The International Treaty
ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Full Project Proposal

Third Call for Proposals under the Benefit-sharing Fund

Deadline for submitting full project proposal: 5th of December 2014
at Treaty-Fund@fao.org and PGRFA-Treaty@fao.org

TABLE OF CONTENTS

PROJECT PROPOSAL COVER SHEET

Project No. _____ (*For Treaty use. Do not write anything here)*

Project Title: Using modern biotechnologies to sustain food security in Pacific island countries

Project duration: 36 months

Target crops: Aroids (taro, alocasia, xanthosoma, swamp taro)

Targeted developing country/ies: Cook Islands, Fiji, Kiribati, Marshall Islands, Palau, Samoa, Tonga

Other Contracting Party/ies or partners involved: University of Queensland, Australia

Project geographic extension (km²): Covers seven countries in the northern and southern Pacific region. SPC is an intergovernmental agency of the 22 Pacific island countries and territories[1]. Seven countries have a total land area of 23,653 square kilometres (8,155 sq miles) with a total population of 1,380,015[2].

Total requested funding: USD 499,765 **Total co-funding** : USD 25,000

Please select the type of project you are applying for:

☐ Single-country Immediate Action Project (Window 2)
☐ Multi-country Immediate Action Programme (Window 2)
☐ Single-country Co-development and Transfer of Technology project (Window 3)
yes ☐ Multi-country Co-development and Transfer of Technology project (Window 3)

Applicant : Name of Organization: **Secretariat of the Pacific Community**

Type of organization: **International and Regional Technical Organisation**

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[1] www.spc.int

[2] *Information compiled from the Pacific Tourism Travel and information Guide (2013-2014)*

SECTION A: EXECUTIVE SUMMARY

1. Executive summary

Rationale

Pacific island countries have an abundance of plant genetic resources of their principal food crop staples, but do not have the capacity to exploit their full potential. Part of the reason is that, individually the countries do not have adequate resources for research and development. As a consequence, total food production is in decline and, to meet the needs of expanding populations, food, often processed, is imported, and this change in diet has led to epidemics of non-communicable diseases.

In response, national governments have put food and nutrition security central to policy agendas, and have called upon SPC, an intergovernmental organisation of Pacific island countries, to take the lead by spearheading the collaboration required. Collections have been made, described and conserved in CePaCT and, for taro at least, core samples have been identified, indexed for viruses, distributed and used in local breeding programs. However, if further gains are to be made to harness biodiversity to raise crop production, molecular marker selection systems are needed.

Aim: The project aims to extend SPC's capacity to carry out plant genetic resource programs by establishing a facility to carry out DNA fingerprinting. Once the capacity has been established, it will be used to redefine core collections of edible aroids, assist with taro breeding for leaf blight tolerance, monitor *in situ* conservation of diverse genotypes, and to make preliminary studies on salinity and drought tolerance in orphan crops and underutilised species, where conventional approaches offer little potential.

Objectives: Overall objective: Reduced vulnerability of farmers in selected Pacific island countries to the impacts of climate change on food security by improved management of crop genetic resources

Specific objective: To develop regional skills, capacity and understanding of modern biotechnologies for genetic resource conservation and utilisation of Pacific crops using aroids as a model

Research team, approach, impact pathway and expected impacts

The project is built around SPC CePaCT scientists who will be trained in DNA fingerprinting and its applications by experts from the University of Queensland, Australia. A UQ post-doctoral scientist will help SPC equip a lab and train two SPC staff (a research officer and a database assistant). Monitoring of the project will be done at annual meetings of PAPGREN (national PGRFA representatives) and biennial meetings of HOAFS (national heads of agriculture).

Countries will participate in the project in a number of ways. There will be annual workshops demonstrating the use of DNA markers in assembling core collections, screening germplasm for tolerance to salinity and drought, and in plant breeding. There will also be short-term attachments for staff and students from local universities. One country will be requested to host an *in situ* conservation study to determine the potential impact of allelic diversity on farmers' portfolios of varieties.

SECTION B: PROJECT DESCRIPTION AND CONTENTS

2.1. Problem definition

2.1.1 Background

Food security has become a major issue in Pacific island countries. Although agriculture is important across the region, employing 70-80% of the population in some countries, per capita food production is declining, even where population growth has stabilised[3]. But it is not only total production that is of concern; it is the quality of food consumed. Diets are changing. Traditional starchy roots crops, supplemented with coconuts and fish, are being replaced by imported processed foods. The result has been an epidemic of non-communicative diseases, with large proportions of government budgets spent on health services. As the World Bank reported in 2013[4], "… the Governments of Vanuatu, Samoa and Tonga, supported by their development partners, provided 90%, 87% and 81% of total expenditure on health respectively in 2010. In addition to these concerns, crops are becoming more vulnerable to pests and diseases; and soon, climate change will exacerbate an already precarious situation, with air and water temperatures warming, countries becoming drier and the severity of natural disasters increasing.

