost. Duplicate field collections held in different places would provide some safeguard for germplasm against these biotic and abiotic factors, and in vitro (slow−growth storage or cryopreservation) collections are essential backup. Farmers should be encouraged to continue to conserve germplasm diversity in situ on their farms.

COUNTRY PAPERS

A regional approach to conserving and utilising the genetic diversity in the region is supported but it is seen as important that each country in the South Pacific region has a strong national program or at least appropriate strategies for plant genetic resource conservation and use. The region should approach international donors for funding maintenance of regional germplasm collections that will be useful for both regional and international breeding and crop improvement programs. In the past, funding by international agencies has been available only for collecting germplasm not for establishing and maintaining the field collections. Material Transfer Agreement and Prior Informed Consent details have to be put in place to allow exchange and sharing of germplasm and information within the region and the world.

2.2.2 Conservation and sustainable utilisation of bio−resources: medium term development strategy for Solomon Islands

Ruth Liloqula 1

Conservation and utilisation activities of natural resources and other bio−resources of Solomon Islands for the next three years will have to take into account the country's major reform program and the economic situation. The reform program will set the scene for the long−term sustainable utilisation and conservation of bio−resources, and the equitable sharing of benefits arising from commercialisation of these resources.

The vast majority of Solomon Island germplasm and other bio−resources are currently being actively conserved by communities and landowners. These conservation activities have been, and are still very effective, but with the rapid growth in population, big development projects, changes in market forces, and the need for income, there is an urgent need to investigate how systems can be improved.

Before the introduction of cassava, sweet potato and Hong Kong taro, people were generally dependent on endemic yam, taro and fruit and nut trees with many other species such as sago and Polynesian chestnut supplying seasonal or occasional food. Many species of multipurpose trees yield edible fruit. The variety of leafy vegetables that are collected from both cultivated and wild plant species including ferns, climbers, shrubs and trees is far greater in Solomon Islands than elsewhere.

In all, the main food species have been enumerated as follows: staple, 22; vegetable, 72; fruit, 45; nut, 18; herb/spices, 12; traditional, 11; miscellaneous, 38. There are also several species of minor fruits and berries. Nut trees have played an important role in the social history of the Solomon Islands: their

1. Ministry of Finance and Development Planning, Solomon Islands

COUNTRY PAPERS

potential as an export commodity for confectionery and/or oils or to meet local food demands needs investigating. Over time, a number of exotic tropical fruits have become established, adding to people's diet.

The national germplasm collection of food crops has been maintained by the Solomon Islands Department of Agriculture and Fisheries as follows:

root crops:− collections of root crops germplasm over the years resulted in over 400 accessions each of sweet potato, taro and greater yam, 30 of lesser yam, 167 of taro, 40 of cassava and a few of other species. The collection consisted entirely of indigenous or landrace materials. Due to difficulties associated with the maintenance of living collections in the field genebank, the collection was lost or mixed over the years.

fruit and nut trees:− 105 germplasm accessions are maintained for fruit and nut trees. A total of 59 cultivars of introduced mango are maintained in five field experimental stations and there are a number of accessions of other fruit trees.

plantation crops:− A germplasm collection of coconut including material from national as well as regional and international collections is maintained as well as 25 hybrids of cocoa originally from Sabah, several 'Amelonado' clones, and 18 clones of coffee.

vegetables, herbs and spice: There are no germplasm collections of indigenous or endemic species used as vegetables in Solomon Islands. Forty five accessions of aibika were held in the past but only 8 of these are still maintained in Côte d' Ivoire. Only one variety of an indigenous spice is maintained in the germplasm collection but farmer cultivars are still maintained in home gardens. Germplasm collections of the introduced species, vanilla and chilli, are maintained.

Germplasm conservation, apart from for tree crops, has not flourished in the Solomon Islands, largely because of the poor economic status of the country and because decision−makers have not been convinced of the tangible benefits. While regional cooperation in plant genetic resources conservation is important, strategies are needed to enable countries to establish and maintain their own germplasm collections to match their aspirations, and there needs to be an incentive at the community level to conserve both germplasm and the valuable knowledge associated with growing crops.

Under the Medium Term Development Strategy, the Solomon Islands is drafting legislation to: (a) establish sovereign rights over its bio−resources under the Convention on Biological Diversity, (b) provide for equitable sharing of benefits arising from the utilisation of knowledge, innovations and practices of indigenous communities and individuals, (c) provide for the establishment of regulatory regimes governing access to the genetic resources at the national level and (d) provide for conservation and sustainable utilisation of biological resources.

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2.2.3 Fiji country report on germplasm conservation

Joeli Vakabua and Aliki Turagakula 1

Germplasm of most vegetatively propagated plant food species grown in Fiji has been conserved in field collections at the Koronivia Research Station. Plants include taro, yam, cassava, sweet potato, kava, elephant's foot or suran, and pineapple. Germplasm of sexually propagated crop species in the field collection includes coconut, mango, some citrus species, and some fruit trees. Some accessions have yet to be described, and not all the yam species which grow naturally in the forest, or the fruit tree species and certain members of the aroid family, are represented in collections. Seed germplasm of most grain and pasture crops is conserved in a seed store. In a new TaroGen project, the efficiency and effectiveness of field conservation is being compared to cryopreservation for 50 accessions of taro at Koronivia.

Linkage between national, international and regional research institutions can benefit plant genetic resources conservation and improvement. Plant breeding in Fiji is today at a standstill. Breeding in rice, taro and coconut, which produced high−yielding cultivars for commercial and subsistence production, has been terminated, mainly due to lack of adequately trained personnel and the funds to sustain them. Feasibility studies carried out by regional institutions like SPC can help coordinate research and lessen duplication. More complete collection of germplasm of crop species and crop varieties from countries in the Pacific is needed, together with vigorous breeding programs; however conservation at field experiment stations is costly as well as vulnerable to biotic and climatic disasters. While funding national research programs has always been low on the national priority list because benefits are often a long time being realised, money from donor institutions can help start, maintain, and justify research projects of national and regional importance, and costs and risks can be shared in regional research projects such as the TaroGen project. Regional training programs and funding for these programs, particularly at the postgraduate level, are needed to allow effective staffing of germplasm conservation installations.

1. Ministry of Agriculture, Fisheries and Forestry, Suva, Fiji

COUNTRY PAPERS

2.2.4 Status of plant genetic resource collections in Samoa: a country paper

Kirifi Pouono and Semisi Semisi 1

Samoa's native flora consists of about 550 species of flowering plants and 225 species of ferns and fern allies. Two thirds of the 95 families and about 300 genera of flowering plants are dicotyledons, one third are monocotyledons. Clearance of forest for agriculture and other developments has resulted in environmental degradation and the Government of Samoa has taken several steps to counter this. These include the enactment of the National Parks and Protected Areas Act 1974; the Lands, Survey, and Environment Act 1989, the signing of the Apia Convention, the South Pacific Regional Environmental Programme Convention and the Convention on Biological Diversity. Several villages and NGOs have also been very active in the conservation of the environment. A number of food crops have been selected for genetic conservation.

In situ conservation has been the most common and popular practice in Samoa. Farmers conserve diversity in food plants in their natural habitat or on farms by maintaining 'farmers' varieties'. Various characteristics are consciously selected for and material is gathered for replanting. The responsibility for managing genetic resources in this way rests with the farmer and his or her family. Traditional crops involved are coconut, cocoa, breadfruit, banana and taro. This form of conservation is dynamic, and allows for continued natural evolution of species along with their progeny. It is seen as a backup to government−initiated germplasm collections.

Ex situ field conservation: Department of Agriculture collections in the early 1960s of 109 varieties of breadfruit were mostly lost through neglect, though some of the accessions are conserved in situ. Collections of cocoa made up until 1990 (91 local, 58 introduced), established at Vailima, Nafanua and Nuu suffered the same fate. Similarly, taro and yam accessions were lost from the University of South Pacific (Alafua) and Department of Agriculture collections within five years of their collection in the early 1980s. Currently, field collections are of coconut, fruit trees, banana and taro, at four main sites, namely Olomanu, Nafanua, Atele, and Nuu. These germplasm centres are managed by the Ministry of Agriculture, Forests, Fisheries and Meteorology.

In vitro conservation: The tissue culture laboratory at the Nuu Crop Development Station became fully operational in 1994, and now houses 23 varieties of banana, 21 of taro, 14 of orchid and 5 types of anthurium. At 10 plants per accession, the total number of slow−growth plantlets is 630.

1. Ministry of Agriculture, Forests, Fisheries and Meteorology, Apia, Samoa

COUNTRY PAPERS

It is intended that vanilla, yam, and pineapple collections be conserved in vitro also.

Samoa is collaborating in the COGENT and TaroGen projects which aim to assist Pacific Island countries in the collection and conservation of coconut and taro germplasm and use of this material for plant improvement, including disease resistance. The use of Material Transfer Agreements for safeguarding nations' sovereign rights during germplasm exchange is supported by Samoa.

2.2.5 Regional cooperation for germplasm conservation in the Pacific: country report − Tonga
Pita Taufatafua 1

Tonga, being one of the smaller countries of the region, naturally has less diversity than larger Pacific nations in its plant genetic resources. The loss of about 80% of its rainforest to agriculture during the early part of the 20th century has meant loss of natural diversity and further losses are due to commercialisation of food cropping systems and importation of new foods.

Crops	No. accessions	Field collection	Tissue culture
sweet potato	31/264	X	X
yam	8	−	X
taro	28	X	X
Xanthosoma	6	X	−
cassava	16	X	X
Irish potato	7	X	X
Musa spp.	40	X	X
orchids	5	−	X
Anthurium	3	−	X
callal lily	2	−	X
coconut	9	X	−

Plant genetic resources are being used for:

· crop improvement (sweet potato, taro and coconut)
· increasing export, thus improving the economic status of the country
· improving nutrition

COUNTRY PAPERS

Problems in national conservation activities include:

· low priorities given to such activities
· insufficient resources for maintenance of collections
· natural disasters (flood and drought, pests and diseases)
· poor conservation practices e.g. animal populations on uninhabited islands

Potential areas for regional collaboration include:

· strengthen regional programs such as in tissue culture labs at SPC, Suva, Fiji and at PRAP, Alafua, Samoa
· reduce unnecessary quarantine and revise policies restricting movement of plant materials within the region
· increase involvement in regional agricultural programs
· need for special conservation programs for endangered species

Strategies needed to realise the goal of regional cooperation include:

· cultivate and nurture the sense of Pacific solidarity and cooperation
· transfer genetic materials between countries, e.g. paper mulberry from Tonga to replenish planting material in Niue.

2.2.6 Germplasm collection, conservation and use in Vanuatu

Vincent Lebot 1

It is estimated that about 1500 species of vascular plants compose the local flora of Vanuatu. Yam and taro were the main staples for the population for centuries, with banana and breadfruit important additional crops. The sweet potato arrived between the 17th and 18th centuries. Next came manioc and tannia. Commercial plantations of copra, cocoa and coffee were established in the 19th century. Their impact on indigenous agrosystems and their genetic resources has been considerable.

In 1993−94, a general strike of public servants directly affected the activities of the Department of Agriculture and many germplasm accessions collected as long ago as 1981 were lost. Accessions presently maintained in Vanuatu are tabulated then described in more detail.

1. Department of Agriculture and Horticulture, Port Vila, Vanuatu

COUNTRY PAPERS

Crop species	Local cultivars	Introduced
sweet potato	37	15 (+2000)
manioc	26	−
taro	250	
yam	300	
tannia	6	
kava	60	
citrus	−	28
mango	−	22
pepper	1	11
coconut	7	29
cocoa	−	80
coffee	−	98

sweet potato: The collection is considered to be representative of the total sweet potato germplasm in the country. Accessions lost in 1994 were collected again during the 1994−1998 PRAP project funded by the European Union (EU) and a few promising cultivars were introduced from Papua New Guinea. Although this project has now terminated, the collection is presently maintained by the Vanuatu Agricultural Research and Training Center (VARTC) on Santo. About 2000 offspring progenies, introduced from a breeding program in Indonesia, are also under evaluation for their beta−carotene and dry matter contents. To keep the collection free of diseases, mainly little leaf or witch's broom, and pests, mainly Indian weevil, the collection has to be replanted at least twice a year entailing considerable labour costs. This is a major problem for the long−term preservation of this germplasm collection in Vanuatu.

manioc: The evaluation of cultivars began in 1982 and was completed in 1987 with a final selection of 8 superior cultivars. All cultivars are presently maintained at VARTC. The manioc collection is one of the easiest of the root crops to maintain.

taro: A collection of 126 distinct cultivars representative of the southern part of Vanuatu, was taken to the University of Hawaii for isozyme fingerprinting. When zymotypes were compared with those from other Pacific island countries the genetic base in Vanuatu was found to be rather narrow compared to northern Melanesia. This collection was completely lost in 1994 during the public servants' strike. In June 1998, VARTC initiated a new national root crops program and about 250 accessions were collected, mostly from the northern part of the archipelago. These accessions are presently being characterised using a short list of morphological descriptors.

yam: In June 1998, VARTC started new collections following the loss of all previously gathered accessions. At present about 300 accessions are maintained and are being described as part of the South Pacific Yam Network (SPYN) regional research project funded by the EU (1999−2002).

