Pacific Community
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The Centre for Pacific Crops and Trees

Investing in Excellence

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List of Acronyms

ACIAR	Australian Centre for International Agricultural Research
BP	Business Plan
CePaCT	Centre for Pacific Crops and Trees
CIAT	International Center for Tropical Agriculture
CGIAR	Consultative Group for International Agricultural Research
CIP	International Potato Center
COGENT	Coconut Genetic Resources Network
CROP	Council of Regional Organizations of the Pacific
CRP	CGIAR Research Program
CSA	Climate Smart Agriculture
DFAT	Department of Foreign Affairs and Trade (Australia)
DOIs	Digital Object Identifiers
DRR	Disaster Risk Reduction
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FRDP	Framework for Resilient Development in the Pacific
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHU	Germplasm Health Unit
GIZ	German Society of International Cooperation
GLIS	Global Information System
HoAFS	Heads of Agriculture and Forestry Services
ICKM	Information, Communication & Knowledge Management
IITA	International Institute of Tropical Agriculture
INEA	Innovation & Networks Executive Agency
ISO	International Organization for Standardization
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
KU Leuven	Catholic University Leuven
LDN-TS	Land Degradation Neutrality Target Setting
LRD	Land Resources Division
MFAT	Ministry of Foreign Affairs and Trade (New Zealand)
MLS	Multilateral System
MTAL	Material Transfer Agreement Letter (to accompany all germplasm distributed by CePaCT, in addition to the SMTA)
NARI	National Agriculture Research Institute
NCDs	Non-Communicable Diseases
NPC&T	Northern Pacific Countries and Territories
NZAID	New Zealand Agency for International Development
PACGEN	Pacific Genetic Resources Database
PAPGREN	Pacific Plant Genetic Resources Network
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
PICTs	Pacific Island Countries and Territories
PIFON	Pacific Island Farmers Organisation Network

PITSC	Pacific Islands Tree Seed Centre
PMEL	Planning, Monitoring, Evaluation and Learning
PNG	Papua New Guinea
POETCOM	Pacific Organic & Ethical Trade Community
PWA	Pacific Week of Agriculture
QDPM	Quality Declared Planting Material
QMS	Quality Management System
RBM	Results Based Management
REDD	Reducing Emissions from Deforestation and Forest Degradation
RGC	Regional Germplasm Centre
SDGs	Sustainable Development Goals
SMTA	Standard Material Transfer Agreement
SOP	Standard Operation Procedure
SPC	Pacific Community
TANSAO	Taro Network for Southeast Asia and Oceania
TAROGEN	Taro Genetic Resources
UNCCD	United Nations Convention to Combat Desertification
UNPS	United Nations Pacific Strategy
WorldVeg	World Vegetable Center

I. Narrative executive Summary

The agriculture and forestry sectors remain the mainstay of the economy in the Pacific region contributing to food security, livelihoods and a major source of export earnings. However, declining agricultural production and the increasing consumption of relatively cheap imported foods of low quality, Pacific Islanders have some of the highest incidences of Non-Communicable Diseases (NDCs). Climate change adversely impacts agricultural production and causes a rapid degradation of land and water ecosystems and loss of diversity in genetic resources, increased frequency and severity natural disasters and incursions of pests and diseases, as well as overall land degradation. Conserving and redeploying crop diversity can provide the foundation for improving livelihoods in the Pacific islands who depend on agriculture and ensuring their resilience in the face of climate change. The lack of crop diversity can spell disaster as demonstrated by the taro leaf blight (TLB) outbreak in Samoa, which as a result of the reliance on a single crop variety susceptible to TLB wiped out a US$10 Million export industry in 1993. The conservation of local diversity can also support the development and exploitation of traditional, underutilized crops which are often more resilient to climate change and of higher nutritional value than the imported staples.

The Centre for Pacific Crops and Trees (CePaCT) is the only regional genebank for the Pacific. Established in 1998 by the Pacific Community (SPC) as part of its long-term investment strategy to support a sustainable food-secure Pacific, CePaCT's key role is to assist Pacific Island Countries and Territories (PICTs) to sustainably conserve and utilize their plant genetic resources, adding value, as well as sourcing improved crop diversity from outside the region to address food and nutritional security and improved resilience to climate change and pest and disease incursions. CePaCT is internationally recognized by the Global Crop Diversity Trust, the CGIAR Research Institutes and international networks as a focal point for Plant Genetic Resources for Food and Agriculture (PGRFA) in the region. CePaCT currently conserves 2183 accessions of 17 crops of significance to the Pacific region and the world, including approximately 70% of the taro genetic resources held ex situ globally, and is, therefore, considered the world center for taro, a major staple crop and source of livelihoods for the region. Apart from taro and edible aroids, other major crop collections for the Pacific region include banana, sweet potato, yam, breadfruit, cassava, and some selected tree species (pandanus, sandalwood). Coconut, an important livelihood component of many Pacific islanders, will soon be added to this list.

Given the high risk of spreading diseases through the sharing and exchange of root and tuber crops, CePaCT is the only source of safe germplasm exchange in the Pacific region. It has a robust and internationally recognized mechanism in place to test germplasm for pathogens and eliminate them using internationally approved protocols before crop accessions are released for distribution to farmers. National genebanks in the South Pacific, in general, do not avail of germplasm health testing laboratories, hence CePaCT remains the only vital source of planting material for all key crops. Similarly, CePaCT is the only reliable and safe hub in the South Pacific for sharing indigenous Pacific diversity with other parts of the world as successfully demonstrated in the case of taro. Over the past 10 years, 22 PICTs and 31 countries outside Oceania have accessed CePaCT (disease-free /climate smart/ nutrient dense) plant materials contributing to improved genetic diversity, resilience of food systems and enhanced access to local and international markets.

The Centre is making a critical contribution to attaining global development goals (SDGs) to end hunger and improve food and nutrition security by ensuring the safe conservation and sustainable use of plant genetic resources in the Pacific. It contributes to achieving Targets 2.5 and 2.6 of the UN Sustainable Development Goal 2. Furthermore, CePaCT is contributing to the three objectives of the Global Action Programme on Food Security and Nutrition in Small Island Developing States (GAP) in support of the Samoa Pathway, namely: (1) Strengthen the enabling environments for food security and nutrition; (2) Improve the sustainability, resilience and nutrition-sensitivity of food systems; and (3) Empower people and communities for food security and nutrition.

Lack of sustainable funding remains a major threat to CePaCT and its operations. In recent years, there has been a shortage in staff – seven staff lost since 2016 – and a decline in operational funding. Under the new structure of the SPC Land Resources Division (LRD), CePaCT has its home in the Genetic Resources pillar. The other pillars are: (2) Sustainable Forests and Land Management; (3) Sustainable Agriculture; and (4) Markets for Livelihoods. The pillars individually and collectively develop and implement programmes, projects and activities to deliver outcomes contributing to LRD's objectives. Supporting the technical work of the pillars are LRD's advisory services in (1) Climate Smart Agriculture, (2) Research for Development, (3) Plant Health and Biosecurity and (4) Animal Health and Production. The matrix structure enables the development of an integrated work programme based on a value chain model, starting with genetic resources and ending with consumption and markets and improved livelihoods.

SPC-LRD is eager to transform CePaCT into a Centre of Excellence to better address the needs of the PICTs in climate readiness as well as in combatting NCDs. The Centre will focus on two main areas: (1) Conservation and (2) Utilization of Plant Genetic Resources (PGR). Regarding safe germplasm conservation and distribution, the Centre is putting in place Standard Operation Procedures (SOPs) as part of a transparent, efficient and accountable Quality Management System (QMS) and is upgrading its Germplasm Health Unit (GHU). To benefit smallholder farmers and consumers, PGR development will entail enhanced participatory screening, evaluation and selection of improved climate-resilient and nutrient-dense crop varieties. CePaCT will collaborate across pillars to develop and strengthen seed/planting material supply networks and help build regional, national and community capacity on all relevant areas of genetic resources management (conservation, development and utilization). The Centre will ensure access to food crops as part of its Disaster Risk Reduction (DRR) mainstreaming strategy in partnership with global networks and treaties. It will also put in place an effective risk mitigation strategy, eventually leading to the setting up of decentralized conservation and distribution hubs.

To achieve these ambitious goals, CePaCT will invest in strong partnerships at the global, regional, national and community levels. At the global level, the Global Crop Diversity Trust (Crop Trust) is a key partner providing financial resources to the Centre and enabling CePaCT to access knowledge platforms of the CGIAR and to engage directly with CGIAR genebanks for sharing of latest information and know-how as well as germplasm. Existing collaborations with other CGIAR Centres such as CIP, CIAT, the International Musa Transit Centre in Leuven, Belgium, and IITA will be strengthened to keep abreast of conservation methods and crop improvements relevant to Pacific farmers, and the potential for safety backup of crop germplasm conserved at CePaCT will be explored.

At the regional level, CePaCT will strengthen and expand its network of partners by engaging with PAPGREN, ACIAR, APAARI, APCC, USP, French Overseas Territories, and others. At the national level, the Centre will strengthen its collaboration with the Vanuatu Agricultural Research and Technical Centre. A partnership with the Kosrae tissue culture laboratory in the Federated States of Micronesia (FSM) will be explored to support the distribution of planting material in the North Pacific. To strengthen seed/planting material supply networks, CePaCT will strengthen engagement with NGOs, farmer associations, and the private sector.

To be able to achieve the intended outcomes, it is essential to invest at the level of CePaCT in the hiring of skilled staff and staff development, to replace obsolete equipment, establish an upgraded GHU, barcoding, a DNA fingerprinting and a cryopreservation facility, and a web platform with a user-friendly genetic resources information system for the Pacific (PacGRIS). To build strong germplasm utilization and seed/planting material networks, the capacity of national partners needs to be strengthened by building an 'octopus' network and training the 'tentacles' in safe handling of tissue culture plantlets, local conservation, screening and participatory variety development and distribution of elite planting material to farmers.

While the current CePaCT budget is amounting to EUR 682K, CePaCT operating as a Centre of Excellence that meets the international genebanks standards will require additional funding to be able to deliver the expected outcomes.

1. Introduction

The Centre for Pacific Crops and Trees (CePaCT) plays a critical role in assisting PICTs in the process of conservation and sustainable utilization of their genetic resources. At the same time, the Centre facilitates access to improved germplasm through the acquisition of new sources of genetic diversity from other genebanks and international agricultural research centres and through the sharing of elite germplasm derived from crop improvement programmes in the Pacific. Through the effective and efficient conservation, thorough germplasm health testing, responsible sharing and the utilization of genetic resources, dynamic, resilient, and sustainable agricultural systems can be developed that will increase food and nutrition security, and assist in the protection of our resource base to the benefit of future generations.

While CePaCT has performed well within the current operating model and has already taken on several new initiatives, limited resources and unpredictable funding have constrained the Centre's capability and potential to respond more effectively to emerging needs of the changing development context in the region and to improve accessibility to the plant genetic resources managed by CePaCT. Moreover, many internal and external stakeholders are showing a keen interest in CePaCT's current role and future potential. This has been recognised in SPC's strategic plan which charts CePaCT's evolution into a Pacific Community Centre of Excellence.

CePaCT developed a first draft its Business Plan in late 2017, which was presented for review at the Pacific Regional Seed Forum[1] held in June 2018 in Nadi, Fiji, where priority areas of focus in the conservation and utilization of plant genetic resources (PGR) were reviewed and means for establishing and effectively strengthen linkages to national seed development programs carefully considered. Based on the feedback from the stakeholder consultations, a final version of the CePaCT BP has been developed, which informed the current Investment Plan.

This Investment Plan outlines the long term strategy for the Centre, providing details on the intended work plan, outputs and expected outcomes and the resources required for CePaCT to evolve into a Centre of Excellence.

[1] Attendees included high-level and senior officials from the Ministries of Agriculture (covering research, extension and advisory services), non-government agencies, farmer organizations and key development agencies and technical partners. Country representation included Cook Islands, Federated States of Micronesia (FSM), Fiji, French Polynesia, Kiribati, Nauru, Niue, Palau, Republic of Marshall Islands (RMI), Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, and Wallis & Futuna.

2. Development context

Pacific people have a history of strong resilience based on their understanding of their environments and sustainable use of resources. The Pacific Region faces several challenges, including the effects of climate change; degradation of ecosystems due to unsustainable use of land resources; and the need for capacity building to produce healthier food and generate economic opportunities for growing island populations. The Pacific region has a substantial base of natural resources, which provides immense potential for productive development. They include fish, timber, agricultural products, minerals and limited reserves of oil and gas.

The region is particularly prone to disasters including cyclones, severe storms, flooding and earthquakes. Changes in rainfall patterns, temperature and wind direction could result in the introduction and dissemination of pests and diseases and exposure of crops to abiotic stresses, thus severely threatening production.

2.1. The agricultural and forestry sector in the Pacific Island countries and territories

The economic importance of the agriculture and forestry sectors varies greatly among Pacific Island Countries and Territories (PICTs), although remaining as the mainstay of the regional economy providing significant employment and contributing to household income and export earnings. Subsistence food production forms a significant part of household income, contributing to more than 50% in some countries.

Agricultural production has been steadily increasing in the Pacific Region since the 1960s but annual growth rates in the entire agricultural sector have slowed down since the 1990s in most countries for which there are data, except for modest gains in Kiribati, Solomon Islands and Tonga (Roger and Martyn, 2009). There have been actual declines in agricultural production in this period in Fiji and Samoa. Sector contribution to GDP has also declined, steeply in some countries, since the 1990s, except in Papua New Guinea (PNG) where the share has increased. Since the 1990s, food production per capita has declined in all countries except for Kiribati and Samoa and this decline has been associated with increased import dependency in several countries.

2.2. Food and nutrition security in the Pacific and the SDG challenge

Urbanization and high population growth rates accompanied by stagnant agricultural productivity is severely challenging existing farming systems to produce enough food to meet the needs. The total number of people in the region is predicted to increase by around 50% by 2030. This will present a major challenge to produce adequate local foods for urban areas.

Increased consumption of imported, refined foods and decreased local food production and consumption are having deleterious and burdensome effects on the health of many people in the region. With a growing youth population across the region, the rise of global food and labour costs exacerbates the increased reliance on cheap imports and the consumption of over-processed food, a factor that is also contributing to growing youth un- and under-employment. Imports of affordable (e.g. rice, wheat), low quality (e.g. lamb flaps, turkey tails) and convenient (e.g. ready-to-eat) foods now compete with domestic foods (e.g. root and tuber crops) that often have higher production costs and are less convenient to store and prepare.

The increasing reliance on imports to meet the demand for food has heightened the Pacific's susceptibility to food and fuel price levels. Many poor people are faced with higher food prices during a global economic slowdown. This is significant as one third of the total Pacific population lives below national poverty lines. With real gross domestic product (GDP) growth rates forecasted to remain low or negative in most countries because of weak to moderate agricultural economy performance, reliance on food imports will be a real burden for many households. In addition, due to increased consumption of low quality cheap imported foods, the Pacific Islanders have some of the highest incidences of Non-Communicable Diseases (NCDs) coupled with the emerging vitamin and mineral deficiencies like iron.

A further threat to food security comes from the dependency on rice. Climate change is expected to affect rice yields and overall rice production in tropical locations. With less than 10% of rice produced that is traded internationally, there will be increasing pressure on the rice supply available for international trade to be retained to meet domestic market needs. Such a scenario would severely threaten food security in the Pacific islands, which are increasingly dependent on grain imports (McGregor et al. 2016). 2.3 Threat of climate change in the Pacific

2.3. Threat of climate change in the Pacific

Climate change adversely impacts local agriculture production and causes a rapid degradation of land and water ecosystems and loss of diversity in genetic resources, resulting in increased incidences of pests and diseases, as well as overall land degradation. Climate change is likely to manifest itself around increased risks to rural livelihoods, declining land productivity which, together with ailing markets are contributing toward a lower GDP share of agriculture.

Long-term sea level rise driven by global climate change presents clear and highly consequential risks over the coming decades and centuries[2]. Rising seas are already causing flooding and other disruptions on various Pacific islands. Coastal wetlands, where important staples such as taro are grown, are experiencing saltwater intrusion. As we move into a warmer future, climate models are projecting that the Pacific will experience more frequent strong El Niño events. El Niño years bring with them enormous changes for all Pacific islands — changes in rainfall, in winds, in drought, in erosion processes, and in water temperature. Globally, data show a shift to increased rain intensity. With more extreme precipitation, there is the possibility that less water will soak into the ground to recharge aquifers and more of it will remain on the surface as runoff. This can deplete freshwater reserves and increase flooding. In some areas this trend is compounded by extended periods of drought.