2.1.2 Country aspirations

Countries are acutely aware of the issues that confront them, and have determined that exploitation of staple food crop for household needs and also export is a priority; and that the best approach is regional through the auspices of the SPC. Individual countries do not have the resources to exploit their genetic resources, nor is anyone country self-sufficient. In recent years, major collections have been made and described, facilities for conservation have been built, and PAPGREN meetings held frequently to determine policy. In 2009, at the Third Session of the Governing Body of the ITPGRFA, CePaCT collections were placed officially in the multilateral system and, for taro specifically, and CePaCT began to receive long-term support from the Global Crop Diversity Trust for conservation and sharing. Whether members of the Treaty or not, countries have willingly agreed to share their genetic resources and, in 2012, sanctioned SPC's role as lead agency of the International Network of Edible Aroids, and the despatch of taro to 16 countries worldwide, several in West Africa which had recently been struck by devastating epidemics of taro leaf blight, similar to those in Samoa in 10 years' earlier.

In a further effort to work collaboratively on plant genetic resources of the priority food crops, PICTs established the first Pacific Plant Breeders Network at a meeting in Santo, Vanuatu, May 2014. This is funded by the Benefit Sharing Fund of the FAO International Treaty on Plant Genetic Resources for Food and Agriculture project, with the aim of: *Strengthening the resilience of Pacific agricultural systems to climate change through enhancing access to and use of diversity*.

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[3] *Food security in the Pacific and East Timor and its vulnerability to climate change (2011) Prepared for the Australian Government Department of Climate Change and Energy Efficiency by the Secretariat of the Pacific Community in conjunction with CSIRO. SPC, New Caledonia.*

[4] *Anderson 1 (2013) The economic costs of non-communicable diseases in the Pacific islands. HNP Discussion Paper Series, The International Bank for Reconstruction and Development / The World Bank, 1818 H Street, NW Washington, DC 20433.*

2.1.3 The problem

Pacific island countries find it difficult to exploit their own genetic resources, and to them to solve the concerns of farmers. However, many countries outside the region have benefitted from Pacific germplasm. For instance, most of the accessions distributed worldwide under INEA to help countries of West Africa are from the taro leaf blight-breeding program in Samoa, a program that began in 1998 under TaroGen. Although successful in producing lines that re-established the crop in Samoa within 5 years of breeding, major improvements since that initial success have been wanting. Taro of export quality is still needed, and there is no idea of the genetic diversity of the lines that have been released.

This illustrates the situation confronted by PICTs in the exploitation of the genetic resources of taro, and other major staple foods: they are guardians of extensive genetic resources, but they have not do not have the capacity to exploit them and, in the case of taro, a major crop for domestic use and trade in Pacific islands, there is no CGIAR institute that is mandated to work on it. It is a so-called "orphan" crop. It is timely, therefore, for PICTs to move past the stage of collecting, conserving and pre-breeding, and use modern biotechnologies to more efficiently exploit the resources that exist in order to be able to respond to changing environments. This project proposal describes how this can be done.

2.2.Project objectives: Overall and specific objectives

Overall objective: Reduced vulnerability of farmers in selected Pacific island countries to the impacts of climate change on food security by improved management of crop genetic resources

Specific objective: To develop regional skills, capacity and understanding of modern biotechnologies for genetic resource conservation and utilisation of Pacific crops using aroids as a model

The overall objective is to ensure that Pacific island farmers have the aroids of importance - *Colocasia*, *Cyrtosperma*, *Alocasia* and *Xanthosoma* - with broad allelic diversity, strengthening the region's food production systems, and building resilience to future climate change impacts in both high islands and atolls. Aroids have been chosen because of their prominence in many PICTs as favoured foods of high cultural value, crops sold on domestic and export markets, and because of on-going research that can benefit from the application of modern biotechnologies.

The project will encourage the use of modern technologies in other crops of regional importance, sweetpotato, yams, cassava, *Abelmoschus* cabbage, etc.

The specific objective describes the assistance to be provided to a regional institution in a highly specialised and costly area of research where it would not be practical to sustain such expertise at the national level.