COUNTRY PAPERS

These accessions are representative of the diversity existing in the northern part of the archipelago but many more cultivars need to be collected. Yam is probably the most difficult of the root crop collections to maintain. At least 4 plants of each cultivar have to be planted and harvested each year. Yam plants are best staked and most types of supporting poles available in large quantities can be used for only one season.

tannia: All known distinct cultivars in Vanuatu are presently maintained in the VARTC collection.

kava: After the national collection of 247 accessions was completely lost because of theft and the public servants strike, VARTC initiated a new kava research program and the collection is now being re−established on Santo. There are presently about 60 accessions preserved ex situ. Kava is probably the easiest of all root crops to maintain as it is perennial. A major constraint is the occurrence of cucumber mosaic virus (CMV) that causes kava dieback.

fruit crops and spices: Tagabe Agricultural Station on Efate maintains small collections of Citrus spp. (28 accessions), mango (22 accessions), and pepper (15 accessions). Because these are perennials, their maintenance is fairly easy; however, the future of Tagabe station is uncertain. Germplasm collections of major indigenous nut trees, begun in the late 1980s, were lost. Banana was not included in the Root Crops Development Project of the 1980s and, consequently, very little has been achieved in genetic conservation. Numerous distinct morphotypes exist throughout the archipelago and the pacific plantains are amongst the most important staples. Local cultivars were fingerprinted for isozymes and zymotypes and compared with other Pacific islands countries, however all accessions and the characterisation data have been lost.

Perennial crops, being the major export crops from Vanuatu, have received more attention and funding than others:

coconut: For almost thirty years now, the Saraoutou coconut research station (now VARTC) has been building up one of the most important coconut germplasm collections in the region. In 1998, the collection had 14 dwarf cultivars and 24 tall cultivars including 9 local cultivars from Vanuatu. The station operates as a part of the International Coconut Genetic Resources Network (COGENT).

cocoa: In 1982, a research station was established at Valeteruru, near Saraoutou, to work with cocoa and coffee. Thirty two (32) clones of 'Forastero' were introduced from South America, Papua New Guinea, and Ghana; 30 clones of 'Trinitario' include 7 locals and introductions from Costa Rica, Grenada, Trinidad, Malaysia, Samoa, Colombia and Ivory Coast; and 11 clones of 'Amelonado' and 'Criollo' were introduced from Mexico, Brazil, Ecuador, Surinam, Venezuela and Costa Rica. All are presently maintained and are being characterised with internationally standardised descriptors.

COUNTRY PAPERS

coffee: The germplasm collection established on Valeteruru station and managed by VARTC presently consists of 43 accessions of Coffea robusta and 23 varieties of Coffea arabica introduced from New Caledonia, 22 breeding lines of 'Catimor', 'Sarchimor' and 'Caturra' introduced from Costa Rica in 1992, and 10 'Catimor' varieties introduced from Papua New Guinea in 1994.

Except for coconut, very little genetic improvement and breeding has been attempted, though a cocoa hybridisation program has been initiated. In Vanuatu, the smallholder farming sector is distributed among 80 islands, 800 small and isolated communities representing about 22,000 households, putting severe constraints on extension activities. Most activities are project−driven, leading to difficulties once funding support terminates. Furthermore, local staffing is very limited. As in other Pacific island countries, Vanuatu's major traditional crops are asexually propagated meaning that field maintenance of germplasm ex situ is very labour−intensive. For reasons of cost, it may be necessary to rationalise collections and preserve core samples rather than maintain comprehensive national collections. In the near future it will be essential to culture in vitro accessions from species where gene losses have been severe in the past (taro, yam, kava). Participating in regional networks (TaroGen, COGENT, SPYN, TANSAO… etc.) and collaborating with the SPC germplasm centre in Suva will avoid duplication of effort and allow sharing of resources and information.

Vanuatu should not restrict its outlook to Pacific islands countries but also consider cooperation with Asian countries.

2.2.7 Regional collections of plant genetic resources in the Pacific

Param Sivan 1

Attempts have been made over the last two to three decades to collect germplasm of some of the more important Pacific food plants such as taro, yam, sweet potato and breadfruit and hold these in national collections. Experience has shown that many countries are not able to maintain these, so recently there have been initiatives to collect germplasm through regional programs and conserve the material in institutions which serve the whole region. The International Plant Genetic Resources Institute (IPGRI) has been assisting in developing these strategies.

The Secretariat of the Pacific Community (SPC) with financial assistance from AusAID, Australian Centre for International Agricultural Research (ACIAR) and the European Union (EU), and technical assistance from the AusAID−funded

1. TaroGen Project, Secretariat to the Pacific Community, Suva, Fiji

COUNTRY PAPERS

Taro Genetic Resources: Conservation and Utilisation (TaroGen project) has recently established a Regional Germplasm Centre within its Agriculture Programme in Suva, Fiji. The Centre currently has only a small number of accessions of root crops and banana from the region (taro, 89; yam, 42; sweet potato, 204; banana, 25; potato, 8; vanilla, 9); however, it has the capacity to hold the germplasm of a great variety of the region's plants and make genetic material available for exchange. Taro and yam germplasm from collections made under the TaroGen and EU−CIRAD funded South Pacific Yam Network (SPYN) projects will be conserved there. Discussions are underway with IPGRI to include the Centre in the FAO network of ex situ germplasm collections which includes the 12 CGIAR Centres and the International Coconut Genebank in India. Under the EU−funded Pacific Regional Agricultural Program (PRAP) a tissue culture collection, mostly of root crops and bananas from the region, is held at the University of the South Pacific, Alafua, Samoa, but, as its future is uncertain, a duplicate collection is being transferred to the SPC Regional Germplasm Centre in Suva.

The National Tropical Botanical Garden in Maui, Hawaii has important collections of germplasm of some regional food crops such as breadfruit, taro and banana. Its breadfruit collection, containing 159 accessions (possibly more than 130 cultivars), is reasonably representative of Micronesia and Polynesia but not of Melanesia. There are also some 400 accessions of taro.

The germplasm conservation status of Pacific food plants is outlined below:

coconut: International Coconut Resources Network (COGENT) was formed in 1992 to coordinate and promote the collection, evaluation and conservation of coconut diversity in Asian and Pacific regions. Material is conserved in 11 genebanks and at least 142 accessions in eight Pacific island countries. In five of these countries, viz. PNG, Solomon Islands, Tonga, Tuvalu and Samoa, there is serious erosion of genetic diversity. The Papua New Guinea Cocoa and Coconut Research Institute, Madang has been nominated as the Pacific agency for the International Coconut Genebank. A large number of Pacific genotypes are duplicated in the International Coconut Genebank for Asia, at CPGRI Kasaragod, India.

taro, in addition to being an important traditional food crop, is an important export crop in a number of Pacific island countries. The introduction of taro leaf blight into Samoa in 1993 and the subsequent devastation of the taro industry in that country showed the vulnerability of a narrow genetic base. Taro genebanks held in a number of Pacific countries suffered substantial losses between 1986 and 1994 due to diseases, lack of staff, costs of maintenance, and drought. The concept of a regional germplasm centre for taro and yam genetic resources was developed at a meeting of Pacific island countries and regional and international institutions held in Lae in 1995. The AusAID project, TaroGen was subsequently developed. The project is currently coordinating taro germplasm collecting

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efforts while the Taro Network for South East Asia and Oceania (TANSAO) is assisting collection in Papua New Guinea and South East Asia and Agriculture Development for the American Pacific (ADAP) is currently seeking funds to collect in Micronesia. National collections exist in Fiji and New Caledonia, and Vanuatu is collecting under its national program. Breeding programs are underway in Papua New Guinea and Samoa to develop cultivars resistant to leaf blight. A complementary ACIAR project, DNA finger printing and virus indexing, is assisting rationalise collecting and safe exchange of germplasm.

swamp taro is a crop of special importance in the atoll islands and in swampy areas of larger islands like PNG and Fiji. TaroGen is collaborating with ADAP countries to collect and maintain the germplasm of this aroid. Giant taro is important in Tonga and Samoa but there are presently no collections of it.

yam: Several species of yam are used for food in the Pacific islands as well as being used for traditional ceremonies. Over 1000 accessions of cultivated yam are reported to be held in Pacific island countries. The EU−CIRAD SPYN project has recently started to collect yam in Papua New Guinea, Solomon Islands, Vanuatu and Fiji. The project aims to collect 1250 accessions and characterise, evaluate and rationalise the collection using DNA markers, then select 150 cultivars for conservation in the SPC Regional Germplasm Centre. The project will also help develop virus−indexing methods for safe exchange of germplasm, research conservation methods including cryopreservation for yam, and identify cultivars resistant to anthracnose, a major disease of yam.

sweet potato: PRAP Project 4 has over 1100 accessions in its collection in Papua New Guinea, however these have not been rationalised using DNA markers, hence may contain some duplicates. The accessions have been evaluated for scab resistance and other agronomic characteristics. Many of the elite types have been virus−indexed and distributed to other countries including, Fiji, Tonga, Solomon Islands and Vanuatu. Seventy six of the accessions are held as tissue culture at the SPC Regional Germplasm Centre in Suva.

kava is a crop of great value in traditional ceremonies − used for making a traditional drink and for its medicinal values. It used to be grown widely in the Pacific but production is now largely confined to Vanuatu, Fiji, Tonga and Samoa. In recent years it has become exceptionally profitable as an export crop for use in pharmaceutical products. This has led to a reluctance to exchange germplasm but 129 accessions are held in 10 Pacific countries, mostly in Vanuatu.

banana and plantain: There are reports of over 800 accessions in Papua New Guinea, of which about 500 accessions are in the national collection at Laloki. There are small collections of local and introduced cultivars in other countries such as Fiji, Tonga and Samoa. The International Network for the Improvement of Banana and Plantain (INIBAP) also has some Pacific materials in its

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genebank. In the past, ACIAR, in collaboration with INIBAP, has introduced improved genetic materials, particularly clones resistant to black leaf streak, to a number of Pacific islands including Tonga, Samoa and Cook Islands.

tropical fruits and nuts: There appears to be no organised collections or production of tropical fruits and nuts indigenous to the Pacific Islands. Most commercial production is confined to imported fruits such as pawpaw, mango, pineapple and citrus; however, a number of indigenous fruits are important in the region. These include pometia, golden apple, bilimbi, Citrus spp. and pandanus which is of particular importance on the atolls. Important among the indigenous nuts are canarium, terminalia, Tahitian chestnut, cut nut, candle nut, and betel nut. Little is known about their genetic variation.

tropical vegetables: A large number of indigenous plants are used as vegetables in the Pacific. Probably the most important of these are aibika, or bele, and taro used for its leaves. Papua New Guinea appear to have a large diversity in aibika − over 100 accessions have been gathered, with about 30 maintained at Laloki. A few selections of aibika has been introduced to other Pacific island. Some other plants used as vegetables include kangkong, watercress, amaranthus and coastal pitpit, or daruka. Foliage of a number of species of native ferns is eaten also.

2.3 RATIONALE FOR REGIONAL COOPERATION

2.3.1 Technical rationale for a regional approach for the conservation and use of plant genetic resources in the Pacific

Ken Riley 1

Plants were being domesticated in Melanesia as much as 9000 years ago, according to archaeological evidence. Species of sugar cane and banana which originated in that region have been used around the world. Many other crop plants including coconut, sago palm, breadfruit, pandanus, pili nut and a wide range of leafy vegetables appear in both wild and domesticated forms across the Pacific and Indonesian islands. Root crops have moved to the Pacific from their Centre of Origin and have developed an enormous number of cultivars, forming an additional Centre of Diversity for yam, taro and sweet potato.

The several complementary methods in use for conserving plant genetic resources in the Pacific can be divided into two categories, in situ and ex situ. In situ conservation refers to either (1) wild relatives and uncultivated useful plants in natural ecosystems, or (2) cultivars conserved on−farm by local communities using traditional subsistence farming methods. Ex situ conservation refers to deliberately assembled and maintained collections of key domesticated species in special field plantings (field genebanks) or stored seeds or tissue culture or cryopreservation. In situ on−farm conservation, being inexpensive and practical, appears to be of high priority for the key Pacific species.