Coconuts and other staple food crops in the Pacific are threatened by biosecurity hazards. Coconut Rhinoceros Beetle (CRB), in particular the G-Biotype of CRB that is showing resistance to biocontrol agents which to date have successfully controlled the spread of the beetle. The CRB-G can cause the death of all coconuts in infested areas and is also posing a threat to the oil palm industry. In the last eight years, CRB-G has spread to five PICTs – Guam (2007), PNG (2009), Hawaii (2013), Palau (2014), and the Solomon Islands (2015). The Bogia Coconut Syndrome (BCS) is having a fast impact on coconut-based livelihoods (as well as banana, betel-nut palm and sago), especially in Melanesia. BCS threatens the existence of the International Coconut Genebank for the South Pacific, located near Madang in PNG. An increase in the incidence of pests and/or diseases can destroy a crop completely or at least some susceptible crop varieties. In 1987 sweet potato scab disease almost devastated sweet potato in Tonga. Taro leaf blight temporarily wiped out commercial taro production in Samoa in the late 1990s.

2.4. The importance of plant genetic resources in the Pacific region

The availability of and access to crop diversity can greatly enhance the ability of farmers in the Pacific to adapt to climate change. At the same time, increasing the availability of and promoting the consumption of a range of diverse, nutritionally-rich local foods will support nutrition outcomes in the Pacific.

Plant genetic resources for food and agriculture are playing an ever-growing role on world food security and economic development. As an integral component of agricultural biodiversity, these resources are crucial for sustainable agricultural production intensification and ensure the livelihood of a large proportion of women and men who depend on agriculture. In a world where around one billion people go hungry every day, with an expectation of a world population of nine billion by 2050, countries must make greater efforts to promote the conservation and sustainable use of plant genetic resources for food and agriculture.

Traditionally, Pacific Island communities have incorporated diversity into their food production systems, growing multiple crops, thereby strengthening the resilience of the food supply, as not all crops are affected by specific climatic extremes such as droughts or cyclones. However, with the influence of various factors, such as export markets and increased urbanization, diversity in food production systems has declined, the genetic base of many food crops has weakened and some traditional varieties (landraces) have been lost. The increasing flow of imported food with its added convenience has also weakened the importance of home gardens.

Diversity of crop production is a vital climate change adaptation strategy as it helps mitigate the impact on households of gluts and shortages that result in large price fluctuations. Enhancement of intra-specific and inter-specific diversity is considered a "no regrets" approach with a potentially high return on investment. Tree species diversity is also important for adaptation. In native forests that are relatively species-rich, the genetic diversity contained within and among tree species provides an essential buffering against climate related (direct and indirect) impacts on productive and service functions.

Encouraging diverse food production systems can not only improve resilience, it can also provide a wide and varied range of nutrient-rich foods and dietary components with important health properties. A change in diet to include Pacific staples, and more fruit and vegetables is likely to have a positive effect on the nutrition and therefore the health of Pacific communities.

[2] https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf

3. The Centre for Pacific Crops and Trees (CePaCT)

The Centre for Pacific Crops and Trees (CePaCT) is the only Pacific regional genebank and was established in 1998 by the Pacific Community (SPC) as part of its long-term investment plans to support a sustainable food-secure Pacific. Its establishment was a response to the recommendations made during the Heads of Agriculture and Forestry Meeting (HOAFS, 1996) to put in place policies to conserve, protect, and best utilize plant genetic resources in countries and through regional cooperation. CePaCT's key role is to assist PICTs to sustainably conserve and utilize their plant genetic resources as well as sourcing improved crop diversity to address food and nutritional security and for improved resilience to climate change and pest and disease incursions. CePaCT is internationally recognized by the Global Crop Diversity Trust, the CGIAR Research Institutes and international networks as a focal point for Plant Genetic Resources for Food and Agriculture in the region.

3.1. Strengths, Weaknesses, Opportunities and Threats

Strengths

CePaCT has good working relationships with the 22 SPC member countries, which has resulted in significant trust and respect in CePaCT for what it does and what the genebank achieves. Both the Crop Trust and Jackson and Walton (2016) reviews agreed that CePaCT has been very responsive to the requests of countries for germplasm and does an excellent job of distributing germplasm regionally and also globally (mainly through the INEA). Between the years 2009-2015, CePaCT distributed about 4500 accessions (more than 42,000 plants) to the Pacific and other regions for evaluation by governments, NGOs and farmers, in response to emergencies, or to backstop the main collection. Throughout these years, the work was done well; in most cases, plant cultures arrived in excellent condition so that transfers to soil were invariably successful.

Weaknesses

The Crop Trust is one of CePaCT's key donors, currently providing a small annual grant for the long-term conservation of the valuable collections of edible aroids (mainly taro) and yams. The Crop Trust has put in place four key performance indicators (aligned with the FAO Genebank Standards) which must be met and maintained to receive substantial long-term funding from the Crop Trust endowment mechanism (see Table 1).

In June 2017, the Crop Trust commissioned a review of the CePaCT genebank operations. The review acknowledged the dedication of the CePaCT staff in carrying out their work, their organization in managing the genebank, and their team spirit but recognized that a shortage in staff and the decline in operational funding were constraints in implementing activities. Such factors have led to backlogs for some of the core activities of the CePaCT, such as virus indexing and data management. At the time of the review, the CePaCT was not meeting the targets for all four indicators, except for data availability for the collection of yams. At present, the CePaCT crop collections are not safety duplicated as the arrangement with the University of the South Pacific (USP) in Samoa to maintain back-up collections no longer exists.

Table 1. Key performance indicators for genebanks supported by The Crop Trust

Indicator	Indicator description	Performance targets
Availability	% collection which is clean of pathogens of quarantine risk, viable, and in sufficient quantity to be immediately available for international distribution from medium-term storage (or local distribution for some tree spp.).	90% accessions available
Security	For seed crops: % collection held in long-term storage at two locations and also in Svalbard Global Seed Vault (except for tree spp.). For clonal crops: % of the collection held in long-term storage or cryopreservation at two locations; % of the collection held in slow growth conditions in vitro at two locations.	90% seed accessions safety duplicated 50% clonal accessions in cryopreservation Intermediate target 90% accessions duplicated in in vitro
Data availability	% collection with minimum passport and/or characterization data online	90% accessions documented
Quality Management System	A set of policies, processes and procedures for verifying that the genebank meets international standards and improves the overall efficiency and effectiveness of operations.	Agreed elements of QMS/ISO are in place

The Crop Trust has developed an evidence-based Quality Management Systems (QMS)[3] and implementation of QMS is the fourth key performance target indicator of international genebanks. A genebank's QMS defines the necessary activities to ensure that genebanks meet all policy and technical standards and outlines ways to achieve continual quality improvement in the genebank's administrative, technical and operational performance. As a result, it allows genebank users, regulatory bodies and donors to recognize and confirm the competence, effectiveness and efficiency of genebanks. CePaCT is still at the basic level (undocumented) of a QMS.

Distribution efforts have not resulted in generating a wealth of evaluation information. In the Jackson and Walton (2016) study the countries gave a number of reasons for this shortfall, including lack of a regional policy towards evaluation, insufficient awareness of what germplasm is available, concerns with safety, reluctance to share, poor infrastructure and lack of funds. Both the Crop Trust and the Jackson and Walton reviews considered that limited national capacity was the major constraint to the successful uptake of these materials and adequate evaluation. As a result, currently only a small number of farmers are benefiting from the CePaCT material, falling short of the goals of the CePaCT programme.

[3] A quality management system documents every procedure as it is carried out in an organization and verifies that the steps in the manual are actually carried out. Secondly, the QMS aligns the genebanks' procedures with the international standards published by FAO.

Opportunities

The opportunities are significant. Availability of and access to crop diversity is central to enabling Pacific farmers and communities address the two main challenges of climate change and NCDs. In addition, crop diversity opens opportunities for income generation. Examples exist in other regions, for example, in Rwanda, CIP is working with businesses to drive consumption of orange-fleshed sweet potatoes (OFSP), and OFSP have been incorporated into a range of commercial food products stimulating demand and reducing dependence on imported wheat and flour. Many traditional vegetables are of considerable commercial value and thus can make a significant contribution to household income. Value-adding can ensure that high quality produce reaches the market and satisfies consumer expectations.

CePaCT could also work more closely with a number of CGIAR Centres and the World Vegetable Center by offering to test user subsets from CG genebanks which are of interest to Pacific farmers, enriching and exploiting integrated data portals (Genesys) and building joint datasets on crops of interest for the Pacific with the aim to accelerate the development and deployment of climate-resilient and nutrient-dense crops and crop varieties.

Threats

Lack of sustainable funding remains the major threat to CePaCT and its operations. In recent years, there has been a shortage in staff – seven staff lost since 2016 – and the decline in operational funding. Seed systems at the national level and linkages between regional and national initiatives must be strengthened so that crop diversity can be fully utilized to enhance climate resilience and address food and nutrition security challenges. Failure to do this would undermine the impact of CePaCT's germplasm distribution efforts.

3.2. CePaCT's performance targets

3.2.1. Quality Management System (QMS)

The Genebank QMS applies to all genebank operations including procedures, staff capacity building and succession, infrastructure and work environments, equipment, information technology and data management, user satisfaction, risk management and genebank operational policies. It is a guide to strengthen and enhance genebank efficiency. In 2017, the CePaCT genebank started to develop an appropriate Genebank QMS with the assistance of a Genetic Resources expert. Currently, the Centre is still at the basic implementation level. A draft of the Distribution SOP was submitted to the QMS Manager of the Crop Trust in June 2018 for a 'Documentation audit'. The other SOPs are still under development.

Apart from the implementation of a QMS, there are additional three performance targets that the genebanks need to meet to receive comprehensive long-term funding from the endowment mechanism of the Crop Trust. The additional performance targets concern the availability of accessions for distribution, the security of the crop collections, and data availability. Apart from developing and implementing a QMS, CePaCT staff are dedicated to reaching the other three performance indicators established by the Crop Trust for genebanks.

3.2.2. Availability of accessions

Only about 26% of all accessions conserved by CePaCT have been virus-indexed and were found to be free from quarantine pathogens and are, therefore, available for distribution. This is well below the 90% availability target set by the Crop Trust.

Plant health testing and virus indexing have been neglected during the last few years due to a study leave of the CePaCT Germplasm Health Scientist. This activity will be taken up again and stepped up to reduce the huge backlog in plant health testing and make more material available for distribution. The CePaCT collection is not very large and a concerted effort into plant health testing and virus-indexing should allow CePaCT staff to eliminate the backlog during a period of 5 years. Once the backlog of virus-indexing and virus elimination has been completed, availability of accessions will be greatly improved and safe movement of germplasm within the Pacific and beyond can be assured.

3.2.3. Security of the crop collections - Safety duplication

Duplicating tissue culture collections at another location, in another country can offer a medium-term solution for the security of the collections. However, due to the frequent sub-culturing and rejuvenation needs these measures are costly and bear the risk of contamination of the cultures.

Safety duplication of the CePaCT collections is a burning issue as the backup collection originally installed at the University of the South Pacific (USP) in Samoa has been lost. SPC-CePaCT management will address this issue and find new hosting arrangements for safeguarding the major CePaCT collections under in vitro conditions. Discussions are on-going between SPC and the New Caledonian Agronomic Institute (IAC) to establish a safety duplication site at IAC for the CePaCT collections. However, IAC does not have tissue culture (TC) facilities or TC know-how. Hence, a major investment (out of the scope of this document) is necessary for transforming and equipping existing laboratories and hiring and training staff to do tissue culture work. The existing partnership with the Vanuatu Agricultural Research and Technical Centre (VARTC) and the National Agriculture Research Institute (NARI), Papua New Guinea (PNG) might be strengthened to include ix-situ collections of CePaCT material.

Cryopreservation is a viable long-term solution for the security of the collections. CePaCT is planning to invest in cryopreservation for safety duplication of edible aroids, currently the largest collection, and coconut which is difficult to maintain in vitro. Legal arrangements shall be made to identify hosting institutions willing to accept CePaCT's core collection(s) to be kept in cryopreservation for safety backup. A Memorandum of Understanding (MoU) is in preparation with Bioversity International's International Musa Transit Centre at the Catholic University Leuven (KULeuven), Belgium which could serve as a cryopreservation duplication site for the key CePaCT crops of edible aroids and banana. IITA in Ibadan, Nigeria might be interested in safety duplicating CePaCT's yam collection, and CIP in Peru, CePaCT's sweet potato collection.

3.2.4. Data availability

Data on collections need to be made available online for easy access by potential users to enable them to make an informed choice of accessions of interest for their use. While CePaCT data is now available on the Genesys platform of the Crop Trust, most germplasm orders are still directed to the respective genebank. The CePaCT website is poorly designed and is need of a major overhaul to include detailed descriptions of each collection, covering as a minimum passport data and, where available, characterization and evaluation data. The website currently lacks information on the modalities of seed/planting material distribution, the use of the SMTA, and an order form. Climate-resilient and other elite germplasm would also need to be described in more detail. The website of the World Vegetable Center (WorldVeg)[4] and the AVGRIS genebank website of WorldVeg is being considered as a model for the upgrade of the CePaCT website.

[4] WorldVeg website https://avrdc.org/seed/improved-lines/

3.3. CePaCT's germplasm distribution efforts

CePaCT has been actively distributing improved crop diversity (climate-resilient, nutrient-rich, and disease-resistant) to PICTs and the global community facilitated by the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). During the past eight years, CePaCT distributed a total of 3902 accessions, 2935 accessions (67%) within the Pacific region and 967 accessions (33%) beyond the Pacific. The average annual distribution during this period amounted to 367 accessions within the Pacific and 121 to countries outside of the Pacific region.

Germplasm distributions during the period from 2009 to 2014 were mostly project-driven. Under the International Climate Adaptation Initiative funded by AusAID a climate-resilient germplasm collection was established and germplasm was distributed from June 2009 to the end of 2010 to several countries in the Pacific to evaluate the performance of these accessions and to provide feedback to CePaCT. In 2011, two major projects with germplasm distribution activities were initiated. Firstly, the EU-INEA (International Network for Edible Aroids) project, and secondly, the FAO Technical Cooperation Project for Cyclone Pam assistance to Tuvalu. Under the latter project, 600 plantlets of banana, swamp taro and sweet potato were targeted for distribution. Germplasm distribution under these two projects was completed in 2012. From 2013 to 2014, funding provided by New Zealand supported the distribution of climate-resilient crops to cover all 22 PICTs. Under the EU-INEA project, further edible aroid germplasm distributions were made to countries outside of the Pacific (2012-2013). The decline in germplasm distribution starting from 2015 onwards was due to the lack of project-funded distributions and could possibly also be attributed to the introduction of full cost recovery by SPC in 2016. To strengthen a more demand-driven exchange of germplasm, CePaCT needs to be proactive and redesign its website, making it more informative and user-friendly. Apart from a link to the detailed description of each crop collection, covering as a minimum passport data and, where available, characterization and evaluation data as well, the website should highlight elite germplasm accessions of all major crop collections which are climate-resilient and/or nutrient-dense with photos and concise trait information. Customized subsets and accession selection tools would also be helpful for the users enabling them to make an informed choice when selecting germplasm for their needs. The website should also contain information on the modalities of seed/planting material distribution, the use of the SMTA, and an online order form.

4. Investing in genetic resources in the Pacific

Working in close collaboration with international, regional and national partners and aligning its work with country priorities, CePaCT will contribute to the goal:

"Consumption of diverse, nutritious domestic food ensures healthy diets and sustainable livelihoods for the Pacific communities"

Towards achieving this long-term impact, CePaCT's work will focus on the strategic outcome:

Increased production and domestic supply of safe and nutritious agricultural and forest products using profitable, sustainable production systems based on climate-resilient crop varieties.

LRD's programmatic intent is to leverage national, regional and international support to develop and coordinate better integrated programs, such as climate-resilient agriculture or nutrient sensitive food systems and the use of genetic resources to enhance adaption to climate change and combat non-communicable diseases or land degradation.