The objectives align with *Towards a food secure Pacific: Framework of action on food security in the Pacific 2011-2015*[5], agreed at the Pacific Food Summit, Port Vila, Vanuatu April 2010, and which, *inter alia*, emphasised sustainable production, processing and trading of safe and nutritious

5 Towards a food secure Pacific: framework for action on food security in the Pacific (2010) Food Secure Working Group. Pacific Food Summit. Port Vila, Vanuatu. The Framework of Action was formulated in response to a recommendation for action on food security from Pacific leaders at the 39th Pacific Islands Forum, held in Niue, August 2008.

local food. In recognising the multiple threats to food security, the Summit stated specifically: "Support the conservation and development of traditional food crops and systems and use of agricultural biodiversity", including the need for coordination and alignment of technical assistance at the national and regional levels.

2.3. Targeted outputs, activities and related methodology of implementation

Outcome:

To develop regional skills, capacity and understanding of modern biotechnologies for genetic resource conservation and utilisation of Pacific crops using aroids as a model

Output 1: DNA characterised aroid collections

Activities:

- Equip and staff a DNA-fingerprinting facility at SPC CePaCT
- Train participants from selected PICTs
- Assemble a global core collection from TaroGen, TANSAO and INEA collections
- Integrate DNA fingerprinting info. into global database, e.g., Genesys.
- Monitoring meetings

Rationale & methodology: The project will be led by SPC Plant Genetic Resources Coordinator, CePaCT, assisted by a team of experts from Treaty-member countries (Cook Islands, Fiji, Kiribati, Marshall Islands, Palau, Samoa and Tonga), which will meet annually. The task will be devolved to PAPGREN focal points in those countries. In the past, PAPGREN meetings have allowed countries to monitor projects efficiently, to share successes and, where problems have occurred, to find solutions in a constructive and timely manner.

Within the region, the capacity to undertake plant DNA fingerprinting currently exists in Lae at the PNG National Agricultural Research Institute (NARI). This project aims to develop this capacity at CePaCT, and to undertake training workshops and attachments for scientists. These workshops will be held annually, led by scientists from the University of Queensland (UQ) and NARI, and will engage staff from national programs, as well as from the universities undertaking agricultural research - University of the South Pacific (Suva and Alafua campuses) and the PNG University of Technology (Lae campus).

The DNA fingerprinting facility to be established at CePaCT will require a start-up investment of approximately US$100,000 for equipment. This equipment will be available for the duration of the project and, importantly for the DNA fingerprinting workshops to be held over the course of the project.

A post-doctoral scientist will be employed to establish the laboratory, and the project will support two SPC research officer/technicians, who will assist with the development of the facility, databasing the information (using Genesys) and, in time, extending the techniques to other regionally important crops. The lab will be equipped and staffed within 6 months from the beginning of the project.

The most important aroid crop is taro (*Colocasia esculenta*), of which there are two major forms: *dasheen* with one large corm, and the multi-cormed *antiquorum* types (also known as eddoes). The SPC CePaCT has a large collection of over 1,000 taro lines, including those collected as part of the TaroGen project (centred on the South Pacific) and the TANSAO project (centred across Indonesia, Southeast Asia and PNG). More recently, there has been further addition of accessions from the

Global Crop Diversity Trust, which has provided global representation from South Asia, Africa and Latin America.

Core samples have been selected from the TaroGen and TANSAO accessions by DNA fingerprinting; however, they have not been genotyped with the same markers. Hence the two collections cannot be integrated for genetic diversity, and they cannot be assessed against the Global Crop Diversity Trust (GCDT) accessions.

Integrating the genotypic data for these separate collections will be an important outcome of this project. This will be achieved by using the SSR markers developed at UQ as part of the TaroGen project. Integration of the DNA fingerprint data would be of great benefit to INEA and other breeding programs internationally. It is expected that this "global" core will be in place by the end of the project.

The minor aroids are of local significance in a number of countries. CePaCT has a collection of around 94 accessions of these, consisting predominantly of *Xanthosoma* (cocoyam, tannier), *Alocasia* (giant taro) and *Cyrtosperma* (giant swamp taro). DNA fingerprinting these accessions will be an important process for national scientists to undertake as part of the DNA training workshops to be held annually at SPC in Suva. DNA markers for *Xanthosoma* have been developed by CIRAD and are publically available.