Most Pacific Island countries have started surveying the status of ex situ collections of introduced and local plant genetic resources and the status of in situ conservation in uncultivated reserves and in farmers' fields. The loss of unique varieties, due the change from traditional subsistence farming to more commercial forms of farming, can be avoided by timely collecting and conserving ex situ in secure genebanks. Improved documentation of existing collections and traditional varieties may offer the most effective mechanism to start protecting this diversity. The most extensive ex situ collections are maintained in field genebanks in Papua New Guinea. These include sweet potato, yam, ginger, okra, taro, coconut and banana amongst others.

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Regional efforts for conservation based on commodity groups, such as sweet potato, taro, tree species, coconut and yam, are now starting and are clearly needed. There are three international processes available at the global level to assist in local and regional conservation efforts. One is the FAO Network of Ex Situ Collections with a total of 600,000 accessions in various centres around the world, including the Cocoa and Coconut Research Institute in Madang, Papua New Guinea. Another is the international Convention on Biodiversity of 1993 through which 180 countries have a commitment to conserving and sharing biodiversity while recognising that each country has national sovereignty over their own genetic resources. Also there is the FAO Global Plan of Action of 1996 which aims at strengthening both crop and regional networks for conservation and use of plant genetic resources for food and agriculture.

Crop networks cover genetic resources of a particular crop either globally or for a number of countries in a region and are especially effective in ensuring close linkages between conservation and breeding. In the Pacific region the International Plant Genetic Resources Institute (IPGRI) is involved in crop networks related to coconut, tropical fruits, bamboo and rattan, taro, sesame, vetche and sweet potato. These networks operate on a minimal recurrent annual budget ($10,000 − $20,000) and attract outside funds as grants. For example, the Coconut Plant Genetic Resources Network, which is coordinated by IPGRI from its Malaysia office, has 35 member nations globally and 10 in the Pacific Sub−network .

There is a strong technical rationale for increased collaboration in the Pacific to improve conservation, use and sharing of benefits from plant genetic resources. The establishment of a Pacific Regional Network on Plant Genetic Resources appears to offer the best opportunity to focus and prioritise activities, and make necessary linkages with complementary projects and networks which are operating or planned. Fig. 2.1 shows some network types.

A regional network can serve to establish priorities across the various crop networks operating in a region so that appropriate balance is achieved for conservation and improvement activities. Representatives would come from the national plant genetic resources agencies in the member countries. Three regional PGR networks now operate in the Asia−Pacific−Oceania region. The network for seven South East Asia countries from PNG to Thailand (RECSEA−PGR) was established in 1977 and is coordinated from the IPGRI office in Malaysia. The South Asia network for India and five neighbouring countries has been coordinated from the Delhi office of IPGRI since 1990 and the East Asia Network on Plant Genetic Resources for China, Mongolia, Korea and Japan was established in 1989.

When a Pacific PGR Network is established, the first priority would be to document existing collections of key crops held in each of the Pacific island countries including 'passport' data on the origin of accessions, data to

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characterise accessions uniquely, evaluation data describing desirable traits, and local indigenous knowledge. Documentation will serve to prevent inappropriate patenting of these accessions as well as encourage selection and use. IPGRI is prepared to assist with technical backup and advice, and to assist in seeking funding.

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2.3.2 Economic rationale for cooperation in germplasm conservation

David Godden 1

The paper explores difficult issues of costs and benefits in germplasm conservation; attempting to match costs and benefits; and the form in which conservation might occur.

A genebank, which can be thought of as a 'museum', collects, catalogues and evaluates varieties. A decision on how many varieties (and the total number of samples or 'accessions') to evaluate and maintain is based on balancing several key variables. They are the funding available (national, international aid, commercial), the type of material (root crops, annuals, perennials, trees) and technology available (field collections, stored seed, tissue culture, cryopreservation). Field collections (field genebanks) of living, growing plants are labour intensive because of the need to plant, care for, harvest and replant, while seed stores, tissue culture and cryopreservation are capital intensive.

The principal economic reason for maintaining a collection of germplasm is its future use in genetic improvement of currently used varieties of crop plants. Finding, evaluating and using conserved germplasm is an important component of breeding crop plants. The value of the crop influences the resources society is prepared to commit to maintaining plant collections and to plant breeding.

If conservation funds were unlimited, the best strategy would be to maintain all known germplasm. As funds are always limited, it is necessary to make an economic analysis of optimal investment in germplasm preservation. While estimating approximate costs is always possible, it is more difficult to estimate benefits with assurance. Estimating benefits requires a model to forecast approximate future value of existing collections for future incorporation of the genetic material into commercial varieties via plant breeding.

Plant breeding, being a production process is suited conceptually to economic modelling. One way to make an estimate of benefits is to use agronomists' and plant breeders' knowledge of current constraints on crop production (such as the reduction in yield due to a particular pest or disease). Such knowledge can indicate the benefits of being able to relax the constraint by incorporating genetic traits from selected individuals of the conserved germplasm.

Modelling for costs and benefits becomes more uncertain when complex traits and multiple objectives such as yield and product quality are included, rather

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than a single objective such as resistance to a disease or breeding a blue rose. The breeder might search for new varieties in the wild or in farmers' fields or in genebanks, use conventional selection and breeding to improve an existing commercial variety, or use new molecular biotechnologies. Mathematical programming might be used to estimate the optimal allocation of resources to each type of plant breeding effort and to germplasm conservation, and to estimate the probability of achieving certain goals using different values for the variables in the model.

The benefits of maintaining germplasm for plant improvement are specific to a particular crop in a particular location. A study was made tracking the distribution of material from Papua New Guinea collections of banana, sweet potato and taro to collections in other countries and investigating the benefits. Although thousands of accessions of these three crop plants have been sent overseas, the amount of awareness or use by the recipient agencies was surprisingly small. Indeed, several of the recipients were unaware, several years later, that they held PNG material. The survey detected very few examples of plant breeders incorporating PNG material into varieties released to farmers for cultivation. Accordingly, a further survey has commenced. Recipients are asked in face−to−face interviews to give their assessment of the value of potential future gains from use of their current PNG and other germplasm holdings of banana, sweet potato and taro. The insurance value of having a large pool of genetic diversity as a protection against unpredictable risks and needs in the distant future would be one component of the benefit being assessed.

Choosing the appropriate level of germplasm maintenance involves substantial policy issues in addition to consideration of direct costs and benefits. One is the issue of who benefits from the preservation of germplasm? Often the original holders of the valuable germplasm have great difficulty in asserting their property rights and thus earning sufficient revenue to compensate for preserving the material. Another issue is major environmental uncertainty and risk to germplasm collections through volcanic eruptions, drought, floods, landowner disputes, failure of electricity supply and financial restrictions.

International cooperation can offer significant economies of scale and reduced risks when considering the broader economic rationale for optimal investment in conservation of crop plant germplasm.

The full paper presented at the Lae Workshop included ten diagrams giving details of economic modelling and tracking the benefits of germplasm conservation.)

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2.3.3 Practical reasons for regional collaboration in plant genetic resources conservation and use.

Rosa Kambuou 1 and David Godden 2

In Papua New Guinea the past is still very much alive in many ways, in particular in the use of primitive methods in growing, preserving, conserving and utilising indigenous plant genetic resources for food, clothing and shelter. PNG has a rich genetic diversity of indigenous food crops and their wild progenitors. The old ways which maintained crop diversity on−farm are giving way to the cash economy, leading to rapid depletion of genetic diversity. Realising this, the PNG government undertook major germplasm collections and established comprehensive ex situ field collections (field genebanks) of the country's major crop plants. Increasing difficulty with funding has led to serious losses from the collections, with only half the original material left and the remainder threatened. With funds from ACIAR, a study has been made of the costs of maintaining germplasm in PNG's field collections for four major crop plants: sweet potato, taro, banana and aibika.

For sweet potato, the country's most important staple root crop, over 1400 landraces and cultivars were initially collected and maintained. Of the 1000 accessions of lowland sweet potato 844 were still being maintained in 1998, but less than 200 of 1400 highland accessions remained. Similarly with taro, there are 301 of the 600 original accessions, banana 298 out of 500, and aibika 112 out of 142.

Flowcharts were made showing all the activities required for maintaining field collections of germplasm. Detailed information was obtained on the costs of land preparation, planting, maintenance (weeding, irrigation, fertilisers, pesticides), harvesting and keeping records. There is a 6−month cycle for taro, sweet potato and aibika, and a 2−year cycle for banana. Current costs were documented on spreadsheets showing inputs, rates and prices, and cost budgets were prepared for each of the four crops.

The results of the cost budgeting showed the total cost in 1997−98 of maintaining the four collections to be K170,580 of which the direct cost of growing the collections (i.e. the 'variable cost') was only 25% (mainly seasonal labour). This means that fixed costs (mainly salaries of trained staff) dominate the economics of maintenance of field collections of germplasm. The fixed costs for maintaining collections stay the same whether the number of accessions are large or small. For example, for taro the annual cost of keeping each accession fell

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from K52 to K34 when number of accessions increased from 316 to 580, and for sweet potato rose from K85 to K303 when the number of accessions fell from 435 to 110.

This finding on the importance of fixed costs in germplasm maintenance in field collections suggests a major advantage in cooperation in maintaining collections. Where a collection already exists, the extra cost of maintaining additional varieties is only the variable cost. However, when a completely new collection is established or separate small collections are maintained, the average cost per accession is extremely high.

Commonly the collections have been used simply for selecting the most promising cultivars in the collections and releasing them to farmers as new varieties after appropriate evaluation and screening trials. Breeding from selected cultivars in the PNG collections has taken place only for taro, from three farmer cultivars resistant to the devastating taro leaf blight. Another major use for the collections has been the free sharing of hundreds of accessions of PNG germplasm with institutions in other countries.

In situ conservation of genetic resources in the forest, the natural habitat of many PNG food plants, may no longer be safe due to continuing encroachment by logging, mining, clearing for tree crops and other farming. Crop diversity in farmers' fields (on−farm conservation) is also threatened with genetic erosion as population pressure leads to change from traditional shifting cultivation to more intensive agriculture with cash crops. Only a few popular crops are grown using only a few varieties compared with the multitude of crops and varieties in former times.

For *ex situ* conservation in field collections of germplasm the present situation is that over half the collected materials have already been lost and the surviving germplasm is also at risk if funding does not increase. The long−term benefit of these collections is the future food security of the country.

PNG has tried over the years to conserve the rich genetic diversity of their indigenous food crops with little or no outside assistance. With current economic trends in PNG it will be very difficult to maintain genetic diversity in ex situ collections or in situ in natural habitats or on−farm. International funding agencies are more likely to respond to requests from regional or international networks than to individual countries because of greater cost effectiveness in regional cooperation. This is indicated by the importance of fixed costs in the ACIAR project on the economics of preserving genetic diversity in PNG (ANRE 1994/028).

2.4 INTERNATIONAL DEVELOPMENTS

2.4.1 International frameworks and arrangements for conservation development and management of plant genetic resources: their significance for the Pacific

Ian Bevege 1

Mankind has conserved, developed and managed plant genetic resources (PGR) since the dawn of agriculture. Practices for the conservation of genetic differences include saving of seed for sowing following crops, sharing and exchanging seed of special plant types with neighbours, rudimentary plant improvement through phenotypic selection leading to farmers' varieties or landraces, and, ultimately, more sophisticated plant breeding and genetic transformation through the application of biotechnology. Much biological material has, in the past, been moved about without restriction, resulting in numerous ex situ collections of plant genetic resources in institutions ranging from herbaria and museums to genebanks in plant breeding stations outside their countries of origin. While informal open access still operates within communities and inside national boundaries, there have gradually emerged instances of exclusion policies imposed by sovereigns, governments and trading companies to preserve some conceived comparative advantage or trade monopoly. Plant property rights find their expression today in several international arrangements and protocols ranging from open access systems to legally binding restrictive and exclusive protocols under intellectual property regimes.

IPR

The two forms of intellectual property rights (IPR) most generally applicable to innovations based on plant genetic resources are patents and plant breeders' rights (PBR). Trade Related Aspects of Intellectual Property Rights (TRIPS) covers the former and the International Union for the Protection of New
Varieties of Plant (UPOV) the latter. It should be noted that

· intellectual property rights refer to the intangible content of goods or to processes, not to the goods themselves
· ownership of IPR is temporary − up to 20 years for patents, 20−25 years for PBR − while physical ownership of goods and products is perpetual

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· IPR can be exercised only in countries where title has been granted, which presupposes an IPR legislative regime
· neither patents nor plant breeders' rights confer ownership of products
· PBRs generally confer less protection than patents but are cheaper to obtain
· patents require demonstration of novelty, non−obviousness and utility, whereas PBR criteria demand distinctness, uniformity and stability.