4.1. Program Results

4.1.1. CePaCT's contribution to the UN Sustainable Development Goals

The CePaCT genbank will ensure increased conservation and use of genetic resources in the Pacific, thus contributing to achieving Targets 2.5 and 2.6 of the UN Sustainable Development Goal 2 ("End hunger, achieve food security and improved nutrition and promote sustainable agriculture). Furthermore, CePaCT will contribute to the three objectives of the Global Action Programme on Food Security and Nutrition in Small Island Developing States (GAP) in support of the Samoa Pathway[5], namely:

- Strengthen the enabling environments for food security and nutrition
- Improve the sustainability, resilience and nutrition-sensitivity of food systems
- Empower people and communities for food security and nutrition

4.2. Economic and social benefits and impacts

While the value of crop diversity is not disputed, it has multiple components and can be complex to quantify and calculated to calculate a precise economic value. Zerbe (2015) cited an o bservation by the Food and Agriculture Organization (2002) that the introduction of genetic material from a wild relative of the tomato plant contributed an estimated $250 million per year to the value of tomato production in the State of California alone. Frisvold et al. (2003) estimated that the overall economic welfare of U.S. crop producers across five commodities (corn, soybean, wheat, cotton, sorghum) increased by more than US$160 million and that consumer welfare increased by more than US$220 million (1989 constant dollars) due to U.S. genetic improvements. Total U.S. economic welfare increased over US$350 million. Net global welfare increased by $590 million, with the

[5] http://www.sids2014.org/index.php?menu=1537

United States capturing 60 percent of the total gain, other developed countries 25 percent, and developing and transitional economies 16 percent.

In the Pacific, Taro cultural and economic importance. It is the most important root crop in Samoa and was its top export earner up to 1993, when an outbreak of TLB, inflicted severe damage to the crop and wiped out a $10M industry due to lack of genetic diversity. Coconut is another important crop which is immensely valuable to the livelihood of coastal communities throughout the Pacific islands – comprising some five million vulnerable people. This livelihood system is facing significant problems with ageing trees and biotic stresses like the Coconut Rhinoceros Beetle (CRB), which has already affected several countries and poses a risk to other PICTs. Collecting, safeguarding, characterization and dissemination of genetic diversity of coconut will be extremely important to revive the coconut industry in the Pacific.

Transforming CePaCT into a centre of excellence that responds to the international genebanks standards will contribute into two broad categories of adding economic value of crop diversity: the use and conservation value. “Use value” refers to the ability of crop diversity to provide yield and non-yield (e.g. nutritional, environmental) benefits. “Conservation value” is associated with retaining potentially valuable but unknown genes and traits within a crop diversity collection, which may be discovered and provide use value in the future. This category of value can be equated with the insurance provided by crop diversity against present and future unpredictable challenges, such as climate change, the NCDs, new pests and diseases and evolving market conditions. Both categories of value are critical within the context of the Pacific region.

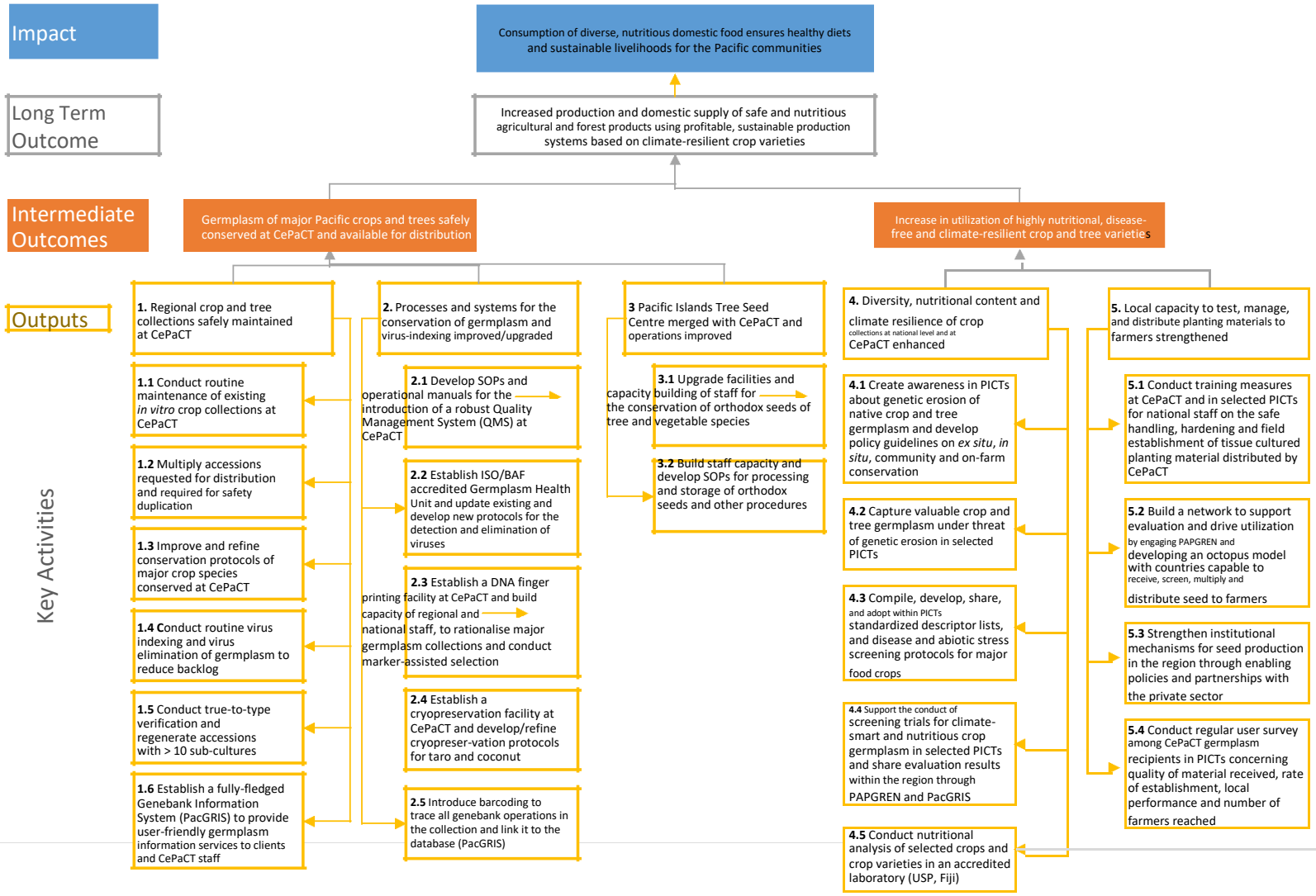
CePaCT will be a central hub for an effective seed system seed system in the Pacific, building a strong network, and responding effectively and efficiently to food and nutrition security in the Pacific and in the world. The ultimate objective at the end of a five year plan will be reaching 150,000 farmers growing CePaCT-derived material and 1 million people benefiting from highly nutritious, high-yielding CePaCT derived germplasm.

4.3. Theory of change

CePaCT's theory of change, detailed in Figure 1, identifies how the Centre will progress towards the strategic long-term outcome through an emphasis on two intermediate outcomes and supporting outputs. CePaCT's contribution to attaining the global development goals is outlined in section 6.2.1 further below.

Pacific Community
Communauté du Pacifique

Figure 1 CePaCT Theory of Change



4.3.1. Long term Outcome

Increased production and domestic supply of safe and nutritious agricultural and forest products using profitable, sustainable production systems based on climate-smart crop varieties

In the Pacific region, CePaCT is instrumental in promoting participatory plant breeding, evaluation and selection of improved crop varieties and the introduction and testing of elite crop varieties with tolerant traits and high nutrient density from other CGIAR centres. As part of an integrated programme on Climate Smart Agriculture, CePaCT is actively engaged in the multi-locational evaluation of climate-resilient and nutrient-dense crop varieties at farmers' level in the South Pacific, Africa and the Carribean and the promotion of superior varieties to contribute to more profitable and sustainable production systems in integrated crop-livestock home garden models that allow farmers to adapt to climate change and produce healthier food.

4.3.2. Intermediate outcomes and associated outputs and activities

This section will provide a description for each intermediate outcome and the outputs which contribute to each outcomes. These outcomes, when achieved, are expected to build towards wider benefits and realized change addressing the problems identified in the Theory of Change (Figure 2).

Detailed activities for each output and resources required are described in the CePaCT Logframe (Annex 5). Annex 6 shows a summary of the activities planned for 2019-2023 and Annex 7 illustrates the indicator framework for the goal, intermediate outcomes and output levels.

4.3.2.1. Intermediate Outcome 1 - Conservation of genetic resources

Germplasm of major Pacific crops and trees safely conserved at CePaCT and available for distribution

This Conservation Outcome, first and foremost, supports the core CePaCT operations, the minimum activities that must be undertaken without which the fundamental security of the collections and their use are at serious risk. The entire CePaCT collection currently comprises 2,169 accessions, out of which 1,857 accessions require safety duplication as they are not available in other genebanks. About a quarter of the CePaCT collections have been virus-indexed and cleared for distribution (567 accessions). Over 2,000 accessions require additional virus-testing and virus elimination. By 2024, it is expected that 1,633 accessions (75.3% of entire collection) will be available for distribution. Close to 350 accessions are expected to be added to the CePaCT collection by 2024 through additional collecting and acquisitions, hence the collection will then reach about 2,500 accessions in total.

Genebank efficiencies will be pursued on several levels, including in data management, routine operations, rationalization within same-crop collections, and improving and refining conservation protocols. Activities will include improving the quality of data resources and developing or adopting software and tools to support increased efficiency of workflows, implementation of digital labelling and use of more automated processes from field to medium-term storage. The rationalization within same-crop collections and the building of core or mini-core collections will be achieved through the establishment of a fingerprinting facility at CePaCT. The establishment of a cryopreservation facility and the development and refinement of cryopreservation protocols will ultimately make a major contribution to the security of the collections and will reduce costs of safety duplication in the long-term.

To ensure safe exchange of healthy germplasm, CePaCT is building staff capacity and is seeking accreditation for its GHU. The GHU will improve and update routine phytosanitary diagnostics and build capacity to accelerate the rate of germplasm indexing and phytosanitary cleaning. CePaCT will initially go for accreditation with the Biosecurity Authority of Fiji (BAF) until resources become available for international accreditation through New Zealand or Australia.

In close collaboration with the CGIAR Genebank Platform, CePaCT is currently improving its processes and systems to the highest international standards by implementing a Quality Management System. CePaCT will work towards the four key Crop Trust performance targets concerning the availability, security, documentation and quality management of the collections and will aim to reach them by the end of 2028.

Three outputs contribute to achieving the Conservation Outcome:

- Output 1 Regional crop and tree collections safely maintained at CePaCT
- Output 2 Processes and systems for the conservation of germplasm and virus indexing improved/upgraded
- Output 3 Pacific Islands Tree Seed Centre merged with CePaCT and operations improved.

Detailed activities for each output and resources required are described in the CePaCT Logframe (Appendix 1). Appendix 2 shows a summary of the activities planned for 2019-2023.

Output 1: Regional crop and tree collections safely maintained at the CePaCT

Researching in vitro conservation and multiplication methods

CePaCT will continue to improve in vitro culture (maintenance and multiplication) methods so as to improve the service provided to the PICTs. Yam and cassava protocols would benefit from improvement so that plantlets available for distribution are more robust, and therefore easier to acclimatize to ex vitro conditions. Research into maintenance protocols will aim to extend the subculture period while avoiding impact on the genetic integrity.

Improving the availability of germplasm for distribution

Approximately 26% of all accessions conserved by CePaCT have been virus-tested negative and therefore, are available for distribution. This is well below the 90% availability target set by the Crop Trust as a performance indicator. Staffing and funding have been the major constraints in virus testing and virus elimination. Further, yam virus testing has been delayed while protocols are being optimized, particularly for *Dioscorea badnavirus* (DBV). The CePaCT Germplasm Health Scientist has now developed a working protocol for yam badnavirus which works for all species and which will facilitate the clearing of the backlog.

The GHU will focus efforts on clearing the back-log of infected material. During the stakeholder consultation on the draft Business Plan, a range of factors were suggested for prioritizing the indexing of the back-log; these were demand (number of requests received), nutrition, climate resilience, disease resistance, market opportunities (based on market research and forecasts), and acceptability. Passport, characterization and evaluation data will assist the prioritization process. CePaCT plans to address the backlog over a 5-year period commencing from 2019 and assuming funding is available.

The GHU will increase its efforts in virus cleaning research, focusing primarily on those accessions that have been prioritized because of their user-value. Preliminary research carried out in the period 2011-2014 in cleaning yams and taro of the badnaviruses was not successful. The current thinking is that optimizing protocols will take two years, and that it will be an on-going process as new infected accessions are identified.

Virus cleaning research will also encompass investigating the rates of reinfection of clean material once it is planted in the field. This need was highlighted at the Pacific Seed Forum in association with seed systems work and the possibility of introducing quality declared seed and planting material as a means of generating income (see section 5.6.3). Research has been carried out with sweet potato that indicates virus loading impacts on yield after 3 years.

The crop collections held in trust by CePaCT are not very large and a concerted effort into plant health testing and virus-indexing should allow CePaCT staff to eliminate the backlog during a period of 5-8 years. Once the backlog of virus-indexing and virus elimination has been completed, availability of accessions will be greatly improved and safe movement of germplasm within the Pacific and beyond can be assured.

Managing genetic integrity

In response to the Crop Trust recommendation, CePaCT plans to carry out research, initially on taro as it is the largest collection, making up more than 50% of the entire collection. Subculture intervals for taro accessions are in the range of 10-12 months, depending on genotype; the aim will be to extend the sub-culturing interval beyond this period. A sample of taro plants will be grown out in the screenhouse for true-to-type verification (observed for abnormal growth patterns, yield and eating quality and compared with existing characterization data if available). A DNA level monitoring system will be developed for somaclonal variation and samples checked after every 3-year or 3-subculture intervals. This process will be repeated for plants cultured on different slow growth media to see if the subculture period can be significantly extended without any somaclonal variation. If funding becomes available, this work will also be carried out with banana and sweet potato.

Safety duplication

CePaCT will, as a matter of priority, explore the options for safety duplication of its tissue culture collections at another location, in another country as a medium-term solution for the security of its collections. These include: (a) the Bioversity International Musa Transit Centre hosted at KUL, which could duplicate CePaCT banana accessions; (b) CIP for duplication of sweet potato; (c) IITA for duplication of yam; and (d) CIAT for duplication of cassava. When discussions on safety duplication were held in the past, CIP indicated that they would also consider hosting a duplicate collection of the CePaCT taro core collection.

Safety duplication at a national laboratory in the region is a possibility and, in this regard, CePaCT is having discussions with the Institut Agronomique néo-Calédonien (IAC), New Caledonia as one of the possibilities for safety duplication of the aroid and breadfruit collections. In 2002, the Heads of Agriculture agreed that a regional collection should not be duplicated in a national laboratory, therefore, CePaCT will consult with the Heads of Agriculture as to whether their opinion regarding national laboratories remains the same; or whether with the appropriate agreements in place, and assuming the potential host laboratory meets the standards required for safety duplication, and demonstrates adequate funding is in place for the national laboratory to ensure its sustainability, a

national laboratory in the region could host a back-up collection for CePaCT – or at least could hold a back-up collection until other, preferable long-term options such as cryopreservation are implemented. Another possibility at the national level is French Polynesia. Under a collaborative effort of Bioversity International, the Crop Trust and SPC, a regional field collection site has been established for bananas in French Polynesia.

However, due to the frequent sub-culturing and rejuvenation needs (after about ten subcultures to avoid somaclonal variation) these measures of safety duplication are costly and bear the risk of contamination of the cultures.

Development of a Pacific Germplasm Information and Management System

Data availability is one of the key performance indicators for the Crop Trust and relates to the % of the collection with minimum passport and/or characterization data online; the Crop Trust performance indicator states that 90% of the collection should be documented. The Crop Trust review recommended the recruitment of a documentation and database position to strengthen the implementation of the barcoding system, provide advice on the development of the documentation system and ensure a smooth transition towards its application in the genebank.

CePaCT has engaged a documentation and database officer who has made significant progress in improving data management in CePaCT. The Centre is planning to establish a fully-fledged Genebank Information System (PacGRIS) to provide user-friendly germplasm information services to clients and also to enable CePaCT staff to reach the Crop Trust performance indicator on data availability. The existing website will be overhauled to ensure it is attractive to visitors and users, and that it contains detailed description of each collection, covering as a minimum, passport data and, where available, characterization and evaluation data as well. The revised website will be modelled on the website of the World Vegetable Centre (WorldVeg) (https://avrdc.org/) and the AVGRIS genebank website of WorldVeg (http://seed.worldveg.org/). AVGRIS links all germplasm conservation and management operations, from registration, characterization, evaluation and seed inventory to seed distribution to end-users. Links and documents will be added to relevant sites, such as the Pacific Agricultural Information System (PAIS), to provide exposure for the CePaCT genebank, and possible links to crop information on research material, extension material, articles, conference documents and other reference material relevant to CePaCT and PGR.