Output 2: Well informed aroid breeding program

Activities:

- Assess genetic diversity of Samoan breeding lines
- Use global core to broaden diversity

Rationale & methodology: The SPC taro breeding program in Samoa has incorporated genetic materials from outside the Pacific region, primarily aimed at developing new lines with resistance to taro leaf blight (*Phytophthora colocasiae*). TLB initially arrived in Samoa in 1993 and devastated taro production. The few important lines at the time had a very narrow genetic diversity, and hence there was great genetic vulnerability to the epidemic. New sources of resistance have come from Micronesia and the Philippines, and lately from introgression of selections from the TANSAO collection of Southeast Asia. Resistant lines have been developed.

This very successful program has given rise to lines that have been distributed within and beyond the Pacific. However, in programs elsewhere with other crops that have been primarily focused on the introduction of pest and disease resistance traits, there have been a number of instances where this has led to considerable narrowing of the genetic diversity of the crop population. The population mean has shifted, yet overall diversity has become or remains low. For example, this was the case with the Australian public and private sorghum breeding programs in the 1970-90s, when the primary focus was on the introgression of midge resistance from Indian and African sources.

The project will check whether this is also the case with the lines produced from the Samoa breeding program. The application of DNA fingerprinting to the lines in the current breeding program in Samoa will enable a reference to be established against which the genetic diversity of taro grown in Samoa prior to the TLB epidemic could be estimated. This will give valuable information on whether the current Samoan taro lines have increased in their genetic diversity and, hence, are less likely to be genetically vulnerable to a new pest or disease incursion.

Output 3: Enriched farmers' varietal portfolios

Activities:

- Choice of country and villages (PAPGREN meeting)
- Development of a questionnaire, and PRAs in the selected villages
- Multiplication of taro clones with wide genetic diversity
- DNA fingerprinting of traditional farmer cultivars
- Distribution of taro lines to 5 households in 10 villages
- Assessment of genetic diversity Year 3

Rationale & methodology: A study in Vanuatu by CIRAD/VARTC investigated on-farm conservation by introducing varieties in traditional cropping systems[6]. The research question asked was is it possible to broaden genetic base of taro and at the same time to include for instance resistance to taro leaf blight while conforming to growers' criteria of taste and agronomic characteristics. By so doing the varietal portfolios of farmers would be enriched, which would give protection against possible future environmental changes (for instance, pest and disease and climate change) would be ensured. The study was successful and found that farmers do enrich their taro holdings with introduced genotypes, thus broadening the genetic base. This was an importance find, as it suggests that on-farm conservation of root and needs to be repeated in another country.

PAPGREN will choose the country in which the study will be undertaken. There will be opportunities to engage research students in this work, even secondary school students, from rural households.

Output 4: Molecular markers for salinity and drought

Activities:

- Develop screening procedures for salinity tolerance and root morphology

Rationale & methodology: A small component of the project will be to develop screening procedures for salinity tolerance and root morphology traits; this will be done at CePaCT. Root branching patterns are an important component of drought resistance. Screening these traits in breeding populations will ultimately allow the identification of DNA markers for these traits. Collaboration will be developed with the University of Madeira which is trying to develop markets to drought resistance in taro for INEA.

2.4. Targeted PGRFA

In terms of targeted PGR, the project will focus on DNA fingerprinting the following:

(i) the collections of taro already present at SPC CePACT using the markers previously developed by UQ;
(ii) gap-filling with collections from Treaty-member countries not yet represented in CePaCT collections;

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[6] *Camus P, Lebot V (2010) On-farm assessment of clonal introduction of root crops diversity in Vanuatu, Melanesia. Experimental Agriculture 46(4), 541-549.*

(iii) Samoan breeders' lines, to gauge present diversity of taro leaf blight tolerant lines and susceptible cultivars;

(iv) the collections of minor aroids: *Cyrtosperma*, *Alocasia* and *Xanthosoma* from the Pacific. If possible, the *Xanthosoma* collections from the Pacific and Central America (e.g., Costa Rica and Cuba) will be compared.

A summary of the aroid collections in the CePaCT are as follows.