UPOV's around 30 signatories include both Australia and New Zealand but none of the developing countries of the Pacific. There is a general view that countries are likely to be disadvantaged in gaining access to new plant varieties by not having national PBR regulatory systems in place through either sui generis systems or by becoming a signatory to UPOV. Some 70 developing countries are signatories to TRIPS but, as breeders' rights are excluded from the scope of TRIPS, and given the embryonic nature of developing sui generis systems, it would appear that the UPOV convention is the only international instrument which currently provides a modicum of protection for developed plant varieties. TRIPS, by providing for protection of plant varieties by either patents or an effective sui generis system or some combination of both, in effect provides opportunities for further expansion of IPR and restriction of access in areas that developing countries and CGIAR centres have attempted to keep in the public domain.

CGIAR

The establishment in 1971 of the Consultative Group on International Agricultural Research (CGIAR) for the purpose of increasing production and improving the quality of food in developing countries has led to a non−formal, albeit regulated, international system for the management of genetic resources of important food crops based on germplasm accessions from traditional varieties used by farmers supplemented by collections of wild material. Thus international agricultural research centres (IARCs) have built up significant ex situ collections of germplasm which complement those held in national seed banks. Currently around 600,000 accessions are held within the CGIAR system out of a global stock in all ex situ collections estimated at over 6 million accessions.

The International Board for Plant Genetic Resources (now the International Plant Genetic Resources Institute (IPGRI)) was established in 1974 to promote and coordinate PGR management within the CGIAR. In 1988, a Policy on Plant Genetic Resources was adopted with three key elements:

1. Ensure that the diversity of germplasm is safely maintained and made available for use in programs of research and crop improvement for the long term benefit of all people

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2. Encourage all countries to support the unrestricted interchange of germplasm throughout the world
3. Collections assembled as a result of international collaboration should not become the property of any single nation, but should be held in trust for the use of present and future generations of research workers in all countries throughout the world

The 1992 CGIAR Working Document on Genetic Resources and Intellectual Property confirmed the 1988 policy, recognised plant breeders' rights and the concept of farmers' rights, and declared that IARCs would not seek intellectual property protection unless absolutely necessary to ensure access by developing countries to new technologies and products. In 1994, each CGIAR centre signed parallel agreements with FAO placing designated material in their respective collections under formal trustee arrangements, and in 1996 CGIAR endorsed an interim Set of Working Guidelines which took account of developments since 1992, particularly the Convention on Biological Diversity (CBD), the FAO/CGIAR Trustee Agreements, the revision of the FAO International Undertaking on Plant Genetic Resources (IUPGR), and the Agreement on Trade Related Intellectual Property Rights (TRIPS) under the auspices of the multilateral General Agreement on Tariffs and Trade (GATT − now World Trade Organization, WTO). Among the guidelines were provisions for centres to:

· recognise that the acquisition of germplasm post CBD is subject to the provisions of the convention, in particular to the sovereign rights of states over their genetic resources;
· recognise the contribution of farming and indigenous communities to genetic resources conservation and enhancement,
· reach understanding with national governments on mutually agreed terms facilitating the fair and equitable sharing of benefits arising from their PGR activities, and
· provide materials for breeding without restriction, allowing recipients to protect the products of breeding in ways consistent with the UPOV provisions, or any effective sui generis system that does not preclude others from using the original materials in their own breeding programs.

Documents promulgated in 1998 covered:

· CGIAR's ethical principles relating to genetic resources
· Centres' policies and instruments for management of genetic resources, biotechnology and intellectual property rights, including materials transfer agreements under trustee arrangements

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· guidelines for designation of accessions and acquisition agreements
· a joint statement by FAO and CGIAR centres on the manner in which designated germplasm and breaches of trusteeship arrangements will be managed.

The CGIAR and its centres now have a considerable body of policy and management guidelines enabling the centres to fulfil their obligations to the international community in their stewardship of PGR. CGIAR, through its Genetic Resources Policy Committee, monitors centre activity and provides policy advice to members. Through IPGRI, advice is also provided to FAO and its Commission on Genetic Resources for Food and Agriculture.

IUPGR

The FAO International Undertaking on Plant Genetic Resources was adopted by FAO members in 1983. Although IUPGR is not a legally binding agreement, it codified the international open access system in its Article 1:

The objective ...... is to ensure that plant genetic resources of economic and/or social interest, particularly for agriculture, will be explored, preserved, evaluated and made available for plant breeding and scientific purposes. This undertaking is based on the universally accepted principle that plant genetic resources are a heritage of mankind and consequently should be available without restriction.

From the outset there has been a high degree of policy convergence between IUPGR and CGIAR and this has continued through subsequent FAO Conference resolutions. Arrangements to be implemented under IUPGR included:

· establishing or strengthening the capabilities of developing countries
· intensifying international activities for PGR conservation and management, including those of FAO and CGIAR
· considering funding mechanisms to finance activities relating to PGR
· developing an internationally coordinated network of centres, including international genebanks, to hold base collections of PGR of particular plant species for the benefit of the international community and on the principle of unrestricted exchange
· establishing a global information system relating to the base collections
· developing an early warning system for hazards threatening efficient operation of genebank centres

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· mandating IPGRI to pursue its activities in liaison with FAO for improving capacity of developing countries, including professional and institutional capability, for production and distribution of improved crop varieties.

While there appears to be a general consensus within the FAO Commission on Genetic Resources on the desirability of maintaining a multilateral system, the current debate centres on how that system might be structured, operated and financed, and on the issues of scope, access and benefit sharing, and the legal status of the FAO Undertaking (IUPGR) which is currently being revised to harmonise it more closely with the Convention on Biological Diversity. The issues are extremely complex and can not readily be resolved as most, if not all, countries which are members of the Commission have yet to consolidate respective national policies and legislate their own obligations flowing from their ratification of the CBD; also, other pre−existing international mechanisms which are more restrictive, e.g. the traditional intellectual property rights regimes reflected in TRIPS and UPOV, must be accommodated. Attention is drawn to the dependence of forest and agricultural plants on microorganisms (including nitrogen−fixing bacteria, mycorrhizal fungi, biocontrol agents) which also need to be conserved for effective functioning of the plants.

Opportunities for the Pacific

Most Pacific countries, certainly the larger ones which are members of FAO, have the opportunity to participate in the FAO Commission on Genetic Resources which oversees and monitors the FAO Global System currently comprising:

1. The IUPGR (under revision)
2. The CGIAR/FAO trusteeship agreements
3. The network of national, regional and international genebanks (including CGIAR centres)
4. The World Information and Early Warning Systems (still under development)
5. FAO Code of Conduct for Plant Germplasm Collecting and Transfer
6. International Fund (yet to be established)
7. Global Plan of Action (adopted 1996).

The following resolution was endorsed by a meeting of six of the eight Pacific Ministers of Agriculture and forwarded to the SPC meeting in 1996:

Conserving genetic diversity is the key to crop performance and thus its neglect could imperil agriculture. Linked to this is the need to protect and utilise plant genetic resources so that there is an equitable sharing of benefits. The Honourable Ministers of Agriculture are urged to put in place both in their countries and through regional cooperation, policies to conserve, protect and best utilise their plant genetic resources.

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The first tangible outcome of the adoption of this resolution was the formation of the PRAP/SPC Working Group in 1997. Subsequent reports of the Working Group have highlighted the need for PGR conservation and development in the Pacific and the need for regional cooperation and coordination. The larger countries of the south west Pacific have in general become signatories to the various international arrangements which are the subject of this paper. They are participating in IUPGR, CBD and WTO. However, apart from Australia and New Zealand, they have remained outside of UPOV and the CGIAR, although some participate actively in the PGR programs of CGIAR mainly through IPGRI and its networks and with the Asia Pacific Economic Commission (APEC) and AVRDC. Although signatories, a number of countries in the region lack sufficient capability in policy development, and the scientific and financial resources, to participate effectively in the negotiations and deliberations of these international instruments.

The significance and complexity of the issues should not inhibit the orderly management of PGR within the region based on national policy and regulatory frameworks operating in a spirit of cooperation for mutual benefit among Pacific countries. The cohesiveness among countries, the informality with which regional dialogue takes place, the existence of well established and tested regional organisation frameworks, and community interest in important staple crops provide a sound platform on which to build effective regional arrangements. However these regional arrangements should nest between the sound policy and regulatory frameworks at national levels and the international regimes which increasingly determine the global agenda for PGR. That this global agenda is addressing far wider issues than PGR increases the complexity but does not reduce the need. There is no future in the region attempting to put in place arrangements which fly in the face of global trends of trade liberalisation, increasingly complex IPR environments, and strong conservation imperatives for sensitive and sustainable husbandry of biological resources. Some of these objectives have their own contradictions but these will be worked through step by step, and the Pacific countries need to participate if for no other reason than to protect their interests.

2.4.2 Developments in plant genetic resources conservation technologies and implications for Pacific Island countries

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An integrated conservation strategy for a species requires the use of a number of approaches, some relatively simple others quite sophisticated: in situ

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conservation in nature reserves and on−farm collections, and ex situ conservation in seed stores, field genebanks and in vitro genebanks. Germplasm collections in field genebanks have suffered considerable losses over recent years. Tissue culture is the common in vitro technology for secure medium−term storage and for international exchange of material. Tissue culture is being used increasingly as a supplement and a secure alternative to field genebanks for conservation of Pacific Island crop species where seed storage is not possible. This is the case with vegetatively propagated crops (yam, taro, cassava, banana, sweet potato) and crops with seed that cannot be stored (coconut).

Molecular markers are the most sophisticated of the technologies used in plant genetic resources conservation, requiring highly specialised laboratories and scientific staff. They are particularly useful for 'fingerprinting' to check the identity and suspected duplicates in collections and to assess the amount of genetic diversity in a collection.

In vitro collecting has been used when seed of coconut, cacao or cotton is unavailable or not viable. This technology involves surface sterilisation of the plant material in the field, placing on sterile medium in sterile tissue culture vials and transport to the laboratory.

Tissue culture is invaluable for storing and distributing disease−free plants. Meristem tip culture has been used to eliminate viruses from almost all clones in a cassava genebank in Costa Rica. Crop species for which disease−free in vitro genetic exchange is quite common include banana, potato, yam and cassava, using shoot culture or microtubers.

Seed storage is a well developed and highly successful conservation technology for species with seeds that can withstand drying before storing at −20 ºC in reliable freezing units. Seed storage is not possible for the many tropical species with short−lived, recalcitrant or non−orthodox seeds and for conservation of clones of vegetatively reproduced material including root crops.

Medium−term storage for conservation by tissue culture formerly required frequent and expensive sub−culturing to maintain health and keep the culture alive for an extended period. Slow−growth regimes have been introduced (reduced temperature, reduced light, etc.) to extend sub−culture intervals to between 6 months and 4 years for some species, with dramatic reduction in costs. A number of large international genebanks routinely use these in vitro technologies to maintain worldwide collections with thousands of accessions of vegetatively propagated crop plants for which seed storage is difficult or impossible or inappropriate: cassava in Costa Rica, sweet potato in USA, banana in Belgium, yam in Nigeria.

Long−term storage using cryopreservation technology is still under development, though routine conservation has been achieved for a few crop plants (Pyrus,

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Rubus) using shoot tips, embryos, pollen and other small parts of plants. This technology, once widely established, is likely to replace medium−term storage using tissue culture which sometimes has the serious disadvantage of somatic mutation. Plants grown out after a year or two may be quite different after tissue culture at +20ºC, but not after cryopreservation at extremely low temperature, low enough to inhibit any change in DNA. If a species cannot be put into tissue culture it cannot be successfully stored by cryopreservation because it could not be grown out again into a whole plant. There are particular difficulties in developing tissue culture technology, and therefore cryopreservation, for coconut and a few other species for which there is a particular need. Coconut seed cannot be stored and coconut trees are subject to damage and loss in field genebanks

For successful genetic conservation through tissue culture and cryopreservation it is absolutely essential to secure round−the−clock electricity supply, a reliable supply of liquid nitrogen, modern, well−maintained laboratory facilities, and appropriate training for staff. Training requires university courses, regional workshops and sponsorship for study and travel. Tissue culture centres within the region would also be well placed to provide advanced technology back−up storage of Pacific islands genetic resources.

A major challenge lies ahead in finding the mechanisms by which to support and facilitate the initiation and management of both National and Regional genebanks which focus on in vitro conservation technologies.

2.4.3 Regional funding: costs of conservation and national and international roles.
Detlef Virchow 1 and Murthi Anishetty 2

National programs play the leading role in PGR conservation, storing more than 80% of all accessions worldwide and providing about 85% of all expenditure. A group of 24 high GDP per capita countries, mainly from North America and West Europe, accounted for approximately 70 percent of the total domestic expenditure of US$733 million in 1995.