CePaCT's collections are visible and accessible under the Genesys portal. The complete passport data of the CePaCT collections (with 2,163 accessions) have been uploaded/updated to the web portal Genesys achieving an average PDCI score of 3.96, with a minimum score of 3.50 and a maximum score of 4.20. This PDCI score represents a good average among international genebanks. CePaCT will continue to update its data and make it accessible under the Genesys portal as this provides an opportunity for increased integration and standardization of data with other genebanks. CIP, CIAT and IITA have adopted GRIN-Global as their primary system for genebank data management, however, this system is considered too complex for a small genebank like CePaCT conserving less than 3000 accessions.

Output 2: Processes and systems for the conservation of germplasm and virus indexing improved/upgraded

Implementing a Quality Management System (QMS)

A regularly reviewed and validated QMS is essential to demonstrate the conformity to international standards and the commitment of genebanks to the sustainability of high-level quality operations, including staff training, health, safety and succession planning and comprehensive risk management.

All genebanks receiving a grant from the Crop Trust are required to establish a QMS or to obtain ISO certification to show to the international community that high and verifiable standards of operations are maintained. The Crop Trust has developed a QMS framework which encompasses documented procedures, policies, international standards, performance targets and best practices in the form of Standard Operating Procedures (SOPs) for specific genebank operations (acquisition, storage, regeneration and distribution). Currently, the CePaCT genebank is still at the basic level (undocumented) of QMS.

CePaCT staff continue to attend Genebank Operations and Advanced Learning (GOAL) workshops, where genebank operational issues are being discussed, including the development of SOPs. With the assistance of a Genetic Resources Expert, CePaCT staff mapped the key procedures of the Centre's genebank. Ten (10) SOPs have been defined: (1) Collecting; (2) Acquisition; (3) Seed Drying & Storage;

(4) Conservation (field & in vitro); (5) Distribution; (6) Germplasm Health; (7) Regeneration/Rejuvenation; (8) Characterization; (9) Safety Duplication; and (10) Documentation. After the mapping exercise CePaCT staff were tasked-based on their current responsibilities—to develop and maintain/update these SOPs. An intensive QMS training for CePaCT staff, including finalization of some of the SOPs was conducted in September 2018 with the Crop Trust QMS Specialist.

The CePaCT team will also address risk management by identifying the risks and developing an overall risk management plan and risk mitigation strategies that address the physical and biological risks identified in the FAO Genebank Standards including issues such as fire, floods and power failures. Equipment that is well-calibrated and functions accurately is an important aspect of quality management therefore CePaCT will also focus on testing and calibrating equipment and replacing those that have passed their serviceable age.

Building an internationally accredited Germplasm Health Unit (GHU)

GHUs are required to adhere to similar high standards of operation as the genebanks. Some genebanks (CIP and CIMMYT) have pursued ISO 17025 accreditation, and this is an option for the CePaCT GHU as well. The process of ISO accreditation takes time and is very expensive. CePaCT is currently liaising with an accreditation agency in New Zealand to see what accreditation actually entails, the costs and to ensure that the GHU can meet the required standards. Given the very high accreditation and annual assessment costs, CePaCT might initially go for BAF certification amounting to annual fees of only EUR470. International accreditation could be applied for at a later stage. Discussions at the Business Plan Stakeholder consultation also raised the possibility of utilizing a validation approach known as a ring test[6] which has been used for banana in the Pacific region.

[6] A ring test (also called as proficiency test) is an inter-laboratory test that allows the performance of testing laboratories to be assessed and is based on analysis of similar homogeneous samples.

Raising the overall standard of the GHU will require replacement and upgrading of equipment, some of which is more than seven years old. Replacement and new back-up equipment, total cost is amounting to EUR204, 723.

The Crop Trust review recommended that all arriving germplasm should first go into a quarantine holding area—to avoid virus infected materials compromising the viability of the CePaCT active or conservation collections—until virus-indexing can take place. CePaCT has responded to this recommendation and a screen house (post-entry quarantine facility) has been constructed.

The GHU will improve diagnostics through new research so as to accelerate the rate of germplasm indexing.

Rationalization of collections – identification and elimination of duplicates and creating core collections of major collections (taro, yam, sweet potato, banana)

CePaCT will embark on rationalizing its major collections through identifying redundancies in crop collections and establishing core collections of Pacific crops, commencing with taro and other edible aroids. Redundancies (identical or near-identical accessions) may occur in collections for various reasons, for example, documentation errors, exchange of identical accessions between genebanks and the sampling of populations from genetically homogenous collection sites. Redundant accessions require resources to maintain them, therefore identification and elimination of redundancies are important aspects of an efficient PGR management.

CePaCT will review the accessions obtained from the CGIAR genebanks and based on the results of Pacific evaluation data, decide whether or not CePaCT should continue to maintain them. Passport data, morphological data and importantly molecular markers can be applied to identify or validate redundancies. CePaCT will think of itself as part of a global germplasm system: it doesn't necessarily need to 'hold' accessions that are well conserved and readily available from other genebanks.

Core collections are an important component of any genebank; a good core collection should have no redundant entries, represent the whole collection with regards to species, subspecies and geographical regions and should be small enough to be easily managed. A core collection usually comprises about 10% of entries of the entire collection. Because a core collection is smaller in size compared to the whole collection, it enables some operations of the genebank, such as evaluation (of the selected accessions), to be handled more efficiently and effectively. The reduced size of a core collection is a key to its manageability and, in many cases the representation of the total collection's diversity enables the core to function as a reference set of accessions for the whole collection.

A DNA fingerprinting facility is under development (late 2018) with funding from the Treaty Benefit Sharing Fund, to enable CePaCT to carry out molecular characterization and progress the development of core collections. CePaCT will be involved in sample preparation and DNA extraction. All sequencing will be outsourced, and analysis carried out at partner universities. This genotyping capacity will facilitate a better level of quality and genetic integrity control through accession identification during acquisition, elimination of duplicates, clarification of taxonomic relationships and ploidy levels, and the stratification of collections according to genetic relationships and gene pools. The CePaCT team will also consider phenotypic and evaluation data before accessions are eliminated as duplicates. Sometimes genetically very similar genotypes might differ phenotypically in a single, but very

important trait, such as disease resistance. Core or mini-core collections can also be established around 'use' such as the climate-resilient collection.

For taro, a core collection has already been defined for the entries from the Pacific under the TaroGen project[7]. However, further accessions have been added to the taro collection from the Taro Network for Southeast Asia and Oceania (TANSAO)[8], from Indonesia, Philippines and Vietnam (Crop Trust-funded regeneration project) and INEA projects, and since TaroGen, genotyping protocols have changed and advanced. CePaCT will review the taro core collection to take into account the additions to the collection post-TaroGen. In addition, other edible aroids (*Alocasia macrorrhizos, Xanthosoma sagittifolium* and *Cyrtosperma merkusii*) require genotyping. The Crop Trust supported the development of an 'Edible Aroids Strategy'[9] which should be consulted as it provides very useful information for reviewing the existing taro core. For example, the strategy highlights that for both the TANSAO and TaroGen cores, the numbers held by CePaCT are less than originally selected. This is not due to losses in tissue culture, but because some were not deposited at CePaCT in the first place. For instance, the original core sample of TANSAO was 168 (134 diploids and 34 triploids), but CePaCT has only 120. There is a need to go through the list, identify those that are missing and determine if they are required.

Cryopreservation

Cryopreservation is a viable long-term solution for the security of the collections. CePaCT is planning to invest in cryopreservation for safety duplication of edible aroids, currently the largest collection, and coconut which is difficult to maintain in vitro. Core collections provide an option for long-term conservation and safety duplication of CePaCT's major crop collections. Once crop-specific, reliable cryopreservation protocols have been developed, legal arrangements shall be made to identify hosting institutions willing to accept CePaCT's core collection(s) to be kept in cryopreservation for safety backup. A Memorandum of Understanding (MoU) is in preparation with Bioversity International at the International Musa Transit Centre at the Catholic University Leuven (KULeuven), Belgium which could serve as cryopreservation duplication site for the key CePaCT crops of edible aroids and banana. IITA in Ibadan, Nigeria might be interested in safety duplicating CePaCT's yam collection, and CIP in Peru, CePaCT's sweet potato collection.

Cryopreservation expertise was developed in CePaCT through a taro cryopreservation project supported by the Crop Trust – some equipment was purchased and so is available, and one member of staff was trained in taro cryopreservation. CePaCT intends to establish a cryopreservation facility with liquid nitrogen producing capacity[10] supported initially by the ACIAR Coconuts for Livelihoods

[7] TaroGen, a 5.5-year project funded by AusAID and implemented by SPC in collaboration with IPGRI and USP, worked with national programmes to develop a regional strategy for taro genetic resource conservation and crop improvement.

[8] TANSAO a joint project on taro involving 2 European countries (France and Netherlands), 5 Asian countries (Indonesia, Malaysia, Thailand, Philippines, and Vietnam), and two South Pacific countries (Vanuatu and. PNG) launched in 1998 for a period of 3 years.

[9] https://www.croptrust.org/wp/wp-content/uploads/2014/12/EdibleAroids-Strategy-FINAL-13Jan10.pdf

[10] Liquid nitrogen is available in Fiji from one supplier (BOC Gases Fiji Ltd) but supplies in the past were not reliable.

project which is expected to start in 2019. Cryopreservation protocols for taro and coconut will be optimized over 5 and 7 years, respectively.

The CePaCT collections are relatively small in number and only two small cryo-tanks would be needed, hence the estimate for CePaCT's cryopreservation facilities are approximately EUR141,000 (that comprise a liquid nitrogen generator.

A long-term strategy for safety back-up of CePaCT's major crop collections under cryopreservation could be as follows:

Transfer a genetically non-redundant subset (core collection) of taro, banana, sweet potato, and yam into cryo-storage, with two copies per accession:

- 1 copy for a base collection at CePaCT headquarters
- 1 copy for safety back-up at Bioversity International / KULeuven, Belgium (taro, banana), IITA, Nigeria (yam), CIP, Peru (sweet potato).

Tracking and monitoring genebank operations

The Crop Trust review recommended the use of a barcoding system for better management and tracking of the routine operations applied to the accessions for their conservation, and to link this information with the documentation system. CePaCT will follow up on the recommendation from the Genetic Resources Expert for the CePaCT database and documentation officer to receive short-term training to be able to further develop the CePaCT documentation system with integrated barcoding functions. After appropriate training, the officer will be responsible for the implementation of a barcoding system and its effective integration into the database.

The Treaty is deploying the Global Information system (GLIS) and introducing Digital Object Identifiers (DOIs) as a common standard to uniquely and permanently identify PGR and to trace the movement of germplasm under the Treaty Multilateral System (MLS). DOIs provide a single standard for the identification of PGR of any kind, in contrast to existing identifiers designed for particular communities such as genebanks and breeders. All genebanks receiving funding from the Crop Trust are expected to use DOIs when sharing germplasm.

Output 3 Pacific Islands Tree Seed Centre merged with CePaCT and operations improved

The PITSC was established in response to a Strategy and Action Plan for the Conservation, Management and Sustainable Use of Forest and Tree Genetic Resources in the Pacific approved by the Ministers of Agriculture and Forestry in 2008. One of the major recommendations under the endorsed regional strategy, and in line with the LRD Strategic Plan 2009-2013, was the establishment of a regional tree seed centre within CePaCT to assist PICTs to collect and share germplasm of priority woody species.

A draft strategy for the merger of PITSC with CePaCT has been developed which emphasizes the role that trees play in boosting the resilience of production systems. The draft strategy points out that integration will maximize use of resources and ensure efficient utilization of human resource and capital across both tissue culture and seed-based conservation efforts. Specialized services such as pathogen testing will not be duplicated and can be standardized. Synergies in this potential integration exist with regards to the implementation of QMS, for example, and the development of joint proposals

for roots and tubers and trees. Further, breadfruit is already part of the CePaCT collection and coconut is coming on board soon. During the Pacific Seed Forum, the question of CePaCT expanding its crop focus to vegetable seeds was raised. In the end consensus was reached around traditional vegetables to be incorporated into CePaCT, possibly at a later date, when processes and systems have been improved and staffing and funding constraints addressed. This opens up the possibility that the integration of the PITSC could not just focus on tree seeds (timber, fruit/nut trees, and shrub species) but seeds of traditional vegetables as well which are key to Pacific food and nutritional security and livelihoods. All these crops and species are of high regional importance in terms of food and nutrition security, coastal protection, cultural use, and traditional medicines.

Upgrade facilities and capacity building of staff for the conservation of orthodox seeds of tree and vegetable species

There is recognition of the need to provide adequate funding for improving the collection and conservation of significant Pacific Island tree species and traditional vegetables. The PITSC equipment is relatively new and does not yet require replacement. A Due to the lack of drying and medium-/long-term storage facilities for orthodox seeds, all tree seed accessions collected in PICTs are currently conserved at the Millennium Seed Bank (MSB), Kew, UK. The total capital investment needed for PITSC equipment is EUR99,400.

Build staff capacity and develop SOPs for processing and storage of orthodox seeds and other procedures

There is a need for building staff capacity in the processing and storage of orthodox seeds and the development and implementation of corresponding SOPs. A collaboration with international centers might prove useful for issues regarding tree seed conservation and storage.

4.3.2.2. Intermediate Outcome 2 : Utilization of genetic resources

Increase in the availability and utilization of highly nutritional, disease-free and climate-resilient crop and tree varieties

Given the increasing need for locally adapted, climate-resilient, and nutrient-dense quality seed and planting stock of food and tree crops, the Genetic Resources pillar in conjunction with the Sustainable Agriculture pillar will build regional, national and community-based capacity in all relevant areas of genetic resources (germplasm conservation, enhancement and utilization) and seed/planting material supply networks, so that farmers have timely access to and can grow climate-resilient and healthy food crops. CePaCT conserves the region's major staple food crops with over 2100 accessions, including taro, yam, sweet potato, banana, cassava and breadfruit.

CePaCT will support farmers in their efforts to implement resilient production systems of healthy crop varieties by enhancing the diversity and resilience of its crop collections and making locally adapted, climate-resilient and nutrient-dense planting stock of food and tree crops available for distribution. CePaCT usually distributes its high-quality planting stock to national research and extension systems, rather than directly to farmers. To ensure that farmers can benefit from CePaCT's work on climate-resilient and nutrient-dense crop germplasm, the Centre is building capacity at the national and community levels in the safe handling and management of tissue-cultured planting stock, its field establishment, multi-locational testing, including participatory plant breeding and selection and in the multiplication and distribution to farmers. Through these measures, the genetic resources pillar

strengthens resilient food production systems, food and nutrition security and livelihoods in the Pacific.

Two outputs contribute to achieving the Utilization Outcome:

- Output 4. Diversity, nutritional content and climate resilience of crop collections at the national level and at CePaCT enhanced
- Output 5. Local capacity to test, manage, and distribute planting materials to farmers strengthened

Output 4: Diversity, nutritional content and climate resilience of crop collections at the national level and at CePaCT enhanced

Policy development and compliance

The Crop Trust review recommended that the CePaCT genebank supports PICTs in achieving the implementation of the FAO Second Global Plan of Action for the Conservation and Use of PGRFA, as part of the global system, specifically for the priority activities for *ex situ* conservation, in serving as safety backups for the national collections, in building capacity and in promoting use of PGRFA of importance in the region. Further, the Business Plan Consultation highlighted the importance of creating an enabling policy environment for PGR across all sectors. CePaCT will work with the Pacific Seeds for Life (PS4L) initiative in this regard. A first step will be the development of a policy brief which will focus on the importance of PGR for food and nutrition security with an emphasis on climate change resilience and nutritional well-being, to be presented at the HOAFs meeting in 2019.

Linked to this policy brief will be efforts at the national level to create awareness about genetic erosion and of the various different conservation approaches. There is little information available in the Pacific on *in situ* conservation, on-farm conservation and community genebanks. Establishment of community seed banks in target communities is a planned outcome from the PS4L initiative.

These conservation approaches are important in the deployment of crop diversity, especially in the larger and more fragmented islands, facilitating more wide-reaching distribution through farmer-to-farmer exchanges and promoting participatory varietal selection and breeding. Capacity building in these conservation approaches using lessons learned from elsewhere would be a valuable development and supportive of resilient food systems. Melanesian countries do have experience in community genebanks and *in situ* and on-farm conservation which would be valuable for other countries to draw on and develop. An interesting example is the National Agriculture Research Institute (NARI), Papua New Guinea (PNG) where studies have been conducted on *in situ* and on-farm conservation.