Aroid	Collection*	No. of varieties	No. of accessions
Colocasia esculenta	Core	209	210
Colocasia esculenta	Non-core	268	269
Colocasia esculenta	Elite	270	272
Colocasia esculenta	TANSAO	118	118
Colocasia esculenta	Trust	303	303
Alocasia macrorrhizos	Pacific		11
Cyrtosperma merkusii	Pacific		64
Cyrtosperma merkusii	Philippines		7
Xanthosoma sagittifolium	Pacific		10
Xanthosoma sagittifolium	Philippines		1
Xanthosoma sagittifolium	Nigeria (wild)		1

**Core = 10% representative sample of the genetic diversity of the Pacific taro collection based on DNA fingerprinting by UQ; Non-core= 20% representative sample of the genetic diversity of the Pacific taro collection based on DNA fingerprinting by UQ; Elite = collection comprising of breeding lines acquired from SPC and partners breeding programs; CropTrust = collection established from the Global Crop Diversity Trust global regeneration projects*

All the collections mentioned in this project document are available for sharing between Treaty members under the Standard Material Transfer Agreement. Where there are restrictions on sharing, it is because of virus infections. SPC does not distribute germplasm that is not virus-indexed and shown to be free from known pathogens.

Colocasia and *Xanthosoma* are listed among the crops and forages in Annex 1 of the Treaty, covered under the multilateral system, but not *Alocasia* and *Cyrtosperma*. However, the Treaty Governing Body discussed these issues and endorsed a resolution that requires the use of SMTA for non-annex 1 crops that are considered crucial for sustaining global food security. Similarly, all crops acquired under the Global Crop Diversity Trust global regeneration projects that include non-Annex1 crops

are required to use the SMTA.

2.5. Target groups and beneficiaries

The target groups for the project are the approximately 45 scientists from 5 PICTs who will be trained at three (annual) workshops in DNA fingerprinting, from departments of agriculture and regional universities and research institutions. In addition, there will be two attachments for national scientists to visit CePaCT for 2-4 weeks at a time for in depth studies.

The direct beneficiary of the project is SPC, including the scientists and technicians at CePaCT, Fiji, and those at the taro breeding program in MAFF, Samoa. The project will employ two staff to be based in SPC – a scientist for DNA fingerprinting and a research assistant for databasing.

The indirect beneficiaries of the project are the 200 farmers in Samoa who collaborate with the participatory breeding program to breed taro with leaf blight tolerance. Other indirect beneficiaries are 50 farmers (to be selected by PAPGREN) to test ways of broadening the genetic base of taro maintained in farmers' fields, based on the Vanuatu experiences.

2.6. Impact and impact pathways

2.6.1. Food security and poverty alleviation

The project will widen the core collection that is held by CePaCT from a Pacific collection to one that incorporates accessions from Southeast Asia, the largest genepool of *Colocasia*, as well as from the minor genepool of Africa. The diversity will be representative of the species, and available for any country to evaluate. However, to make maximum use of the collection, the project intends to test whether it has the qualities to enrich farmers' varietal portfolios. It will do this in a Pacific island country that is vulnerable to epidemics of taro leaf blight. The collection will also be used to widen the genetic base of the breeding program in Samoa for taro leaf blight tolerance.

The taro leaf blight epidemic in Samoa focused attention on the vulnerability of the Pacific crop to pests and diseases. Although, taro can once more be grown, it is mostly for household use and local markets. In 2010, 9000 tonnes of taro was produced valued at AUD9.3 million. Added to the financial benefits are those of health and nutrition from the consumption of taro leaves as well as the corms. Regaining the export market still remains illusive.

However, progress to date leaves no room for complacency, given the impact of socio-economic and environmental changes in PICTs. In West Africa, the introduction of the disease, which is now spreading across the continent, has inflicted considerable hardship on farmers who valued taro as an important staple. To ensure food security and alleviate poverty, it is important to continue with research and development on a culturally significant crop to PICT communities. At this time, the critical response is to create varieties with broad genetic diversity, and to maintain a core collection regionally, as well as in farmers' fields, to meet the challenges that emerge in the near future.

2.6.2. Adaptation to climate change and environmental sustainability

The taro breeding programme in Samoa has concentrated on producing taro with tolerance to leaf blight, and has done so successfully, using accessions mainly from the Pacific and one from the Philippines. They have been selected to be phenotypically similar to the dasheens that were grown prior to taro leaf blight, but with the accumulation of alleles resulting in blight tolerance. In terms of their adaptability to other pests and diseases or to climate

change, there is no knowledge among the breeders' lines released. As mentioned under Output 1, the overall diversity may be the same as before or lower. There is a need to find out.

It is extremely important to look at the genetic diversity of the lines selected from the breeding program. As McGegor *et al.* (2011)[7] says when discussing food security in the region, "The traditional food garden provides the majority of the population with a high degree of food security, even in the face of natural disasters such as cyclones. However, the high level of food security is at considerable risk due to the narrow genetic base of the traditional crops upon which this security is based. In the future, Pacific island farmers will face extremes of climate – be this in the form of excessive and prolonged rainfall and flooding, extended droughts, severe cyclones and exceptional tides. Staple crops with a narrow genetic base are particularly vulnerable to these extremes."