Conserving and utilising PGR at the international level involves collaboration between the international and national institutions mainly based on the bi− or multi−lateral transfer of technologies and financial resources. At least US $190 million are contributed each year for these activities. A separate survey of

1. Centre for Development Research, Bonn, Germany
2. FAO/AGPS, Rome, Italy

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multilateral agencies suggests that about US$140 million per year are channelled through international organisations. Programs involve the FAO Global System for the Conservation and Sustainable Utilisation of PGR, CGIAR, other international organisations, bilateral programs, foundations and NGOs, as well as institutional processes like the International Undertaking on the Plant Genetic Resources or the Convention on Biological Diversity and other international agreements.

Regional collaboration is characterised by common interests and objectives of partners. Their national programs often have similar objectives and regional cooperation aims at mutual support through cooperation. Networking also brings together specialists who use shared databases and genetic resources to improve PGR conservation and utilisation for particular crops. The development of regional genebanks can complement national genebanks, especially for the conservation of duplicate long−term base collections. Most regional networks have been established using external funds, often from outside the region, but for these programs to be sustainable there must also be soundly based national programs with specific funding allocations from governments.

Collaborative programs exist in Europe (ECP/CGR, EUFORGEN), Scandanavia (NGB), the Near East (WANANET), Sub−Saharan Africa (SPGRC), South America (REDARFIT, TROPIGEN, PROCISUR), Central America (REMERFI). The Caribbean Committee on Management of Plant Genetic Resources was set up in 1998 in an attempt to create a program comprising the entire Caribbean.

Regional plant genetic resources networks for Southeast Asia, South Asia, East Asia and the Pacific are at various stages of development. The most developed is the Regional Collaboration in Southeast Asia on Plant Genetic Resources (RECSEA−PGR), which was formally established in 1993. Members currently are Indonesia, Malaysia, Papua New Guinea, the Philippines, Thailand and Vietnam. RECSEA−PGR has identified the establishment of a regional network information system, and on−farm conservation, as its priority areas. The budget is small, around US$21,000 annually plus in−kind contributions by sponsors equivalent to about US$12,500. The South Asia National PGR Coordinators Meeting (SAN−PGR) has been an informal network bringing together six countries of South Asia, namely Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka. The proposed budget for the now formally established network is US$76,000 annually. The International Plant Genetic Resources Institute − Regional Office for Asia, the Pacific and Oceania (IPGRI−APO) and the National Institute of Agrobiological Resources (NIAR) jointly developed a proposal for the establishment of a Plant Genetic Resources Network for East Asia (EA−PGR) to be funded approximately US$97,000 per year by the Government of Japan.

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Oceanic races of rice, fe'i banana, sugar cane, coconut, kava, pepper and sago palm have their centres of origin in the Pacific Region and the region is also an important secondary centre of diversity for crops such as banana, other plantains and breadfruit. Germplasm collections are mainly the result of collaboration with CGIAR centres and other organisations with much collecting being crop−specific.

Even though the Pacific Region is the smallest of all identified regions, the genetic resources conserved ex situ reflect a certain under−investment in conservation. All the region's accessions comprise only 3% of the world's total with 95% of them held in Australia and New Zealand. Only a few countries in the region have storage facilities. Papua New Guinea, an important area of genetic resources, does not have a long−term seed storage. Field genebanks provide the most common form of germplasm storage for the mainly vegetatively propagated crops dominating the agriculture in Pacific island countries. Scarcity of trained personnel, shortages of funds, and a lack of facilities are limiting genetic conservation activities but a regional program is now functioning with support from IPGRI, the South Pacific Regional Environmental Program, the South Pacific Commission, and the University of the South Pacific, and conservation activities are being carried out within other cooperative programs, for instance the Pacific Agricultural Research Program, the South Pacific Regional Environment Program, and the Pacific Community. Some countries from the region are already members of networks outside their region, e.g. Papua New Guinea is a member of Regional Collaboration in Southeast Asia on Plant Genetic Resources (RECSEA−PGR) as well as of Plant Resources of Southeast Asia (PROSEA).

A number of proposals for innovative funding have been made in the course of negotiations for the revision of the International Undertaking on Plant Genetic Resources. The developing countries of Asia, for example, have proposed an innovative funding mechanism through an international tax on the sale of plant varieties and products protected under intellectual property systems. The seed industry has indicated that it is prepared to study a system in which the owners of patents would contribute to a fund established for collecting, evaluating and enhancing genetic resources.

The Pacific Region, as a small region, has the opportunity to establish a regional system which could be an example for other regions or even for the international PGR conservation and utilisation system still under discussions. The time is ripe for this development with calls for urgent action to improve the PGR conservation efforts in several of the countries in the region.

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2.4.4 Germplasm collections in the CGIAR − assembling and managing a major world resource

CGIAR System−wide Genetic Resources Programme 1

The current decline in biodiversity is largely the result of human activity and represents a serious threat to human development. Agricultural biodiversity was created in farmers' fields by selection and selective mating over thousands of years and by scientific research institutions over the last century. The more distant relatives of crop and forage and tree species growing in the wild are another source of genetic diversity. These genetic resources have been fundamental in the past in producing high−yielding varieties. They are an essential part of modern high−tech breeding and will be essential in the future in feeding the world's growing population.

The Cooperative Group for International Agricultural Research (CGIAR) genebanks at eleven International Centres hold precious ex situ collections of germplasm (most species stored as seed) of the major food crops of the world, with emphasis on the crops grown by small−scale farmers in developing countries. The CGIAR Centres hold 600,000 samples of the estimated 6 million accessions now stored around the world. National and private company genebanks give more emphasis to commercial varieties of crop plants grown by large agribusinesses.

The CGIAR collections which have been assembled since 1974 are especially rich in traditional varieties and landraces, non−domesticated species, advanced and obsolete cultivars, breeding lines and genetic stocks. It is this huge reserve of genetic diversity that will be used to breed new crop varieties required for the food security of future generations. Keeping the material both safe and available is an insurance against genetic erosion and a source of improved quality and yield and resistance to diseases, pests, climatic and other environmental stresses.

CGIAR Centres have very large collections, the largest holdings of germplasm in the world for 13 of the world's major food crop plants. For example, the CGIAR Centre in Colombia (CIAT) holds 4700 cassava clones from 23 countries in its field genebank and 5600 clones in its in vitro genebank. The Centres try to cover the full range of diversity of their mandate species. For example, since 1994 four Centres and several partner institutions have collaborated to fill gaps in their sampling of the worldwide rice genepool. They gathered 14,000 previously uncollected samples of traditional rice (mainly from Laos) and 1100 samples of wild species.

1. A submission by CGIAR System−wide Genetic Resources Programme presented by Ken Riley, IPGRI Asia, Pacific and Oceania Regional Office, Selangor Darul Ehsan, Malaysia

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When Centres engage in collecting expeditions, they are always done with express permission of the relevant country and in partnership with national collaborators. The material collected is always equally shared with the source country. CGIAR has taken on the responsibility to ensure that its irreplaceable collections are safely housed to international technical standards, viable, well documented, readily accessible and freely available to researchers.

Curating the collections is a continuous series of operations to ensure the viability, health, availability and usefulness of the material in storage. An important element is documentation. The International Plant Genetic Resources Institute (IPGRI − a technical offshoot of CGIAR established in 1974) has provided Descriptor Lists to document collections. This standardised international characterisation system has become a universally understood 'language' for plant genetic resource data. Most genebanks now maintain their records with the help of the IPGRI database program SINGER. It is international, multi−institutional and available over the internet and on CD−ROM.

Training in germplasm collecting, conservation and genebank operations is another important aspect of CGIAR's responsibilities. Several thousand key personnel have received training on−the−job, in courses and by sponsored postgraduate studies at universities.

Research at the CGIAR Centres has improved genebank management procedures including improved seed storage, in vitro culture of vegetatively propagated species, and international guidelines for safe movement of healthy germplasm. Research has also led to the publication of numerous manuals and guidebooks. There is a series of five 'Handbooks for Genebanks', 'Crop Genetic Resources Field Collection Manual', and many others including the overview published by Cambridge University Press in 1997 'Biodiversity in Trust − Conservation and Use of Plant Genetic Resources in CGIAR Centres' (' … This book presents a unique synthesis of knowledge drawn from the CGIAR Centres, providing an invaluable sources of reference for all those concerned with monitoring, maintaining and utilising the biodiversity of our staple crop species').

Restoration of germplasm collections destroyed by disease, war or other disasters is a recurring task of all CGIAR Centres. Between 1981 and 1995, germplasm of 19 species was restored to collections in 38 countries. For example, after the 1994 civil war in Rwanda eight CGIAR Centres and several other agencies reintroduced planting material adapted to Rwanda's unique environment.

The assembly, management and dissemination of the international germplasm collection by CGIAR is an important and impressive achievement likely to have great lasting value, with its positive effects being evident well into the future.

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2.5.1 Taro genetic resources: conservation and utilisation project (TaroGen)

Param Sivan 1

The major impetus behind the development of the TaroGen project was the loss of taro genetic resources and the spread of taro leaf blight to the Samoan Islands in 1993 and its devastating effect on the economy. Many other Pacific island countries are vulnerable to the disease. The three year project, funded by AusAID and implemented by SPC in collaboration with IPGRI and USP, works with national programs to develop a regional strategy for taro genetic resource conservation and crop improvement. A complementary project financed by ACIAR uses DNA fingerprinting to facilitate accurate genetic assessment of germplasm accessions, and virus indexing procedures to overcome quarantine concerns in the international exchange of taro germplasm. In addition, the Ministry of Foreign Affairs and Trade in New Zealand is supporting plant breeding programs. Working relationships have been established between Pacific island countries, USP, IPGRI−APO (Malaysia), ACIAR and Hort−Research (New Zealand) to deliver the inputs required.

There are only two Pacific island countries with substantial collections of taro − Fiji and New Caledonia, although there are collections of taro from the Pacific maintained outside the region. In some countries, collections will have to be re−established, e.g. Papua New Guinea, Vanuatu and Solomon Islands. Vanuatu is collecting under its national program while TaroGen will provide assistance to Papua New Guinea, Solomon Islands and countries in Polynesia. Collections held in Asian countries will be accessed through an EU−financed TANSAO project. ADAP has agreed to develop a collaborative program to collect and conserve swamp taro (Cyrtosperma) and taro genetic resources of Micronesian countries. All accessions will be described using agreed descriptors, and the information added to database records. A regional collection of taro will thus be developed which is representative of the genetic variation found within Pacific island countries. The design of the core collection, which will be stored at the recently established regional germplasm laboratory at Suva, will be based primarily on phenotype and origin but also on genotype as determined by molecular markers.

1. TaroGen Project, Secretariat to the Pacific Community, Suva, Fiji

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Testing germplasm for disease will be carried out in Papua New Guinea and Samoa while improved methods of disease−indexing will be developed at the Queensland University of Technology, Australia for transfer to the Agriculture and Biotechnology Centre, UNITECH, Papua New Guinea.

In order to assist countries keep pace with Intellectual Property Rights developments, a policy for the movement of genetic resources is to be formulated for ratification by all countries. A Code of Conduct has already been signed by a number of countries and collaborators to facilitate movement of germplasm within the project.

In addition to active national collections of taro and a core regional collection at SPC, the project will develop a base collection stored at extremely low temperatures (cryopreservation). Past experience has shown the numerous pitfalls in trying to maintain ex situ field collections of taro. In vitro technology offers alternative methods for conservation so the SPC tissue culture laboratory in Fiji will be expanded to act as a regional station for in vitro plantlets in culture and cryopreserved shoot tips, and the efficiency and efficacy of different methods will be compared. If present difficulties with seed storage can be solved seeds may become the main method of conservation, with supplementary in vitro storage of particular genotypes. To obtain information on the usefulness of in situ conservation, pilot projects will be carried out involving local communities and an NGO, the Farm Support Association (FSA,Vanuatu) and IPGRI (Fiji).

Several countries have attempted selection and breeding programs for taro leaf blight control, but none have so far achieved success. TaroGen has provided a plant breeder for work in PNG while in Samoa it is helping with evaluation of seedlings produced from crosses with Micronesian taro. In Solomon Islands, a collaborative program to test seed from Papua New Guinea will be established between Government services and taro growers. The primary focus of all programs will be the development of clones resistant to taro leaf blight

Screening plants for taro leaf blight resistance is difficult. The plant breeding workshop of 1998 recommended that tests on progeny be done in the field on mature plants not on seedlings in screenhouses. Plants will be planted at high density, inoculated uniformly, and evaluated for reaction to infection. Lines from the Papua New Guinea breeding program will be so tested. Plants with horizontal resistance based on polygenes vary in reaction to taro leaf blight depending on the environmental conditions under which they are grown. Because of this, it will be important to test selected lines before release to farmers.