CePaCT will draw and build on this information and develop policy guidelines for the different conservation approaches, including *ex situ* for those PICTs who are interested in establishing national genebanks. Working with PS4L, CePaCT will aim to establish best practices for community genebanks.

CePaCT will ensure that it is well versed in all international agreements and conventions relating to PGR and will keep PICTs updated on new developments. The currently used Material Transfer Agreement Letter (MTAL) requires some attention to ensure it is not in conflict with the conditions of

the Treaty Standard Material Transfer Agreement (SMTA). CePaCT will consult with the Treaty legal advisers to ensure that the MTAL conforms to the conditions of the SMTA. CePaCT will also register as an Easy SMTA user to eliminate the burden of reporting the issuance of SMTAs to the Treaty on a regular basis. The Centre will support recipients of CePaCT germplasm to register on the Treaty Easy SMTA website.

Twelve (12) PICTs are Contracting Parties to the Treaty; both France and USA are signatures to the Treaty which means that the French and American Territories are also covered. CePaCT will support the remaining PICTs to become Parties.

Collecting and acquisition

CePaCT will consult with countries and crop experts to identify valuable germplasm under threat of genetic erosion. CePaCT will follow the FAO Genebank Standards, which provide best practice guidelines on how to implement collecting missions and protocols for acquiring germplasm. If collecting is required to complement the existing taro core collection, then the Edible Aroids Strategy would be a good guide as to gaps in the collection, together with advice from several taro experts in the region. The definition of valuable germplasm will cover geographical, taxonomic, trait and genetic gaps in the collection, to be filled through collecting or complementary conservation strategies, for example, community genebanks. Expanding and strengthening the climate-resilient collection will be a priority, once funds are available, and collecting missions will be implemented associated with this activity, after prioritization of sought-after climate resilience traits. CePaCT will conduct multi-crop collecting missions with national partners, where appropriate.

Participants of the recently held Pacific Seed Forum suggested that CePaCT should include coconut as mandate crop and this is likely to happen through an ACIAR-funded 'Coconuts for Pacific Livelihoods' (CPL) programme, with activities cutting across various LRD pillars. The CPL programme will link with SPC's Geoscience, Energy and Maritime (GEM) Division to avail of the use of remote sensing and GIS and related techniques to identify coconut genetic diversity under threat of genetic erosion and to plan and direct an integrated management approach to Coconut Rhinoceros Beetle (CRB), including its Guam strain (CRB-G). The research work on CRB-G will draw on the expertise of Pillar 3 – enhanced pest and disease management. To address market issues and explore market potentials of coconut and its value-added products, the programme will closely collaborate with Pillar 4 – Markets for Livelihoods and Value Chains.

Improving evaluation of germplasm distributed by CePaCT and the feedback of information

Out of the 4,500 accessions distributed by CePaCT from 2009 to 2015, there is little information on how many accessions survived over the medium and long-term, how they were evaluated, and the results that were obtained. Furthermore, due to poor national seed systems, few of the accessions are getting to the farmers. This means that CePaCT is not accumulating sufficient information on its accessions so that further distributions can be made with confidence that they will meet country expectations and respond to the needs of PICTs.

The recently held Pacific Seed Forum in Nadi, Fiji (June 2018) and the follow-up meeting in November 2018 emphasized the need to improve evaluation of the CePaCT germplasm and in general for PICTs to have more standardized protocols and user-friendly tools to characterize and evaluate PGR. The difficulty faced in identifying varieties was raised, as common practice is for varietal names to be changed as they are transferred to different users.

Recommendations from both meetings included the use of technical tools such as KoBo Toolbox[11], which have offline capacity, for gathering data in the field; a mobile app for helping to identify diversity in the field and related issues, such as biotic and abiotic stresses; and for countries with poor internet connectivity, simplified evaluation forms, which will take into account the need for user-friendly descriptors.

Crop evaluation protocols for screening of germplasm for abiotic and biotic stresses are an urgent need. Protocols were developed under the ICCAI[12] and INEA but are still embedded in project reports and are yet to be extracted to form a user-friendly tool. These protocols are very important considering the support needed from the region for building a reliable CePaCT climate-resilient collection.

CePaCT will work with countries and partners in simplifying the CePaCT evaluation form and workshops will be held to both provide training in the use of these forms, and at the same time, allow for modifications – this would support the ownership and adoption by the countries. CePaCT will also explore the possibility of introducing KoBo ToolBox for gathering evaluation data through the PS4L initiative. Discussions will be held with MORDI in Tonga and/or the Agriculture extension services in the Solomon Islands[13] to see how a pilot could be established to evaluate the use of KoBo ToolBox.

In developing user-friendly descriptors for evaluation and characterization, CePaCT has worked with NARI, PNG to develop minimum descriptor lists for major Pacific crops. Progress has also been made by INIBAP/Bioversity International on developing minimum descriptors for banana. Under the INEA, in Vanuatu, a seven-character vegetative index is used to score taro. Such an index could become standard throughout the region, and indices for other crops could be selected. User friendliness is a feature of the minimum descriptors, including a good set of photographs; such images can be used with an app for crop/variety validation. CePaCT will continue to develop descriptors with partners which will help in improving the collecting and sharing of crop- and accession-specific information on PGR generally, and on the distributed CePaCT accessions in paticular. Discussions will be held with experts to see whether a mobile app could be developed, possibly as an addition to an existing successful app, such as PestNet[14].

CePaCT will work with the Departments of Agriculture, NGOs, universities and research organizations to form consortia to carry out the evaluations needed. Some countries due to their widely differing environments, for example, Solomon Islands and Vanuatu, could deliver valuable evaluation information from country-wide, multi-locational evaluation trials. Consortia could also be formed between countries to evaluate crop collections in different environments. At the Pacific Seed Forum, atoll countries expressed their willingness to be involved in such evaluations which would provide useful information for building a climate-resilient collection.

Building a climate-resilient crop collection for the Pacific region

The CePaCT response to supporting the PICTs in adapting to climate change has been to promote and distribute diversity, in particular, to develop a climate-resilient crop collection, a collection of

[11] Some countries in the Pacific, such as Solomon Islands and Tonga, have been using this tool and provided positive feedback on its use.

[12] ICCAI: International Climate Change Adaptation Initiative funded by AusAID

[13] Both MORDI and Solomon Islands Agriculture extension have experience in using KoBo ToolBox

[14] http://www.pestnet.org/PestNet.aspx

accessions that countries can use as insurance against the vagaries of climate changes. PICTs have expressed their support for this initiative at various meetings and this support was confirmed emphatically at the recent Pacific Seed Forum.

The climate-resilient collection has been established from crops and varieties that have demonstrated tolerant traits in countries of the Pacific or Asia, for tolerance to drought, salt water, waterlogged soil, or other climate-change related attributes. It is emphasized that the collection contains crops/varieties that could help with managing climate variability[15], but the level of tolerance to abiotic stress has to be determined by further evaluation. The collection currently comprises 131 accessions, consisting of 57 sourced locally from within the Pacific Island region and 74 sourced from outside of the region, mostly from the CGIAR genebanks. Despite the challenge in obtaining evaluation information, the evaluation data that does exist tends to indicate that locally-adapted crop diversity can perform better than germplasm imported from the CGIAR genebanks, for example, sweet potato.

CePaCT staff will develop a proposal aiming at sourcing funds to expand and develop this area of work. The new focus will be on a Pacific-specific collection. The diversity in PICTs and in farmers' fields will be assessed through national consultations with farmers, farmer organizations, government extension and research staff, so that accessions which have demonstrated resilience to climate change (extremes and variability) can be identified. Countries would be supported to further evaluate selected accessions using the screening protocols developed by CePaCT. Further consultations will identify which of the nationally-selected accessions should be held by CePaCT in the regional climate-resilient collection. For example, the Solomon Islands Ministry of Agriculture and Livestock (MAL) were partners in the EU-Agriculture and Rural Development project (EU-ARD)[16] project made some significant gains, such as: (a) promising drought and excess moisture tolerant sweet potato accessions identified – and pathogen-tested materials available; (b) identification of four sweet potato varieties showing tolerance to drought and three varieties with tolerance to excess soil moisture conditions; and (c) identification of salinity tolerant sweet potato varieties among 38 tested *in vitro*. There is also scope to enhance the resilience potential of the climate-resilient collection through the import of aroid germplasm from elsewhere – in particular, cocoyam (*Xanthosoma sagittifolium*) and Colocasia eddoes.

For the existing climate-resilient collection, CePaCT will carry out multi-locational evaluation (comparing with local germplasm), in partnership with PICTs. Discussions have been initiated with the Fiji Ministry of Agriculture in this regard, and other countries expressed an interest in participating in this initiative at the Pacific Seed Forum, including some atoll countries.

Supporting nutrition outcomes

Reports in the literature inform of projects where nutritionally rich crops have been promoted to achieve changes in nutritional status and improvements in health. Orange-fleshed sweet potatoes (OFSP) have been used in many African countries to combat Vitamin A deficiency – efforts are now

[15] Crop diversity: A tool for managing climate variability. AusAID International Climate Change Adaptation Initiative (Phase 2). March 26–30, 2012. Suva, Fiji

[16] A five-year Project financed by the European Union, overall objective is to mitigate climate change associated risks to food security and livelihoods for vulnerable smallholder farming communities in Western Pacific Countries – PNG, Solomon Islands and Vanuatu

ongoing in several countries in Africa and in India to deliver OFSP to millions of households. OFSP projects have seen the inclusion of OFSP in school meals as part of efforts to improve the nutrition of children[17]. Closer to home, in Solomon Islands, the promotion of OFSP and other crops by an ACIAR-funded project reaped success in increasing the use of vegetables and fruits, in particular those with yellow and orange flesh, compared to before the project intervention[18].

Merely distributing nutritionally rich varieties is unlikely to have the desired impact on diet and health. Therefore, CePaCT will establish partnerships that ensure distribution activities are supported by an enabling framework of promotion, evaluation and value-adding (for example, converting staples such as breadfruit into a more 'convenient' form of food). As discussed in the LRD BP, more integrated programming of SPC will see LRD working with the SPC Public Health Division in awareness creation and promotion of healthy local diets and use of traditional crop varieties.

Working in partnership with regional and national public health sectors will facilitate the monitoring of the health impacts of any food biodiversity or agricultural diversity intervention. Cross-sectoral partnerships are not easy but examples exist from projects implemented in other parts of the world as to how such partnerships can be developed. Partnerships will also be required for the nutritional analysis of food crops and varieties, as SPC does not have that capacity; it exists within the region at USP, Suva, or outside the region, for example, the University of Adelaide, who were involved in OFSP work in Solomon Islands.

Partnerships with farmers' organizations and the private sector can also prove fruitful in promoting nutritionally-rich diversity and can lead to engagement with interventions such as school gardening/feeding programmes. Home gardening programmes can also help to preserve and increase consumption of traditional varieties and crops of high nutritional value. The World Food Programme (WFP)'s Home Grown School Meals initiative is linking school meal programmes with local smallholder farmers to provide millions of schoolchildren in 46 countries with food that is safe, diverse, nutritious, and above all local; CePaCT will explore the opportunities to work with WFP in this area.

Participants of the Pacific Seed Forum strongly supported work in this area, highlighting the huge challenge facing PICTs with the NCD epidemic that is sweeping the Pacific. CePaCT, therefore, will work with partners to develop funding for an agrobiodiversity for food and nutrition project. In addition, CePaCT will identify partnerships and projects where the involvement of CePaCT with distribution of nutritionally-rich accessions, would provide added value and help to optimize nutrition outcomes.

Output 5: Local capacity to test, manage, and distribute planting materials to farmers strengthened

Improving management of planting materials

The Crop Trust and the Jackson and Walton (2016) reviews considered that limited national capacity was the major constraint to adequate evaluation and successful uptake of germplasm distributed by CePaCT. To improve the efficiency of the distribution process and importantly strengthen the flow of

[17] http://reliefweb.int/report/nigeria/orange-fleshed-sweetpotato-school-meals-improve-nutrition-and-cut-nigeria-s-wheat

[18] https://www.adelaide.edu.au/lumen/issues/36681/news36701.html

PGR to the farmers, CePaCT is aware that it has to increase its efforts to build national capacity in the handling of tissue culture plantlets and to strengthen local seed systems.

CePaCT will conduct training activities at its base in Fiji and in selected PICTs to strengthen national skills in handling, hardening and field establishment of tissue culture planting material. This training need was also identified at the Business Plan Consultation to help in reducing the losses that can occur in the acclimatization of tissue culture plants prior to field establishment. Yam and cassava plantlets were noted as difficult. CePaCT will partner with farmer organizations through the Pacific Island Farmers Organisation Network (PIFON) to maximize the outreach of any training. YouTube videos will be compiled of the training to further enhance outreach.

Building a network to support evaluation and drive utilization

CePaCT works with the PICTs through the Pacific Agricultural Plant Genetic Resources Network (PAPGREN) which was established in 2001 to support work in the region on plant genetic resources and funded by the New Zealand Agency for International Development (NZAID) and the ACIAR. The network is open to all 22 SPC member countries, and the stakeholders include mainly government ministries, with some (limited) involvement of farmer groups, planting material networks, universities and others. PAPGREN aims to support national programmes in targeting the conservation, utilisation, exchange and management of PGR. Building institutional capacity of SPC member countries was a focus of the PAPGREN – and this was achieved during the years of targeted donor funding. Donor funding specifically for PAPGREN ended in 2009, however SPC continues to source funding, and submit proposals where possible, to support the activities of the network. Funding has been obtained from the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) benefit sharing mechanism for those countries that have ratified the Treaty. PAPGREN meetings are still held

– the two most recent ones were in 2014 and 2017 - where countries and SPC reported on activities and new developments in the PGR field.

PAPGREN provides the institutional mechanism for PGR activities in PICTs and has supported CePaCT in the distribution and evaluation of germplasm, amongst other activities. Since funding for PAPGREN ended in 2009, the network has to some extent, drifted, with minimal funding support, sustained largely by the enthusiasm of its members and commitment from CePaCT staff. At the 2017 PAPGREN meeting, the participants agreed that for PAPGREN to be effective, the network should become more formalized and institutionalized with a defined role and scope, and that there should be more support for the network at the national level.

PAPGREN's functions are likely to revolve around some or all of the following:

- Coordinate and monitor CePaCT activities in-country
- Facilitate interaction and networking to promote PGR in country, with support from CePaCT, across all sectors and support mainstreaming of PGR into policies, strategies and action plans.
- Develop and promote evidence-based best practices and identify capacity building needs
- Enhance CePaCT (and PAPGREN) links with national, regional and global agencies, institutions and organisations in-country
- Facilitate the flow and sharing of PGR-related information within the country.

PAPGREN will have to work with a functioning seed system to enable effective distribution of CePaCT materials in-country in such a way that they benefit farmers. A sustainable seed system will ensure that high-quality planting material is produced and available in sufficient quantities and at the right time and affordable to farmers and other stakeholders. The lack of effective seed systems in PICTs was highlighted when a survey was carried out by SPC to determine how best to rebuild the agriculture sector post-disaster[19].

The Pacific Seed Forum fully supported the decentralised seed systems approach, acknowledging that some countries are more advanced than others in managing, testing and sharing seed and planting material with the ultimate beneficiaries, the small-scale farmers,. A value chain approach to seed system analysis could identify actors, functions and linkages so as to identify gaps and weak links.

CePaCT will embark on a decentralized seed systems approach using the 'octopus model' to ensure that seedlings are delivered more responsively and regularly to farmers, leading to an increased adoption of CePaCT germplasm by the farming communities. CePact will partner with the Ministries of Agriculture to accredit capable non-government organizations (NGOs, private sector, farmer associations) to be able to request approved materials directly from CePaCT – thereby reducing red-tape without compromising Biosecurity. An important aspect of the 'octopus model' is the presence of multipliers at the national level (tissue culture laboratories, NGOs, private sector) - partner organizations that are better placed to provide services such as multiplication at a local level - in the system, so that CePaCT is supported in the provision of planting material and the volume of planting material is not a constraint. With a functional decentralized seed system in place, supported by the 'octopus model', CePaCT-derived germplasm is expected to be used by 15 000 small-holder farmers in 2021, and 90 000 farmers in 2024. Ten years after the start of the new program, 1 million people (farmers and consumers) are expected to benefit from CePaCT-derived germplasm in terms of stable yield, improved income and better nutrition.

CePaCT will work with the PS4L integrated project in strengthening seed systems to improve outreach of germplasm and information. First steps will be facilitating scoping studies to obtain baseline data, and information around partnerships, roles and functions.