In addition to the DNA fingerprinting that will be carried out under the project, there will be a preliminary attempt to develop screening procedures for salinity and drought tolerance. The reason for doing this is twofold: (i) SPC has received requests from countries, atolls in particular; (ii) some preliminary *in vitro* studies have been made at CePaCT; and (iii) the development of DNA markers for these characteristics will show research, extension and students how the new technologies can be applied, working with breeding programs to accelerate the production of useful lines.

2.6.3. Scientific impact

There are several novel scientific findings that will come from this project. First, a core sample for *Colocasia* will be identified, putting together collections from different genepools. This will be used immediately in the taro breeding program in Samoa, and possibly elsewhere[8]. Importantly, it will allow an estimate of the relative genetic diversity of the breeders' lines in Samoa.

Secondly, molecular analyses of several minor aroids will be made for the first time. The CePaCT has a unique collection of *Cyrtosperma* from atoll countries, but there is no information about the genetic diversity within this crop. The same is true for *Alocasia*. Although here there are far fewer accessions. The application of DNA markers to the *Xanthosoma* accessions will also be a first for the Pacific, and of considerable interest to other regions where scientists are carrying out similar work. Costa Rica and Nicaragua, for instance, are putting together a world collection and using the CIRAD markers to estimate diversity. In the process, they hope to find germplasm resistant to *Pythium* root rot, a severe disease of the crop, not only there but also in the Caribbean and West Africa. The results from the Pacific will be shared.

A third area of scientific interest will come from a pilot project to see how farmers manage new varieties of taro, and whether this can lead to an expansion of diversity. There is need to

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[7] *McGregor, A. with Peter Kaoh, Laisene Tuioti Mariner, Padma Narsey Lal and Mary Taylor (2011). 'Assessing the social and economic value of germplasm and crop improvement as a climate change adaptation strategy: Samoa and Vanuatu case studies'. A background case study prepared for IUCN's report, Climate Change Adaptation in the Pacific: Making Informed Choices, prepared for the Australian Department of Climate Change and Energy Efficiency (DCCEE), IUCN, Suva, Fiji.*

[8] *Taro breeding programs exist in Papua New Guinea, Vanuatu, and they are beginning at Umudike, Nigeria. In all instance taro leaf blight tolerance is a major aim.*

repeat the study done in Vanuatu which showed that considerable impact can be made despite the challenges in distributing planting material of vegetatively propagated species. If *in situ* conservation can be shown to have potential as a climate change adaptation strategy in other countries, this will be a significant outcome from this project.

Finally, the project will make a preliminary study on the development for markers for salinity and drought tolerance. Even if not successful it will nevertheless demonstrate to PICTs how marker assisted selection systems are put to use in crop improvement programs.

2.6.4. Capacity development and empowerment

At present SPC CePaCT has the capacity to conserve *in vitro* a number of crops of interest to the PICTs, to carry out virus indexing to ensure that transfers are pathogen-free to meet international standards. A logical next step in development of the Centre is to be able to DNA fingerprint accessions, a capacity that exists only in PNG NARI. The Biotechnology Centre at NARI is fully utilised, dealing with the extensive germplasm of that country, and cannot take on responsibilities for the region, although it will work with SPC by providing training and advice.

UQ has been chosen to be a partner in this project because of its worldclass expertise on molecular genetics, and its involvement in a previous project[9] on DNA fingerprinting collections of Pacific taro. A core collection was developed, which is now conserved at CePaCT, supported by the GCDT.

SPC will make provision to maintain the laboratory and staff when the project ends. It is a recipient of funds dealing with crop improvement, climate change, plant genetic resources from many donors, who see the advantage of dispersing funds regionally through SPC.

Apart from the direct beneficiaries of the project, it likely that staff and students from local universities will take advantage of the facility once established.

2.7. Relevance to national or regional priorities in its plans and programs for PGRFA

The LRD Strategic Plan (2013-2017) contains the recommendations of the biennial meeting of the Heads of Agriculture, and is endorsed by the CRGA, the last meeting of which was in Noumea, November 2014. In relation to plant genetic resources, SPC LRD advises countries through the CePaCT. In turn, CePaCT takes advice from PAPGREN.