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The project office has been established at the SPC complex in Suva, Fiji where the team leader is assisted by a resident tissue culture expert and staff. A plant breeder at Lae is responsible for the Papua New Guinea breeding program. In Samoa, taro evaluation and research on the fungus causing taro leaf blight is done by a Breeder/Agronomist (a staff member of USP) and by a Plant Pathologist/Breeder.

A taro project monitoring group consisting of Heads of Agriculture (7), funding agencies, organisations, institutions and SPC meets annually to review progress and endorse the work program. Information is disseminated via SPC Agriculture News, regular visits of project staff, and the IPGRI Newsletter circulated throughout Asia.

2.5.2 COGENT− experiences and lessons about regional cooperation in coconut germplasm conservation in the Asia Pacific

Tore Ovasuru 1 and Pons Batugal 2

The coconut palm has a tremendous influence on human activities in many parts of the world. Grown on nearly 12 million hectares in over 85 countries, it supplies food, shelter, fuel and stock feed as well as numerous other commercial products. Over 50 million people, of which 96 percent are smallholders, are directly involved in its cultivation and in some Asian and Pacific countries it is a major export earner. It can grow in environments where many other crops cannot be grown economically and can form a part of sustainable farming systems in fragile coastal, island/atoll, and hilly ecosystems.

Despite its potential, several problems affect coconut production, including comparatively low yield, yield variability, and an unstable market for its traditional products. World yields have been falling in the last 16 years: 710 kg copra per hectare in 1976; 430 kg in 1984; 400 kg in 1992. Further threats include pests and diseases, repeated natural calamities, ageing of palms and genetic erosion. Management of genetic resources is one strategy holding promise for increased productivity and yield security.

On the suggestion of the Consultative Group on International Agricultural Research (CGIAR) and its Technical Advisory Committee, representatives of 15 coconut−producing countries recommended in 1991 establishing an international coconut genetic resources network. With the endorsement of the CGIAR and its donors, the International Plant Genetic Resources Institute (IPGRI), established

1. PNG Cocoa and Coconut Research Institute, Madang, Papua New Guinea
2. IPGRI APO, Kuala Lumpur, Malaysia

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the International Coconut Genetic Resources Network (COGENT) in 1992. This network comprises 42 countries served by five regional centres. Papua New Guinea and eight other countries in the South Pacific are active members. COGENT functions at the national, regional and global levels to strengthen the capacity of national programs to conserve and utilise coconut genetic resources.

COGENT has developed and published standardised descriptors for both in situ and ex situ coconut collections with recommendations for minimum morpho−agronomic features to be recorded for passport data. The network is investigating how sustainable in situ conservation can be fostered because it has advantages over ex situ conservation but is subject to socioeconomic pressures which can result in loss of precious diversity.

Because morphologically similar material may be genetically different the use of DNA marker techniques can provide data on genetic make−up and isn't influenced by stage of growth or environment. Partner institutions identified by COGENT to collaborate in developing DNA markers are Long Ashton Research Station, UK and Scotland Crops Research Institute. Eventually, appropriate technologies will be available to the countries hosting International Coconut Genebanks (ICGs), viz. India, Indonesia, PNG, Côte d'Ivoire, and other countries with laboratories for biotechnology research.

COGENT funds member countries to collect coconut germplasm. Lack of a dormancy period prevents storage of coconut seed. 936 accessions are held in field genebanks at 20 sites in 17 countries. Eight countries including PNG and Solomon Islands have already benefited from funding assistance. Nineteen (19) countries in the Asia Pacific and 22 countries in Africa /Indian Ocean and Latin American countries will collect coconut germplasm during the second phase of the project. At least 200 accessions will be conserved at each ICG. Once the technologies becomes available, duplicate samples of important germplasm will be conserved in each ICG in the form of embryo in vitro, cryopreserved embryos and pollen. Practical and stable short−term conservation has been achieved through manipulation of culture medium. Long−term conservation using cryopreservation has been successfully applied on zygotic embryos. These collections will provide alternative materials for the national breeding programs.

Development of improved coconut varieties has been undertaken by many nations using their own or aid funds during the last 30 years. A study began in 1998 to compare the performance of improved varieties and hybrids which had been planted in 18 countries. Most countries are developing their own local hybrids, an approach COGENT encourages as they are most likely to be suited to local conditions. COGENT is coordinating breeding programs to most effectively utilise conserved germplasm to generate improved disease and pest−resistant planting materials for coconut farmers. Cloning of coconut is possible, however it is expensive and genetic fidelity has yet to be confirmed. COGENT is cooperating with research under way in France, Germany, and the UK in

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collaboration with laboratories in Philippines and Mexico, and research initiated by the University of Queensland, Australia. Funding secured from the UK Department for International Development (DFUD) will allow laboratories in 10 countries to refine embryo culture protocols so that pest−free germplasm can be exchanged by member countries.

At its genesis COGENT initiated an International Coconut Genetic Resource Database (CGRD) with CIRAD, France as the central coordinating agent. This has developed into a data exchange system enabling coconut breeders and CIRAD to have access to each other's data and assists in efficient recording and analysis. The need to document, publish and disseminate research information to the wider community has not been overlooked.

COGENT has salvaged national programs that were on the verge of extinction and reorganised and restarted others, providing opportunities for germplasm conservation in the most disadvantaged countries. Capacity−building is seen as important for less advanced countries so that the assistance provided by more advanced countries can be fully utilised: 50 persons have been trained to serve as trainers in the Asia Pacific, Africa and Latin America/Caribbean in standard techniques of coconut conservation and breeding.

2.5.3 SPRIG: a regional forest genetic resource aid development project in the South Pacific
Doug Boland and Lex Thomson 1

The South Pacific Regional Initiative on Forest Genetic Resources (SPRIG) commenced in December 1996 as an AusAID−funded project involving Government forestry organisations in Australia, Fiji, Samoa, Solomon Islands, Tonga and Vanuatu. Continuing loss of forest genetic resources in the region, due to logging native forests and conversion to agriculture, jeopardises prospects for long term sustainable development in the region.

CSIRO Forestry and Forest Products, Queensland Forest Research Institute and a consulting company FORTECH manage SPRIG. They work with local in−country personnel in hands−on skill upgrading through joint seed collections, planting and assessment of field trials, in−service training, work attachments in Australia, scholarships, meetings and workshops. SPRIG also contributes regularly to a SPC newsletter and assists with equipment for seed collection and storage.

1. CSIRO Forestry and Forest Products, Canberra, Australia

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A total of 49 priority tree species receive attention in the five island countries. Several are high value timber species, indigenous and exotic. The exotics include Swietenia macrophylla (mahogany from Central America) and Santalum and Toona (sandalwood and red cedar from Australia and India). Indigenous fruit and nut trees for traditional agroforestry are featured highly. To assess community views on conservation of forest genetic resources SPRIG has conducted Rapid Rural Appraisals on ten priority indigenous tree species. These appraisals recorded uses, cultural values, folk varieties and traditional conservation measures. This information contributed towards development of a conservation strategy for ten indigenous priority species.

In tree improvement the main SPRIG activities are seed collections, establishing 15 ha of new field trials in each country and developing a data base of 350 South Pacific tree species. The database includes information on access to germplasm, field trials, quarantine issues, utilisation, taxonomy, biology of flowering, seed technology and vegetative reproduction.

Because forest trees are so tall and produce fruit irregularly they pose special difficulties for seed collection for ex situ conservation in seed stores or field plantings. In addition the seed of many tropical trees is recalcitrant, having such a short life in storage that some have to be sown within days of collection. Therefore conservation of forest genetic resources in situ in the native forests is preferred, in managed reserves of sufficient size to sustain the species genetic integrity. Attempts at in situ conservation on the forest land of customary land owners has met with only limited success in South Pacific island countries (PICs).

Long term security is also a difficult issue in ex situ conservation of forest genetic resources in PICs. For example, when the cool store refrigerator broke down at Munda in the Solomon Islands all the stored seed perished. Special plantations of field genebanks are being established, but on customary land this approach has also proved difficult. A land dispute, for example, caused the loss of a teak seed orchard on the Gazelle Peninsular in Papua New Guinea. Solutions may be found through international cooperation and agreements for the sharing of reliable central seed stores and secure long term field genebanks.

Equitable sharing of benefits from research and utilisation of forest germplasm in PICs is a potentially contentious issue, especially for pharmaceutical products but also for commercial production from newly domesticated fruit and nut species. To avoid conflict, rules for sharing and exchange of germplasm have been developed in a Code of Conduct agreed to by SPRIG partners (3.4). The principal feature of the Code is that 'germplasm collected and supplied under SPRIG is for research and demonstration purposes only and remains the property of each contributing partner'. For further protection of the rights of the original owner, a Material Transfer Agreement (MTA) is proposed, based on the current

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MTA of the Australian Tree Seed Centre at CSIRO (3.3). Under this proposed Agreement 'the recipient will not claim ownership over the material nor seek intellectual property rights over the germplasm or related information'. The MTA would seek commercial recompense to land owners for conservation of forest genetic resources on their land and facilitate access to seed and other germplasm.

The guiding principle for field operations during the first three years of the SPRIG project has been to train and encourage local in−country personnel (Forest Department staff and contractors) to undertake their own seed collections, community surveys and establish field trials, after appropriate training and sometimes with assistance of Australian experts. At present there is no regional germplasm bank for forest genetic resources in the South Pacific region and any collections for SPRIG are used in−country within a short period after collection, with some important exchanges within the region.

2.5.4 Networking with food crops: a new approach in the Pacific?

Vincent Lebot 1, Patricia Simeoni 2 and Grahame Jackson 3

Root crops have been the traditional staples in Pacific island countries for thousands of years, and even today form the mainstay of many economies. Their vital contribution to people's welfare and countries' GDP has never been questioned, but efforts to conserve the wealth of germplasm and improve the crops for subsistence and commercial potential have been largely ineffective. National budgets have found it difficult to sustain research and development programs, and international assistance has not always achieved stated goals. Different strategies are now being sought, but these need an understanding of the history of the crops in the Pacific Islands.

There is evidence to suggest that most cultivars were not brought by the first settlers from the Indo−Malaysian region as previously suggested, but rather were domesticated from wild sources existing in Melanesia. For several crops, for instance, sugarcane, coconut and banana, a western Melanesian centre of origin has been largely accepted, and there is now circumstantial evidence that taro and yam may have been domesticated in that area too. Attention has mainly focused on Papua New Guinea, with evidence of human settlement as far back as 40,000 years, and of agriculture for 9000 years.

1. CIRAD, Port Vila, Vanuatu
2. VARTC, Port Vila, Vanuatu
3. 24 Alt Street, Queens Park, NSW 2022, Australia

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Domestication appears to have captured a limited portion of the genetic diversity of wild species, so that the majority of cultivars are probably clones from a narrow genetic base. For the most part, traditional staple food crops are sterile because of high ploidy levels and mutations inhibiting sexuality, or rarely flower, and are propagated by suckers, cuttings or shoots. Growers have selected particular mutants, and by vegetative processes preserved the new characters, helping to create the scores of variants found today.

The small, volcanic oceanic islands of the Pacific exhibit limited biodiversity, but high rates of endemism due to speciation in isolated environments. The larger continental islands, with the Gondwanan inheritance of their flora, present a great number of species, genera and families, unique on earth, as well as phenomenal biodiversity (15,000 species in New Caledonia, but only 1500 species in Vanuatu). Where they occur, sterile cultivars are not able to exchange needed genes to respond rapidly to pathogen introductions and, therefore, they tend to perform poorly when under stress from recently modified environments. Because of the low genetic diversity in Pacific islands, there is a need to exchange materials with others to get access to a wider base. The Pacific region, therefore, necessitates an approach to plant genetic resources that is quite different from the one used traditionally in other great centres of diversity located on continental masses.

In the late 1970s, development assistance agencies began to take a more regional approach to root crop improvement. However, the projects failed to build the institutional structures at national and regional levels necessary to sustain them. Emphasis was on national holdings of genetic resources. Root crop collections were expanded in many countries, documented, and, in some cases, evaluated, but rarely rationalised, compared or exchanged. Many of these collections no longer exist, or are no longer representative of the genetic resources of a particular country, and, in some instances, the databases of passport and descriptor information have also disappeared.

New approaches to the conservation and use of germplasm are required. This paper looks to see how Pacific island countries, with typically modest research resources, can take advantage of the crop germplasm available in Oceania as well as in Asia through the development of regional crop networks. The advantages of such an approach are first considered and then examples are presented of networks recently established (yam, taro) and others which are needed (breadfruit, kava).