The utilization of germplasm includes the capacity to select and breed for locally adapted PGR. Capacity building in participatory varietal selection (PVS) and participatory plant breeding (PPB) will be carried out by CePaCT. Some PVS and PPB training has been conducted in Cook Islands, Fiji and Tonga. Breeding expertise from the Ministries of Agriculture in Samoa, NARI in PNG and VARTC in Vanuatu will be utilized to support this training.

Partnerships will be essential in supporting evaluation and driving utilization and these are discussed in section 5.6.

Ensuring benefits to smallholder farmers, including women and youth

CePaCT will conduct regular user surveys among CePaCT germplasm recipients in PICTs concerning quality of material received, rate of establishment, local performance and number of farmers reached (including women and youth). An automated survey will be established by 2019.

[19] http://pafpnet.spc.int/attachments/article/501/Consolidated%20Responses_Re-bulding%20the%20Agri%20sector%20%20Farmer%20Livelihoods-Post-Disaster.pdf

CePaCT will ensure that in all its activities from collecting to distributing germplasm, including capacity building, smallholder farmers, women and youth will be included.

Impact assessments of awareness campaigns, capacity building and germplasm distribution will enable CePaCT staff to get a better understanding of the Centre's outreach to the stakeholders in the Pacific region. Impact research is particularly important to assess what factors are influencing uptake and adoption of PGR.

As described further below in section 5.6, partnerships will be crucial and CePaCT will work with farmer organizations such as (PIFON)[20], Kastom Gaden Association – KGA (Solomon Islands) and Mainstreaming of Rural Development Innovation (MORDI) Tonga Trust to ensure benefits reach farmers.

4.4. Risk Management

Risk management is of paramount importance to the sustainability of the collections. CePaCT will, as a matter of priority, explore with key stakeholders various options for safety duplication of its tissue culture collections at another location, in another country as a medium-term solution for the security of its collections. Cryopreservation is a viable long-term solution for the security of the collections. CePaCT is planning to invest in cryopreservation for safety duplication of edible aroids, currently the largest collection, and coconut which is difficult to maintain *in vitro* with key stakeholders.

While safety duplication ensures that collections are not lost, the physical infrastructure and operations of a genebank remain vulnerable to extraordinary natural and man-made disasters. Therefore, CePaCT is in the process of establishing a solid concrete structure - called 'CePaCT Emergency Seed Vault' which will accommodate a safety duplicate of three (3) flasks per accession of the entire collection to be checked monthly. CePaCT staff will also integrate risk management aspects in each major genebank procedure (SOP). SOPs are currently under development as part of a comprehensive QMS and will be validated by Crop Trust staff. These highly refined genebank procedures will help control many of the risks affecting long-term conservation and distribution of germplasm.

As part of risk analysis and mitigation, CePaCT will also establish an Operational Health and Safety Plan and a Staff Succession plan. CePaCT staff will revise and update risk management strategies as defined under each SOP, annually. This level of risk management is of paramount importance to the sustainability of the collections. The risks and risk mitigation measures are described in detail in Appendix 4.

[20] http://www.pacificfarmers.com/

5. Program implementation

The program will be implemented by the Land Resources Division (LRD) of the Pacific Community (SPC). SPC has been established by treaty in 1947 as an International Organization, owned, and governed by 26 members including 22 Pacific Island Countries and Territories (PICTs). The LRD is one of SPC's 10 Divisions and/or programs. LRD's mission is to provide expert scientific advice and services on agriculture and forestry, promoting the latest innovative and relevant applications for sustainable food and nutritional security and assisting in building resilience for the Pacific Communities. One of LRD's main pillars is the Centre for Pacific Crops and Trees (CePaCT), established in 1998 with funding from the Australian Government and the European Union.

5.1. Organisation and management

LRD's structure comprises four pillars: (1) Genetic Resources (where CePaCT is housed); (2) Sustainable Forests and Land Management; (3) Sustainable Agriculture; and (4) Markets for Livelihoods and four integrated programmes. The pillars individually and collectively develop and implement programmes, projects and activities to deliver outcomes contributing to LRD's objectives. Supporting the technical work of the pillars are LRD's advisory services in (1) Climate Smart Agriculture, (2) Research for Development, (3) Plant Health and Biosecurity and (4) Animal Health and Production. The matrix structure enables the development of an integrated work programme based on a value chain model, starting with genetic resources and ending with consumption and markets and improved livelihoods. The flexibility and efficiency of the structure allow for projects housed in one pillar to have a number of its components implemented through other pillars, while ensuring that expertise via the advisory services is available to these projects. The structural efficiency, moreover, avoids duplication. LRD is also working on different scenarios for a decentralized setup including the improvement of access to genetic resources across the Pacific. This will have const implication in the medium to long-term.

5.2. Staffing Plan and indicative organizational chart

As of January 2019, CePaCT is planning to have 26 staff positions (of which 16 are currently filled). The staff list comprises a Programme Leader as Leader of Pillar 1 - Genetic Resources; a Seed Systems Expert and a Field Technician for outreach activities to address the stronger focus on evaluation and utilization of germplasm; a Curator overseeing conservation and distribution activities of the CePaCT genebank; a Germplasm Health Scientist heading the Germplasm Health Unit, and a Coconut Genetic Resources Expert liaising with APCC to coordinate regional coconut germplasm conservation and utilization issues and liaise with the ACIAR-funded coconut livelihoods project (expected to begin in January 2019). There is an indication that Bioversity International might be willing to fund the coconut expert during the first three years (2019-2021). Furthermore, there will be a Documentation and Database Officer, a Finance Assistant, an Administrative Assistant, 2 Senior Research Technicians (responsible for *in vitro* culture activities), 3 Senior Lab Technicians (virology, molecular biology, cryopreservation), 1 Tree Seed Technician, 1 Research Technician (orthodox seeds), 3 Lab Technicians, 6 Lab Assistants, and 1 Lab cleaner. All staff are based in Suva. The Organizational chart for CePaCT is detailed in Appendix 3.

5.3. Supporting a rights-based approach (gender and indigenous groups)

Broadly, a rights-based approach is about putting people at the centre of development, ensuring that programme activities and outputs benefit all, and especially those most marginalized. A rights-based approach has been framed appropriately as 'people-centred and participatory' development. In strengthening the resilience of food production systems and contributing to nutrition improvements, CePaCT will be supporting the building of social, cultural and economic assets among vulnerable groups.

CePaCT, through LRD, will work in close collaboration with SPC's Social Development Program (SDP) and cross-cutting programmes to integrate gender empowerment and social inclusion into programmes and activities. These activities may include the integration of youth perspectives and efforts to understand the social and cultural contexts influencing adoption (or not) of diversity.

Gender issues, and rural women, are crucial to the conservation and use of PGR, being responsible for ensuring household food security and family health (often through home gardens), although their roles vary in different contexts. When women are involved in varietal selection for gardens they consider not only agronomic characteristics, but also those related to nutrition, processing, storage and consumption needs. Home gardening activities can support dietary improvements and contribute to women empowerment through income generation[21]. CePaCT will ensure that programmes and activities are supportive of women and the important role they play in the conservation and use of PGR. Similarly youth involvement in agricultural initiatives is crucial for the future of agriculture in the Pacific. CePaCT will endeavour to ensure that initiatives target youth, wherever possible; a partnership with Tei Tei Taveuni[22], based on evaluating some of the CePaCT collections will be explored.

5.4. Capacity building

Sustaining and augmenting of capacity at the national and regional level is fundamental to the development of a more effective network of partners which will contribute to the overall global system of conservation and use of PGR. Capacity development is also fundamental to the strengthening of genebank operations and efficiency. QMS will provide an important framework by which capacity needs can be assessed and addressed at the level of individual staff as well as at a genebank level. The standard operating procedures (SOPs) and staff time allocations to specific operations will introduce a means to further monitor CePaCT capacity and capacity development.

The Crop Trust review recommended that a twinning arrangement with an internationally reputable institution be established to allow technical, capacity building exchanges to take place. SPC-CePaCT has already responded to this recommendation and a draft MOU with Bioversity International is about to be concluded with the aim to establish close links between CePaCT and the International Musa Transit Centre in Leuven, Belgium. Such a twinning arrangement will enable the building of technical capacity which would support the further development of new and existing staff of the genebank through mentoring, additional training, refresher courses, more advanced training so as to keep the staff up to date with the latest techniques of tissue culture, genebank management, new conservation methods, and cryopreservation.

[21] http://ifad-un.blogspot.com/2016/09/home-gardening-in-kiribati-brings.html

[22] http://teiteitaveuni.com/

CePaCT staff will also improve linkages with the CGIAR genebanks generally to benefit from the expertise across the Centres through technical exchanges and participation in GOAL (genebank operations and advance learning) workshops, which bring together genebank staff to share their expertise and perspectives in implementing and optimizing operations, meeting standards and achieving efficiencies.

Capacity building outside of CePaCT in the conservation and use of PGR will take place through workshops, training sessions and open field events in response to PICTs' specific needs. Of priority is strengthening skills in the handling and acclimatization of tissue culture plants to support distribution efforts and improve uptake of diversity, and enhancing national capacity in characterization and evaluation of PGR to enable progress to be made in the establishment of the climate-resilient collection. As with internal capacity building, partnerships will be essential in assisting CePaCT to carry out in-country capacity building to improve conservation and use skills, for example, community genebanks and participatory plant breeding. The CePaCT website will also be harnessed as a tool to disseminate protocols, training resources and knowledge related to plant genetic resources.

The Genetic Resources Pillar will build regional, national and community capacity in all relevant areas of genetic resources management (conservation, development and utilization) and seed/planting materials supply networks, and will ensure access to food crops as part of its Disaster Risk Reduction (DRR) mainstreaming strategy in partnership with global networks and treaties. It will also put in place an effective risk mitigation strategy (see subsequent section 8) which may include setting up decentralized conservation / utilisation hubs.

5.5. CePaCT's current and future partners

5.5.1. Partnerships at global level

At the global level, the Global Crop Diversity Trust (**Crop Trust**) is a key partner to the Centre for Pacific Crops and Trees (CePaCT). Apart from providing financial resources to CePaCT, the Crop Trust through its supervisory role in the management of the Genebank Platform CRP, under which all 11 CGIAR Centres with genebanks operate, enables CePaCT to access knowledge platforms of the CGIAR and to engage directly with CGIAR genebanks for sharing of latest information and know-how as well as germplasm. The Crop Trust provides substantial technical support to CePaCT through capacity-building measures such as GOAL (Genebank Operation and Advanced Learning) workshops, documentation audits, QMS intensive courses, and external genebank reviews. The support provided by the Crop Trust helps to establish a regularly reviewed and updated QMS at CePaCT that is essential to demonstrate the conformity of the Centre's operations with international genebank standards, including staff training, health and safety of staff, succession planning and comprehensive risk management. A regularly validated QMS can provide confidence to donors and partners that the institute is operating at the level of internationally agreed standards.

CePaCT is in the process of establishing a twinning arrangement with Bioversity international's **Musa Transit Centre** in Leuven, Belgium and the **International Potato Center (CIP)** in Lima, Peru to allow exchanges for enhancing technical capacity in *in vitro* genebank management, new conservation methods, barcoding, cryopreservation, database management, and joint proposal development.

Existing collaborations with other CGIAR Centres and programmes working on similar crops and conservation methods, for example, with **CIP**, **CIAT** and **IITA**, will be strengthened to keep abreast of

crop developments that could be of use to Pacific farmers. The mentioned Centres might also serve as partners for the safety backup of crop germplasm conserved at CePaCT.

Linkages with **CGIAR** programmes with shared thematic areas, such as the Climate Change, Agriculture and Food Security (CCAFS), will be explored. Similarly, global development programs within the context of NCD's and improved adaptation to climate change will be pursued with partners such as the Green Climate Fund (**GCF**), the Global Environment Facility (**GEF**) and accredited partners including GIZ, and FAO among others.

Outside of the CGIAR, AIRCA, the Association of International Research and Development Centres for Agriculture is of interest to CePaCT for building partnerships. Among the AIRCA members, the **World Vegetable Center** headquartered in Shanhua, Taiwan is already collaborating with SPC-CePaCT by providing climate-resilient and nutrient-dense vegetable varieties to countries in the region. The World Vegetable Center is dedicated to healthier lives and more resilient livelihoods through greater diversity in what we grow and eat and could offer significant support for diversification in vegetables to improve nutritional security of the people in the Pacific.

ICBA, the International Center for Biosaline Agriculture with headquarters in Dubai, United Arab Emirates might become an essential partner for developing protocols and screening for salinity and drought tolerance of crops. ICBA is building partnerships to deliver agricultural and water scarcity solutions in marginal environments.

In 2009, SPC-CePaCT signed an agreement with **FAO** and designated all its crop collections under the auspices of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) to facilitate germplasm conservation and exchange within the Pacific as well as globally under the ITPGRFA. CePaCT encourages countries in the Pacific to sign and ratify the ITPGRFA to facilitate access and benefit-sharing mechanisms under this international treaty. Furthermore, CePaCT supports PICTs in the implementation of FAO's second Global Plan of Action (GPA) for the conservation and sustainable utilization of PGRFA.

CePaCT is initiating a collaborative project with the **International Atomic Energy Agency** (IAEA) on adaptation to climate change. Nuclear and related techniques can induce variability in crops that make them tolerant to drought, salinity or pests, thus, complementing traditional breeding techniques.

5.5.2. Partnerships at regional level

CePaCT will strengthen and formalise partnerships (to define roles) with regional agencies. In the past, university researchers supported CePaCT in developing protocols, for example, in vitro salinity testing and taro somatic embryogenesis. CePaCT staff have both carried out further studies (Masters and PhDs) in collaboration with regional and overseas universities, and engaged in teaching activities in regional universities. CePaCT will also look to the Universities in Australia and New Zealand, where collaborations and partnerships are generally established for specific projects. In the 1990s, research scientists from overseas were attached to regional agencies to gain experience and at the same time mentor local staff; revival of this arrangement would benefit CePaCT. The Vanuatu Research and Technical Centre (VARTC) have experience of collaborating with French universities and could provide guidance to CePaCT.

CePaCT is working closely with the Australian Centre for International Agricultural Research (**ACIAR**), a valuable research for development partner supporting CePaCT in its effort to contribute to poverty

reduction and improved livelihoods through securing genetic resources in the Pacific and assuring safe germplasm exchange. A good example of this collaboration is the currently negotiated project on "Safeguarding and Deploying Coconut Diversity for Improving Livelihoods in the Pacific Islands".

CePaCT will work closely with LandCare NZ, a valuable research partner, already associated in the development of the PS4L project.

CePaCT is initiating a partnership with the Asia-Pacific Association of Agricultural Research Institutions (**APAARI**), a regional stakeholder network of members from research institutes, genebanks, research and development centres, universities, extension services and civil society for Asia and the Pacific that contributes to the development of agriculture and agri-food research and innovation systems in the region. This partnership will strengthen the outreach capacity of CePaCT and benefit the livelihoods of people in the Pacific through a value chain approach.

CePaCT is cooperating with the International Coconut Community (**ICC**) to co-host COGENT, the International Coconut Genetic Resources Network and to secure the coconut genetic resources of the Pacific including the regional genebank in Papua New Guinea which is under severe threat from the Bogia Coconut Syndrome (BCS). CepaCT will develop safe protocols for germplasm exchange and long-term conservation using cryopreservation technologies.

The importance of South-South partnerships is well recognized, specifically with the **French Overseas Territories** (New Caledonia, French Polynesia, Wallis and Futuna) and needs to be strengthened, possibly with support from the European Union for the benefit of other members in the Pacific. The French Territories have much to offer the Pacific region—CePaCT has already collaborated with both New Caledonia and French Polynesia in analysing Pacific banana genetic diversity (New Caledonia) and establishing a regional banana collection (French Polynesia). Through PAPGREN members in these countries, links can be established with **IRD** (Institut de Recherche pour le Développement), **CIRAD**, (Centre of International Cooperation in Agricultural Research for Development), and **IAC** (Institut Agronomique néo-Calédonien). CePaCT will continue ongoing discussions with IAC, New Caledonia on safety duplication possibilities and with both countries to explore further areas of interest and expertise.