At the last meeting of PAPGREN in Suva, 1-5 December 2014, 15 PICTs acknowledged the importance of CePaCT's program on plant genetic resources and, in light of impacts of climate change and disasters (natural or man-made) on food and nutrition security, urged members to (i) strengthen national PGR activities, in particular in atoll countries, (ii) provide PGR materials to CePaCT for conservation, duplication, and for sharing under the multilateral system of the ITPGRF, and (iii) welcomed the research focus of donor-funded projects aimed at improving the resilience of Pacific island agriculture, livelihoods and food security. The meeting also noted the recommendation of MOAF/HOAFs in 2012 that requested countries that had not ratified the Treaty to do so.

The PAPGREN meeting also noted that the challenges faced by different countries in the region vary amongst Melanesian, Polynesian and Micronesian communities. The countries most vulnerable to

[9] *Virus indexing and DNA fingerprinting for the international movement and conservation of taro germplasm. ACIAR, Canberra (http://aciar.gov.au/project/cp/1994/043).*

the impact of climate change and natural disasters are the atolls islands. For Kiribati, there is the need for greater diversity of swamp taro. Similarly, Tuvalu, stressed the need for screening varieties of swamp taro for salt and drought tolerance (also voiced by Marshall Islands), where the drought of 2012-13 had caused losses of swamp taro varieties in the outer islands. For Samoa, the need was continued support of the taro breeding program as a way of increasing exports. Fiji acknowledged the importance of PGRFA in ensuring food and livelihood security. Fiji and Tonga were affected recently by cyclones and Fiji has also sustained severe and unusually prolonged floods. Flooding was also a problem in Cook Islands, which requested crops tolerant to waterlogging. It is suspected that some of these events are related to climate change.

Many PICTs have publically stated their need for assistance in combating the effects of climate change. For example, five countries (Cook Islands, Fiji, Kiribati, Palau and Samoa) are current recipients of the SPC FAO Benefit Sharing project: *Strengthening the resilience of Pacific agricultural systems to climate change through enhancing access to and use of diversity*, in collaboration with the Vanuatu Agricultural Research Training Centre. In this project, the affected countries have acknowledged their vulnerability to climate change, with its potential impact on food security, and have established community genebanks to access new diversity acquired through the breeding and selection of major root crops (aroids, cassava, sweet potato and yam).

SECTION C: OPERATIONS

3.1. Methodology of project implementation

The project strategy is to develop the capacity of a regional intergovernmental organisation with expertise in plant genetic resources to assist Pacific island countries improve production of food crop staples; specifically, the project will use aroids as an example of how modern biotechnologies can be used to meet this goal.

SPC, through its CePaCT, will be responsible for project implementation, including the monitoring of progress (using the indicators of the logframe, Appendix 2) with country member representatives of PAPGREN. It will work in collaboration with the University of Queensland, Brisbane, to establish the DNA fingerprinting capability within CePaCT, and apply it to CePaCT aroid collections, and on lines from the taro breeding program in Samoa. In addition, UQ will research markers for tolerance to drought and salinity, and co-supervise the USP masters or doctorate student employed under the project to carry out the project's work of on-farm genetic diversity.

The project builds on the project, *Strengthening the resilience of Pacific agricultural systems to climate change through enhancing access to and use of diversity*, supported by the Benefit-sharing fund of the ITPGRFA. The present project will use the collaboration established with farming communities and test methods of on-farm (in situ) conservation by introducing germplasm representative of wide allelic diversity.

The PAPGREN representatives from the departments of agriculture of Pacific members of the Treaty are:

- Ministry of Primary Industries, Fiji
- Centre of Excellence in Atoll Agriculture established within the Ministry of Environment, Lands and Agriculture Development, Kiribati
- Community College and the Bureau of Agriculture, Ministry of Resources and Development, Palau
- Ministry of Agriculture and Fisheries, Samoa
- Ministry of Agriculture, Cook Islands
- Ministry of Agriculture & Food, Forests and Fisheries, Tonga
- Ministry of Resources and Development, Marshall Islands.

PAPGREN members will meet annually. At the first meeting, the partners will review the collections maintained by INEA members and prioritise them for importation by CePaCT. Eddoes as well as dasheens will be considered, as the breeding program for their tolerance of lower rainfall needs eddoes. The meeting will also consider which country will host the work on *in situ* conservation, and whether, like Vanuatu, it is possible to increase genetic diversity in farmers' fields, and under what circumstances.