In general, over the last 30 years research services have been reduced considerably in Pacific island countries. It seems likely that public funding of agricultural research will continue to decline as governments restructure and downsize in their attempts to rein in budget deficits. Traditional subsistence root crops have received even less support than cash crops which earn revenue from exports. If present research organisations and policies have been found wanting,

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do the currently developing crop networks have anything better to offer?

Collaboration through crop networks offers better funding, standardisation of descriptors of cultivars, central databases, core collections, exchange of germplasm, property rights for protection from outside exploitation, and linking scientists and building enthusiasm. The advantages of networks are considered through recently established networks for taro and yam.

The Taro Network for Southeast Asia and Oceania (TANSAO) aims to advance the competitive position of taro in cropping systems and markets. TANSAO seeks to utilise existing fragmented germplasm collections and appropriate biotechnology to facilitate crop improvement for which there had been little progress in the member countries. The members are Thailand, Vietnam, Malaysia, Philippines, Indonesia and Papua New Guinea, coordinated by CIRAD (France). The Wageningen Agricultural University (The Netherlands) is a scientific collaborator. Funds come from the European Union. TANSAO's current activities include: describing 1700 taro accessions and analysing genetic diversity; exchanging 170 clones in vitro among all participants; identifying sources of disease resistance; developing achievable breeding strategies; sharing information.

Taro genetic resources, conservation and utilisation (TaroGen) is a network of Pacific island countries extending the work of TANSAO eastward from Papua New Guinea, where there is overlap. The network was started in 1998 with AusAID funds and several scientific collaborators in Australia and New Zealand and through TANSAO. The immediate objective is to develop improved varieties to overcome the severe problem of taro leaf blight (caused by Phytophthora colocasiae). The disease was a disaster for many subsistence farmers, particularly in Samoa, and the small−scale of agricultural research capability in each Pacific island country was unable to react effectively to the challenge. The well−organised collaborative network of TaroGen is tackling the problem with free exchange of information, expertise and germplasm, and by employing advanced technologies well beyond the capacity of individual countries to achieve.

The South Pacific yam network (SPYN) was initiated in 1998 to enhance the competitive position of yam in traditional cropping systems in Fiji, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu. The decline in yam production in the region may be overcome by tackling the problems of irregular tuber shape, starch quality, anthracnose disease (caused by Colletrichum gloeosporoides), and the need for staking the plants. As most of the germplasm collected in the 1980s no longer exists, the network will be particularly valuable in collecting, conserving and sharing remnant germplasm. The University of Reading, UK, is using DNA technology for 'fingerprinting' to identify clones. Other activities by local agencies and by out−sourcing to regional and international agencies include preparing databases, surveying for

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anthracnose inoculum and yam viruses, using in vitro chemotherapy to remove virus infections, and conserving germplasm by in vitro culture and cryopreservation.

South Pacific networks would also be appropriate for breadfruit, kava and some other crops as a pragmatic alternative and a saving in costs compared to a single centralised institute. The genetic resource network concept is a method for international collaboration, strengthening national programs, overcoming the limited agricultural research capabilities of small island states, and raising awareness about plant genetic resources among policy makers.

2.5.5 Regional genebanks: practical strategies for sharing, caring and funding
Mary Taylor 1

No country is independent in terms of the plant genetic resources for agriculture needed to sustain and improve its major crops. Action for conservation of genetic resources is needed because of the acknowledged contribution of genetic diversity to agricultural productivity, and because genetic erosion of many crop plants is continuing at a significant rate and genetic resources are not renewable. Among the strategies available for conservation of genetic resources of Pacific island crops, in situ measures in the forest and in farmers' fields, though desirable, are less secure than the ex situ measures now available utilising both field and in vitro genebanks. Participation in a regional genebank and in regional and international networks offers Pacific Island countries benefits of evaluation, sharing, secure conservation of cultivars and funding which they cannot achieve on their own resources.

The FAO Global Plan of Action (GPA), 1996, states that conservation could be better achieved by regional and international cooperation placing more emphasis on a smaller number of quality facilities. This would reduce costs and increase efficiency. Legal agreements would enable countries to place collections in these facilities without compromising their access, control or ownership of the materials and with an equitable sharing of benefits.

Concerning the preferred method of ex situ conservation, the cost of maintaining a field genebank was three times that of an in vitro genebank at the Corvallis Repository, Oregon, USA. Field conservation and all associated activities was estimated to be US$77 per accession per year and US$23 for the secondary on−site tissue culture back−up. Security of in vitro collections has been demonstrated in Vanuatu. As a result of a general strike by public servants in 1994 all the

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collections of taro were lost from the field genebank but the desirable varieties evaluated and selected as part of an FAO project were safely maintained in tissue culture.

The EU−funded Pacific Regional Agricultural Program (PRAP) in Samoa has demonstrated the feasibility of an in vitro genebank for the region by conserving 500 accessions of regional crop plants in tissue culture. Associated field genebanks are essential so that cultivars can be evaluated and selected in field conditions. A genebank should not be regarded only as a repository for safe keeping of material. Ease of access to cultivars and information is just as important genebanks are about sharing.

Until the Convention on Biodiversity (CBD) in Rio de Janiero in 1993 recognised a country's sovereignty over its plant genetic resources, the general principle had been free exchange of germplasm without restriction. The CBD required that 'free exchange' policies be reconsidered for equitable sharing of benefits as well as access. Material Transfer Agreements (MTA) are now used to allow for the source country's rights to compensation should the use of the germplasm lead to financial benefits to the recipient. The first and subsequent recipients also agree not to claim property rights over the material. Membership of the FAO International Network of ex situ Collections (1994) provides a legal framework for countries and institutions to hold material in trust for the international community.

The FAO Global Plan of Action recognised the potential of networks to assemble genetic resources for food and agriculture, to provide sufficient capacity and to transfer material with applicable international legal agreements. The GPA specifically noted the need for a Plant Genetic Resources (PGR) network in the Pacific. Being part of such an international network would be effective and efficient for the Pacific Islands region, providing security for the germplasm and legally controlled and accurately monitored distribution. In its coordinating role the PGR network for the Pacific would locate, document, evaluate, describe and exchange Pacific PGR collections, and improve communications and training.

Guaranteed funding is a major consideration. There is no doubt that inadequate funding leads to loss of collections. Initially funding would be almost entirely from outside the genebank (also known as a germplasm centre) but in future there are prospects for an approach towards self−funding from revenue. From the suppliers' point of view, although the genebank would not provide direct payment to suppliers for germplasm designated for open exchange, there is scope through use of MTAs to negotiate compensation should the material be commercialised. While it may not be possible to charge for access to germplasm which was donated to the regional centre for open exchange, there would be opportunities for the centre to charge for access to copyright information which was gathered by members of the network through evaluation and screening trials.

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A regional in vitro genebank would be managed with applicable legal safeguards to achieve fair and equitable sharing of germplasm and benefits. Governments and farmers would have the assurance that their valuable germplasm was being well cared for to standards set by FAO.

2.5.6 South Pacific regional cooperation: principles, processes and institutional arrangements

William Sutherland 1

The Pacific Community (SPC), the South Pacific Forum and the South Pacific Regional Environment Program (SPREP), Forum Fisheries Agency and the South Pacific Organisations Coordinating Committee (SPOCC) are the main vehicles for regional cooperation in the Pacific. The latter body was created to coordinate regional cooperation. Other major regional organisations are the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission, Pacific Islands Development Program and the Tourism Council of the South Pacific. Another initiative especially relevant to developing a regional approach to germplasm conservation is the Regional Strategy for Regional Development Assistance (commonly referred to as the Regional Strategy).

Unlike other regional organisations which are concerned with service delivery, the South Pacific Forum's broad mandate is political and economic policy. Though it does not have formal status with other key international organisations, it has observer status at the United Nations and APEC and has developed strong links with the secretariats of the Commonwealth, Caribbean Community, ASEAN, Pacific Economic Cooperation Council, South Asian Association of Regional Organisations and the Africa, Caribbean and Pacific group in Brussels. The Forum's membership currently stands at sixteen − Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Republic of Marshal Islands, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. There are two sub−regional groupings of Forum members outside the Forum: the recently−formed Micronesian Council and, of longer standing, the Melanesian Spearhead Group. Major development partners are Canada, the European Union, France, Japan, Malaysia, Peoples Republic of China, South Korea, the United States and the United Kingdom. There is a separate dialogue between some member countries and Taiwan/ROC. Out of a total of nearly A$11 million comprising the Forum budget in 1998, three quarters was provided by donors.

Several facilities which may be sources of funding for germplasm conservation activities are managed by the Forum's Development and Economic Policy

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Division. The Division also has a key role in negotiating with donors. In addition to its own high level consultations, it also has the leading role in the biennial Pacific Island Countries/Development Partners meeting and coordinates management of the Canada−South Pacific Oceans Development Program and EU's regional assistance. The Division provides the secretariat for SPOCC and works to further develop the Regional Strategy. Another division, the Trade and Investment Division, may be able to assist in germplasm conservation, particularly in relation to intellectual property rights and quarantine. In 1988 the Division hosted a symposium which established the Pacific Kava Council to protect rights to Pacific kava in the face of worldwide demand from herbal medicine and pharmaceutical companies.

The Pacific Community is the oldest and largest inter−governmental regional organisation. Known as the South Pacific Commission until 1997 when the new name was adopted, the Pacific Community was established in 1947. The establishing agreement was signed by the six metropolitan countries with territories in the Pacific, viz. Australia, France, the Netherlands (no longer a member), New Zealand, the United Kingdom and the United States. In the 1960s and 1970s several Pacific Islands countries were admitted and in 1983 full membership was extended to all governments and administrations in the region, including in the North Pacific. Membership of the organisation now stands at 27.

The Pacific Community is primarily a technical/advisory organisation with a work program focusing on technical assistance and education and training delivered through courses, workshops and seminars at in−country, sub−regional and regional levels. Responsible for policy implementation, the Secretariat of the Pacific Community (SPC) set up a tissue culture laboratory in Fiji and a Pacific Plant Protection Service Project with support from a number of sources. In 1997 the Pacific Community's budget of A$18.75 million included contributions of over A$14 million from Australia, France, New Zealand and USA.

The Forum Fisheries Agency is acclaimed as a successful example of regional cooperation and useful lessons can be drawn from its achievements, particularly in illustrating the efficacy of treaties rather than declarations or codes of conduct as instruments of cooperation.

The South Pacific Regional Environment Program evolved from a small beginning to become a fully−fledged regional organisation of direct relevance to germplasm conservation some 25 years later. A regional workshop on nature conservation held in 1969 led to the inclusion within the South Pacific Commission (now the Pacific Community) of a program for the conservation of nature. SPREP was formally established within the South Pacific Commission in 1982. In 1991 it was decided that the organisation should become autonomous and it was headquartered in Apia, Western Samoa. In August 1995, SPREP officially became autonomous when Niue became the tenth country to ratify the establishing agreement.

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SPREP's broad mandate for environmental matters is reflected in the its Mission Statement: 'to promote cooperation in the South Pacific region and to provide assistance in order to protect and improve its environment and to ensure sustainable development for present and future generations'. Membership is the same as that of the Pacific Community. Since establishment as a separate entity its secretariat has continued to expand its coverage of environment issues to the extent that its staff has grown from less than ten to almost sixty. It has also greatly expanded its international linkages. In addition to serving as a clearing house on regional environmental issues, SPREP's program activities range over biodiversity and natural resource conservation, climate change, integrated coastal management, waste management, pollution prevention and emergencies, environmental management, planning and institutional strengthening; and environmental education, information and training . Of importance to germplasm conservation is the South Pacific Biodiversity Conservation Program. SPREP's extensive and growing activities in this area flows from its responsibility as the region's lead agency coordinating action on key international conventions, including the UN Convention on Biological Diversity, Climate Change and the International Trade in Endangered Species of Wild Flora and Fauna. In 1997 funding was nearly A$12 million, mainly from donors such as UNDP, Global Environment Facility, Australia, Canada and New Zealand.

In addition to teaching and research, the University of the South Pacific has an extensive outreach program. Through its Centres in member countries, Law School in Vanuatu and School of Agriculture in Samoa, USP has a presence throughout the region which may be useful for plant genetic resource conservation. Among the major areas of research of its Institute for Research, Extension and Training in Agriculture are plant breeding, tissue culture, crop production, plant protection, postharvest technology, farming systems and information dissemination.

The paper concludes with observations on

· paths to cooperation
· modalities of cooperation
· mandates, work programs and inter−organisational coordination
· membership
· instruments of cooperation
· institutional structures and process
· relations with donors
· funding arrangements and their effectiveness
· Regional Strategy and SPOCC

At some point PGR conservation will draw the interest of the region. SPC is already involved in the discussions and, charged as it is with ensuring that regional initiatives are consistent with the principles and requirements of the Regional Strategy, SPOCC, as well as other regional organisations, will have a critical role to play.