Partnerships with other regional agencies should be strengthened and where appropriate formalised to define roles. A non-formal partnership exists with the University of the South Pacific (**USP)** in Suva, under which CePaCT is providing facilities and technical support for university students at undergraduate and postgraduate levels. Similar type of partnerships could be established with national education or research institutes and also to some extent with Universities in Australia and New Zealand, where collaborations and partnerships are generally established for specific projects. We also envision the attachment of research scientists from overseas to regional agencies such as SPC in the Pacific to gain experience and at the same time mentor local staff. In this context, the recent (November 2017) establishment of a multi-year Resilient Pacific Programme by SPC and the Pacific Regional Environment Programme (**SPREP**) could further partnerships with SPREP in the field of climate change adaptation and mitigation. The Programme is set to run through to 2025 and will be a key regional platform for resilience planning, coordination and implementation.

5.5.3. Partnerships at national level

At the national level, partnerships will be established with national agriculture departments and research organizations in support of the evaluation and development of climate-resilient crops and crop varieties. CePaCT will look at where partnerships with national tissue culture laboratories can help the Centre to increase the availability of planting material in-country, and to improve the likelihood that farmers will receive a sufficient number of plants for cultivation. For example, a partnership with the Kosrae tissue culture laboratory in the Federated States of Micronesia (FSM) could prove useful to support the distribution of planting material in the N. Pacific; comprehensive discussions would be needed to determine how that could be achieved, especially in the area of governance.

CePaCT will explore how the existing partnership with the Vanuatu Agricultural Research and Technical Centre (**VARTC**) can be strengthened so that the products of the VARTC breeding programme can be better shared within the region; how capacity in participatory breeding can be improved; and how through such a bilateral partnership, the activities of VARTC can be strengthened. The VARTC sweet potato breeding programme generated 120 hybrids, some of which have been adopted by farmers in Vanuatu. Similarly with yams, farmers in Vanuatu have adopted some of the hybrids that are anthracnose resistant and high-yielding. It is important that the farmers outside of Vanuatu can also benefit from this important breeding programme.

Linkages with national tissue culture laboratories can help CePaCT to increase the availability of planting material in-country, and to improve the likelihood that farmers will receive a sufficient number of plants for cultivation ('octopus' model; hub-spoke relationship). A partnership with the Kosrae tissue culture laboratory in the Federated States of Micronesia (FSM) could prove useful to support the distribution of planting material in the North Pacific.

CePaCT currently collaborates with **French Polynesia** in the maintenance of a regional field collection of Pacific bananas. Other opportunities for conservation-type collaborations with French Polynesia, including safety duplication of CePaCT crop collections will be explored.

In **Kiribati**, improved linkages with the Centre of Excellence could be beneficial for atoll countries.

CePaCT will build strong and robust relationships with all national biosecurity services, in particular, Biosecurity Fiji, who are responsible for the importation of planting material. ISO/BAF accreditation for the CePaCT Germplasm Health Unit (GHU) will build a new level of confidence in CePaCT's GHU operations. With a view to importing non-tissue culture (clonal) material into Fiji for establishment in tissue culture by CePaCT, LRD Plant Health and CePaCT will work together with biosecurity services to try and harmonize disinfection protocols for clonal material.

Private sector partnerships are likely to be based on the provision of planting material where the private sector function is as a multiplier of CePaCT material, possibly within the context of a Participatory Guarantee System for Quality Declared Seed and Planting Material. During the partnership mapping this avenue will be pursued and at the same time, farmers will be consulted to assess the willingness to pay for planting material.

5.6. Procurement

SPC's Procurement Policy and Grants and sub-delegation's policies will apply to all procurement and grants related to funds managed by SPC.

Project goods and services will be procured according to SPC rules and bidding documents. Procurement of technical assistance, short-term consultancy will be undertaken through limited competition based on short-list using selection procedure of combining technical quality with prices.

SPC has been assessed positively by the European Union through its Pillar Assessment under the following pillars:

- Internal control systems
- Accounting systems
- Independent external audit
- Grants
- Procurement
- Sub-delegation, and
- Financial instruments.

SPC's Financial Regulations will apply to funds received through this engagement and these are supported by financial policies and procedures as well as financial delegations approved by the Director-General. The respective policies will be provided upon request.

5.7. Implementation schedule

The first phase of the programme is designed for a 5-year phase (2019-2023). The implementation of the activities leading to outputs, intermediate and long-term outcomes as per Theory of Change (section 4.1) and description of outputs (section 4.2) and the respective timelines are summarized in Appendix 2. It is recommended to conduct a comprehensive review and planning exercise in year 4 of the first phase to evaluate the results achieved so far and to fine-tune planning for the second phase.

5.8. Program sustainability

5.8.1. Income generation through fee-for-use service

The Crop Trust review team recommended that CePaCT explores how it could offer a number of valuable services, potentially as a source of income, but not at the expense of the core conservation and use functions. These services should only be carried out on a full cost recovery basis. The 'user-pays' model was supported by the participants at the recently held Pacific Seed Forum as an acceptable approach for supporting the costs of CePaCT.

In the following areas full-cost recovery services could be offered to generate some complementary funds for the operations of the CePaCT genebank:

- A fully functional virus-indexing lab can provide a service for screening viruses from plant materials for breeding programmes in the region, for example for the national partners in Samoa. However, given the huge backlog in virus-indexing and virus elimination work of the CePaCT germplasm collection, it is necessary that the virology team stays focused on clearing

this backlog and developing and updating virus-indexing and virus elimination protocols, at least during the coming 5 years.

- In the long run, a fully functional DNA fingerprinting facility can offer genomic tools to fast-track breeding efforts of private sector breeding programmes.

- Similarly, the intended cryopreservation facility, once fully functional and running smoothly can also be of service for the conservation of other agrobiodiversity including animal genetic resources, fish genetic resources and can be used to back-up collections of other institutions /programmes/centres. However, this is unlikely to happen during the first project period described here (2019-20234). Excess supply of liquid nitrogen (LN) producing plant for the cryopreservation work could be offered to other companies at full cost recovery. The latter is achievable in a shorter timeframe.

Other possible revenue streams that will be explored are:

- Full cost recovery for providing planting material for donor-funded projects.

- Offering planting material for commercial crops, such as pineapple, kava etc. for the private sector.

- Germplasm health testing, virus indexing and elimination of commercial seed/planting material for the private sector.

Either of the last two options could see the development of certified quality declared planting material, clean of viruses.

Multiplication of commercial crops (pineapple, kava, coffee, etc.) for the private sector

This 'fee-for-service' will be considered through the development of a commercial arm of CePaCT, at a later stage in the implementation of the CePaCT business plan (after the first 5-year phase) and linked to the production of quality planting material .

Careful analysis is required to determine whether the development of a commercial arm by CePaCT will make a significant contribution to the overall funding needs of the Centre.

Germplasm health testing, virus-indexing and elimination of commercial seed/planting material for the private sector

Eliminating viruses can have a significant impact on yield as can be shown with sweet potato. Sweet potato accumulates viruses that have been shown to contribute to a significant decline in yield and quality of varieties grown in the Pacific. The use of pathogen-tested material, that is, clean of known viruses gave yield increases of 40-60 per cent (van Wijmeersch, pers. comm.). Studies in other regions have shown that farmers are willing to pay for planting material - the deciding factor has been quality. FAO have produced protocols and standards for Quality Declared Planting Material for vegetatively propagated crops, including the staple root and tuber crops of the Pacific.

This system could also be used to support community genebanks within the seed system, thereby contributing to the efficiency of CePaCT distribution and utilization. Other regions have looked at establishing community-based seed and seedling production and dissemination systems. These systems have effectively improved the on-time dissemination, accessibility, affordability and availability of quality planting materials in sufficient quantity (FAO and ICRISAT, 2015).

5.8.2. Long-term funding need for CePaCT Centre of Excellence

FCR charges and income generation for fee-for-use services will only cover a small fraction of the overall costs of CePaCT's operations. Beyond the first 5-year program phase, followed on (after a thorough review and planning process) by a second program phase, there will be a continued need for a jointly funded Program, with funds ideally provided from the Crop Trust endowment income supporting core essential operations of germplasm conservation and germplasm health, and complemented through other support mechanisms both core and project related funding. This comprises strategic and collective needs, such as policy, germplasm screening, development and outreach to the farmers.

6. Conclusion and recommendation

Seeds and planting material are key components in the conservation, ownership and use of agricultural biodiversity as identified by the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. The Centre for Pacific Crops and Trees (CePaCT) is the only Pacific regional genebank and is committed to support a sustainable food-secure Pacific. The Centre currently uses in vitro technology to conserve collections of some of the Pacific's important staple crops, such as taro and other edible aroids, banana, breadfruit, cassava, sweet potato, yam and some selected tree species. CePaCT also has virus indexing facilities that test germplasm from the Pacific region for viruses using internationally approved protocols to facilitate safe distribution of crop diversity (improved and traditional) to farmers. CePaCT's key role is to assist PICTs to sustainably conserve and utilize their plant genetic resources as well as sourcing improved crop diversity to address food and nutritional security and for improved resilience to climate change and pest and disease incursions. CePaCT is internationally recognized by the Global Crop Diversity Trust, the CGIAR Research Institutes and international networks as a focal point for Plant Genetic Resources for Food and Agriculture in the region.

Strengthening CePaCT and transforming it into a Centre of Excellence with a transparent, externally monitored QMS in place is essential to demonstrate to partners and donors alike that the Centre operates in conformity to international standards and that it is committed to the sustainability of high-level quality operations. To enable the Centre to respond better to the regional challenges of climate change and NCDs it is important to invest in improved research capabilities and facilities, such as disease screening and elimination through a cost-efficient GHU, rationalizing collections and building core and mini-core collections with a major focus on germplasm use for specific needs based on genotyping and phenotyping and long-term conservation of valuable germplasm through cryopreservation, specifically for taro and coconut. SPC-LRD and CePaCT will embark on a decentralized seed systems approach, involving multiple stakeholders including the private sector with the aim of benefiting the farming communities and ensuring a healthy life for the people in the Pacific.

It is, therefore, recommended that the donor community considers investing into the transformation of CePaCT into a Centre of Excellence so that the Centre can make a significant contribution to food and nutrition security and sustainable livelihoods of people in the PICTs.

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8. Appendices

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Appendix 1. CePaCT Logframe

OBJECTIVES	INDICATORS	MEANS OF VERIFICATION	BASELINE	TARGET	ASSUMPTIONS
GOAL: **Increased production and domestic supply of safe and nutritious agricultural and forest products using profitable, sustainable production systems based on diverse, climate-resilient, and nutritious crop and tree varieties.**	G1 - % increase in yield (per unit area) of selected crops using climate-resilient and/or nutritious varieties compared to traditional varieties. G2 – % increase in market supply of nutritious crop varieties	Ministry of Agriculture/NGO statistics based on pilot farms	0% increase in yield of selected crops using climate-resilient and/or nutritious varieties compared to traditional varieties	5% increase in yield of selected crops using climate-resilient and/or nutritious varieties compared to traditional varieties 10% increase in market supply of nutrient-dense and/or resilient crop varieties	No major disaster or civil unrest occurring.
Outcome 1: **Germplasm of major Pacific crops and trees safely conserved at CePaCT and available for distribution**	**Availability:** % Collection which is clean of pathogens of quarantine risk, viable, and in sufficient quantity to be immediately available for international distribution from medium-term storage **Security:** % Collection held in slow growth conditions in vitro at two locations	Crop Trust online-reporting tool, SPC LRD annual reports, CePaCT annual reports.	**Availability:** 26.14% of collections clean of pathogen of quarantine risk, viable, and in sufficient quantity to be immediately available for international distribution from medium-long term storage **Security:** 0% collections held in slow growth conditions (in-vitro) in two locations (at base location and outside of base location)	**Availability:** 50% of aroids and yam collections clean of pathogen of quarantine risk, viable and in sufficient quantity for distribution by the end of 2023. **Security:** 100% of accessions kept in slow growth at CePaCT. 50% of accessions (aroids and yam collections) safety duplicated in vitro outside of Fiji.	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.
Output 1 Regional crop & tree collections safely maintained at CePaCT	• % Annual loss of accessions due to contamination or loss of viability	Crop Trust online-reporting tool, SPC LRD annual reports,	• 2,169 total accessions (at end of 2018) conserved in all locations in CePaCT	• Maintenance of existing collections via tissue culture, seeds and field by end of 2023; <5% annual accession loss due to contamination or loss of viability.	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.

	• % Clonal accessions with in-vitro safety duplicates maintained on-site and off-site to safeguard collections • For orthodox seeds: % collection held in long term storage at CePaCT • % Collection with minimum passport data online and accessible through CePaCT website • Annual % increase in accessions becoming available for distribution due to enhanced germplasm health testing and virus elimination work.	CePaCT annual reports.	• 0% duplicated on-site (at base location) and off-site. • 0% orthodox seeds in collections. • 50% of collection with minimum passport data online and 0% accessible through CePaCT website • 0% annual increase in accessions being tested and verified clean for distribution.	• At least 80% of clonal accessions duplicated on-site and 50% (aroids and yams) duplicated off-site. • At least 50% of orthodox seed accessions held in long-term storage at CePaCT • At least 10 distribution requests met annually • 100% accessions with passport data available online and through CePaCT website • At least 5% annual (total 25%) increase in accessions (aroids and yam) becoming available for distribution due to improved germplasm health testing and virus elimination work. • 10% aroid accessions characterised and regenerated *Additional targets (end of 2023):* • 40% yam accessions duplicated off-site via slow growth • At least 3 research carried out to improve conservation and health testing protocols and procedures • 10% annual increase in availability for aroids collections (from 25% to 35%) • 20% of aroid accessions characterised and regenerated • 30% aroids and 10% yam accessions with characterisation and nutritional data available online and via CePaCT website	
Output 2 Processes and systems for the conservation of germplasm and virus indexing improved/upgraded	• Number of SOPs developed and implemented for verifying that the genebank meets international standards • CePaCT QMS evaluated at level 3	Crop Trust online-reporting tool, SPC LRD annual reports, CePaCT annual reports, project reports.	• No SOPs developed. • QMS at level 1 • BAF accreditation for existing facilities • Average of 5 staff and 10 country participants trained on an annual basis • Taro core collection identified but needs validation to include	• At least 25% QMS elements met at end of 2023 including: ○ 6 SOPs developed and audited by end of 2023. ○ Instruction sheets for all key equipment developed ○ Reagent and Equipment management systems developed ○ Genebank Policy developed ○ Staff Management Plan developed.	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.