3.2. Partnerships and collaboration arrangements

The project brings together a consortium of agencies to provide efficient and effective implementation. National governments will work with a regional organisation established to assist them with socio-economic development. A university with considerable expertise in molecular genetics will help establish a lab to service the region, provide a post-doctoral student, and transfer appropriate technologies for use on conserved collections, breeders' lines, as a way of measuring farmers' crop diversity, and to develop markers to select breeders' lines for drought and salinity.

3.3. Project management team

The project team is as follows:

Name	Responsibility	Field of expertise
A. Regional		
Valerie Tuia, SPC CePaCT, Fiji	Project Coordination	Manager of SPC's PGR program
Professor Ian Godwin, University of Queensland, Australia	Technical advice DNA fingerprinting	Plant Molecular Genetics
Tolo Iosefa, Plant breeder, SPC Samoa	Increase diversity of taro breeding program	Participatory plant breeding
B. National		
PAPGREN focal points	Project monitoring (annual)	Agriculture R&D
HOAFS	Project monitoring (biennial)	Management of Government services

The countries taking part in the project are contracting parties to the Treaty: Cook Islands, Fiji, Kiribati, Marshall Islands, Palau, Samoa and Tonga. SPC also liases with regional technical advisers for technical support for its projects.

SPC has been the implementing or main collaborating agency for a number of plant genetic resource projects, carrying out the work together with its 22-member countries.

- *Adapting clonally propagated crops to climatic and commercial changes*. (2011-2015). Established the International Network of Edible Aroids. EU, Brussels. €3.5 million.
- *Strengthening the resilience of Pacific agricultural systems to climate change through enhancing access to and use of diversity* (2014-2016). FAO ITPGRFA, Rome. US$270,000.
- *Developing a clean seed system for market-ready taro cultivars in Samoa.* ACIAR (2011-2014). AUD349,285
- Enhancing climate change knowledge and resilience of Pacific Island Countries (2011-2014) *AusAID International Climate Change Adaptation Initiative (ICCAI).* AUD4.5 million
- Developing commercial breadfruit production systems for the Pacific islands (2011-2015). ACIAR. AUD530,335
- How an indigenous vegetable can contribute to sustainable development Bele (*Abelmoschus manihot*) (2012-2014) French Pacific Fund. €50,000.

3.4. Sustainability

SPC has incrementally increased its support to plant genetic resources in the region over a number of years. It took over a small lab established at SPC by FAO in the mid 1980s, expanding it under TaroGen and, in 2010, constructed a purpose built facility which has become CePaCT for the conservation and utilisation of priority food crops of the Pacific; a year later, it added a laboratory

and recruited a scientist to establish a virus-indexing capability to ensure the health of germplasm distributions.

The gradual expansion of SPC's capacity in PGRFA has been considered carefully at each step, and always done with prior discussions with partners, national governments through PAPGREN and HOAFS meetings, and with donors. This approach is now being extended with the development of a lab and staff for molecular genetics. The Global Crop Diversity Trust provides a long-term grant for the conservation of collections of taro and yam. For these reasons, the sustainability of the project is assured.

Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AUD	Australian dollar
CePaCT	Centre for Pacific Crops and Trees
CGIAR	Consultative Group on International Agricultural Research
CIRAD	Centre de Cooporation Internationale en Recherche Agronomique pour le Developpement
CRGA	Committee of Representatives of Governments and Administration
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization of the United Nations
GCDT	Global Crop Diversity Trust
INEA	International Network for Edible Aroids
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LRD	Land Resources Division
MAF	Ministry of Agriculture and Fisheries
MOAFS	Ministers of Agriculture and Forestry Services
HOAFS	Heads of Agriculture and Forestry Services
NARI	National Agricultural Research Institute
PGRFA	Plant genetic resources for food and agriculture
PICTs	Pacific island countries and territories
PNG	Papua New Guinea
SMTA	Standard Material Transfer Agreement
SPC	Secretariat of the Pacific Community
TANSAO	Taro Network for Southeast Asia and Oceania
TaroGen	Taro Genetic Resources: Conservation and Utilisation
UQ	University of Queensland
USP	University of the South Pacific

SECTION D: APPENDIXES

By signing this submission form for full proposal, the applicant confirms that all the above statements, including the attached Appendixes, are true to the best of his/her knowledge. Any deliberately untruthful response will lead to the automatic exclusion from the further screening and appraisal process, and may lead to the denial of awarded grants from the Benefit-sharing Fund.

VSTuia	***4.12.2014, Suva, Fiji***
Signature of contact person:	**Date and location**