3. APPENDICES

3.1 Workshop Program

ACIAR−NARI Workshop
Regional Cooperation in Conservation and Management of Plant Genetic Resources in the Pacific Region;
Lae International Hotel, Lae, PNG, 30−31 March 1999,

Day 1 − Tuesday, 30 March 1999

Session 1 (8.30 − 9.40 am)	**2.1 Registration and Opening Session** Chairperson − Mr Valentine Kambori
8.30 − 9.00 am	Registration
9.00 − 9.30 am	Opening by, Honourable Minister Tukape Masani, the Minister of Agriculture and Livestock, PNG
9.30 − 9.40 am	2.1.1 Workshop background − Ms Rosa Kambuou Workshop aims and expected outcomes − Dr Padma Lal
9.40 − 10.30 am	Morning Tea and Group Photo
Session 2 (10.00 − 1.00 pm)	**2.2 Status of Plant Genetic Resource Conservation and Use in the Pacific − Country and Regional Papers** Chairperson − Ms Suliana Siwatibau Rapporteur − Dr David Godden
10.30 − 10.45 am	2.2.1 PNG − Ms Rosa Kambuou
10.45 − 11.00 am	2.2.2 Solomon Islands − Ms Ruth Liloqula
11.00 − 11.15 am	2.2.3 Fiji − Dr Joeli Vakabua
11.15 − 11.30 am	2.2.4 Samoa − Dr Semesi Semesi
11.30 − 11.45 am	2.2.5 Tonga − Dr Pita Taufatafua
11.45 − 12.00 pm	2.2.6 Vanuatu − Dr Vincent Lebot
12.00 − 12.15 pm	2.2.7 Regional collections of plant genetic resources in the Pacific − Dr Param Sivan
12.15 − 1.00 pm	Discussion led by Ms Rosa Kambuou
1.00 − 2.00 pm	Lunch
Session 3 (2.00 − 5.00pm)	**2.3 Rationale for Regional Cooperation** Chairperson − Dr Mark Johnston Rapporteur − Dr Param Sivan
2.00 − 2.30 pm	2.3.1 Technical rationale for a regional approach for the conservation and use of plant genetic resources in the Pacific − Dr Ken Riley

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2.30 − 3.00 pm	2.3.2 Economic rationale for cooperation in germplasm conservation − Dr David Godden
3.00 − 3.30pm	Afternoon Tea
3.30 − 4.00 pm	2.3.3 Practical reasons for regional collaboration in plant genetic resources conservation and use − Ms Rosa Kambuou
4.00 − 5.00 pm	Discussion led by Dr Jimmie Rodgers
6.30 − 10.30 pm	Workshop Dinner Hosted by ACIAR
Day 2 − Wednesday, 31 March 1999	
Session 4	**2.4 International Developments**
(8.30 − 11.45 am)	Chairperson − Dr Joeli Vakabua, Rapporteur − Dr Mary Taylor
8.30 − 9.00 am	2.4.1 International developments in PGR, IPR and the Pacific − Dr Ian Bevege
9.00 − 9.30 am	2.4.2 Developments in plant genetic resources conservation technologies and implications for Pacific Island countries − Dr Sarah Ashmore
9.30 − 10.00 am	2.4.3 Regional Funding: Costs of conservation and national and international roles − Dr Murthi Anishetty
10.00 − 10.30 am	2.4.4 Germplasm collections in the CGIAR: assembling and managing a major world resource − Dr Ken Riley
10.30 − 10.45 am	Morning Tea
10.45 − 11.45 am	Discussion led by Dr Tony Fischer
11.45 − 12.30 pm	Lunch
Session 5	**2.5 Current Regional Collaboration in the Pacific − Experiences and Lessons**
(12.30 − 3.00 pm)	Chairperson − Mr Ted Sitapai/ Dr Ruth Liloqula, Rapporteur − Dr Ken Riley
12.30 − 1.30 pm	2.5.1 TaroGen − Dr Param Sivan
	2.5.2 COGENT −Mr Tore Ovasuru
	2.5.3 SPRIG −Mr Doug Boland
1.30 − 2.00 pm	2.5.4 SPYN & TANSAO − Dr Vincent Lebot
2.00 − 2.30 pm	2.5.5 Regional genebanks: practical strategies for sharing, caring and funding − Dr Mary Taylor
2.30 − 3.00 pm	2.5.6 South Pacific regional co−operation: principles, processes and institutional arrangements − Dr William Sutherland
3.00 − 3.15 pm	Discussion led by Dr Padma Lal
Session 6	Afternoon tea
(3.15 − 5.30 pm)	**Possible Solutions and Way Forward**
3.15 − 4.15 pm	Chairperson − Dr Ian Bevege, Rapporteur − Dr Mark Johnston
4.15 − 5.30 pm	Presenting the key conclusions from sessions 2 to 5 − Rapporteurs
5.30 pm	Way forward − action plan for the future − Dr Padma Lal
	Closing remarks − Mr Valentine Kambori/ Dr R.Ghodake

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3.2 Workshop participants

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3.3 CSIRO Material Transfer Agreement

1. CSIRO's Australian Tree Seed Centre collects and maintains germplasm and information on Australia's flora for the benefit of Australians. The Centre conducts research, or assists others to conduct research, which adds to collective knowledge of the performance and utility of Australian forest genetic resources.

2. Australia has signed and ratified the Convention on Biological Diversity and pursuant to this Convention, the Australian Tree Seed Centre is committed to 'the fair and equitable sharing of benefits arising out of the utilisation of genetic resources' as well as facilitating access to genetic resources under Australian ownership on 'mutually agreed terms'.

3. Use of the germplasm in this consignment from CSIRO ('Material') is subject to this Material Transfer Agreement. The terms, obligations and acknowledgments of the Agreement itemised below apply once the Recipient removes the Material from its packaging.

4. The Recipient acknowledges that CSIRO provides the Material to the Recipient solely for the purposes of growing and testing for wood and non−pharmaceutical products.

5. It is mutually agreed that the Recipient will:

(a) acknowledge the origin of the Material in all published and distributed information;
(b) allow CSIRO access to assessment data and information on the characterisation procedures and performance of the Material;
(c) allow CSIRO access, for research purposes, to germplasm samples from plants grown from Material included in this consignment;
(d) take reasonable steps to ensure that these conditions are met in any subsequent deployment of the Material; and
(e) use the Material at its own risk.

6. Nothing in this Agreement affects existing proprietary intellectual property rights in respect of the Material.

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3.4 SPRIG Code of Conduct

Under this code of conduct SPRIG partners agree that:−

(a) tree germplasm collected and supplied under SPRIG is for research and demonstration purposes only and remains the property of each contributing partner, and

(b) the distribution of material to non−SPRIG parties and/or the commercial development of non−indigenous material within country by signatories to this agreement, will require additional negotiation with the SPRIG party who originally supplied the germplasm.

The agreement should be interpreted to cover all these species plus any other tree species collected during the course of the project. This code of conduct will last for the life of the material collected and distributed. Collections of germplasm will follow the FAO code of conduct for tree germplasm collectors.

Tree germplasm constitutes genetic materials such as seed, pollen, vegetative cuttings, herbarium material and DNA. Plant quarantine guidelines will be strictly followed for all countries.

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3.5 Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADAP	Agriculture Development for the American Pacific
APEC	Asia Pacific Economic Commission
AusAID	Australian Agency for International Development
AVRDC	Asian Vegetable Research and Development Centre
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CGRD	International Coconut Genetic Resource Database
CIAT	Centro Internacional de Agricultura Tropical, Columbia
CIRAD	Centre International Recherche Agriculture pour le Development
COGENT	International Coconut Genetic Resources Network
CPGRI	Coconut Plant Genetic Resources Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFUD	UK Department for International Development
EA−PGR	Plant Genetic Resources Network for East Asia
ECP/GR	European Cooperative Program for Crop Genetic Resources Networks
EU	European Union
EUFORGEN	European Forest Genetic Resources Program
FAO	Food and Agriculture Organisation of the United Nations
FSA	Farm Support Association, Vanuatu
GPA	FAO Global Plan of Action
IARC	International Agricultural Research Centre
ICG	International Coconut Genebank
INIBAP	International Network for the Improvement of Banana and Plantain
IPGRI	International Plant Genetic Resources Institute
IPGRI−APO	International Plant Genetic Resources Institute − Regional Office for Asia, the Pacific and Oceania
IPR	intellectual property rights
IUPGR	International Undertaking on Plant Genetic Resources
MTA	Material Transfer Agreement
NARI	National Agricultural Research Institute, PNG
NGB	Nordic Gene Bank
NIAR	National Institute of Agrobiological Resources
PBR	plant breeders' rights

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3.5 Acronyms

PGR	plant genetic resources
PHALPS	Permanent Heads of Agriculture and Livestock Production Services
PICs	Pacific island countries
PRAP	Pacific Region Agriculture Program, Samoa
PROCISUR	Programa Cooperativo para el Desarrollo Tecnológico Agropecuario del Cono Sur
PROSEA	Plant Resources of Southeast Asia
RECSEA−PGR	Regional Collaboration in Southeast Asia on Plant Genetic Resources
REDARFIT	Andean Plant Genetic Resources Network
REMERFI	Mesoamericana de Recursos Fitogenéticos
SAN−PGR	South Asia National PGR
SACCR	Southern Africa Development Cooperation in Agriculture and Natural Resources Research and Training
SADC	Southern Africa Development Cooperation
SINGER	System−wide Information Network for Genetic Resources, CGIAR
SPC	Secretariat of the Pacific Community (formerly South Pacific Commission)
SPGRC	Southern Africa Development Corporation's Plant Genetic Resources Center
SPOCC	South Pacific Organisations Co−ordinating Committee
SPREP	South Pacific Regional Environment Programme
SPRIG	South Pacific Regional Initiative on Forest Genetic Resources
SPYN	South Pacific Yam Network
TANSAO	Taro Network for South East Asia and Oceania
TaroGen	Taro Genetic Resources
TRIPS	Trade Related Aspects of Intellectual Property Rights
TROPIGEN	Amazonian Plant Genetic Resources Network
UPOV	International Union for the Protection of New Varieties of Plants
USP	University of the South Pacific
VARTC	Vanuatu Agricultural Research and Training Center
WANANET	West Asia and North Africa Plant Genetic Resources Network
WTO	World Trade organisation

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3.6 Common and scientific names

aibika flea beetle	*Nisotra basilis*
aibika	*Abelmoschus manihot*
amaranthus	*Amaranthus spp*
anthracnose	*Glomerella cingulata*
anthracnose disease	*Colletrichum gloeosporioides*
banana	*Musa spp.*
banana skipper or leaf roller	*Erionota thrax*
banana weevil borer	*Cosmopolites sordidus*
betel nut	*Areca spp.*
bilimbi	*Averrhoa bilimbi*
canarium	*Canarium spp.*
candle nut	*Aleurites moluccana*
cassava	*Manihot esculenta*
cercospora leaf spot	*Cercospora spp.*
coastal pitpit or daruka	*Saccharum eduli*
cocoa	*Theobroma cacao*
coconut	*Cocos nucifera*
coffee	*Coffea arabica, C. robusta*
cut nut	*Barringtonia spp.*
elephant's foot or suran	*Amorphophallus companulatus*
fruit flies	*Bactrocera spp.*
giant taro	*Alocasia spp.*
golden apple	*Spondias cythera*
greater yam	*Dioscorea alata*
Hong Kong taro	*Xanthosoma spp.*
Indian weevil	*Euscepes postfasciatus*
kangkong	*Ipomoea aquatica*
kava	*Piper methysticum*
mahogany	*Swietenia macrophylla*
mango	*Mangifera indica*
manioc	*Manihot esculenta*
neem	*Azadirachta indica*
pandanus	*Pandanus conoideus*

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3.6 Common and scientific names

pepper	*Piper nigrum*
pineapple	*Ananas comosus*
pometia	*Pometia pinnata*
red cedar	*Toona ciliata*
sago	*Metroxylon spp.*
sandalwood	*Santalum sp.*
swamp taro	*Crytosperma spp.*
sweet potato	*Ipomoea batatas*
sweet potato weevil	*Cylas formicarius*
sweet potato hawkmoth	*Agrius convolvuli*
Tahitian chestnut	*Inocarpus fagiferus*
tannia	*Xanthosoma siggitifolium*
taro	*Colocasia esculenta*
taro leaf blight	*Phytophthora colocasiae*
taro beetle	*Papuana spp.*
taro plant hopper	*Tarophagus spp.*
taro hawkmoth	*Hippotion celerio*
terminalia	*Terminalia spp.*
watercress	*Nasturtium spp.*
yam	*Dioscorea spp.*