	• Biosecurity Authority of Fiji (BAF) accreditation received • Number of staff and country participants trained on plant genetic resources management and use. • Taro core collection re-defined • Cryopreservation capacities established and operationalised including local nitrogen production system • Barcoding implemented and operationalised. • Upgrading of existing and establishment of new facilities to support genebank activities and quality management system.		new acquired accessions. • No cryopreservation capacity • No barcoding capacity	○ Information management plan developed • QMS audit carried out in 2023 • New Cryopreservation and molecular laboratories established, equipped, and operationalised • Barcoding implemented for at least 20% of genebank processes • GRIN-Global database implemented and launched as PacGRIS • At least 5 CePaCT staff and 20 country participants trained/year • BAF accreditation for upgraded/new facilities secured • Upgrading of seed laboratory, germplasm health unit, greenhouses. • 100% aroid collections fingerprinted *Additional targets (end of 2023):* • Risk Management Plan developed • Virus detection and elimination efficiencies increased by 80% for aroids and 50% for yam. • At least 1 training video on developed for capacity building on DNA fingerprinting procedures and 1 training conducted for CePaCT staffs. • At least 2 research carried out to optimise cryopreservation protocols on coconuts • 20% increase in number of processes barcoded. • 1 partnership secured for external audit of GHU operations and procedures.	
Output 3 Pacific Islands Tree Seed Centre merged with CePaCT and operations improved	• PITSC merged with CePaCT • SOP for seed drying and storage of orthodox seeds developed and implemented • Seed drying room established and operationalised	Crop Trust online-reporting tool, SPC LRD annual reports, CePaCT annual reports, project reports.	No seed activities for CePaCT	• Endorsement from PHOAFs for PITSC and CePaCT merge • Upgrade seed laboratory facilities including establishing long-term conservation capacities and seed dry room. • Maintenance of existing seed collections.	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.

	and long-term seed storage established • At least 2 partners identified and engaged for safety duplication of seed accessions and capacity building.			• At least 4 priority tree species and 10 crop accessions conserved long-term at CePaCT by end of 2023. • At least 50% seed accessions duplicated off-site • Acquire at least 10 tree species for conservation at CePaCT and off-site locations. • At least 3 regional trainings held for at least 3 staff and 2 country participants per year on seed conservation methodologies *Additional targets (end of 2023):* • 1 tree species and 10 crop accessions acquired and conserved long-term at CePaCT. • At least 3 regional training conducted per year for staff and country members. • At least 1 new partnership secured for safety duplication and knowledge sharing.	
Outcome 2: **Increase in availability and utilization of highly nutritional, disease-free, and climate-resilient crop and tree varieties**	• Number of accessions distributed by CePaCT within the Pacific region on an annual basis • % Accessions received from CePaCT successfully established, tested and maintained at a national level • % CePaCT accessions maintained by countries that do reach farmers' fields and are adopted by farmers • Number of highly nutritious CePaCT accessions included in local production and	Crop Trust online-reporting tool, SPC LRD annual reports, CePaCT annual reports.	• Average of 100 accessions distributed annually out of which 15% belong to the climate resilient collection • 5 disease-tolerant accessions maintained by countries	• At least 200 accessions distributed, out of which 25% belong to the climate-resilient collection • At least 50% accessions received from CePaCT that are successfully established, tested and maintained at national level. • At least 25% accessions maintained by countries that do reach farmer's fields and are adopted by farmers. • At least 10 accessions of highly nutritious accessions included in local production and consumption by country • At least 20 climate-resilient and/or disease-tolerant accessions maintained by countries that reach farmers' fields and are adopted by farmers.	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.

	consumption, by country • Number of climate-resilient / disease-free CePaCT accessions maintained by countries that do reach farmers' fields and are adopted by farmers				
Output 4 Diversity, nutritional content, and climate resilience of crop collections at the national level and at CePaCT enhanced	• # New accessions identified, collected, and included in CePaCT collections per year. • # Screening trials carried out per year for either or both abiotic and biotic stress factors • # New climate-resilient and/or nutritious Pacific accessions introduced to CePaCT genebank from screening trials selections. • # Accessions of new climate-smart and/or nutritious crop germplasm introduced from CGIAR centres per year. • % Accessions nutritionally analysed on an annual basis and results shared online via PacGRIS or other means for access	Crop Trust online-reporting tool, SPC LRD annual reports, CePaCT annual reports.	• TBC	• 15 coconut and 15 bele accessions identified in countries, collected, and included in CePaCT collections. • 40 new climate-resilient and/or nutritious and/or threatened Pacific accessions introduced to CePaCT genebank from screening trials selections. • 10 accessions of new climate-smart and/or nutritious crop germplasm introduced from CGIAR centres per year. • 10% of aroid accessions nutritionally analysed and results shared online via PacGRIS or other means for access • 1 partnership secured for nutritional analysis • 2 screening trials carried out per year for either or both abiotic and biotic stress factors • 2 policy briefs developed on genetic erosion of native crop and species in at least 2 countries • 3 standard guidelines developed for screening germplasm either in the field, screen house or in-vitro • 90 accessions evaluated in the field for abiotic stress. *Additional targets (end of 2023):* • 50 new accessions (threatened or improved) acquired and fully curated	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.

				• 2 policy briefs developed on status of genetic diversity available at national level in at least 2 countries • At least 6 mini descriptors uploaded onto CePaCT website for access by end of 2024 • 10% of aroid accessions nutritionally analysed and results shared online via PacGRIS or other means for access	
Output 5 Local capacity to test, manage and distribute planting materials to farmers strengthened. strengthened	• # Small holder farmers/country for at least 5 countries demonstrate improved knowledge of in situ conservation and participatory breeding and selection • Policy guidelines on effective in situ/ex situ conservation and the establishment of community-based seed banks developed and published • Annual user surveys conducted and reports documented in ORT of Crop Trust, SPC LRD reports and PacGRIS	Crop Trust online-reporting tool, SPC LRD annual reports, CePaCT annual reports.	• TBC	• At least 10 small holder farmers/country in at least 5 countries demonstrate improved knowledge of in situ conservation and participatory breeding and selection • Policy guidelines on effective in situ/ex situ conservation and the establishment of community-based seed banks developed and published • User-survey developed and implemented on an annual basis to collect evaluation, germplasm distribution and utilisation data from recipients. • At least 1 training video developed for users to understand how to transfer and manage tissue culture plants • At least 10 country participants from at least 5 countries trained on tissue culture transfer and management upon receipt • At least 1 training tool developed for screening accessions to abiotic stress • At least 1 regional PAPGREN meeting organised for consultations to finalise PAPGREN Charter. *Additional targets (end of 2023):*	No major natural disaster or civil unrest occurring: No disruption in financial support provided by donors.

				• 1 PAPGREN meeting to review and validate the next phase of the CePaCT business plan. • At least 1 regional training carried out on policy guidelines on effective in situ/ex situ conservation and the establishment of community-based seed banks. • At least 2 regional training carried out to create awareness on important of PGR	

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Appendix 2. Summary of CePaCT workplan for 2019-2023

Long-term Outcome: Increased production and domestic supply of safe and nutritious agricultural and forest products using profitable, sustainable production systems based on climate-resilient crop varieties	2019	2020	2021	2022	2023
Intermediate Outcome 1 Germplasm of major Pacific crops and trees safely conserved at CePaCT and available for distribution					
Output 1. Regional crop and tree collections safely maintained at CePaCT					
Activity 1.1 Conduct routine maintenance of existing in vitro crop collections at CePaCT					
Activity 1.2 Multiply accessions requested for distribution and required for safety duplication					
Activity 1.3 Establish on-site and off-site in vitro safety duplicate to safeguard the CePaCT collections					
Activity 1.4 Improve and refine conservation protocols of major crop species conserved at CePaCT					
Activity 1.5 Conduct routine virus indexing of germplasm to reduce the backlog					
Activity 1.6 Conduct virus-elimination procedures on infected accessions					
Activity 1.7 Conduct true-to-type verification and regenerate accessions with >10 subcultures					
Activity 1.8 Establish and update a fully-fledged Genebank Information System (PacGRIS) to provide user-friendly germplasm information services to clients and CePaCT staff					
Activity 2.1 Implement external genebank review (August 2017) recommendations					
Activity 2.2 Develop and update SOPs and operational manuals for the introduction and operation of a robust Quality Management System (QMS) at CePaCT					
Activity 2.3 Establish ISO/BAF-accredited Germplasm Health Unit (GHU)					
Activity 2.4 Update existing protocols and develop new ones for the detection and elimination of viruses in major CePaCT crops					
Activity 2.5 Establish a DNA fingerprinting facility at CePaCT and conduct molecular characterization with the aim to rationalize major collections and to build core collections					
Activity 2.6 Establish and operate a cryopreservation facility at CePaCT					
Activity 2.7 Introduce barcoding to trace all genebank operations in the collection and link it to the database (PacGRIS)					
Activity 3.1 Upgrade facilities for the conservation of orthodox seeds					
Activity 3.2 Build staff capacity and develop SOPs for processing and storage of orthodox seeds and other procedures					
Activity 3.3 Collect and process samples of native tree and traditional vegetable species, under threat of genetic erosion					
Activity 3.4 Conduct orthodox seed research to optimize species-specific conservation protocols					
Activity 3.5 Develop a risk management plan for orthodox seeds					

Intermediate Outcome 2: Increase in availability and utilization of highly nutritional, disease-free and climate-resilient crop and tree varieties	2019	2020	2021	2022	2023
Output 4 Diversity, nutritional content and climate resilience of crop collections at the national level and at CePaCT enhanced					
Activity 4.1 Create awareness in PICTs about the genetic erosion of native crop and tree germplasm and develop policy guidelines on ex situ, in situ, community and on-farm conservation					
Activity 4.2 Capture valuable crop and tree germplasm under threat of genetic erosion in selected PICTs (PNG, Samoa, Fiji, Vanuatu) through joint collecting missions with the respective countries; collected germplasm to be added to the national collection and duplicate to be transferred to CePaCT for long-term conservation					
Activity 4.3 Compile, develop, share, and adopt within PICTs standardized minimum descriptor lists, and disease and abiotic stress screening protocols for major food crops in the Pacific					
Activity 4.4 Based on national priority needs, support the conduct of screening trials for pathogen and/or abiotic stress tolerance, testing locally collected germplasm, alongside germplasm shared by CePaCT in selected PICTs (Fiji, Samoa, PNG, Vanuatu, Palau), with support from PS4L.					
Activity 4.5 Conduct nutritional analysis of selected crops and crop varieties in an accredited laboratory (USP, Fiji)					
Activity 4.6 Evaluate screening trials at national and regional levels and share results with PICTs through PAPGREN and PacGRIS					
Activity 4.7 Acquire outstanding lines from screening trials if not yet part of the CePaCT collection and make them available for distribution after virus-indexing					
Output 5 Local capacity to test, manage, and distribute planting materials to farmers strengthened					
Activity 5.1 Conduct training measures at CePaCT and in selected PICTs for national staff on the safe handling, hardening and field establishment of tissue-cultured planting material distributed by CePaCT					
Activity 5.2 Build capacity in participatory varietal selection (PVS) and participatory plant breeding (PPB) and selection to strengthen the development of improved, locally adapted plant genetic resources					
Activity 5.3 Build a network to support evaluation and drive utilization by engaging PAPGREN and developing an 'octopus' model with countries capable of receiving, screen, multiply and distribute seed to farmers					
Activity 5.4 Strengthen institutional mechanisms for seed production in the region through enabling policies and partnerships with the private sector					
Activity 5.5 Conduct regular user survey among CePaCT germplasm recipients in PICTs concerning the quality of material received, the rate of establishment, local performance and number of farmers reached					

Pacific Community
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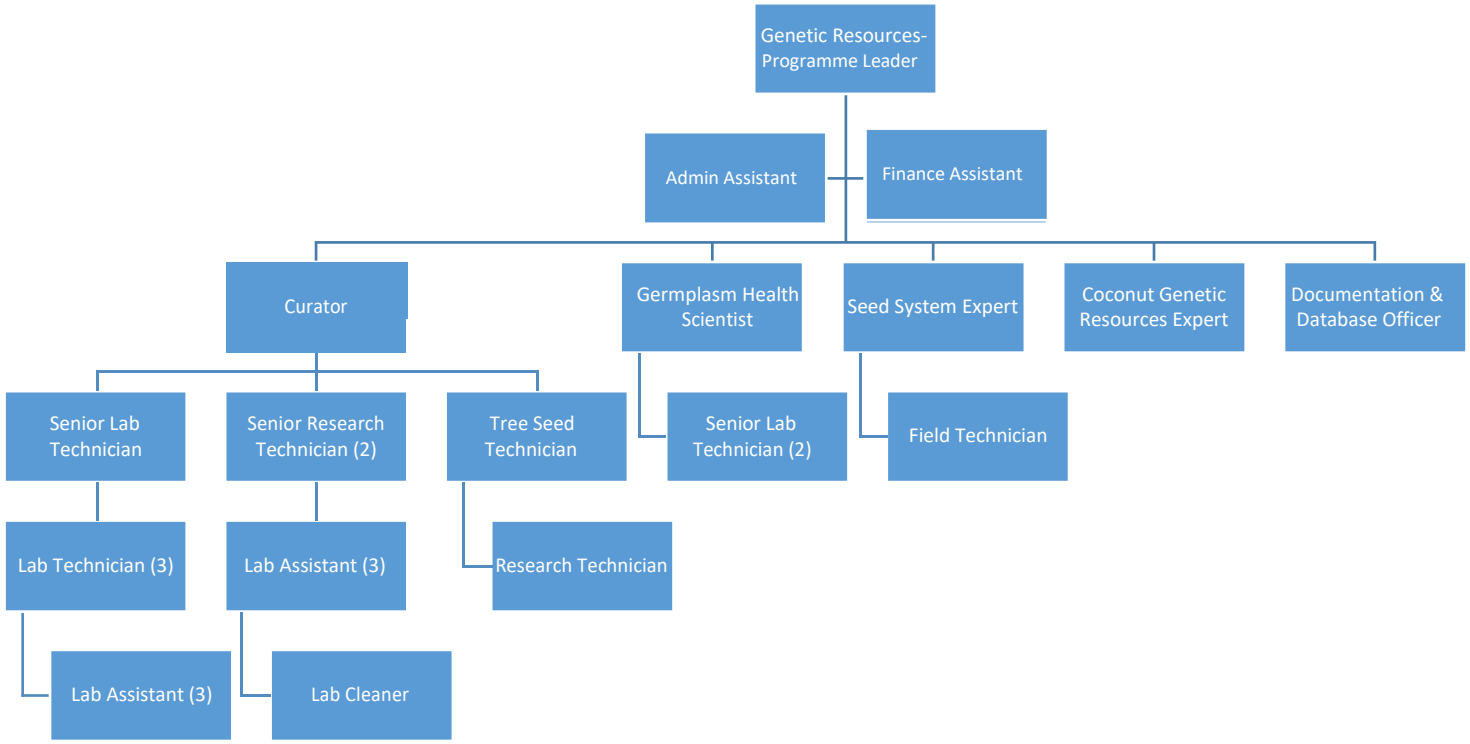
Appendix 3. Staffing structure of CePaCT



Appendix 4. Risk analysis and mitigation measures

Risks	Likelihood (low (L); moderate (M), high (H)	Impact (low (L); moderate (M), high (H)	Risk Mitigation Strategy
CePaCT management			
Failure in contractual obligations between SPC-CePaCT and donors	L	M	Clear legal agreements and responsibilities; agreed planning and reporting templates that are appropriate to donors and SPC; regular communications between project coordinator and donor
Failure in contractual obligations between SPC-CePaCT and sub-contractors at country level	M	M	Clear legal agreements and responsibilities; agreed planning and reporting templates that are appropriate to donors, SPC, and country partners; regular communications between project coordinator and country partners; strong support mechanisms instituted by the Division's Directorate regarding financial monitoring and reporting.
CePaCT outputs			
Inadequate input from partners to achieve proposed outputs	M	M	Frequent and formal coordination and follow-up at all levels between CePaCT and partners
Misuse of resources towards unplanned outputs	L	M	Detailed work plans and budgets; close monitoring and follow-up
Lack of engagement in collective activities	M	H	Participatory planning and consultation in developing collective work, close monitoring of outputs, re-alignment of activities where needed
Partner failure to make characterization and evaluation data available	M	M	Close monitoring and follow-up at all levels between CePaCT and partner; sharing of failures at the regional level to exert peer pressure
CePaCT facilties			
Equipment breakdown affects the performance of genebank and GHU	M	M	Collating and regular updating of the list of equipment, the date of purchase and serviceable age. Needs for equipment purchase or replacement to be accounted for in the budget, annually. Regular servicing and calibration of all genebank equipment. Adequate backup of essential equipment as part of QMS.
Inadequate infrastructure compromises the performance of genebank and GHU	L	H	Regular reporting of infrastructure deficiencies to SPC management who is in charge of appropriate maintenance of the Centre's infrastructure.
Natural or human-made threats to facilities and collections	M	H	CePaCT has a risk management strategy in place that includes an emergency evacuation plan; collections are duplicated in an on-site concrete seed vault that can resist strong cyclones.
Current setup does not live up to high quality conservation and use	H	H	CePaCT has a decentralization strategy of safety duplicating its material outside of Fiji and creating

			hubs in Samoa or New-Caledonia where CePaCT tissue culture material can be duplicated.
Partnership			
Failure in the engagement of external partners	L	M	Annual meetings in the context of the 'octopus' network; joint projects; distribution of germplasm and data, active engagement and role of partners in multi-country, multi-locational evaluation system
Reputational loss for being associated with 'biopiracy.'	M	M	Close monitoring and participation in international deliberations concerning access and benefit-sharing rules and how they apply to germplasm and associated data.
Funding			
Shortfall in funding from the Crop Trust endowment	M	H	The Crop Trust has a robust fundraising strategy in place
Shortfall in funding from development partners	M	H	Timely technical and financial reporting to donors; effective communication strategy; spreading donor portfolio to minimize risks
Fluctuations in institute costs and full cost recovery	H	H	Clear guidelines on acceptable costs, multi-year budgets, financial monitoring and reporting of FCR elements, allowance of carryover, outsourcing of services.
Inadequate budget for proposed activities	H	H	Prioritization of funds towards genebank routine operations, rationalization of activities.
Delay in the disbursement of funds	M	H	Pre-financing by SPC if possible, delay or reduction of activities where possible, prioritization of genebank routine operations.
Global public goods			
Loss or corruption of germplasm	L	M	high standard genebank procedures, regular updating and validation of SOPs and QMS, safety duplication
Loss or corruption of data	L	H	Regular backups of data, security measures in place
Failure of tools or software to achieve planned outputs	M	M	Adequate testing and piloting of tools, dynamic user feedback mechanisms
Failure to comply with relevant national or international policy	L	M	Multiple mechanisms and feedback loops in place to monitor and support compliance; compliance reported annually to Crop Trust and regional authorities.